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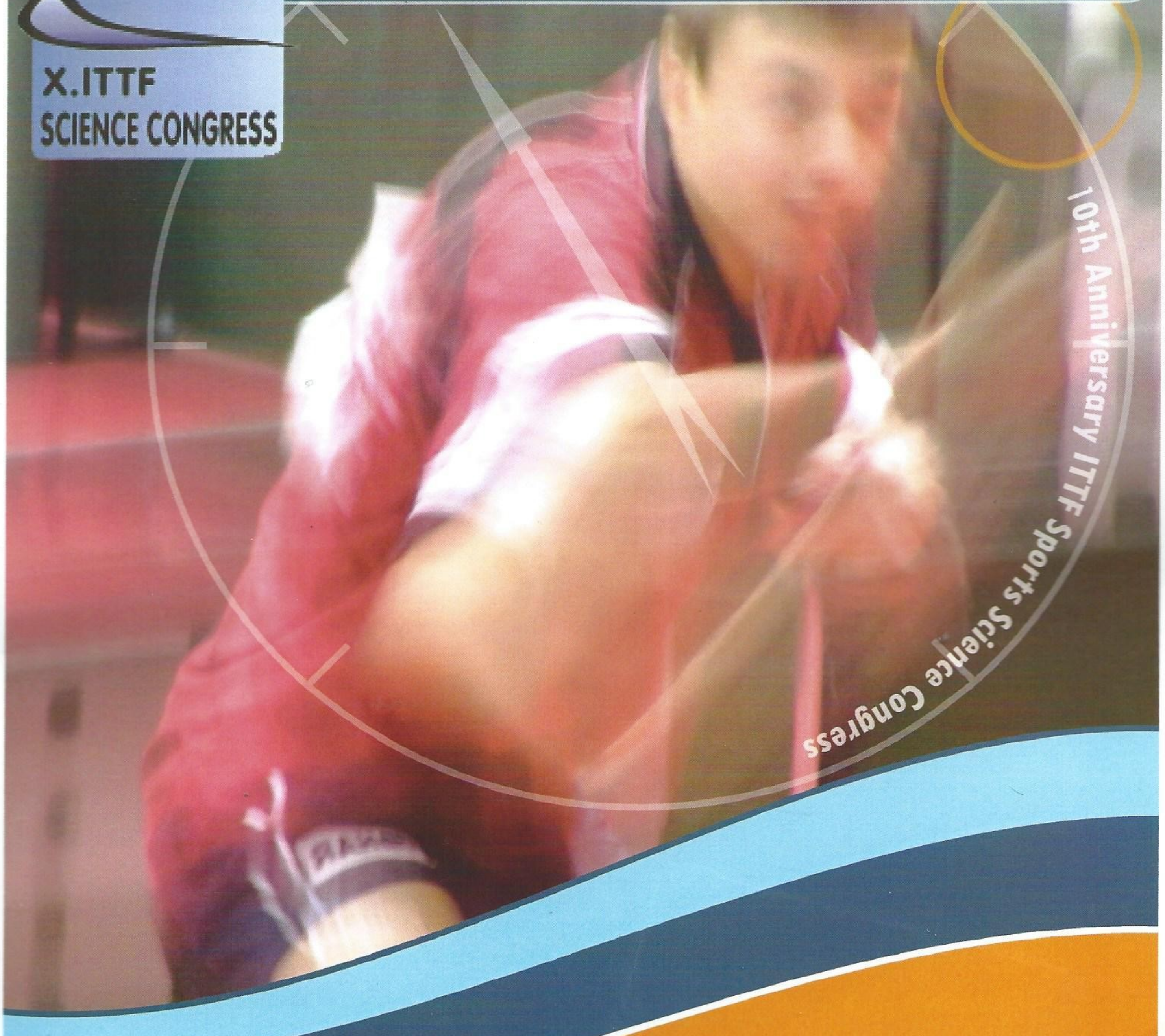

Proceedings book

Zagreb 18th - 20th May 2007

The 10th Anniversary ITTF Sports Science Congress

Proceedings book of the 10th Anniversary ITTF Sports Science Congress Zagreb, May 18th till 20th, 2007

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The 10th Anniversary ITTF Sports Science Congress

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10th Anniversary ITTF Sports Science Congress

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Contents

Message of the Editor-in-Chief

Preface

It is a great honor and pleasure for the Editors to issue this Proceedings book of the 10th Anniversary International Table Tennis Sports Science Congress. This Proceedings book contains selected papers from the congress. It is the principle of the ITTF Sports Science Committee to issue the Proceedings book based on the papers presented at the Sports Science Congress which is held in conjunction with the WTTC (World Table Tennis Championships).

Table Tennis is one of the most popular sports in the world. Players range from children, free time players to the world top classes players. Corresponding to this fact, scientific studies on table tennis are increasing. Research on table tennis has been done in separate and individual areas such as physical training, physiology, psychology, medicine, dietetics, physics, engineering and etc. It is envisaged that this Proceedings book of the Congress will contain papers that will eventually be regarded as a major source of knowledge and material for the advancement of table tennis sport science. We express our thanks to the Faculty of Kinesiology for hosting the 10th International Table Tennis Sports Science Congress. The Congress was organized by members of Croatian Table Tennis Association, teachers at the Faculty of Kinesiology and members of ITTF Sports Science Committee with the support of International Table Tennis Federation. We are very grateful to all these people helping to organize this Congress.

I hope that this and future publications will contribute to the major goal of the International Table Tennis Federation, that is, to bridge the gap between sports scientists and practitioners in teaching, coaching, training and rehabilitation.

Miran Kondric, PhD

The 10th Anniversary ITTF Sports Science Congress

Part one:

Biomechanics in table tennis

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KINEMATIC ANALYSIS OF TOP SPIN STROKE WITH BALLS OF TWO DIFFERENT SIZES

Abstract

In modern table tennis most international competitors favor the forehand top spin stroke as the most favorable attacking stroke, especially on cut balls. Technically correct performance of top spin stroke is, of course dependable on the player's knowledge, his motor abilities, and his morphological characteristics.

The purpose of our research was to find out if there are differences between top spin strokes with 38- and 40-mm ball, respectively. The comparison of selected kinematic parameters proved that differences in the amplitude of forehand stroke of the tested player increase due to increased ball size. The possible reason for the observed difference in technique is that the player uses more power in upper limb segments to produce the same velocity and rotation of the ball. High upward velocity would give the ball increased topspin to ensure that it would hit the opponent's side of the table. A possible means to achieve this goal is to improve his preparation for the stroke.

The gathered data should facilitate planning of the training process of TT players and especially for promising young players.

Key words: *table tennis, kinematic analysis, forehand top spin*

INTRODUCTION

Important role by the learning procedure and technique analysis in modern approach has video and computer equipment. Using the program for biomechanical analysis it is easy to define the most important biomechanical parameters of some strikes in three-dimensional space. In this study we have used method of kinematic analysis, which enables the precise registration and evaluation of the most significant parameters of forehand top spin strikes of two different sized balls.

In modern table tennis most international competitors favor the forehand top spin as most favorable attacking stroke especially on cut balls. Technically correct performance of top spin strike is, of course dependable on the player's knowledge, his motor abilities and his morphological characteristics.

In most of acyclic movements a three-part pattern is obvious. The same is with the table tennis strokes. The preparation phase is a predecessor to the main phase, in which the basic motor problem is solved the impact of the ball and the racket, and then comes the closing phase of a stroke performance. The principal function of the preparation phase is providing "an optimal preparation for successful and economical performance of the main phase". In table tennis it means the racket-holding arm swing. The basic characteristic of the preparation phase is its movement direction opposite to the direction of the main phase movement execution. Through the swing we provide "an optimal way to muscles and adequate angle of the involved joints" (the shoulder, elbow and wrist).

METHODS

Design

To design an optimal technique of certain stroke, it is essential to establish exactly his own technique and find out in which way it deviate from theoretic model. Therefore, we measured kinematics parameters between the forehand top spin strokes performed with the 38-mm and the 40-mm balls. The greater turn (in the 40mm-ball strike) should ensure the greater angular velocity of the shoulders, which should also assist in generating higher linear velocities of the arm, forearm and hand segments. We analyzed differences in kinematic chain which are produced due to different ball size.

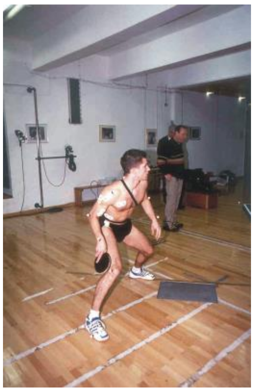
Participant

The measurement has been carried out on a professional table tennis player, a member of the Slovenian national team. The data were collected and analyzed both visually and quantitatively.

Materials

The study came into existence in collaboration between Faculty of Sport in Ljubljana and Faculty of Kinesiology in Zagreb. The measurement has been performed in biomechanics laboratory at the Faculty of Kinesiology in Zagreb. Kinematic analysis is applicable in sports since because it provides objective indicators of the initial, transitive and final states of an athlete's movement. The "Elite 2002" biomechanical system was used for data collection and analysis. Aside the kinematic analysis with eight cameras, it includes also a ground reaction force platform.

Procedure



The player was filmed as he completed a 10 ball play with table tennis robot. Picture shows the experimental setup and also indicates the approximate displacements during the exercise. At least eight trials of subject were filmed and five of these were used for detailed analysis. Best strike was used as the basis for choice of trials for detailed, kinematics analysis.

23 different parameters were measured: different angles, angle velocities, velocities of different body parts and the bat and trajectory of ball flight.

RESULTS

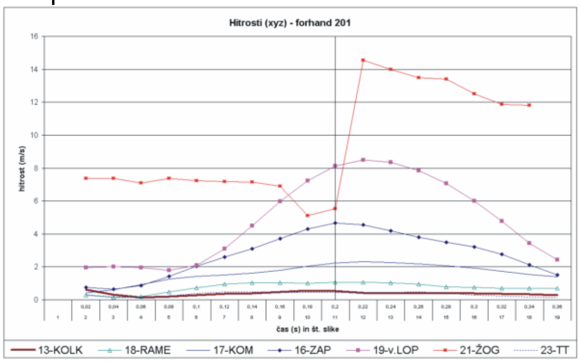
Modern table tennis game demand very good motor abilities as: speed, strength, endurance, agility, balance and good reflexes and touch. The majority of world top players prefer to concentrate on attacking or counter attacking game. Most international competitors favor the forehand spin to produce high velocity and a lot of rotation. The angle under which player hit the ball has augmented with its diameter. The loads of the muscle of upper limb segment have changed due to abduction, which proceeds much more vertically.

Results of kinematic analysis of forehand top spin stroke point out, that there are differences between the strokes with 38- and 40-mm ball (Graph 4. and Table 1.). A number of researchers (Ariel, 1976; Bunn, 1971; Neal, 1989; Čoh, 1998; etc.) have advocated a summation of speed principle for events and activities in which maximal speed at the distal end of kinematic chain is a desired outcome. This principle basis on the theory, that the proximal segments - the ones close to the body - should reach peak velocity earlier in the action than the more distal ones - the ones further out from the center of the body. The data of the present study indicate that these notions held. The timing of the peak velocities of all three upper limb segments (arm, forearm and hand) for the top spin stroke in vertical direction of both strokes (with 38- as also with 40-mm ball) peaked simultaneously at impact.

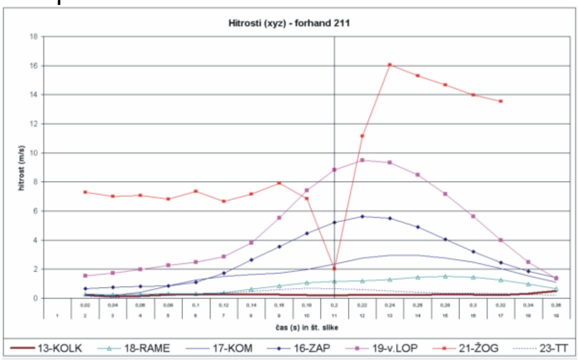
The peak velocities and speeds of the bat, calculated in the present study, ranged from 8,488 m/s with the smaller ball to the 9,485 m/s with the bigger ball. Peak velocities of the shoulder of two different strokes were found to differ significantly in the vertical directions. The speed of the shoulder ranged from 4,650 m/s by the stroke with smaller ball to the 5,619 m/s with the bigger ball. Not surprisingly, there was a significant difference for the speed of the hand as a function of shot type.

The possible reason for the difference in technique is that the player uses more power in upper limb segments to produce the same velocity and rotation of the ball. The high upward velocity would give the ball increased topspin to ensure that it would hit the opponent's side of the table. A possible means to achieve this goal is to improve his preparation for the shot. A graph 3 and 5 indicates this consideration.

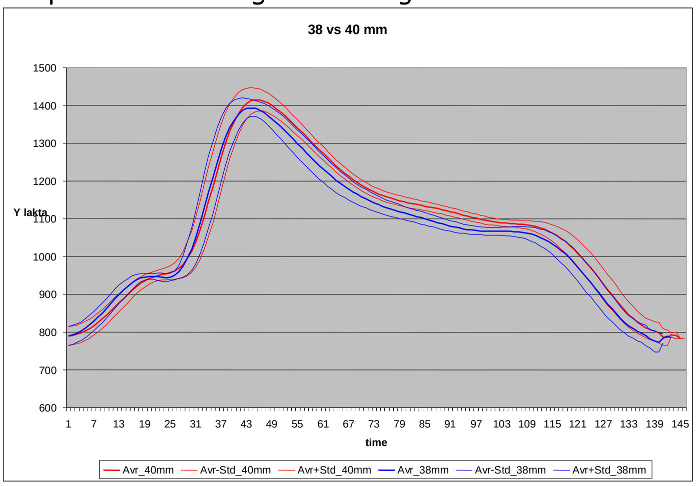
Graph 1: Forehand strike with 38-mm ball



Graph 2: Forehand strike with 40-mm ball



Graph 3: Elbow angles striking 38 and 40 mm ball



Graph 4: Difference in range of motion between two types of ball in elbow joint

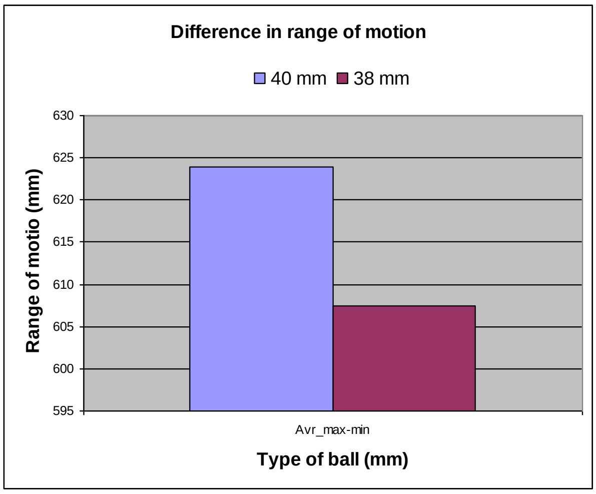


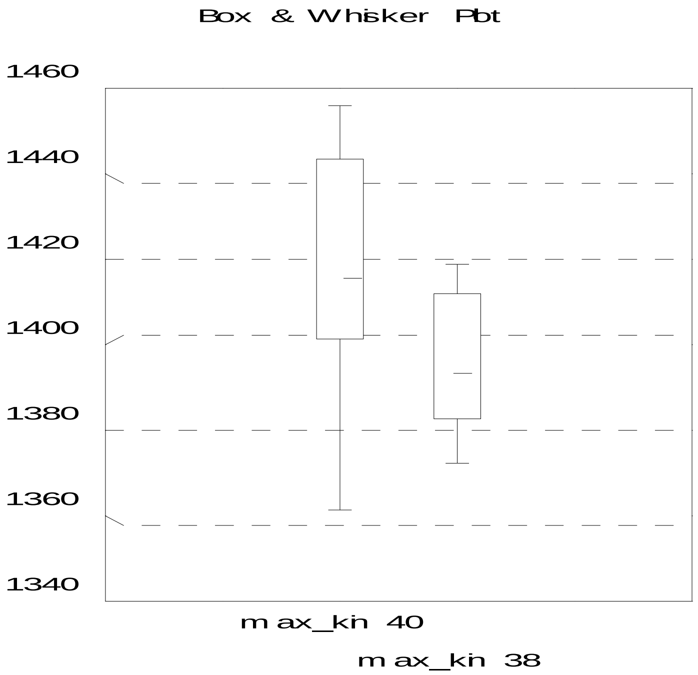
Table 1: Basic data of peaks in range motion of elbow joint

	40 mm	38 mm
Avr_max	1417,59	1395,60
Avr_min	793,64	788,19
Avr_renge (max-min)	623,95	607,40

Table 2: Elbow movement

		Wilcoxon Matched Pairs Test (TT.sta) Marked tests are significant at p <,05000		
Pair of Variables	**Valid N**	**T**	**Z**	**p-level**
max_kin 40 & max_kin 38	8	7,000000	1,540308	0,123486

Graph 5: Elbow movement



DISCUSSION

Forehand top spin is the most common strike on the long cut ball. The majority of world top players prefer to concentrate on attacking or counter attacking game. Many players are playing near the table but there are also players that are playing on the half distance and are using spin strokes. Particularly physically well prepared players decide for longer distance, in purpose to weaken the opponent. One of those strikes is forehand top spin strike, which is analyzed through this measurement.

The greater turn would ensure greater angular velocity of the shoulders which would also assist in generating high linear velocities of the arm, forearm and hand segments. However, while the shoulder joint has great range of motion, it is not very stable. This makes the shoulder vulnerable to problems if any of its parts aren't in good working order. Especially attacking players that are playing far from table have to develop their physical condition to avoid the problems with shoulder injury.

CONCLUSION

The used analysis has some imperfections. We should know that there is no technically correct top spin strike. That is why we, during the technique training, should not stay at the ideal performance, but at defining the most efficient strike of each player.

The purpose of our research was to find out if there are differences between top spin strokes with 38- and 40-mm ball. The comparison of selected kinematic parameters proved that differences increase in the amplitude of forehand strike of the tested player due to increased ball size. The gathered data should facilitate planning of the training process of TT players and especially for promising young players.

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The 10th Anniversary ITTF Sports Science Congress

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Zagreb, Croatia - May 18th - 20th, 2007

Part two:

Health and table tennis

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THE RELATIONSHIP AMONG SELF-ESTEEM, DEPRESSION, AND HEALTH ON ELDERLY TABLE TENNIS PARTICIPANTS

Abstract

Many developed countries are rapidly moving into an aging society. This is also true for Taiwan. That means people are living longer and more people aged over 65 years old. Age affects not only the body of a person but also his mind. Among the mental problems that inflict elderly, depression is becoming more common. Self-esteem is another mental construct that is related to mental health. In addition, health-related quality of life is critical for the elderly. Physical activity has been shown promoting mental health and quality of life. Since table tennis is popular among the elderly in Taiwan. It is interesting to examine the relationship among self-esteem, depression, and health-related quality of life on the table tennis participants. Fifty-four elderly table tennis participants completed the Self-Esteem Scale (SES), Center for Epidemiologic Studies Depression Scale (CES-D), and the MOS 36-item Short Form Health Survey (SF-36). Correlation analysis indicated that a). Self-esteem was negatively related to the depression (r=-.339), positively related to the mental component of the health-related quality of life(r=.383). b). Depression was negatively related to the mental component of the health-related quality of life(r=-.613) but positively related to the physical component of the health-related quality of life(r=-.613). These results suggest enhance self-esteem to the elderly could be key to reduce depression and enhance health-related quality of life for the table tennis participants. Future study could explore how table tennis participation could affect self-esteem of the elderly.

Key words: *table tennis, self-esteem, depression, quality of life*

Introduction

The elderly population in Taiwan has grown rapidly during the last 10 years (Ministry of the Interior Population Administration, Department of population, 2007). The most concerning problem for the elderly population is their health situation. The physical and mental health of older adults is generally deteriorating in the aging process. Among mental health problems, depression and lowered self-esteem are the two critical mental health issues.

At least one-third of individual are expected to experience at least one bout of depression in their lifetime. Depression is a risk factor in older adults. Depression is a major cause and consequence of disabilities among aging population. Suicide rates are high in this population as well. The cost of depression accounted for 20 % of all health care cost, which include direct costs for treatment and indirect costs due to premature death, absenteeism from work, and reduced productivity (Greenberg, Stiglin, Finkelstein, & Berndt, 1993).

Self-esteem is one of the key indicators of good mental health and a significant correlate of life adjustment. A positive self-esteem can enhance mood and support healthy behavior, while negative self-esteem can lead to depressed mood and disadvantageous behavior. High self-esteem is associated with independence, leadership, adaptability, and resilience to stress (Wylie, 1989), while low self-esteem is associated with depression, anxiety, and phobias (Baumeister, 1993).

The beneficial effects of physical activity on the physical health of persons of all ages and especially of older adults are well documented. During the past 20 years substantial research on physical activity in older adults has documented beneficial effects on physical function, control of chronic disease symptoms, and health-related quality of life (HRQL). On the other hand, recent effort has been focused on examining whether physical activity has similar beneficial effect on persons' mind as well (Hung, 2002). That's because to enhance brain health and to keep a sound mind in a sound body has emerged as a major concern in the coming of aging society. In addition to numerous health benefits, frequent engagement in physical activity appears to moderate the decline of cognitive function typically associated with aging (Shi & Hung, 2006).

Why engaging in physical activity can moderate the decline of cognitive function typically associated with aging is a question researchers need to clarify. However, at least three mechanisms have been proposed (Shi & Hung, 2006). Physical activity can enhance cerebral blood flow, synthesis and release of neurotrophic factors, and synthesis and release of neurotransmitters. It is very likely that the combination of these three mechanisms results in an overall improvement of brain functioning of older adults. And the improvement of brain function leads to a soundly mental and emotional functioning of individuals. Many research support that physical activity can reduce anxiety and depression, increase positive emotion, and self-esteem (Landers & Arent, 2001).

Table tennis is a kind of physical activity that is popular for the older adults in Taiwan. The purpose of this study is to examine the relationship between self-esteem, depression and health of Taiwanese elderly table tennis participants.

Methods and procedure

Participants and procedures

Fifty-four table tennis participants (43 males, 11 female, with 50-84 years of age) were invited to this study. The survey was conducted in a local table tennis championship for the elderly. The participants were first contacted separately to obtain their permission to take part in this study. Upon completion of consent forms, participants were instructed to fill out the questionnaires that include the three psychological scales and one with demographic information.

Instruments

Chinese version of Medical Outcomes Study Short-Form Health Survey (SF-36), the test was developed to measure self-perception of physical health and mental health (Ware, 1993). It is a generic measure, as opposed to one that targets a specific age, disease, or treatment group. Accordingly, the SF-36 has proven useful in surveys of general and specific populations, comparing the relative burden of diseases, and in differentiating the health benefits produced by a wide range of different treatments.

It consists of 36 questions and includes eight domains of health: physical functioning (PF), role limitations due to physical health (RP), bodily pain (BP), general health perceptions (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH). It yields scale scores for each of these eight health domains, and two summary measures of physical and mental health: the Physical Component Summary (PCS) and Mental Component Summary (MCS). SF-36 has been shown good construct validity and internal reliability.

Chinese version of Self-Esteem Scale (SES), the original scale was constructed by Rosenberg (1965) to measure people's general evaluation of themselves. SES has a Cronbach Alpha of 0.78.

Chinese version of Center for Epidemiologic Studies Depression Scale (CES-D), the original CES-D was constructed by Radloff (1977) to measure prevalence of depression. CES-D has Cronbach's Alpha of 0.79-0.89 in older population in Taiwan.

Results

Mean and standard deviation of the variables measured in the study is shown on Table 1. Results of correlation analysis among the three measurements are displayed at Table 2. Self-esteem is positively correlated to General Health, Vitality, and Mental Component Summary. Depression is negatively correlated to Self-esteem, Vitality, Mental Health, and Mental Component Summary. Depression is positively correlated to Physical Component Summary.

Table 1. Descriptions of SES, CES-D, and SF-36 of elderly table tennis participants.

	SES	CES-D	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
M	29.93	6.96	51.86	47.11	54.83	58.58	58.28	54.59	48.31	58.97	48.06	59.76
SD	6.36	4.98	7.42	13.04	7.60	8.58	9.85	8.85	11.86	10.30	8.61	9.51

Table 2. Correlation among the SES, CES-D, and SF-36.

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	-.34*	1.00										
3	.20	-.11	1.00									
4	.04	.05	.05	1.00								
5	-.07	-.01	.24	-.04	1.00							
6	.32*	-.24	.23	-.14	.40**	1.00						
7	.50**	-.54**	.30*	-.02	.34*	.47**	1.00					
8	.21	-.25	.16	.13	.40**	.57**	.48**	1.00				
9	.04	.13	.13	.80**	-.10	-.12	-.06	.12	1.0			
10	.19	-.61**	.16	-.08	.32*	.40**	.55**	.38**	-.10	1.0		
11	-.05	.29*	.45**	.79**	.26	-.02	-.12	.15	.69**	-.30*	1.0	
12	.38**	-.61**	.12	-.14	.34*	.64**	.81**	.63**	-.09	.85**	-.33*	1.0

NOTE. SES=1, CES-D=2, Physical Functioning=3, Role Physical=4, Bodily Pain=5, General Health=6, Vitality=7, Social Functioning=8, Role Emotional.=9, Mental Health=10, Physical Component Summary=11, Mental Component Summary=12.

*p＜.05, **p＜.01。

Discussion

The purposes of this study are to examine the relationship among self-esteem, depression, and health of elderly table tennis participants in Taiwan. The results found that self-esteem is positively correlated to General Health, Vitality, and Mental Component Summary. Depression is negatively associated with Self-esteem, Vitality, Mental Health, and Mental Component Summary. These findings are consistent with past studies. Research has found that self-esteem is a key indicator of good mental health and a significant correlate of life adjustment. Persons with higher self-esteem look good upon themselves. Thus higher self-esteem is associated with independence, leadership, adaptability, and resilience to stress (Wylie, 1989). Individual with higher self-esteem is also less susceptible to mental health problems. Other the other hand, depression is a negative mental state. Depressed individuals not only have poor mental health but also have lower self-esteem and lack of motivation to change environment.

Lower self-esteem and higher prevalence of depression have been a major concern for older adults. The current study found higher self-esteem is associated with better health (e.g., lower depression and higher self-reported health components). It is important to enhance self-esteem in the elderly population. Past studies suggest engaging in regular physical activity (PA) is effective on increasing self-esteem. The positive effects on self-esteem from PA are likely due to psychosocial mechanisms such as induced improvement in perception of competence or appearance, improved sense of autonomy and control over body, improved sense of self-acceptance, improved sense of well-being, and improved sense of belonging and significance through social contact in a group or the social setting (Buckworth & Dishman, 2002). However, neurophysiologic mechanisms such as enhanced cerebral blood flow, synthesis and release of neurotrophic factors and neurotransmitters through PA participation could play an important role as well. This is particularly true for the older adults since the decline of brain function lead to both compromised body and mental function of the elderly. The functional deterioration of body and mind in turn are reflected by a lower perception of them-self and their poor self-evaluation of health. Table tennis as a way of physical activity could be promoted among older population due to its participants – friendly features of activity itself. In addition, the activity of table tennis can be effective to stimulate both body and mind of the elderly participants that is particularly beneficial to promote self-esteem and health.

In conclusion, the study found self-esteem is positively associated with better health and depression is negatively associated with health in the elderly table tennis participants in Taiwan.

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MANIFESTATION OF "SPIRIT IN MOTION" BY PARALYMPIC TABLE TENNIS PLAYERS

A Study of Paralympic Table Tennis Players in 2006 World Table Tennis Championships in Montreux, Switzerland

Abstract

Table Tennis is considered as a suitable sport for people of different ages and physical conditions. It has proved to be the pioneer sport in attracting people with physical and intellectual impairments as well as the hearing and vision impaired.

Table Tennis was probably played with improvised equipment in England during the last quarter of the 19th century. Since then, it has been developing and spreading all over the world, winning favor as a popular sport in over 195 countries currently as ITTF members. Table Tennis has been part of the Paralympic Program since the first Games in 1960.

The purpose of this study is to have a look at Paralympic Table Tennis from a new angle, and to try to draw the attention of ITTF towards the unique nature, conditions, and needs of Paralympic Table Tennis as an important part of World Table Tennis Family.

The researcher studied the 348 players with disabilities who participated in 2006 World Table Tennis Championships in Montreux, Switzerland.

The data was gathered from IPTTC Medical and Classification Committee about the number of players in each category and the reasons for their disabilities.

The gathered data was analyzed through descriptive statistics; the results suggested that there were 13 major categories of disabilities of which 5 were the most prominent due to the number of the players in them. These 5 categories are Spinal Cord Injuries (SCI) with % 44.54, Les Autres (LA) with %21.55, Polio with%11.49, Cerebral Palsy (CP) with%9.48 and Amputee with %10.34 of the whole population of 348 players.

With an eye to the enthusiasm, motivation, efforts, and suffering that are displayed by Paralympic table Tennis Players who play, holding the racket with a stump of the arm, with the leg, and even with the mouth, we realize that they play Table Tennis with their hearts, indeed.

This is the manifestation of "SPIRIT IN MOTION" that is definitely of significant importance to ITTF for considerations in their future planning.

Key words: *paralympic players, classification, spinal cord injuries, les autres, polio, cerebral palsy, amputee*

1. Introduction

Table Tennis is considered as a suitable sport for people of different ages and physical conditions. It has proved to be the pioneer sport in attracting people with physical and intellectual impairments as well as the hearing and vision impaired.

Table Tennis was probably played with improvised equipment in England during the last quarter of the 19th century (ITTF Website). Since then, it has been developing and spreading all over the world, winning favor as a popular sport in over 195 countries currently as ITTF members (Tepper, 2003).

Sport for athletes with a disability has existed for more than 100 years. Sports clubs for the people with hearing impairment were already in existence in 1888 in Berlin. The world organization of sport for the people with hearing impairment -CISS- was founded in 1922 and they still organize their own world games, the Deaflympics (Olvech, 2006).

In 1944 Dr. Ludwig Guttmann, at the request of the British Government, opened a spinal injuries centre at the Stoke Mandeville Hospital. A new approach introduced sport as a paramount part of the remedial treatment and total rehabilitation of persons with a disability. Rehabilitation sport evolved rather quickly to recreational sport and the next step to competitive sport for people with disability was only a matter of some years (IPC Website, 2007).

In 1948, at the 1948 Olympic Games in London, Dr. Guttmann organized the first competition for wheelchair athletes which he named the Stoke Mandeville Games. In 1952, the International Stoke Mandeville Games Committee (ISMGF) was founded (Olvech, 2006).

Table Tennis has been part of the Paralympic Program since the first Paralympic Games were held directly following the Olympic Games in 1960 in Rome, Italy (IPC Website, 2007).

The IPTTC is conformed by 163 nations through their National Paralympic Committees, 105 of those nations are actively practicing table tennis in an international level. There are around 2400 active international players in the world and they are divided in 11 classes (Olvech, 2006).

The purpose of this study is to have a look at Paralympic Table Tennis from a new angle, and to try to draw the attention of ITTF towards the unique nature, conditions, and needs of Paralympic Table Tennis as an important part of World Table Tennis Family.

2. Method

2-1. Subjects

The researcher studied the 348 players (104 females & 244 males) with disabilities who participated in 2006 World Table Tennis Championships in Montreux, Switzerland. These players (male & female) had been classified into 10 classes according to IPTTC classification system: sitting classes 1-5 for those who use wheelchair, and standing classes 6-10.

2-2. Data gathering

The data was gathered from IPTTC Medical and Classification Committee about the number of players in each category and the reasons for their disabilities.

***Table 1** – Distribution of Disorders in 10 Classes of Female Players*

CLASS / DISORDER	C1&C2	C3	C4	C5	C6&C7	C8	C9	C10	TOTAL
SCI - tetra	10								10
SCI - para		20	12	8	1	1			42
Dysmelia					1				1
Polio	2	3	3	6	1	1			16
Sclorosis		1							1
Spina Bifida			1						1
Diplegia					1				1
Triparesis					1				1
CP					7	2			9
Forearm Paralysis								1	1
Amputee				1		3AK	8	2BE 1AE	15
Les Autres				1		1		4	6
									104

***Table 2** – Distribution of Disorders in 10 Classes of Male Players*

CLASS / DISORDER	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	TOTAL
SCI - tetra	14	21									35
SCI - para			23	25	18	2					68
Spinal Muscular Atrophy		1									1
Scoliosis			1								1
Gun Shot – T9-10			1								1
Dysmelia											
Polio	2		3	3	4		3	6	3		24
Sclerosis											
Spina Bifida											
Diplegia											
Triparesis											
CP						8	11	4	1		24
Forearm Paralysis											
Amputee				2	5	1		4	6	3	21
Les Autres		2	2		3	13	10	10	14	15	69
											244

3. Results

The gathered data was analyzed through descriptive statistics; the results suggested that there were 15 categories of disabilities of which 5 were the most prominent due to the number of the players in them. These 5 categories are Spinal Cord Injuries (SCI) with %44.54, Les Autres[i] (LA) with %21.55, Polio[ii] with %11.49, Cerebral Palsy[iii] (CP) with %9.48 and Amputee[iv] with %10.34 of the whole population of 348 players.
As tables 1 and 2 demonstrate, 348 table tennis players with many different impairments are involved in world championship levels, which reflects the outstanding and appealing characteristics of Table Tennis.

4. Discussion

Sport has been introduced as a means of treatment and rehabilitation for people with disability since it assists the medical and psychological needs of them. Sport activities prevent the deterioration of their impairments and minimize the consequences of their immobility.

Table Tennis as a very popular sport, especially among people with disability, regarding the above-mentioned results as well as its long existence in Paralympic Movement, is capable of playing a unique role in their social and personal life.

Table Tennis should be introduced not only as an activity for recreation and championship, but also as an effective means of physical and psychological treatment and rehabilitation to the world and medical centers.

5. Conclusion

Due to the fact that a great number of people with disability including 10 Physical classes, Intellectually impaired (class 11), Vision impaired, Hearing impaired, and those with Specific Diseases are eagerly involved in Table Tennis, it has been proved that this sport has enormous capacities and potentials for attracting more and more of the people who are immobilized and deprived of social activities.

With a glance at Tables 1 and 2, we realize this pleasant fact that table tennis possesses a tremendous appeal to a great number of players with disorders in over 15 categories. There is no doubt that table tennis is highly influential not only as sport for fun, fitness, and competition, but also as a means of treatment and rehabilitation, which could further help reduce social problems affecting individuals and their families.

Hence, International Table Tennis Federation (ITTF) as the leading global organization can perform a significant role by creating a link between these groups and by devising innovative strategies in the future plans. The author would like to draw the attention of ITTF to the following suggestions for the purpose of promotion of the world health and recreation:

- Introducing table tennis and its outstanding features to the world of sport and to the medical and health centers
- Expanding connections and supportive cooperation with the institutions which are concerned with sports for people with disability
- Emphasizing inclusion and integration as a principal strategy to relate players with and without disability in order to create an atmosphere of sharing, development, and social interaction among all members of Table Tennis Family

With an eye to the enthusiasm, motivation, and efforts that are displayed by Paralympic table Tennis Players who play, holding the racket with a small remaining part of the arm, with the leg, and even with the mouth, we realize that they play Table Tennis with their hearts, indeed.

This is truly the manifestation of "SPIRIT IN MOTION".

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8. Notes

[i] Les Autres (LA), French term for "others" and has been used to describe athletes with a range of conditions which result in locomotor disorders that have not fitted into the traditional classification systems of the established disability groups.

[ii] Polio (Poliomyelitis), a condition that occurs as the result of a viral infection that affects the motor cells in the spinal cord. Severity and location of paralysis varies between individuals and depends on the number and the site of the motor cells affected by the virus.

[iii] Cerebral Palsy (CP), a disorder of movement and posture due to damage to an area, or areas, of the brain that control and coordinate muscle tone, reflexes, posture and movement.

[iv] Amputee, a person who has all or part of a limb missing.

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BREAKFAST FOR TABLE TENNIS CHAMPIONS

Abstract

If energy intake and expenditure are equal over a given period of time, a state of energy balance exists, and no variation of body weight will take place. However, when energy intake exceeds output there is a surplus of Kilocalories, and the body stores this extra energy in the form of fat tissue. In order to use the fatty reserves, the body needs to spend more energy than what is absorbed. Conversely, when energy expenditure is greater than input, the body compensates for this deficit by using the reserves. Therefore, meals should be carefully planned. In this presentation I will try to explain how we plan an ideal breakfast meal for table tennis athletes.

Key words: *table, tennis, nutrition, carbohydrates, glycemic index*

During a table tennis match, muscles rely primarily on fuel stored from meals consumed in the preceding days. Food eaten in the morning of the table tennis competition mainly fuels the brain. If the matches are long or intermittent, the liver is another contributor since topped-up liver glycogen stores help to prevent hypoglycemia throughout the competition.
Signs of inadequate energy can be immediate such as the symptoms of low blood sugar (hypoglycemia) or they can be longer term.

The main symptoms of hypoglycemia are:

- Light headedness, headache, dizziness
- Fatigue and lethargy
- Inconsistent performance
- Inability to focus or concentrate on the game plan
- Demonstrating slow recovery
- Mood swings and irritability

Long term signs of inadequate energy are:

- Weight loss
- Loss of muscle mass
- Reduced strength
- Persistent injury

Eating disorders can also manifest themselves in many ways showing some of the above symptoms, and it is important for the coach to recognize them. The treatment for eating disorders can be multi-disciplinary to include medical, psychological and nutritional intervention from sport scientists. Athletes with such disorders need a supportive environment and time to modify their behavior. Insults, bribery, manipulation and threatening statements will exacerbate rather than assist the situation. Table Tennis coaches should take care of the nutritional needs of the athletes long before competition.

The objectives of the breakfast meal for table tennis players are to:

- Prevent hunger before and during the match
- Top-up liver glycogen stores
- Ensure adequate blood sugar levels
- Facilitate quick and easy digestion
- Maximize fluid levels to prevent dehydration

- Promote the perception that the selected foods will facilitate a performance advantage, with physical comfort and mental alertness.

The size and items in this meal varies according to the particular needs of each table tennis athlete. Generally, the pre-competition meal should be mainly carbohydrates with fewer amounts of protein and fat. Coaches must take into account that athletes digest their food more slowly when they are nervous, before a table tennis match. Also, high calorie meals take-longer to leave the stomach than light snacks.

→3-4 hours for a large meal to digest
→2-3 hours for a smaller meal
→1-2 hours for a snack or blender/liquid meal, or whatever the athlete's own tolerance indicates.

Table Tennis players cover a wide range of height, weight, body mass index, athleticism and cultural background from the 204 members Associations of the I.T.T.F. Therefore, nutritional needs vary accordingly.

Carbohydrate is the most important fuel for table tennis players, both in training and competition. It is also the only source of energy for the brain and the nervous system. During a table tennis match, the anaerobic lactic system uses only carbohydrate as a fuel. This makes it even more important for coaches to understand why carbohydrates should make up between 60% - 70% of the calorie intake at breakfast, before the match.

There are two main categories for carbohydrates:

- Simple carbohydrates (sugars)
- Complex carbohydrates (starch, fibre, cellulose)

Simple carbohydrates are characterized by a simple chemical structure, and this enables the body to absorb them easily. Mono saccharides and Disaccharides are simple carbohydrates.

Mono – triose ($C_3H_6O_3$) , tetrose ($C_4H_8O_4$) , … glucose ($C_6H_{12}O_6$)
Di – $\underset{\text{(sucrose)}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow \underset{\text{(glucose)}}{C_6H_{12}O_6} + \underset{\text{(fructose)}}{C_6H_{12}O_6}$

Complex carbohydrates (Polysaccharides) are composed of long chains of glucose molecules. Before being absorbed by the body, they must be broken down into simple carbohydrates through digestion.

$$\underset{\text{Polysaccharide}}{(C_6H_{10}O_5)_n} + nH_2O \rightarrow \underset{\text{monosaccharide}}{n\,C_6H_{12}O_6}$$

These can be found mainly in bread, cereals, legumes, potatoes, bananas, corn, rice, pasta, flour, and seeds, bran, fruits, nuts and peel.

There are many kinds of sugars, but the chief physiological sugar is glucose, Glucose is a monosaccharide, a hexose and an aldose.

```
         O                    H
         ‖                    I
         C – H           H – C – OH
         I                    I
    H –C – OH               C = O
         I                    I
  HO –C – H            HO – C – H
         I                    I
    H –C – OH            H – C – OH
         I                    I
    H –C – OH            H – C – OH
         I                    I
    H –C – OH            H – C – OH
         I                    I
         H                    H
Glucose (dextro-)     Fructose (levo-)
```

Another interesting feature of sugars is the degree of sweetness.

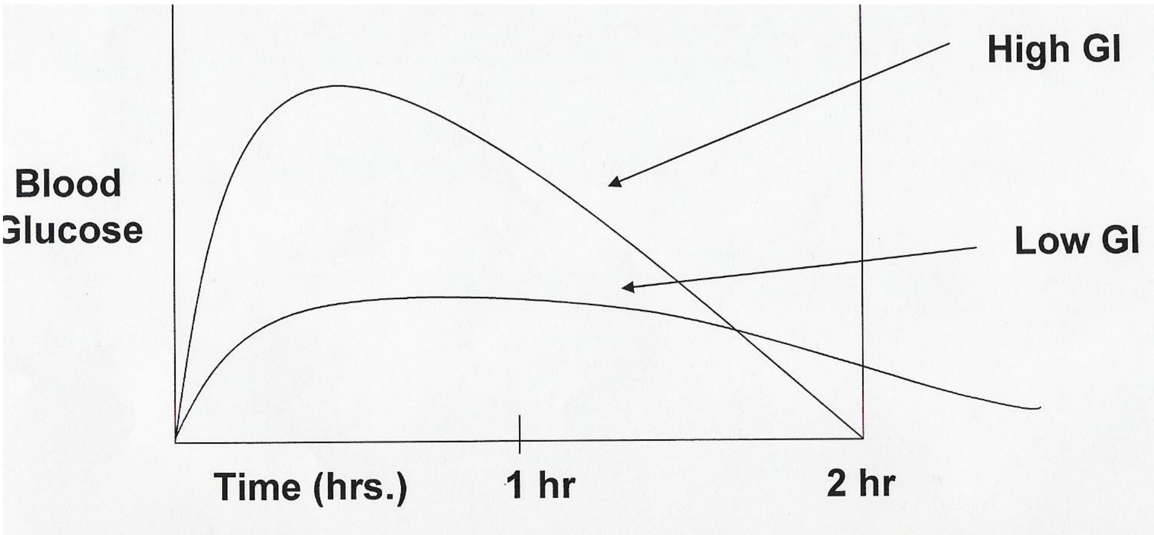
Sugar	Numerical Rating (sucrose = 100)	Units of weight sugar to one unit of sucrose
Lactose	16.0	6.3
Raffinose	22.6	4.4
Galactose	32.1	3.1
Rhamnose	32.5	3.1
Maltose	32.5	3.1
Xylose	40.0	2.5
Glucose	74.3	1.3
Sucrose	100.0	1.0
Invert Sugar	130.0	0.8
Fructose	173.3	0.6

The Glycemic Index

Recent studies have indicated that several factors are involved in the effect that carbohydrates have on blood glucose and insulin levels. In order to assist nutritionists to devise charts and select foods, a glycemic index table was developed.

The glycemic index is a measure of the effect of a food on blood glucose. It measures the area under the glycemic response curve during the two hour period after 50g of carbohydrate, from a test food, has been consumed.

The GI can be considered to be a physiological response to the chemical properties of the food.



Blood glucose level tends to increase quickly after consumption of foods with high glycemic indices. When a food with lower glycemic index is eaten, the blood glucose level has a lower peak and a smaller area under the curve for the two-hour period.

The GI for some foods compared to glucose = 100:

Grains	Veggies	Fruit	Milk products	Legumes
Instant rice 91	Potatoes 85	Watermelon 72	Ice cream 61	Baked beans 48
Corn flakes 84	Carrot 72	Pineapple 66	Yogurt 33	Channa 33
Bagel 72	Sweet potato 54	Orange juice 57	Skim milk 32	Lentils 29
100% wheat bread	Green peas 48	Banana 53	Homo-milk 27	Kidney beans 27
Corn meal 68		Grapes 43		Soy beans 48
Oat meal 65		Orange 43		Peanuts 14
Bran Muffin 60		Pear 36		
White rice 56		Apple 36		
Brown rice 55				
Spaghetti 41				

Some table tennis matches last over an hour while others can end within twenty minutes. Therefore, the coach must plan accordingly. During the match a "fuel blend" made of carbohydrates, lipids and proteins is utilized. The shorter the duration and/or the greater the intensity, the more the "fuel blend" will be high in carbohydrates and lower in fatty acids.

Therefore, the coach must select the breakfast menu with the glycemic index as a focus.

Best choices for breakfast, before competition, can be selected from:
Cereal – with low fat or skim milk
Yogurt – low, plain or with fruit
Fruit
French toast } With no added butter or margarine
Pancakes
Egg dishes – not fried
Lean ham or steak – not fried
Potatoes – not fried

Rice – steamed or boiled
Roti, chapatti or naan
Noodles, pasta, dahl, congee
Toast – limited butter or margarine
Muffins – can add jam or jelly, not butter
Fluid = beverages, bottled water
Fruit juice – fresh, canned carton
Skim milk or chocolate milk (low fat)

Before competition Avoid:

Cookies, crackers, granola bars, cream soups, stir-fry, fried-meat, fish, poultry, potatoes, foods that are buttered in fried sautéed, creamed or souffléd, pâté, sausages, processed meats, liverwurst and parotha.

Suggested examples for a <u>medium</u> breakfast for Table Tennis champions are:

- Cereal with milk + fruit, 1 poached or boiled egg + 2 slices of toast + orange juice
- Pancakes, French toast or waffles, ham, fresh fruit cocktail, milk
- Congee, noodles, pau, tea or juice
- Light ghee, roti, milk and/or juice, tea
- Cream of wheat or oatmeal, eggs, turkey, toast, juice, milk, fruit.

Remember, the main goals of breakfast are to help the table tennis player to feel comfortable and mentally alert.

There is no doubt that what an athlete eats and drinks can affect health, body weight, body composition, substrate ability during the table tennis match, recovery time after the match and, ultimately, a position on the podium.

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HEALTH RELATED HABITS OF TABLE TENNIS COACHES

Sport coaches are part of the population that has its own specificities and because of their connection to athletes, especially young ones, their way of life deserves to be researched. As sports have a very important role in many nations worldwide, and even though for that the athletes take most of the credits the coaches are of great importance also, so their education in all fields would surely contribute to improvement of an athlete's performance.

The sample comprises 46 male table tennis coaches from different clubs in Croatia. For dietary habits, alcohol consumption and smoking habits determination, the new questionnaire was constructed based on previous national and international studies. To determine physical activity levels the Baecke questionnaire of habitual physical activity was used. The questionnaire was completed anonymously. The obtained data were analyzed by standard statistical procedures, with statistical software package SPSS 13.0.

According to the results it is obvious that dietary habits of the coaches are not on adequate level. Especially there is a problem in skipping the meals and eating fast food. Smoking is unfortunately widely accepted and though the campaign against smoking is going on in many countries the real results are still not apparent, and the number of deaths caused by cancer that could be connected with smoking is still very high. Concerning the smoking habits it was found that 34.6% of the table tennis coaches are smokers, although the majority of them stated that that they are smoking between 5 and 10 cigarettes per day. 66% of coaches are consuming alcohol, mostly beer and wine. The levels of all examined dimensions of habitual physical activity were greater than in average Croatia male population.

Key words: health habits, table tennis, coaches, nutrition, smoking, alcohol

Introduction

World Health Organisation has already established the main factors influencing health those being socio-economic factors, way of life and physical environment (WHO, 2003). The risk factors in relation with the way of life are nutrition, physical inactivity, smoking, alcohol consumption and use of drugs.

Sports in general, as well as other professions that are in close relation with sport are usually presumed to be in connection with life quality especially regarding health. Most of the laics would conclude that people involved professionally in sport lead a healthy way of life, take care about their dietary habits and avoid most of the habits that would endanger the health. Sports coaches would be a typical example of a professional who should be well aware of the basis of healthy living. Though, this has never been scientifically proved and there is a great lack of published papers dealing with this issue. Sport coaches are part of the population that has its own specificities and because of their connection to athletes, especially young ones, their way of life deserves to be researched. As sports have a very important role in many nations worldwide, and even though for that the athletes take most of the credits the coaches are of great importance also, so their education in all fields would surely contribute to improvement of an athlete's performance.

The aim of this research is to determine the health related habits of table tennis coaches regarding nutrition, alcohol consumption and physical activity.

Methods

The sample comprises 46 male table tennis coaches from different clubs in Croatia at the average age of 39.5 ± 0.4 years. For dietary habits, alcohol consumption and smoking habits determination, the new questionnaire was constructed based on previous national and international studies (Paugh, 2005.). To determine physical activity levels the Baecke Questionnaire of habitual physical activity was used (Baecke et al., 1982.). The questionnaires were completed anonymously. The obtained data were analyzed by standard statistical procedures, with statistical software package SPSS 13.0.

Results and discussion

Results are presented in tables. Table 1. deals with habitual physical activity, Table 2. with dietary habits, Table 3. with smoking habits and Table 4. with alcohol consumption of tennis coaches.

Table 1. Work, sport and leisure time indices in table tennis coaches

Work index	Sport index	Leisure-time index
2.9 ± 0.6	3.0 ± 0.7	2.9 ± 0.5

There is a great number of different self-reported physical activity questionnaires. They are analysing different types of physical activity. According to Jacobs and his co-workers (1993.) no questionnaire can offer the analysis of all types of physical activity. Baecke questionnaire is a simple one but well constructed questionnaire which offers the determination of occupational, work activity, sport activity during leisure time, leisure time activity, and at last the total physical activity. In comparison with average Croatian population of the same age (Mišigoj-Duraković et al., 2000.) table tennis coaches are showing higher values of all 3 indices. This difference is particularly present in sport index and leisure time index, meaning that table tennis coaches spent more time physically active.

The dietary habits questionnaire consisted of 18 questions (Paugh, 2005.). Dietary habits of the subjects were determined by items regarding the number of meals per day, skipping the meals, intake of particular food subgroups based on the food pyramid, liquid intake and vitamin and mineral supplements intake, especially those used usually in sports. Answers ranged from always (4) to never (1) and the possible range for scores was from 18 to 72. Coaches had 45.6 points on the average. According to the results it is obvious that dietary habits of the coaches are not on adequate level. It seems that coaches, like athletes, have very busy schedule so they are skipping some meals in their daily routine, but breakfast is not the usually skipped one. Especially there is a problem in eating fast food. Coaches are rarely dieting and they do not seek for much nutrition information nor are recording what they eat. It is interesting to notice that no single coach attended some of the nutrition courses and that the sources of information for nutritional facts that they use are not always scientifically justified. Most of their knowledge comes from different popular magazines. Although in recent years there is a significant growth in the literature relating to different aspects of sports nutrition it seems that table tennis coaches have not interest in it.

Table 2. Nutrition habits questionnaire (Paugh, 2005)

1.	How often do you eat breakfast in the morning?
2.	Based on three meals per day, how often do you skip at least one meal per day?
3.	How often do you take vitamin supplements?
4.	How often do you take mineral supplements?
5.	How often do you eat three base meals per day?
6.	How often do you record what you eat?
7.	How often do you drink water?
8.	How often do you drink carbonated beverages?
9.	How often are you on a “diet”?
10.	How often do you eat breads, cereals, pasta, potatoes, or rice?

11.	How often do you eat fruits, such as apples, bananas, or oranges?
12.	How often do you eat vegetables, such as broccoli, tomatoes, carrots, or salad?
13.	How often do you eat dairy products such as milk, yogurt, or cheese?
14.	How often do you eat berry jams, cookies, candies, or other sweets?
15.	How often do you snack on foods like potato chips, cakes, candies, donuts, or soda?
16.	How often do you snack on foods like bagels, yogurt, popcorn, pretzels, or fruits?
17.	How often do you eat fast food?
18.	How often do you seek out nutrition information?

Smoking is unfortunately widely accepted and though the campaign against smoking is going on in many countries the real results are still not apparent, and the number of deaths caused by cancer that could be connected with smoking is still very high.

Table 3. Smoking habits of table tennis coaches

SMOKING			PER DAY		
YES	NO	IF EVER	5-10	11-20	> 20
16	32	11	9	6	1

Smoking is still rather widely accepted habit and though the campaign against smoking is going on in Croatia, as in many countries worldwide, the real results are still not apparent, and the number of deaths caused by trachea, bronchial and lung cancer is still very high (Prabhat and Chaloupka, 1999; Samet and Yang, 2001; Samet and Yoon, 2001). Concerning the smoking habits it was found that 34.8% of the table tennis coaches are smokers, although the majority of them stated that that they are smoking between 5 and 10 cigarettes per day. This is little above the estimated average ratio in Croatian population which is in male population 34.1% (data from Croatian Ministry of health – School of public Health "Andrija Štampar" – www.snz.hr (2006). Interesting there are no pipe or cigar smokers.

Among the non-smokers there are also those who were smoking before. The investigation carried out by The European School Survey Project on Alcohol and Other Drugs showed that about 70% of young people at the age of 15 tried smoking.

Table 4. Alcohol consumption of table tennis coaches

ALCOHOL		BEER			WINE			SPIRITS		
		0.3 l/day			0.2 l/day			0.03 l/day		
YES	NO	1-2	3-5	> 5	1-2	3-5	> 5	1-2	3-5	> 5
31	15	14	2	0	17	5	0	14	0	0

66% of coaches are consuming alcohol, mostly beer and wine. It is well established that large amounts of alcohol have detrimental effect on health influencing the most of organs (Kasper et al., 2004). The scientific investigations established J-shaped relationship between the alcohol use and health with the lowest mortality and morbidity risk occurring among light and moderate drinkers (Gunzerath et al., 2004). Light-moderate drinking is defined as no more than two drinks per day for healthy men (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2000). Lighter drinking carries lower total mortality risk largely because of lower coronary disease risk. The investigators connect this findings with antioxidant and antithrombotic substances present in wine, mostly in red wine, which are potentially beneficial against atherothrombotic disease and cancer (Booyse and Park, 2001; Paschall and Lipton, 2005). Due to Klatsky and his co-workers (2003) upon the prospective study of over 12.000 Californian, light-moderate wine drinking is associated with the lowest risk for all-cause and coronary disease mortality. They also reported that light-moderate beer and spirits drinkers had also lower mortality risk relative to lifetime abstainers.

The results of our study indicate that all 66% of coaches are light-moderate drinkers and most of them are drinking one or two glasses of wine with their main meals. It seems that coaches are not engaged in occasional heavy drinking and, the most important thing, they are not used to drink in front of their athletes. So we can say that the light-moderate habit of wine or beer drinking could actually have beneficial long-term health effects for table tennis coaches.

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ANTHROPOMETRICS, AUXOLOGY AND TABLE TENNIS

Abstract

Anthropometrics is the study of patterns in human body size and their correlates over a period of time. Auxology is the study of human growth. Both studies confirm that the world population (approximately 6 billion people) is getting taller.

Height is determined by the complex interaction of genes and environment. With the advance of modern medicine and plentiful nutrient-rich food in the developed world, average height has increased dramatically. Nutrition is now believed to be the most important factor in determining height. Previously it was thought to be genetics.

Over the past 100 years people have increased significantly in height. Americans were the tallest in the 19th Century at 1.71 m (5'7.3"). Today they average 1.77 m (5'10. 8"). Several nations in Europe have now surpassed the United States, particularly the Netherlands and Scandinavian countries. In a century's time the Dutch have gone from being the smallest people in Europe to the tallest in the world. Their men average 6'1" (185.42 cm) and the women 5'8" (172.72 cm). This increase has been so dramatic that many physical structures had to be redesigned and altered to accommodate their much taller frames. Ceilings had to be lifted, furniture redesigned, lintels raised to keep foreheads from hitting them etc…

Table tennis had its origin around 1900. It was initially played on dinning room tables, which were customarily 2'6" or approximately 76 cm in height, which is the standard height of table tennis tables today. Therefore, for over 100 years the height of the table tennis table has been the same.

Cabinet manufacturers in the United States have always had a standard height for their fixtures such as bath vanities, sinks, kitchen countertops, dining room tables, etc… Until recently this height was as 30" (76 cm) high. Note this 30" (76 cm) was the identical height of most dining room tables when table tennis originated and was no doubt why the table tennis tables have always been the same height of 2'6" (or 76 cm). Until the year 2000, there was not much variation among off-the-rack manufactured bath and kitchen vanities. In the year 2000, manufacturers decided that the furniture height averages based on their prior specifications were now obsolete. They stated that present day Americans were beginning to resent having to stoop, bend, and squat just to brush their teeth or wash their hands in a sink. They are now producing vanities that are 34.5" (87.63 cm) to 36' (91.44 cm) tall. Shouldn't table tennis table's height be adjusted accordingly?

Other sports have adjusted their playing dimensions, rules, and equipment to adjust for the increase in the size of their present day athlete's (e.g. basketball).

If the sport is to continue proportionately to the increase in the height of players perhaps in the distant future even the length and width of the table may have to be adjusted. Standardization of equipment may help to keep down the price of equipment and promote tradition but in the immediate future, if not now, some consideration should be given to adjusting the table height for the personal comfort and health of our athletes from an orthopedic standpoint.

Key words: *table tennis, anthropometrics, auxology*

ANTHROPOMETRICS, AUXOLOGY, AND TABLE TENNIS

Anthropometrics is the study of patterns in human body size and their correlates over a period of time. Auxology is the study of human growth. Both studies confirm that the world population (approximately 6 billion people) is getting taller.

Height is determined by the complex interaction of genes and environment. With the advance of modern medicine and plentiful nutrient-rich food in the developed world, average height has increased dramatically. Nutrition is now believed to be the most important factor in determining height. Previously it was thought to be genetics.

Asian populations were once thought to be genetically inherently shorter. However, with nutritional and health improvement in Asian nations increases in height has also occurred. Therefore it is now a popular assumption that humans, as a species, may possess a roughly similar genetic height potential (excluding permutations such as the Pygmies).

Differences in nutritional status results in wide variations in adult height even within populations of the same genetic make-up. For example: individuals from higher socio-economic classes tend to be taller than their lower class counterparts whether in impoverished third-world countries or in developed nations. As the general health and nutrition increases around the globe, researches have concluded this is the primary cause of the increase in height.

Growth and height have long been recognized as a measure of the health and wellness of individuals as well in the general population. In fact, the United Nations now uses height to monitor nutrition in developing countries.

Historically, increases in height have not been constant. The heights of the century old skeletons are estimated by the length of the skeleton's femur as legs compose approximately one-half of the adult human's height. In northern Europe over the past twelve hundred years human's stature has followed a U-shaped curve: a high about 800 A.D.; a low in the 17th Century; and now considerably higher again.

Before 1750, chronic hunger, malnutrition, disease, and early death were the norm. The maladies of malnourishment and widespread disease were reflected in attainable height. In 1750, the average height of adult males in England, the world's most economically advanced nation at this time was 5'5" (U.S. Customary & British Imperial System of Measurement) or 165.1 cm (International Metric System) and even that exceeded averages in France and Norway. Viewing the suits of armour in the Tower of London reminds us of how small people of long ago really were.

Over the past 100 years people in industrialized nations have increased significantly in height by 4" (10 cm). The average height of British males soared from 5'6" (167.54 cm) to 5'10" (177.8 cm) between 1865 and 1980.

In North America, Europeans who years ago immigrated to the United States, became taller than relatives remaining in Europe. In fact, Americans in the 18th and 19th centuries were the tallest in the world. Today they average 5'10.8" (1.77 m). Several nations in Europe have now surpassed the United States, particularly the Netherlands and Scandinavian countries. Some believe the average rate of height increase in America is now comparatively less because of further migration from Mexico and Asian countries.

In a century's time the Dutch have gone from being the smallest people in Europe to the tallest in the world. Their men average 6'1" (185.42 cm) and the women 5'8" (172.72 cm). Some credit this spurt in height due to the superior Dutch childcare. The

Dutch reportedly have the world's best prenatal and postpartum clinics which are free of charge for every citizen. This increase has been so dramatic that many physical structures had to be redesigned and altered to accommodate their much taller frames. Ceilings had to be lifted, furniture redesigned, lintels raised to keep foreheads from hitting them etc…

The relation of Anthropometrics and Auxology to the sport of table tennis:

Table tennis had its origin around 1900. It was initially played on dinning room tables, which were customarily 2'6" or approximately 76 cm in height. The International Table Tennis Federation (ITTF) records go back to the 1930's and official table tennis tables were standardized at 2'6" in height. Since 1975, the ITTF measurements have been expressed only in metric terms. The listed measurements for an official ITTF table are: 76 cm high; 2.74 m long; and 1.525 m wide. Therefore, for over 100 years the height of the table tennis table has been the same (actually it was lowered 0.2 cm when they changed from inches to centimetres). As we have learned from various sources, the average height of people worldwide has increased several inches over this 100-year period.

Cabinet manufacturers in the United States have always had a standard height for their fixtures such as bath vanities, sinks, kitchen countertops, dining room tables, etc… Until recently this height was as 30" (76 cm) high. Note this 30" (76 cm) was the identical height of most dining room tables when table tennis originated and was no doubt why the table tennis tables have always been the same height of 2'6" (or 76 cm).

Until the year 2000, there was not much variation among off-the-rack manufactured bath and kitchen vanities. The records of the United States cabinet manufacturers state that Americans were getting taller by about 2" (5.08 cm) every 75 years. In 1850, the companies said the average man's height was 5'5" (165.1 cm). By 1925 it was 5'7" (170.18 cm) and today it's about 5'10.8" (177.8 cm). So in the year 2000, the manufacturers decided furniture height averages based on their prior specifications were now obsolete. They stated that the present day Americans were beginning to resent having to stoop, bend, and squat just to brush their teeth or wash their hands in a sink. They are now producing vanities that are 34.5" (87.63 cm) to 36" (91.44 cm) tall. An increase of 4.5" to 6" (11.43 cm to15.24 cm). Some manufactures presently offer wall-mounted sinks that are height-adjustable. Table tennis tables with telescoping adjustable legs have been made for certain players (e.g. children, Paralympics, Special Olympics, wheelchair).

Other sports have adjusted their playing dimensions, rules, and equipment to adjust for the increase in the size of their present day athlete's (e.g. basketball and baseball). Isn't it logical for the sport of table tennis to also do so? Even a minimal increase of 2" (5 cm) would be beneficial.

If the sport is to continue proportionately to the increase in the height of players perhaps in the distant future even the length and width of the table may have to be adjusted. Standardization of equipment may help to keep down the price of equipment and promote tradition but in the immediate future, if not now, some consideration should be given to adjusting the table height for the personal comfort and health of our athletes from an orthopedic standpoint.

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EATING HABITS OF 14 YEAR-OLD MALE AND FEMALE FREE TIME TABLE TENNIS PLAYERS

Abstract

The aim of this study is to analyse eating habits of 14 year-old male and female free time table tennis players. A questionnaire including 22 variables has been used to question 80 9th grade boys and girls from a primary school in Slovenia.

We have established that on average boys and girls alike have a normal body weight and that they are in most cases (68%) happy with their bodies. 14 year-old pupils practice a healthy way of eating – the majority (92%) has three to five meals a day and they mostly eat at home. They go to McDonald's rarely – more than half of the pupils visit McDonald's less than once a month. 3% of 14 year-old pupil's smoke and 64% of them don't drink alcohol.

We are of the opinion that sport is a tool for developing motor abilities in young people and maintaining one's health. In addition, sport helps young people to be protected from various addictions, indifference, and bad influences of the street life, modern trends and to develop a positive self.

Key words: *youth, sport, free time table tennis players, eating habits*

INTRODUCTION

Obesity is a growing problem in contemporary society and table tennis is not excluded from this problem. The reasons are various ranging from genetics, metabolism processes, social and economic standards, psychological reasons, lack of exercising to irregular eating habits (Bratanič, 2000). Lack of exercising in particular is the factor that causes an increase in obesity and diabetes, while genetics is among the prevailing factors causing obesity (Karpljuk, Videmšek & Dervišević, 2003). 40 to 50 % of obese children come from families where one of the parents is overweight, and 80 % of obese children come from families where both parents are overweight. The proportion of obese children where both parents have normal body weight is 10 % (Jurovič, 2003).

In addition to genetics, the two most significant factors causing obesity are the way of life and eating habits within a family. Losing the extra body weight is closely related to regular sport activity, whereas irregular sport activity and quick diets do not produce satisfactory results (Battelino, 2000).

Experts are of the opinion that Slovene national cuisine includes all the good eating habits. Nutrition used to be based on meals prepared from grains and vegetables, meat was eaten on Sundays and holidays only, and people used to have regular fasting days. Unfortunately the plain country meals have almost disappeared from our dining tables, and like the rest of the modern world, Slovene people more and more eat unhealthy fast food (Jurovič, 2003). Fast food is often considered somewhat a lifesaver for people whose work schedules and lack of free time do not allow them to find the so needed time to relax and to enjoy healthy meals. Based on the studies on nutritional values of fast food, from 1986 to 1991 fast food restaurants have however significantly improved the food quality and added to offer some healthier food (Pokorn, 1997). This trend continues today – the fast food providers know of people's healthy eating awareness and must thus make sure to offer a variety of choices and healthy meals in their fast food restaurants (Amon, 1996). Fast food providers have already changed the meals they offer, which now include less deep fried and lower fat roasted foods, more vegetable meals, more low fat milk, and meals prepared from full grain flour (Petrovčič, 2000). In any case, fast food has a solid position in our everyday nutrition; it is important however how we combine this way of eating with healthy daily eating habits. A recipe to add value to our daily eating is to have plenty of fruit and vegetables, and occasionally a fast food meal with not too much fat, sugar and salt (Kmetec, 2002).

The research by Jurovič (2003), in which 1000 15 to 25 year-old visitors of Mc Donald's were studied has shown that people have a positive attitude towards fast food. More than one half of the people questioned know the basic ingredients of fast food, their eating habits are very good – 72 % has three to five meals a day, which conforms to the WHO standards (Požar, 1998). These people primarily eat at home (78 %) or in various restaurants (9 %). Jurovič (2003) established that visitors of fast food restaurants regularly practice sport – over 52 % practice sport more than twice a week, not to disregard those 34 % who practice sport occasionally. All together there are 86 % young people aged from 15 to 25 who practice sport and visit Mc Donald's restaurants.

Sport or exercising generally plays a highly significant role in one's life. Sport activity normally does not give any room for unhealthy eating, alcohol, cigarettes and many other negative factors that too often influence a contemporary way of living. Sport helps to suppress negative factors when already present, or helps to prevent them from occurring. Sport is a way to enrich one's life in any age period, whether young or old age (Shapiro, 1994).

When parents raise their children to come to love exercising and sport, they do much more than just make them exercise and prevent them to become TV or computer addicts. Parents this way influence children's patterns of behavior, their desires and needs. Being engaged in sport, children develop positive motivational structures and permanent, useful habits, children learn how to win or lose – the situations they will face in everyday life (Kropej & Videmšek, 2002). It is above all most important that children learn already in the family that their achievements are the result of their own invested work and effort. Parents influence all three children's personality levels: biological, psychological and social – i.e. they positively influence the child as a whole (Videmšek & Visinski, 2003). The influences will be present not only in childhood and youth period, but also in the period of growing up. Children are raised to lead a sporty way of life which is one of the most meaningful ways of life in contemporary society (Kalar, Videmšek & Zavrl, 2003).

The benefits of practicing sport in youth are there for life. Experts believe that the problem of wide-spread cardio-vascular diseases today has roots in the childhood period. Inadequate exercising extensively contributes to excessive body weight, high cholesterol level and high blood pressure. All of these symptoms may be present already in the teen-age period and represent a high risk of developing serious heart diseases later in life (Keber, 2000). If alcohol, cigarettes and unhealthy eating is added along, the risk of developing various diseases increases highly (Berčič, Tušak & Karpljuk, 1999).

Childhood and youth are the most significant periods of growing up. Growing up into an adult person can be developed through sport and its specific movement activities, and through proper eating habits (Uršič Bratina, 2000a). As the process of socialization starts in the childhood, the family plays a very important role in developing a child's personality. Knowing that parents today are often overloaded with work and have very little time for raising children, their role is often taken by schools and the neighborhood. Neighborhood is the place where children most frequently adopt bad habits, whereas the school is a kind of a counter balance and struggles to control and dominate these influences. The school should help individuals to develop the potentials they possess, in order to be able to enter and start an independent life based on own capabilities, having a high self-esteem and strong determination (Vrba, 2000).

Since the problems and issues described here are most prevalent and interesting, we have decided to carry out a research to analyze eating habits of 14 year-old free time table tennis players.

METHOD

Participants

The sample of subjects included 80 pupils aged 14 (38 boys and 42 girls). All pupils were in the 9th grade primary schools from randomly chosen schools in Slovenia which chose table tennis as extra curriculum's selected sport.

Instruments

This research is based on a questionnaire consisting of 22 questions (variables) on sport and eating. The questionnaire is partially resumed from the study by Jurovič (2003) with a few additions.

The questionnaire includes the following variables:

- Age
- Height
- Body weight
- Are you satisfied with your body?
- Do you smoke?
- Do you drink alcohol?
- In addition to PE in school, how frequently do you practice sport (at least 45 minutes a day)?
- How do you practice (recreationally, competitively)?
- Where do you practice (extra curriculum activities, club, individually…)?
- What is your opinion of your test results in testing for Sports Educational Chart*?
- Do you know the basic nutritional substances?
- List the nutritional substances!
- How many meals a day do you usually have?
- Where do you most frequently have your meals?
- Dou you enjoy food in fast food restaurants?
- What is your opinion of fast food (high in calorie, tasteful, cheap, filling, variegated, healthy)?
- What do you think about the number of Mc Donald's restaurants in Slovenia (too many, too few, enough)?
- What do you most frequently order at McDonald's?
- What do you most frequently drink at McDonald'?
- You're most prevailing reasons for visiting a McDonald's restaurant (lack of time, fast service, affordable, nice place, quality food, tasteful food, good location, courteous staff, meeting friends).
- How often do you visit McDonald's restaurants?
- What do you like best at McDonald's places?

** Sports Educational Chart is a special system for yearly monitoring of motor and morphological development of Slovene youth (Strel et al., 2002).*

Procedures

Data has been processed by the SPSS software (Statistical Package for the Social Sciences). Frequencies have been calculated with the help of FREQUENCY sub-program.

RESULTS

There are more boys than girls who practice table tennis every day during the weekend, while most girls practice sport (in addition to PE in school) two to three times a week. The majority of boys and girls practice table tennis recreationally, usually at extra curriculum activities offered at school. There are few more boys than girls who practice table tennis at various sport clubs.

More than one half of boys and girls are of the opinion that their Sports Educational Chart results are average. Sports Educational Chart is a special system for yearly monitoring of motor and morphological development of Slovene youth (Strel et al., 2002). The results have shown that pupils who are more engaged in sport activities have a better opinion of their own test results. These answers are of course understandable and explainable. At their afternoon sport activities, in addition to learning the sport, children learn and develop their motor abilities, such as movement coordination, agility, strength, speed, etc. – all of which are being part of the Sports Educational Chart testing.

With this research, it has been established that the sample of 14 year-old pupils studied here, are well nourished. The body mass index (ITM – a rate between the body mass and the height squared) of girls in our study is 18.9 kg/m^2, and of boys the ITM is 19.6 kg/m^2. According to the percentile table for ITM examination in children and adolescents (Uršič Bratina, 2000b) the over nourished children are those whose ITM exceeds 95th percentile for their age and sex (Table 1).

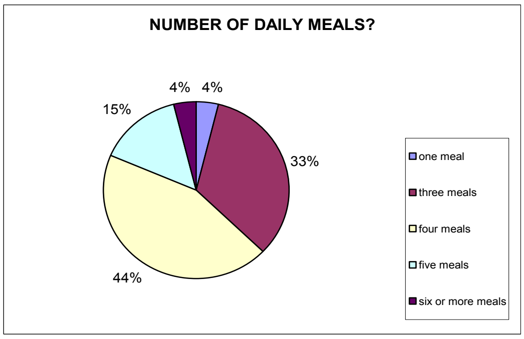
Table 1: The body mass index (ITM) in 14 year-old boys and girls - National health and nutrition examination survey (Uršič Bratina, 2000b)

BOYS	95 P	50 P	5 P	GIRLS	95 P	50 P	5 P
Age 14	26,8	19,1	16,1	Age 14	28,6	19,4	15,7

Over two thirds of boys and girls are satisfied with their bodies. This is a very encouraging piece of information, because the development of a positive self-esteem in the growing-up period is very often a problem.

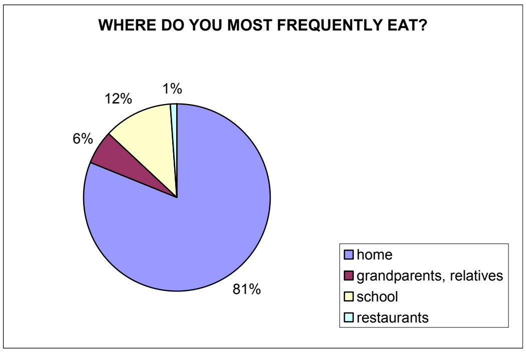
Even though adolescents often tend to get the information about nutrition from their coevals, magazines, and a little from their families, girls and boys in our study are very well informed about healthy food. A high 90 % of pupils are familiar with nutritional substances, and most of them also listed them correctly. We have established that the majority of children have three to five meals a day, and that there are rare individuals who have less than three or five meals a day (Figure 1).

Figure 1: How many meals a day do you usually have?



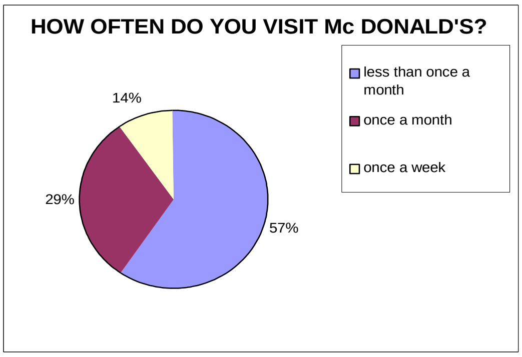
Accordingly, 14 year-old boys and girls mostly have healthy eating habits to follow the biological exchange of nutritional and non-nutritional state of metabolism. Based on the information revealed by the head of the school meals planning (at the school where the questioning was carried out), 85 % of all pupils have a morning meal, 63 % have lunch, and there is one pupil who has the afternoon meal. The majority of pupils (81 %) however still reported that they mostly eat at home, where they are likely to spend most of their time (Figure 2).

Figure 2: Where do you most frequently eat?



Children rarely visit Mc Donald’s restaurants – over one half of them visit the restaurant less than once a month, and nobody visits the restaurant two or more times a week (Figure 3).

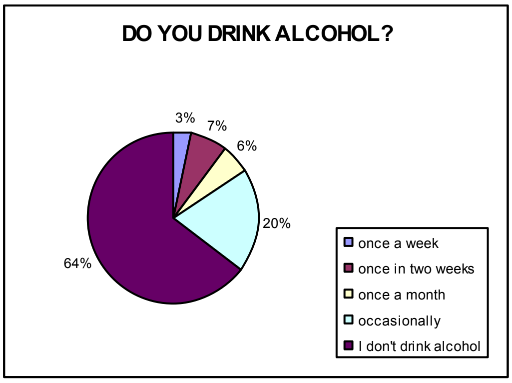
Figure 3: How often do you visit Mc Donald's restaurants?



Most 9th grade pupils are of the opinion that fast food is high in calorie, tasteful, rather expensive, filling, and variegated. However, most believe that this food is not healthy. In spite of that fact, they normally have desserts in fast food restaurants, less frequently menus, sandwiches and French fries, and least frequently salads. They normally have fizzy drinks with the food, rarely fruit juices, and least frequently other drinks such as water, chocolate milk and similar. The most important reasons why 9th grade pupils eat at McDonald’s are fast service, tasteful food, location, courteous staff and meeting friends.

The results have shown that those children, who are more sport active smoke less frequently or they drink alcohol less frequently. Generally, 3% of 9th grade pupils smoke which is less than in a study (Videmšek, Skubic, Karpljuk & Štihec, 2006), where 4 % of 14 year-old boys and 12 % of girls smoked. Almost two thirds of pupils do not drink alcohol at all (Figure 4).

Figure 4: Do you drink alcohol?



DISCUSSION

With this research, it has been established that the sample of 14 year-old free time table tennis players studied here are well nourished. Based on the information of over 200.000 primary school children (Strel, Kovač, Leskošek, Jurak & Starc, 2002), we can ascertain that an increase in body weight and height occurred in the period from 1990 to 2000 (14 year-old boys 1,4 cm in height and 2,4 kg in weight, 14 year-old girls 0,8 cm in height and 0,8 kg in weight). Despite this we can ascertain that the number of girls with an extremely low body weight is increasing more rapidly than it would have been expected according to the basic principles of children's development. The contemporary trends inevitably dictate such occurrences (Strel, Kovač, Leskošek, Jurak, & Starc, 2002). American researchers have come to similar results – they see that within all the groups, young girls have the poorest nutrition because they keep declining food (Gabrijelčič Blenkuš, 2001). A man obtains eating habits already in the early childhood. Eating habits are formed based on the eating habits in the family (number of meals, selection of foods, vegetarian diets …), a significant role are also influences from the environment – kindergarten, school, friends. Eating habits are thus a sum of many influences; they become a part of our everyday life and play an important role in leading a healthy way of living (Gibney & Wolever, 1996). A child's rapid development, a relatively sedentary way of living (school, learning courses, TV, computer …) and a high calorie food intake can lead to a fast weight gain. With exercising, a child can burn a lot of those extra calories and thus control the body weight.

Over two thirds of boys and girls are satisfied with their bodies. This is a very encouraging piece of information, because the development of a positive self-esteem in the growing-up period is very often a problem. More than half of the 15 year-old teenage girls in the developed industrial countries are dieting or think they should be. The top rated country is the U.S.A., where 47 % of 11 year-old girls and 62 % of 15 year-old girls worry about being overweight (Vereecken & Maes, 2000). Scientists have established that higher-grade girls in primary schools, whose relationships with their parents are good, are less worried about the way they look. An individual's self-esteem at the time of turning from a child into an adult is primarily presented by the physical appearance. Teenagers are often facing great difficulties in developing their own perception and in appreciating their own bodies. This developmental phase is particularly delicate because it coincides with sexual maturing, cultural influences, and judgments of values and often prejudices (Strel, Kovač, Leskošek, Jurak, & Starc, 2002). Often teenagers want to achieve a fast loss of real or imaginary extra kilograms by a sudden change of their diet (a restrictive diet) that they usually read about in magazines or hear from friends. Weight loss diets like this can have very dangerous health-affecting consequences with every teenager. They are especially dangerous for top athletes, who can more often face health problems and poorer sport results (Uršič Bratina, 2000a).

Jurovič (2003) already established that young people, aged between 15 and 25, are well informed about a healthy way of eating – more than one half are familiar with the nutritional substances. The percentage is even higher (84 %) with 16 year-old teenagers. This could undoubtedly be the result of the home economics school subject in primary schools. In the new, 9th grade primary school, children's knowledge and information on healthy eating will further improve – in the 7th, 8th and 9th grade, children will be offered to choose the subject "Modern food preparation". The aim of this subject is to inform and teach children about nutritional substances and their correlation with one's health, quality of food and meals, healthy food preparation, and healthy eating habits.

The results have shown that the majority of children (92 %) have three to five meals a day. There are rare individuals (4%) who have less than 3 meals a day and this is something to be concerned about – although it is believed that among those there are children who do not consider chocolate, apples, biscuits etc. as meals. Very few (4 %) children eat more than five meals a day. Considering the standards set by the WHO

(Požar, 1998), five or at least three meals a day is a very good result. Similar results have been obtained in the research by Jurovič (2003), where 72 % of young people aged between 15 and 25 have three to five meals a day.

There are very few among those young people whose way of relaxation is exercising or sport, who would threaten their own health and lives with violence aimed against the others or even against themselves. There are also very few who would look for substitutes like alcohol, drugs, wander aimlessly and similar. This research shows that those children, who are engaged in sport more, are less likely to smoke and drink alcohol (Karpljuk, Videmšek & Zajc, 2003). Generally, 3 % of 9th grade pupils smoke, which is less than in a study (Videmšek, Skubic, Karpljuk, & Štihec, 2006), where 4 % of 14 year-old boys and 12 % of girls smoked. Almost two thirds of pupils do not drink alcohol at all. These facts also comply to the results of researches (Papalia, Wendkos Olds, & Duskin Feldman, 2003) indicating that already primary school children occasionally or regularly drink alcohol, and that the age when children first start drinking is getting lower. 80 % of teenagers have tried more than a couple of sips of alcohol before they finish primary school, and 25 % of 9th grade pupils say they were at least once drunk. According to the experts, these facts are concerning because young people who start drinking before the age of 15 are more likely to become addicted to alcohol than those who start drinking after the age of 20 (Gibney & Wolever, 1996) .

Sport can be the tool to help young people to be protected from various addictions, indifference, bad influences of the street life, modern trends, and to develop a positive self-esteem. When engaged in sport from the early ages, young people get to know certain hardships, strain, the feeling of winning and losing. All of these experiences enrich one's life and are a valuable preparation for battles in life to come, and there are quite a few of them. This way, appropriate sport activity not only contributes to a healthier body but also contributes to a more positive attitude towards oneself (Kropej & Videmšek, 2002).

At the time when children are still prone for parents' and teachers' influences, children should adopt a positive attitude towards a sporty way of life and healthy eating which represent the fundamental condition for a normal way of life without any unnecessary troubles due to harmful habits and modern diseases.

We are aware that this research is just a small piece in the mosaic representing the study of eating habits and sport activity in young people. The sample of subjects studied here is relatively small and not representative for Slovene young people. In spite of this, we have established some significant conclusions, valid for this sample of subject. The future researches on eating habits and sport activity of young people should more thoroughly study and analyze the assumptions stated here.

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The 10th Anniversary ITTF Sports Science Congress

Part three:

Injuries and risk factors in table tennis

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INJURY INCIDENCE AMONG YOUNG TABLE TENNIS PLAYERS DURING 2005 SPANISH NATIONAL CHAMPIONSHIP

Abstract

With the aim to obtain a registration of injuries in table tennis competition we have collected those that were occurred at 2005 Spanish National Championship. A total of 1300 matches were played in two days of competition. About one-hundred table tennis clubs took part, representing fifteen different regions of the country. That's means 355 young players (198 males and 157 females aged between 9 and 21 years) who participated in this event. Ten injuries were attended. Three of the injured were males and the other seven were females. Injury incidence rate during the championships was 2.81%. Paying attention to gender distribution we can observe an injury incidence of 1.01% in males (30% of all sessions) and 4.45% in females (70% of all sessions). Reviewing these injuries we can verify that the most frequent are acute (88,8%) while chronic injuries only represent 11.2%. All of injuries attended were acute in female players. However, in males, the number of acute injuries represented 50% and the remaining 50% was for chronic injuries. The most serious injury reported (a traumatic meniscus injury) was suffered by a female player who without another alternative left the competition. The remaining injured players completed their participation. These results can help us to confirm that table tennis is considered a low-risk sport.

Key words: *table tennis, competition, injury incidence, young players*

1. INTRODUCTION

Table tennis is a very practiced sport among the general population. It's an individual, asymmetric one, in which several beats are given, with a high velocity and power [1]. In which the following qualities are developed: resistance, concentration and coordination. The most worked quality is velocity: explosive strong. It's which has the smallest pitch, racket and ball among dual racket sports. That's the reason because the resistance that arms have to win when they beat the ball is_small. According to Mitchell sports' classification, based on dynamic and static tip in competition, table tennis would be in group IB (Sport of low static component and moderate dynamic component). Competition can last hours or days, and it is possible 4 or 5 matches can be played or more, as it is the case of the competition we have chosen for the study.

2. OBJECTIVE

To know the most frequent injuries in tennis table, in competition, in ages between 9 and 21.

3. METHODS

- The first step was to make one bibliographic review to see the most frequent injuries in this sport.
- The second step was the realization of a data collection by the doctor who covered the concentration. A card was used which contained the following data :

- Name, date of birth, date of attendance, injured body's zone, diagnostic, acute or chronic injury, in competition or previous, made treatment.
- The place of data collection and sanitary benefit was a closed room, isolated of noises. Where was located all the sanitary tools necessary to perform the diagnostic and treatment of different injuries.

4. RESULTS

A sample of n=355 players was followed of 5 different categories, youngest child, alevín, youthful and sub-21 with the distribution gathered in Table 1.

	YOUNGEST CHILD	ALEVIN	YOUTHFUL	SUB-21
MEN	57	66	66	64
WOMEN	35	43	57	31

Table 1. *Participants by category.*

Based on sex, 253 men participated, corresponding to 55.7% of participants, and 166 women who represented 44.2% of the total of players.

During the championship 10 sanitary attentions were carried out. Three were performed in men and seven in women. One of the men was a referee. This is the reason why the global incidence in sport players was of 2.81%. If classification is based on sexual characteristics, an incidence of 1.01% happened in men, and it was of 4.45% in women. (Fig. 1) If we pay attention to the players' age that needed medical aid, we can observe that at the age of 16 a greater lesion incidence occurs. 4 of the total were occurred in 16-year-old players.

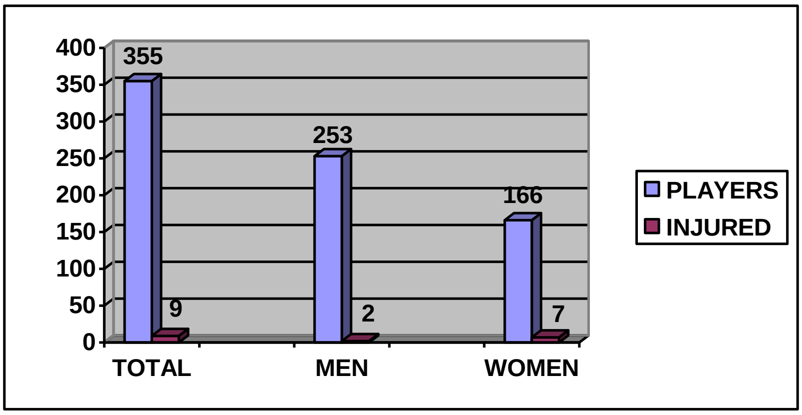

Figure 1. *Injury index*

	Face	Trunk	Upper limbs	Lower limbs
WITH CONTACT			Blisters fingers	Hurt left knee Internal contusion melleolus
WITHOUT CONTACT	Strange body in eye	Strain thoracolumbar Paravertebral muscles	Supraespinatus tendonitis	Meniscal injury Rectus femurus straight strain

Table 2 Type of injuries according to the injury mechanism and injured zone.

The injuries by contact (see table 2) were produced by strike against the table, in the left knee that was the support leg and in internal malleolus of the right ankle. Due to a contact with the racket, a blister in dominant hand in a feminine player, the form of hold caused a reiterated friction of the epidemic weave with the racket. If we pay attention to the proportion we can observe that the injuries produced without contact represent a 66.6% of the total injuries. These are considered the most frequency injuries.

Based on the injury location, we can see the lower limb is the area with most indexes of injuries. The following one in frequency was the upper limb, followed of the trunk and face. In the upper limb we found a very frequent pathology in the table tennis: tendinosis of the supraespinatus, in a man and in the dominant arm, which in addition, it was, the only chronic injury that we gathered.

If we observe the moment at which the injuries took place, 66.6% took place the first day. 60% of the same ones were taken care at first hour of afternoon.

The injuries classification according to the severity shows us that most of them are slight injuries that do not force move away from the game land and the competition. Only one of them caused that the player did not finish the match, had an injury of internal meniscus. A functional bandage was placed to her with the aim to finish the match, but she left the competition.

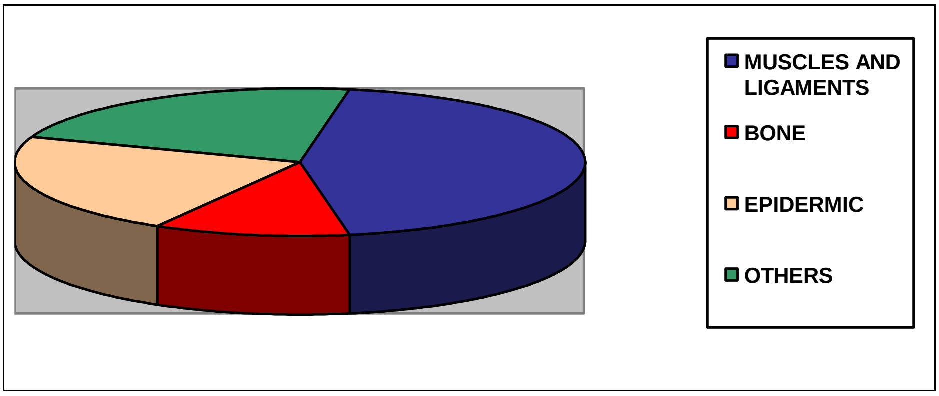

Figure 2 *Injuries according to the injured weave.*

The following results were obtained according to the injured weave (Fig. 2):

- Injuries affecting the muscle : 2
- Ligament and cartilage injuries: 2
- Bone injury: 1
- Epidermic injuries: 2
- Others: 2

5. DISCUSSION

The global lesional incidence has been very low, of a 2.81%. These data agreed with the statistic of the General Mutualidad of Sport Players, that shows us that it is a sport of low traumatologic risk. (Of all the sports the lesional incidence is of 0.19%)[2].

The main producing factors of injuries are biomechanical upheavals and the on use. We found the greater risk of injuries in young people, faced with the veterans, to have a minor experience or even worse technical.

Paying attention to the weave that is injured most frequently we observe it is the muscular and the ligament ones. The same happens in most of the sports. It is probably caused by very hard and intense training with a short time of recovery and mainly to the lack of stretching and heating before and after the training and of the competition. These results vary a little in relation with the data collected in a Spain championship sub-21 where the frequency of muscular injuries was 63.64%, followed of tendon and ligament injuries[3].

Although the superior member is the most used during the matches, it is not the greatest centre of injuries. The zone of the body where we found the greater number of injuries was the lower limbs, followed of upper limbs and trunk. In the upper limbs the zone with greater pathology is the dominant shoulder (consequence of being an asymmetric sport). In most of the players an asymmetry between arms can be observed, being more developed the dominant arm. Also a maximum force variation is found in dominant member with respect to non dominant member[4], although the resistance that must overcome the upper part when the ball is hit is small in this dual sport with racket. The dominant arm makes greater effort and mainly repetition of the sport gesture, that irritates the sinews and causes muscular overload [4,5,6]. This found difference can have to that our sample is a very young population with less years of training. And that in the bibliographical revision where the dominant shoulder with greater injury is seen, the population had been more years training, even more than 16 years. If we refer to the trunk we see strain level of thoracolumbar paravertebral muscle. Following Balius and Juli sports classification according to the degree of aggressiveness on the spine, the table tennis would be in the group of vertebral indifferent sports [7]. But the other authors as Gallo Vallejo and Galán Rodriguez consider this as sport vertebral negative in power in high level players, by the great number of hours of training in a forced position in the rotation movements[2].

Paying attention to if they are acute or chronic, 90% of the injuries were acute, probably because it is a very young sample of sport players. In players who have been training more than 16 years, the type of injuries we can usually find is chronic [8].

Observing the hour of the injury production, we could verify that the greater number of injuries occurred at the beginning of afternoon of the first day of competition. One of the causes could be that the sport player is more tired at those hours of the day because he has played 3-5 matches in the morning and this fatigue increases the referring at technical gesture. Another one of the reasons is that they have not warmed up enough at the beginning of the afternoon increasing the lesion risk.

Having contrasted the injuries produced during the State Championship with the collection in the bibliographical revision, we can see the following summary table which gathers the injury distribution according to the injured body zone [6, 9, 8, 10, 11, 12, 13] (Table 3).

TRUNK	UPPER LIMBS	LOWER LIMBS	SKIN
Cifosis Scoliosis Osteoarthritis	Epitroclheitis Palmar tendonitis Wrist tenosynovitis Supraspinatus tendinitis	Sprain Ankle Osteocondritis dissecans Plantar fascitis	Ping pong patches

Table 3. *Distribution of injuries based on the different parts of the body when the revision is performed.*

6. CONCLUSIONS

1. Table tennis is a low incidence sport of injuries.
2. Women are more injured that man, in these ages.
3. In early ages acute injuries are frequent.
4. Injuries without contact are most frequent, comparing with contact injuries (with racket or table)
5. The lower limb is the most injured zone of the body.
6. The injuries found in upper limbs are most frequent in the dominant member.
7. The injuries distribution according to the hour rank was greater at the beginning of first day afternoon.

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KNEE JOINT INJURIES IN TABLE TENNIS PLAYERS

Abstract

Table tennis is assumed to be a sport with practically no injuries. This is a very common prejudice within general sports medicine community. In contrast, table tennis is accompanied with different types of injuries. There are two patterns of injuries in active table tennis players, first caused by single impact trauma and second following repetitive micro trauma. The latter has much higher incidence. The purpose of this paper is to analyze available literature with respect to injuries involving knee joint.

Percentages of knee injuries in overall number of injuries in table tennis are reported to be within the range of 10 to 15 %. Most common injuries to the knee joint caused by single impact trauma are meniscal tears followed by much lower incidence of ligamentous injuries and osteochondral lesions. Rotating movements on pivoting knee causes meniscus tear. Overuse injuries around knee involve patellar tendinitis (jumper's knee), quadriceps tendinitis and rarely iliotobial band friction syndrome.

There are not many available data in the literature concerning specific knee injuries in table tennis players, in spite of very often assessment of overuse injuries in clinical practice.

Key words: *table tennis, injuries, knee joint*

Anatomy and function of the knee joint

Evolution of different tools and technologies that are available in medicine helps scientists to comprehend organic systems like knee joint on a more complex level. With time, old-fashioned picture of knee as a simple mechanic transmission has evolved with the understanding of biology. The knee is much more than a simple hinge joint, because both gliding and rolling are essential to its kinematics. It is a self-maintaining and to a certain extent self-repairing system of one trillion living metabolically active cells. Depending on the activity it endures 2 to 8 million load cycles in a year. Capability of self repairing and maintaining is in direct relation with activity. Ligaments are not just tissue bands but sensate adaptive linkages with numerous proprioceptors. It is well known that proprioceptors play major role in the nervous steering of the whole knee system. The role of the ligaments of the knee is to provide passive restraints to abnormal motion. Menisci are mobile and sensate bearings built of cartilage tissue with various functions. The collagen fibers of the menisci are arranged radially and longitudinally which allows the meniscus to expand under compressive forces and increase the contact area of the joint. Hyaline cartilage of the knee joint is a sophisticated structure composed of collagen fibers that embed gel structure with proteoglycans and water. Cartilage tissue provides elasticity to the whole joint and absorbs axial and shear forces. As long as cartilage tissue layer is fully intact the dynamic movements and full range of motion are possible. With time and repetition of loading cycles this layer is being thinned which restricts the function of the joint. Muscles that have their insertions around knee joint are extremely important for motion of the whole body. Quadriceps, hamstrings, sartorius, popliteus and biceps femoris muscle contribute to the whole range of flexion/extension and rotation movements of the knee joint.

Mechanism of injuries

Traumatic impact causes injury of a certain anatomic structure. Due to evolution and improvement of diagnostic methods, annihilation of structural elements can be observed as an outcome of stresses on a different scale. Traumatic stress may cause delicate changes in structure of e.g. muscle or cartilage collagen fibers without any traces assessable with common tools like ultrasound or MRT. Various tools like atomic force microscope or scanning electron microscope opened new perspectives. Internal reaction of a certain tissue to the applied force is called stress. Knee joint is exposed to compressive, pulling and shear forces, in static and dynamic type of loading. Injuries occur if stress exceeds level of non-damaging impact. Single impact trauma causes major structural changes and micro trauma causes minor structural changes (Figure 1).

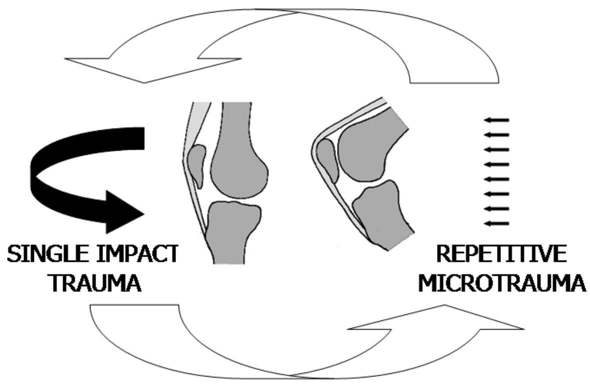

Figure 1. Mechanism of injuries

Overuse disorders can be considered injuries to normal tissue as a result of cumulative, repetitive sub maximal micro trauma due to inadequate time for recovery between stress episodes (Krivickas, 1977). The response of various tissues to stresses is different. Tendons, muscles and bones around the knee joint endure relatively lower level of damaging impact but have good healing response. In contrast, cartilage endures different repetitive loading patterns but once when injured has a very low healing capacity. Menisci are made of fibro cartilage tissue and have certain healing capacity if injured in the zone with good blood supply. Respective specific knee joint kinematics, torsion and compressive forces cause meniscus tears.

Sport results are in good proportion to effort (training and practice) to a certain extent. Athletes and their coaches have to be aware of the fact that at one point they reach the state where maximum possible effort is invested for maximum physiological payoff. Every effort beyond this point leads to injury and does not payoff.

Table tennis specific movements

Table tennis is concerned to be a low rate injury sport, especially for those players that do not have professional training and competition schedule. In cases of frequent and intensive playing, table tennis can cause characteristic injuries in different groups of players regarding age and type of game (Godeke 1998). Typical classification distinguishes three major types: offensive, defensive and half-distance players. This classification can be used only as a rough guide in understanding of specific movements because the game has evolved in the direction where many highly-competitive players mix these patterns. Players who prefer offensive game produce swift and short movements. Top-spin is usually being imposed from the beginning of the rally followed by further top-spins or a counter-attack. Due to extremely tight position to the table players have to move their upper extremities very fast and backwards, causing strain. Upper part of the body including shoulders rotator cuff, pectoral muscles and dynamic segments of spine suffer in this type of game. Affected muscles are either asymmetrically shortened affecting range of motion or overuse injuries of tendons may take place. Due to rapid acceleration and deceleration, presence of a certain form of jumper's knee in this group of players is to be expected with a very high incidence. Defensive players deploy their movements on exchange between long and short running pathways. By switching between these pathways players produce extremely fast stopping movements, simultaneously burdening lower extremities, especially knees. During the game these players maintain a very deep flexion position of the knees which may primarily affect femoropatellar joint with its cartilage layers as well as patellar tendon and insertion of quadriceps tendon. Muscles must have high proprioceptive capabilities in order to respond to the changes of pace otherwise sprains or even ruptures may occur. Half-distance players switch between different game patterns within a single rally. Therefore it is more difficult to consider this group as independent with specific injuries. Nevertheless elbow is very often affected due to the change of pace and top-spin strokes with backhand and forehand side. These movements may disturb ossification in young athletes causing juvenile osteochondrosis.

Localization of injuries in table tennis

Higher expectations of professional players and their teams impose more accurate predictions and understanding in diagnosis and treatment. There are only few studies focused on medical aspect of table tennis. Shida et al reported 25.1% injuries of waist, 15.7% of shoulder and 14.1% of knee joint (Shida, Shida et al. 1994). Kondrič et al. reported 23.3% injuries of shoulder, 9.3% of knee and 9.3% of ankle among table tennis and badminton players (Kondrič Furjan-Mandić et al. 2006). The same group of authors showed interesting distribution of injuries in various tissues. Table tennis has 52.90% of muscle injuries, 17.60% of tendon and 5.90% of joint injuries. Compared with badminton injuries percentage of muscle injuries in table tennis is significantly higher.

Types of knee injuries

The knee joint is engaged in all sport activities and due to that fact knee injuries are very common, affecting all athletes regardless of age or table tennis tactics. All injuries can be divided as shown in Table 1 into group of overuse injuries, single impact trauma and ostechondroses in young athletes.

OVERUSE INJURIES		**SINGLE IMPACT TRAUMA**	**OSTEOCHONDROSES**
Anterior Aspect	Patellofemoral pain syndrome	Meniscus tear	Osteochondritis dissecans
	Patellar tendinitis (Jumper's knee)	ACL (anterior crutiate ligament) tear	
	Stress fracture of the patella		
	Fat pad syndrome	Medial collateral ligament tear	
Medial aspect	Plica syndrome		Osgood Schlatter's disease
	Semimembranosus tendinitis		
	Pes anserinus tendinitis (bursitis)	Cartilage lesions	
	Breaststroker's knee		
	Medial retinaculitis		
Lateral aspect	Iliotibial band friction syndrome (runner's knee)	Patellar tendon rupture	Sinding-Larsen-Johansson's disease
	Popliteal tendinitis		
	Bicipital tendinitis		
Posterior aspect	Fabellitis	Quadriceps tendon rupture	

Table 1 Types of knee disorders following sport activities

Jumper's knee

By far most commonest injury affecting knee joint is disorder called jumper's knee or patellar tendinitis. In the literature this clinical entity is also referred to as patellar tendinosis, quadriceps tendinitis, and patellar apicitis or enthesitis apicis patellae. Jumper's knee is closely related to sports where athletes use the knee extensor system in repetitive manner. Rapid acceleration, deceleration, jumping and landing are provocative activities. Among all these activities maximum biomechanical load of quadriceps tendon and patellar ligament is achieved during stopping movement or deceleration in the landing phase (Pećina, Bojanić et al. 2001). Kujala et al report that 26.4% of athletes among 2762 who were treated in outpatient unit with knee disorder have had jumper's knee (Kujala, Osterman et al. 1986). This implies that this injury has greater incidence than any other knee injury like meniscus tear, ACL tear etc. Ferretti reports about incidence and etiology among volleyball players (Ferretti 1986). He concludes that the type of training plays minor role in contrast to the quantity and length of practice, as well as physical characteristics and biomechanics of lower extremity in a particular athlete. Pećina et al found that in 21.3% pathological changes affected quadriceps tendon insertion to patella, 72.1% involved inferior patellar pole and 6.6% involved tibial tuberosity (Pećina and Pećina 1999). This responds to the clinical localization of pain. Athletes characterize this type of pain as sharp, cutting, various intensity pains, evolving gradually with no relation to single impact trauma. Functional impairment responds to the pain intensity of affected knee. Patellar tendinopathy has traditionally been graded from grade I to grade IV on the basis of pain and its relation to activity according to the Blazina scale (I-pain after activity only; II- pain before and after exercise, gradually lessening during exercise; II pain with activity causing restriction of activity; IV-pain during everyday activities). Medical history and clinical assessment play major role in diagnostics. Additionally, ultrasound, X-ray and MRT can support the diagnosis. Treatment usually starts with conservative approach avoiding provocative activities, correcting biomechanical deformities with insoles and evaluating sport shoes. Depending on the clinical grade rest is also recommended with gradual return to activities. Stretching exercises play major role in prevention, special care must be taken for hamstrings stretching. Anti-inflammatory drugs can be given over a short period accompanied with criotherapy and other procedures of physiotherapy. In long-lasting cases of non-responding to conservative treatment surgical procedures may be undertaken.

Conclusion

Table tennis is associated with low rate of injuries and no recent scientific paper has studied knee injuries in table tennis. However, clinical practice with table tennis players and studies on general sporting population show that these types of injuries have very high incidence and a very disturbing influence on the function of an athlete. Therefore studies involving this population might bring benefit in better understanding of various and specific risk factors.

Appropriate training schedule has vast influence in prevention of knee injuries. Practically all overuse injuries can be prevented with stretching and taking care of muscle balance. All joints must have full range of motion and biomechanical factors influencing the game of table tennis have to be considered. Demands and stakes of an athlete are rising with more and more competitive surrounding and inadequate warming-up and lack in stretching exercises prior to competition or practice can be first step on the way to an injury.

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RISK FACTORS IN VETERAN TABLE TENNIS PLAYERS

Abstract

Like other physical activities such as walking, running, swimming or cycling, table tennis can be practiced from childhood to old age. In general being physically active when getting older has different positive effects. For example and by comparison with sedentary people of the same age, the regular practice of table tennis slows down the unavoidable decrease in muscle mass, especially in legs, and maintains the aerobic capacity at higher values than in sedentary people. It is well known that playing table tennis after 50 years can help to keep balance, skill and reflexes at a good level, and it has also a positive influence on some brain functions and mood. However it must also be kept in mind that the ageing process is characterised by a more or less pronounced reduction in physical and mental abilities, even in the most physically active people. Therefore the risk of illness or injury increases as the body resistance declines, and some accidents can have a tragic outcome as far as the cardiovascular system is concerned.

In order to have a better knowledge of the specific injuries associated to table tennis in veteran players, all the insurance claim reports issued in France and concerning the table tennis players whose age was equal to or above 40 years have been collected over a period of 4 years. Among the 165 injuries reported, 146 were traumatic injuries, and 19 were cardiovascular events of which 16 lead to the death of the player in a few minutes. All the fatal cardiovascular events occurred in competition except one during a training session.

An adapted practice of table tennis by veteran players may contribute to delay and to momentarily soften the negative effects of the ageing process. However since there is no possibility to totally avoid some of these negative effects, veteran players are strongly encouraged to have a regular activity of moderate level without fighting spirit, and to periodically undergo a medical examination preferably made by a physician who is aware of the loads and constraints linked to table tennis, and particularly with regard to the cardiovascular aspects.

Key-words: *veteran players - risk factors - injuries - cardiovascular events - prevention*

Introduction

Like other physical activities such as walking, running, swimming or cycling, table tennis can be practiced from childhood to old age. In general, being physically active when getting older brings different positive effects (Marks, 2006). For example and by comparison with sedentary people of the same age, the regular practice of table tennis slows down the unavoidable decrease in muscle mass, especially in legs, and maintains the aerobic capacity at higher values than in sedentary people. It is well known that playing table tennis after 50 years can help to keep balance, skill and reflexes at a good level, and it has also a positive influence on some brain functions and mood. Since the second half of the past century, there is a real incitation based on scientific works and medical recommendations which underline the positive effects on health of a regular physical activity during the whole life as opposed to the negative effects of a settled way of life (Paffenberger et al., 1986). At the same time, it seems that the significant increase in mean life expectancy mainly observed in industrialised countries, combined to an increasing leisure time and / or a relative decrease in working time, constitute favourable circumstances to start or to continue a sporting activity well beyond the age of 50 years.

However it must also be kept in mind that the ageing process is characterised by a more or less pronounced but unavoidable reduction in physical and mental abilities, even in the most physically active people. Therefore the risk of illness or injury increases as the body resistance declines and also as the intensity of the practice increases. The notion of risk is present in any sporting activities, including in racket sports, and some accidents can have a tragic outcome as far as the cardiovascular system is concerned. Most of the time, practically all the injuries and serious accidents are linked to the presence of identified and well known risk factors which have been neglected or underestimated. It means that most of these accidents could be avoided if the concerned players accepted to follow some preventive measures.

When searching into the literature it appears that some works have already been published about the pathologies connected to the racket sports, but practically all the publications deal only with traumatic injuries, i.e. bone, joint, ligament and muscle injuries (Kibler and Chandler, 1994; Petschnig et al., 1997; Pluim, 2004). Moreover nearly all studies have been conducted in young and / or elite players. Concerning table tennis, to our knowledge no study has ever been conducted to make an inventory of the most common injuries affecting competitive players above 40 years of age (veterans) and including cardiovascular events. Some data of the present article have been presented during the 4th World Congress on Science and Racket Sports (Kahn and Charland, in press).

Materials and method

In order to better know the type and frequency of injuries and accidents occurring in veterans while playing table tennis, all the insurance claim reports issued in France have been collected over a period of 4 years from 8th January 2003 to 14th January 2007. Only the reports of injuries having occurred on the site of the practice (inside the table tennis hall), and having necessitated a medical care have been taken into consideration. Since a specific insurance contract is systematically attached to the playing licence of each registered player of the French Table Tennis Association (FTTA), it is assumed that practically all injuries and accidents have been reported to the insurance company.

Results

During the 4 years period 165 insurance claim reports concerning players aged of at least 40 years (50.6 $\pm$ 9.1 years, M $\pm$ SD) have been received by the insurance company working with the FTTA. The reports concerned 14 women (7.3 %) aged of 49.8 $\pm$ 9.6 years, and 151 men (92.7 %) aged of 50.6 $\pm$ 9.1 years. The distribution of the reports collected in veteran players according to their age category and gender is shown in table I.

Table 1 *distribution of the claim reports according to age group and gender*

	N	%	Male / Female
V1 (40 – 49 yr)	102	61.8	M = 103 F = 9
V2 (50 – 59 yr)	34	20.6	M = 32 F = 2
V3 (60 – 69 yr)	23	14.0	M = 20 F = 3
V4 (70 – 79 yr)	6	3.6	M = 6 F = 0
Total	165	100	M = 151 F = 14

Among the 165 injuries, 146 (88.5 %) were traumatic injuries (Table II): the most frequent were joint and bone injuries (38.8 %) mainly represented by ankle and knee sprains (25.5 %) and fractures (13.3 %).

Table 2 *evolution of the type of injury as the age is increasing*

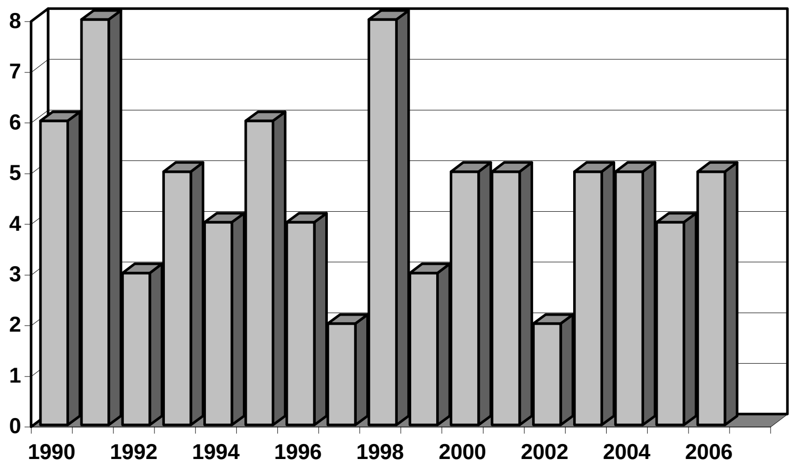
	N (%)	**Age (years) M±SD**
Tennis leg	28 (17.0)	46.2 ± 4.7
Joints	42 (25.5)	47.0 ± 6.9
Rupture of Achilles tendon	33 (20.0)	51.1 ± 6.8
Fractures	22 (13.3)	53.2 ± 11.4
Miscellaneous	21 (12.7)	53.3 ± 11.5
Cardiovascular events	19 (11.5)	57.9 ± 9.5
Total	165 (100)	50.6 ± 9.1

The second largest number of cases (37.0 %) concerned muscles and tendons. The rupture of Achilles tendon represented 20.0 % of all injuries reported; among them, only 1 occurred in a woman. There was also 1 rupture of the patellar tendon. Concerning muscle injuries (17.0 %), there were 23 partial ruptures of the gastrocnemius muscle ("tennis leg") of which 1 in a female player, 3 partial ruptures of the tight posterior muscles, and 2 partial ruptures of the biceps brachii muscle.

In the group "miscellaneous" (12.7 %) there were mainly losses of balance and / or falls: 3 falls were without serious outcome, there were 2 short losses of consciousness, 1 cranial traumatism, and a dozen of minor injuries (bumps against the table or with a racket, etc.)

The remaining cases (11.5 %) constituted the smallest group of accidents but it was also the most serious as it concerned 19 cardiovascular events (57.9 ± 9.5 years of age). In fact 16 of them (9.7 % of all reported injuries) lead to the death of the player (mean age: 59.5 ± 9.2 years) in a few minutes. All the fatal cardiovascular events occurred in men and in competition except one during a training session. This corresponds to a frequency of 4 deaths per year. More data on fatal cardiovascular events in veteran table tennis players have been collected in France during a period of 17 years from 1990 to 2006. During such a long period of time, the mean frequency of occurrence was 4.7 ± 1.7 deaths per year (range: 2 – 8) at a mean age of 53.0 ± 6.9 years (Fig.1).

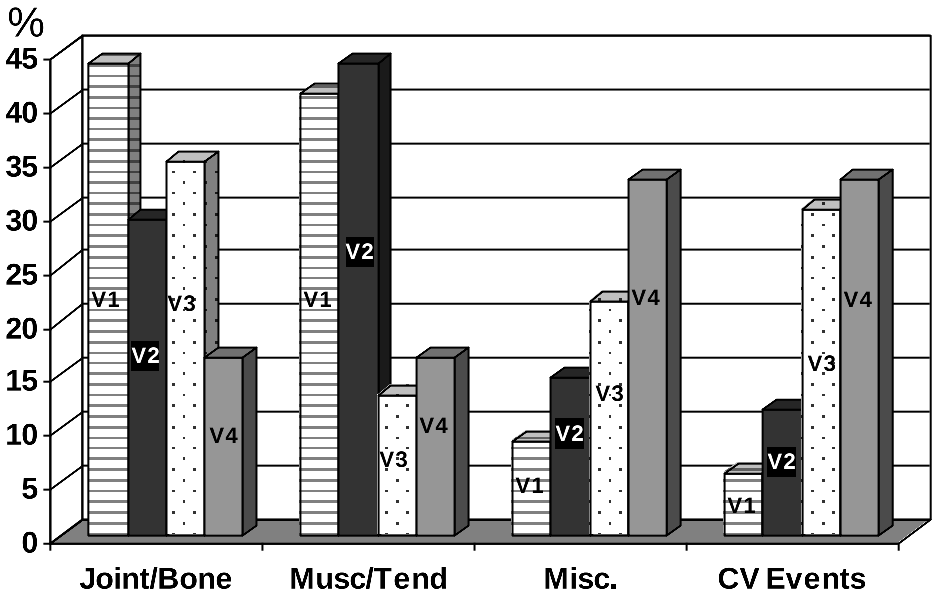
Figure 1 *number of fatal events in veteran table tennis players from 1990 to 2006*



Discussion

Despite its appearance of simplicity and innocuousness (no direct contact with the opponent, light racket and very light ball), table tennis activity is subject to the occurrence of more or less serious injuries, in particular in older players as the risk of injury by falling down and/or of cardiovascular event increases with age (Fig.2).

Figure 2 *distributions in relative values (%) of the different types of injury in each age group*



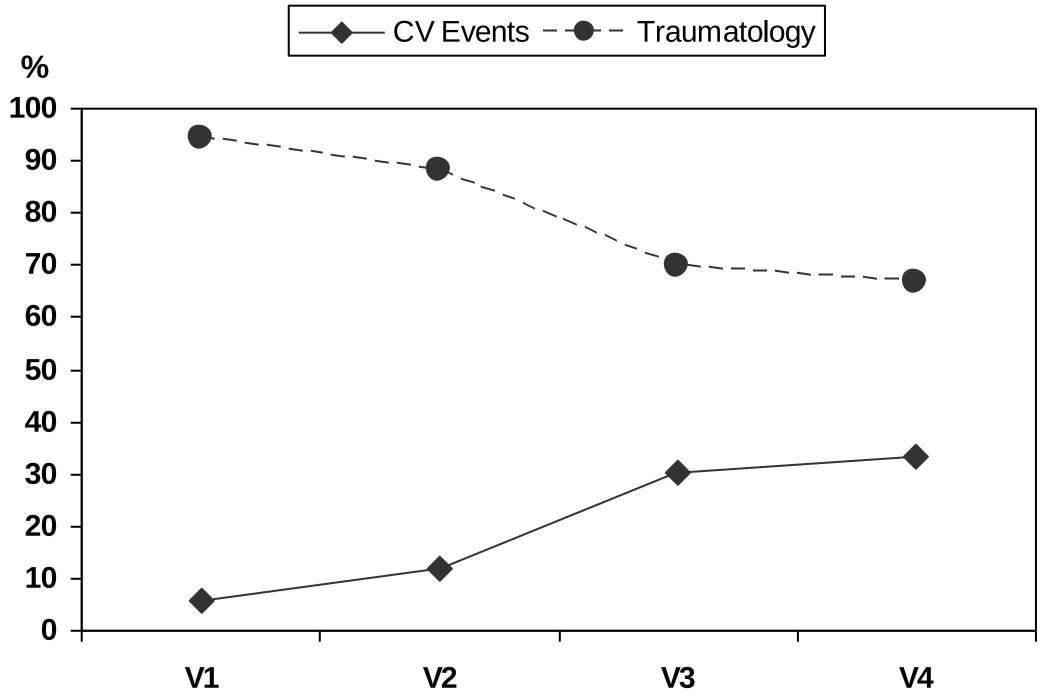
In the French TTA, the players (males and females) aged of 40 years and above roughly represent 20 % of all registered players having a licence, whereas the total of injuries and accidents reported to the insurance company represented around 30 % of all the claim reports received. These figures clearly indicate that the older players are more at risk than their younger counterparts, and that preventive measures need to be developed.

Considering the frequency of occurrence, the first category of injuries related to joints and bones (38.8 % of all injuries), such as ankle sprains or serious knee sprains, and different types of fracture (metatarsal bones, legs, wrists, teeth, etc.). The mean age of the players concerned was 49.1 $\pm$ 9.1 years which corresponds to the "young" veterans (V1). This finding is not surprising since ankle and knee sprains are also the most frequent injuries encountered in table tennis players under 40. It seems that this age group has some difficulty to accept that they are getting older and that their physical capacities have already begun to progressively decrease since several years. In particular there is a small but constant decrease in muscle mass and force, and the central and peripheral nervous system is getting less efficient in controlling fast displacements (lesser coordination efficiency and balance) whereas most of the players of this age group continue to play as if they were 10 or 15 years younger. Moreover, besides the decrease in muscle mass, there is also a progressive decline in bone density and mass of about 0.10 to 0.15 % per year until the age of 50 years. Beyond 50 years the reduction in bone mass is even deeper especially in postmenopausal women. Therefore the induction of bone fragility as people get older combined to some muscle weakness, especially in the lower limbs, easily explains the high frequency of fractures (13.3 % of all injuries) and sprains (25.5 %) in a sporting activity like table tennis where displacements are frequent, sudden and in all directions.

The second largest category of injuries concerned muscles themselves and tendons (37.0 % of all injuries). Not only there is a reduction in muscle mass and force with age, as already mentioned, but there is also a decrease in muscle and tendon elasticity and an increased stiffness, and the couple "muscle + tendon" becomes more and more fragile. The increased muscle stiffness associated to a poorer motor control and a high muscular load ("I want to win that point!") constituted a strong risk of a total or partial rupture of either the gastrocnemius muscle (17.0 %) or the Achilles tendon (20.0 %) at the initiation of a sudden and strong muscle contraction.

It is clear that the most serious accidents were represented by the cardiovascular events, especially when the death occurred in a few minutes, which was the case 16 times out of 19 in 4 years. The 3 survivors were veteran players belonging to V1 and V2 groups (2 and 1 respectively). It means that in V3 and V4 groups, all cardiovascular events were fatal. When comparing the distribution of injuries (in relative values) in players according to their age group, it appears that the occurrence of a fatal cardiovascular event was 5 times as high in players above 60 than in players under 50 (Fig. 3).

Figure 3 *among the injured players, the relative risk of occurrence of a cardiovascular event increases with age, whereas the relative risk of a traumatic injury tends to decrease*



In principle all the players underwent a medical examination at least once a year as they need to obtain a medical certificate to be allowed to play in competition. Even if after a cardiovascular event it is very difficult to get detailed information about the medical history and profile of the victim, it seems obvious that in practically all cases, the player didn't follow the recommendations made by his doctor, and / or neglected some warning symptoms and went beyond his limits while playing. Some of these limits are fixed by the decrease in heart performances with increasing age. For example the maximal heart rate which is about 180 beats per minute (bpm) at 40, is reduced to 150 bpm at 70 years of age. In the same way, all the arteries become more rigid with age which results in an increased resistance to the blood flow, thus the oxygenation of all muscles, including heart, is reduced especially during exercise. Besides age, in sportsmen the cardiovascular system is exposed to several other identified risk factors. These are gender (in general men are at higher risk than women), personal and / or family history of cardiovascular diseases, elevated levels of serum lipids (cholesterol, triglycerides), hypertension, diabetes, overweight, tobacco smoking. All the above risk factors contribute to decrease the inner diameter of the arteries which conduct the blood flow to the brain, heart and muscles. Age and gender are inherited and can't be modified, as well as the family history. On the other hand all the remaining factors can (should) be controlled through a balanced lifestyle and diet (MacLaren, 1998), and the maintenance of a good physical condition during the whole life. Table tennis is characterised by a succession of short and intense periods of activity separated by incomplete recovery which represent an important load for the heart. For this reason veteran players are recommended to spend some time to maintain their endurance abilities through walking, running or cycling. Similarly in order to prevent the decrease in legs and back muscle mass and force, veteran players must be encouraged to regularly make adapted strength training.

In conclusion, like any other sporting activities, table tennis has some risks. At the difference of most other sports, table tennis can be played up to an advanced age. Now the number of risk factors increases with age. In the first age groups (V1 and V2) the risk factors were mainly represented by a progressive decrease in muscle and nervous system capacities together with a decrease in bone density. In these conditions the most frequent injuries were ankle and knee sprains, tennis-leg and rupture of Achilles tendon, and fractures. Above 50-60 years of age, the same risk factors were still present, and were accompanied by cardiovascular risk factors, mainly in male players. In order to detect and to limit the impact of all the risk factors appearing with ageing, every veteran table tennis player should undergo a regular and systematic assessment of his health statute and physical abilities during a medical examination carried out at least once every year. If an abnormality is detected, everything must be undertaken to explore it with the right means and to treat it with the appropriate drug(s), and when necessary the patient must be encouraged to modify his way of life (to lose weight, to stop smoking, etc.). Physical activities must be regular and of moderate intensity.

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A COMPARISION ON HEALTH RELATED QUALITY OF LIFE BETWEEN TABLE TENNIS AND CLOSE-SKILL SPORT PARTICIPANTS

Abstract

Health is a critical component for the quality of life in late adulthood. Many health professionals suggest that maintaining an active lifestyle, especially for the elderly, is key to health. However, what kind of activity provides the best result for the elderly is still a question that needs to be answered. As such, the study tried to compare the health-related quality of life of the elderly participants who participated in table tennis, a sport that is popular for all age ranges in Taiwan, to those that participated in the commonly-studied closed-skill sports such as jogging, walking, and cycling. Fifty-four table tennis participants and fifty-one closed-skill participants completed the MOS 36-item Short Form Health Survey (SF-36). The results of the independent t-test indicated that a). The scores of several measured profiles (i.e. the role limitations due to several measured profiles physical health profile, general health perceptions profile, the role limitations due to emotional problems profile, and the mental health profile) of the geriatrics who played table tennis are higher than those of the closed-skill sports participants, b). The score for the physical component summary for the table tennis participants is higher than that of their counterparts also. The results of this cross-sectional study suggest that table tennis participation provides more health benefits than the closed-skilled sports studied.

Key words: *table tennis, close-skill, quality of life*

Introduction

The elderly population in Taiwan has grown from 8.3% in 1998 to 10% in 2007. (Ministry of the Interior, Population Administration, Department of Population, 2007). The most concerning problem for the elderly population is their health status. To maintain good health is not only a concern for just the younger population but also for the elderly as well. The healthier the elder generation is, the less money is wasted on their medical problems.

The elderly population may improve their health by several methods, such as engaging in all types of normal physical activity. Research of the last two decades has documented exercise's advantageous effect on chronic disease-symptom control, physical function, and overall Health-Related Quality of Life. In addition, recent research has shown that physical activity has beneficial effects on not only the body, but also to the brain, of the older adults. Research supports that exercise can reduce anxiety and depression, and increase positive emotion and self-esteem (Landers & Arent, 2001). Although some recent efforts have explored factors that could moderate the relationship between physical activity and mental health, the ideal exercises to achieve desired health outcomes has not yet been determined (Singh, 2002).

Each type of exercises has different positive outcomes, and each effect is required for the best health and physiological function (Singh, 2002). Aerobic exercise intervention results in better cognitive function than non-aerobic exercise intervention (Dustman, Ruhling and Shigeoka, 1984; Kramer, Hahn, & Harrison, 1999). Studies have shown that Tai Chi can improve one's positive health status by strengthening the cardiovascular and respiratory systems and developing overall fitness (Brown, Mucci Hetzler, & Knowlton, 1989; Lai, Lan, Wong, & Teng, 1995; Lan, Lai, Chen, & Wang, 1998). The population who practiced Tai Chi had better physical and mental health statuses than those who did not practice (Chen, 2000).

To date, research on finding the best type of physical activity for mental health has focused on the taxonomy of aerobic vs. non-aerobic. Not much attention has been paid to the comparison of beneficial effects of the physical activity on mental health between open-skill and closed-skill sports. Open-skilled sports like table tennis are particularly good candidates that may bring extra benefits to the mental health status of older adults. Several reasons can be given to argue for table tennis's candidacy in promoting the mental health status of older adults. On top of practical reasons such as the fact that table tennis is popular among the older population due to the minimal requirement of activity, there are some other features of the playing table tennis itself that could promote the benefits. Table tennis is characterized by a need for fast reaction to unpredictable stimuli. The speed and spin of the ball places a heavy mental and physical load on the participants. Playing table tennis can facilitate the development of hand-eye coordination, maintaining attention ability, and developing muscle strength, endurance and agility. Importantly, it is very likely that the mental load of the skill learning and strategy development is especially stimulating to an aging brain. Animal studies have shown that mice participating in more complex types of exercise secrete more brain-derived neurotrophic factors (BDNF) than those mice engaging in less complex exercises (Gomez-Pinilla, Ying, Opazo, Roy, and Edgerton, 2001). Since BDNF plays significant role on brain functioning, more BDNF release may lead to better brain functioning that in turn results in better mental and emotional health. As such, the purpose of the study is to compare the differences in health benefits between the open-skilled table tennis geriatric exerciser and his closed-skilled counterpart exerciser.

Methods

Participants

One hundred and five geriatrics (fifty-four table tennis exercisers and fifty-one closed-skilled exercisers) completed The MOS 36-item Short Form Health Survey (SF-36).

Instruments

Chinese version of Medical Outcomes Study Short-Form Health Survey (SF-36). The test was developed to measure self-perception of physical and mental health (Ware, 1992). It consists of 36 questions and includes eight domains of health: physical functioning, role limitations due to physical health, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health. This test provides scale scores for these eight health domains, and two summary measures of physical and mental health: the Physical Component Summary (PCS) and Mental Component Summary (MCS).

Result

Table 1 summarizes the mean and standard deviation of SF-36. The score of physical functioning, role limitations due to physical health, role limitations due to emotional problems, and physical component summary of table tennis exerciser are significantly higher than close-skilled exerciser.

Table 1. Comparisons of SF-36 of table tennis exerciser (n=54) and close-skilled exerciser (n=51)

Measure	Table tennis exerciser		Close-skill exerciser		*t*	*P*
	M	SD	M	SD		
physical functioning	51.86	7.42	48.43	12.25	1.73	.09
role limitations due to physical health	47.11	13.04	34.60	10.75	5.38	.00*
bodily pain	54.83	7.60	54.56	31.99	.06	.95
general health perceptions	58.58	8.58	54.56	8.88	2.36	.02*
vitality	58.28	9.85	55.35	10.65	1.47	.15
social functioning	54.59	8.85	53.25	8.64	.78	.44
Role limitations due to emotional problems	48.31	11.86	36.99	10.26	5.23	.00*
mental health	58.97	10.30	53.55	12.58	2.42	.02*
physical component summary	48.06	8.60	41.67	14.35	2.78	.01*
mental component summary	59.76	9.51	56.07	10.57	1.88	.60

*p<.05

Discussion

The purpose of this study is to compare self-reported health-related quality of life between older adults participating in table tennis with those who participated in various closed-skilled sports. The hypothesis of better heath-related quality of life in table tennis participants is supported. Although not all 10 components in the questionnaire reached statistical significance, table tennis participants reported better score on all of them. The 5 components that table tennis participants showed statistically significantly higher scores are Role limitations due to physical health, General health perceptions, Role limitations due to emotional problems, Mental health, and Physical component summary.

There are several explanations for the beneficial effect of physical activity on the brain (Shi & Hung, 2006). First, physical activity improves the cerebral blood circulation, which in turn enhances the supply of oxygen and glucose, two essential fuels for the neuron, to the brain. Second, physical activity increases the synthesis and release of neurotrophic factors (NF) such as brain-derived neurotrophic factors (BDNF). These NFs play an important role in the activity and function of the neurons. Third, physical activity also enhances the synthesis and release of neurotransmitters that are critical for communication between neurons. Thus the combination of the aforementioned effects of physical activity to the brain is particularly beneficial to the older generation because aging places a toll on the normal functioning of the brain. By playing a reverse role against aging's degenerative effect on the brain, physical activity contributes to the elderly population's higher quality of life via its positive effects on the mind.

The finding of better health-related quality of life in table tennis participants is encouraging. Table tennis is a sport that can be both physically and mentally stimulating. The participants in this study engage in the sport regularly. The chronic effect of long-term participation may stimulate more BDNF release than those of the close-skilled sport participants. This explanation is supported by Gomez-Pinilla, Ying, Opazo, Roy, and Edgerton (2001). These authors found that mice participating in more complex types of exercise secrete more BDNF than those that were engaging in less complex exercises. BDNF release is important for neuron function and is the foundation for a sound mind.

In conclusion, the study found that table tennis participation in the elderly is associated with better health-related quality of life than closed-skill sports participation. This finding supports the notion that sports associated with more mental stimulation, such as table tennis, in addition to the physical stimulation, can enhance self-reported health states in the older population.

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THE INFLUENCE OF LONG-TERM TABLE TENNIS TRAINING ON THE INCIDENCE OF THE IMPROPER POSTURAL ALIGNMENTS (PARAMORPHISMS)

Abstract

The main objectives of this investigation were to (a) classify the subjects (table tennis players - TTP, and age-related controls - C) according to their postural alignment status, as well as to (b) determine is there any relation between long-term active table tennis training and emergence of improper postural alignments (paramorphisms) in children and youth. The sample of subjects comprised 67 TTP, younger cadets and cadets; and 80 C (all 10-14 years of age). Measurement of the postural status indicators was performed using the photo-equipment of the high-resolution. Digitalized photo shots were taken in the frontal and sagital plane, and additionally processed using the "Posture Screening" software program in beta version.

According to data calculated by means of the taxonomic and discriminant analysis it can be concluded that there is (a) no significant difference between TTP and C regarding their clustering into groups of the different-postural-alignments, while (b) significant differences were found in several indicators of the postural status. Although considerable incidence of the improper postural alignments is found, it has to be stressed as the general problem in youth and not to be directly related to regular table tennis training. Table tennis training brings forward some specific circumstances in a problem of the improper postural alignment, e.g. lowered shoulder of the dominant hand and somewhat hunchbacked basic position in a sagital plane, all mainly linked to biomechanical and structural characteristics of the sport.

Results obtained herein, as well as the high incidence of the improper postural alignments, directly point at importance of the general preparation of a locomotor system in athletes; mainly because that there is no doubt that multi-approachable conditioning training, adjusted to the athletes age; can positively influence the proper and symmetrical development in young TTP. In such manner, it is possible to diminish some negative consequences that frequent and intensive table tennis trainings could have on the postural status.

Key words: *postural alignments, paramorphisms, table tennis, software program (computer program)*

INTRODUCTION

Increasing incidence of the improper and incorrect body postures (paramorphisms) in children and youth is recognized as highly important problem in modern societies, which, in case of underestimation can lead to structural deformities (dismorphisms), which are hardly correctable, and inquire a long-term and serious medical treatments (in particular cases - even the orthopedic).

Although it is generally clear that the physical activity unquestionably positively influences several organs and organ systems, sport medicine physicians report an increasing incidence of the incorrect and improper body postures and deformities in children and youth regularly included in some sport activities (Kosinac 2002). Therefore, although proper application of the kinesiological operators (in a term of physical exercising and sports) in kinesitherapy is a one of the most reliable basis in the treatment of some ailing conditions and sicknesses, it is also obvious that in some cases and in several sports, exclusive positive influence and effects has to be inquired. It especially considers modern top-level sport, which implicate regular and maximal - even extreme workloads and training intensities, which can initiate negative consequences on children and youth in sensitive developmental age. In young athletes, spine is on particular risk, but the other parts of the locomotor system are also significantly impacted.

Although attitudes of the experts are opposed, and there are no reliable scientific evidence regarding sport as a direct cause and the initiation of some paramorphisms like scoliosis and kyphosis, there are indications that together with some of inheritance and genetically determined inclinations, several sports, especially those asymmetrical, can negatively influence the postural status, and therefore – to cause some deformities. In athletes it can lead to several health issues and problems (e.g. back pain; chronic fatigue,…), and therefore negatively influence theirs' competitive efficacy, and in some cases – theirs' sport career as a whole.

Because of the biomechanical and structural characteristics of the table tennis, which is observable in (a) asymmetrical nature (repetitive performance of the strong, one-arm-strokes); (b) hunched basic position; and (c) strong rotations in hips and lumbar region; there is reasonable doubt that the table tennis players are additionally imposed to several factors which can initiate occurrence and development of the paramorphisms, when comparing to the normal population. Consequently, the main objective of the present study was to (a) classify the subjects - table tennis players in several clusters according to their postural alignment status, as well as to (b) determine is there any relation between the long-term active table tennis training and the emergence of improper postural alignments (paramorphisms) in children and youth.

METHODS

Cases

The sample of examinees in this study was consisted of 67 table tennis players (E; TTP) of the high competitive rank in its age group (younger cadets and cadets; 10-14 years of age). The only obligatory circumstance for the study entry of the TTP was the proper registration in Croatian table tennis federation, and active practicing of the table tennis for three years minimally. The control group (C) was consisted of 80 same-aged boys; non-engaged in table tennis training, for the purpose of presenting general population of boys, 10-14 years of age.

Variables

The sample of variables consisted of postural status indicators. The measurement was conducted knowing the referent points of the body regarding the gravity line in sagital and frontal plane (Auxter, Pyfer, Huettig 1997; Palmer and Epler, 1998) and comprised numerical values of the four referral points in the sagital plane (Figure 1), and five referral points in the frontal plane.

Postural status indicators in the frontal plane:

- FUHO – the indicator of the divergence between the (a) line which connects upper ear lobes (left – to- right) and (b) horizontal line. Indicator is measured by computer program in degrees
- FRAM - the indicator of the divergence between the (a) line which connects left and right sacromion and (b) horizontal line. Indicator is measured by computer program in degrees
- FZDJ - the indicator of the divergence between the (a) line which connects left and right spina iliaca anterior superior and (b) horizontal line. Indicator is measured by computer program in degrees
- FKOL - the indicator of the divergence between the (a) line which connects left and right s epicondylus medialis and (b) horizontal line. Indicator is measured by computer program in degrees

- FNZG - the indicator of the divergence between the (a) line which connects left and right s malleolus medialisa and (b) horizontal line. Indicator is measured by computer program in degrees

Postural status indicators in the sagital plane:

- SUHO – the indicator of the divergence between the (a) upper left ear lobe, and (b) gravity line. Indicator is measured by computer program in numerical unit
- SRAM – the indicator of the divergence between the (a) left acromion, and (b) gravity line. Indicator is measured by computer program in numerical unit
- SZDJ – the indicator of the divergence between the (a) left spina iliaca anterior superior, and (b) gravity line. Indicator is measured by computer program in numerical unit
- SKOL – the indicator of the divergence between the (a) epicondylus medialis, and (b) gravity line. Indicator is measured by computer program in numerical unit

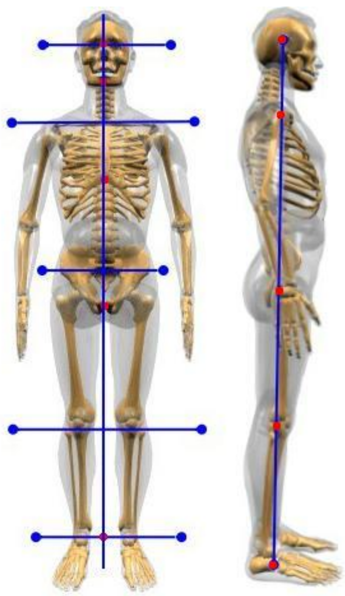

Figure 1. Referral points in frontal and sagital plane including gravity line

The measurement is performed using the digital photo equipment (camera; computer applied with adequate software). The data application is performed by importing digital photo of the subjects in sagital and frontal plane. Accordingly, it was possible to determine eventual improper postural alignments, known as kyphotic, lordotic, and scoliotic body postures; as well as different incorrectness, like improper alignment in the cervical spine, shoulder positioning, flat back, chest muscle asymmetry, so called "X" and "O" legs, etc.

***Figure 2**. Test managing (photographing of the examinee)*

The whole measuring procedure, in each parameter, was repeated three times, to reveal measuring instrument of the composite type with three times. The measuring procedure was performed by the standardized measuring protocol, explained in the following measuring card.

Presentation 1. Test explanation

Exact naming of the test	Posture positioning in two planes
Technical characteristics	The space where the measuring is performed has to be of minimally 5 x 2 meters, and well lightened. The examinees positioning spot is marked by one line on the floor. Three meters apart of the examinee's positioning, photo equipment on stativ-holder is placed.
Explanation of the measurement	The examinee stands on the line drawn on the floor facing the photo. The examiner places yellow markers (small circle adhesives) on referral points of the examinee. Following, the photo was taken. Next, the examinee is placed in sagital plane, markers are positioned, and photo is taken.
Instructions given to the examinee	"You should stand on the drawn line facing the camera in straight relaxed position, hands relaxed, foots shoulder-wide apart. Next, you should turn for 90 degrees in the same position"
Results of the examinee	The results of each referral point will be calculated using the computer software, and referred in degrees and/or centimeters.

Data processing methods

Photographs obtained were processed by software program "Posture screening" in beta version, authored by Jelena Paušić. The results in each indicator of the postural alignment were computed by statistical software package Statistica 6 (StatSoft).

Results were calculated by discriminant analysis (by means of Burtlet's χ^2 test*)*, and included following parameters; variance of the discriminant function (λ), canonical correlation coefficient (*Rc*) and Wilk's lambda coefficient ($W\lambda$) discriminant functions, correlations of the variables with discriminant functions (matrix of the structure), centroids of the groups on the discriminant functions, and descriptive parameters: means (AS), and standard deviation (SD). The types of the postural alignment in frontal and sagital plane were obtained by taxonomic analysis, by method of K-Means, with selection of three clusters.

RESULTS AND DISCUSSION

The calculated indicators of the body posture are divided in two groups regarding plane in which photo was taken. Therefore, they are independent, and can divide examinees in several groups based on the type of body alignment. The types of the body alignment were defined by taxonomic analysis, and three types of body alignment were identified, separately in each plane. The types obtained, and categorizations in each type (expressed in percent) are presented in tables 1 and 2.

Accordingly, it is evident that in both groups (C and E) single type of the body-posture-alignment exists, and that there is a large percent of the boys within some of the groups with improper body-posture-alignment.

Generally, when observing boys in a sample of table tennis players, only few more than one-third (34.3%) can be stipulated as correct in frontal posture. However, it is still far better than in general population, where only each fifth pupil (19.4%) can be considered as correct in the frontal posture. Regarding the sample of table tennis players, situation is far worse in the sagital plane, since only one-fourth can be considered as correct in (sagital) posture (26.9%), while even one-third has highly incorrect posture status (31.3%). The main reason for such a condition can probably be found in hunched basic position while playing, highly characteristic in table tennis, which - if accomplished for a long time, can greatly increase the probability for improper postural alignment in the sagital plane.

Table 1. The percent of the examinees belonging to the different types of frontal postural alignments (OP – general population of boys, ST- boys table tennis players)

Types of frontal postural alignments	**$\%_{OP}$**	**$\%_{ST}$**
correct frontal postural alignment	19,4	34,3
mildly scoliotic postural alignment	47,6	28,4
mildly two-sided scoliotic postural alignment	33,0	37,3
Total	100,0	100,0

Table 2. The percent of the examinees belonging to the different types of sagital postural alignments (OP – general population of boys, ST- boys table tennis players)

Types of frontal postural alignments	**$\%_{OP}$**	**$\%_{ST}$**
correct sagital postural alignment	29,3	26,9
mildly incorrect sagital postural alignment	41,8	41,8
highly incorrect sagital postural alignment	28,9	31,3
Total	100,0	100,0

To establish the differences between the two samples of boys we studied, we defined the structure of discriminant functions, calculated separately in frontal and sagital indicators of the body posture. Results presented in the following tables (3 and 4) shows that discriminant functions are statistically significant, and therefore significant differences between two studied samples can be identified in some of the indicators studied.

Table 3. Test of the significance for the discriminant functions *(F – frontal indicators of the postural alignment, S - sagital indicators of the postural alignment)I*

	λ	**R_C**	**$W\lambda$**	**χ^2**	**df**	**p**
DF_F	0,18	0,39	0,85	23,5	5	0,00
DF_S	0,97	0,70	0,51	96,8	4	0,00

In the frontal indicators, the most important factor of the significant differences between samples is – positioning of the knees. This indicator in frontal plane is more correct in the table tennis players than in boys drawn from the general population. Another one important indicator is divergence in shoulders in frontal plane, where the table tennis players achieve higher divergence than the boys drawn from the general population (0.98 and 0.35 degree respectively). Positive values in degrees, of their average values, indicate that in both samples inclination of the left shoulder when comparing to right one is evident. Since it is more indicated in the table tennis players, the main reason have to be found in a simple fact that a most of the tested players are right-handers. Therefore, it seems reasonable to conclude that they have relatively more developed muscles of the right side of torso, especially m. lattisimus dorsi and m- trapezius, which "pull" the peak of the shoulder down and back. Somewhat lower shoulder of the dominant hand in the table tennis players is often clearly observable, and does not necessarily to be identified by software program.

Table 4. Descriptive indicators *(mean – AS and standard deviation – SD) with identification of the discriminant function structure (DF), and analysis of the variance (ANOVA) separately in frontal, and in sagital indicators of the body posture)*

Indicators	AS OP	SD OP	AS ST	SD ST	F	p	DF
FUHO	-0,20	2,15	-0,85	2,86	2,2	0,14	0,31
FRAM	0,35	1,60	0,98	2,37	3,7	0,05	-0,37
FZDJ	-1,47	1,46	-0,64	2,24	3,5	0,06	-0,53
FKOL	-1,04	1,51	0,10	2,39	10,4	0,00	-0,69
FNZG	-1,23	1,61	-1,63	2,99	1,8	0,19	0,20
						C OP	0,39
						C ST	-0,46

Indicators	AS OP	SD OP	AS ST	SD ST	F	p	DF
SUHO	-3,88	2,71	-6,05	3,14	0,09	0,77	0,38
SRAM	-3,23	2,87	-4,82	3,04	3,24	0,07	0,27
SZDJ	-5,11	2,45	-9,05	2,72	68,32	0,00	0,78
SKOL	-1,72	2,04	-0,39	1,41	27,63	0,00	-0,38
						C OP	0,89
						C ST	-1,07

The factor which mostly contributes to significant differences between samples in sagital parameters is the indicator of the pelvis divergence. This parameter is on average 4 cm larger in the table tennis players, than in control subjects. Additionally, divergence in knees is more proper in table tennis players than in controls. Generally, the mean values in sagital parameters indicate somewhat more inappropriate postural alignment in the table tennis players than in controls. The parameters of the head positioning, and the shoulders positioning lead us to conclusion about somewhat hunched position of the table tennis players, when comparing to control group – general population of the same aged boys.

CONCLUSION

Results of the present investigation show that there is (a) no significant difference between TTP and C regarding their clustering into groups of the different-postural-alignments, while (b) significant differences were found in several indicators of the postural status. Although considerable incidence of the improper postural alignments is found, it has to be stressed as the general problem in youth, and not to be directly related to regular table tennis training. Table tennis training brings forward some specific circumstances in a problem of the improper postural alignment, e.g. lowered shoulder of the dominant hand, and somewhat hunchbacked basic position in a sagital plane, all mainly linked to biomechanical and structural characteristics of the sport.

Anyway, results from this study directly point at particular importance of the general preparation of a locomotor system in table tennis athletes; mainly because that there is no doubt that multi-approachable conditioning training, adjusted to the athletes age; can positively influence the proper and symmetrical development in young TTP. In such manner, it is possible to diminish some negative consequences that frequent and intensive table tennis trainings could have on the postural status.

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A COMPARISON OF INJURIES AND REASONS FOR OCCURRENCE IN TABLE TENNIS BETWEEN EGYPTIAN AND FOREIGN PLAYERS PARTICIPATING IN ITTF WORLD JUNIOR CHAMPIONSHIP 2006 IN EGYPT

Abstract

This study aims for the determination of the types of injuries in table tennis and the organs that are mostly affected as well as the reasons of occurrence for Egyptian players, and comparing them to players of other national teams participating in the TT world cup for juniors 2006 in Egypt.

The sample of the study included (128) players divided into (54) Egyptians and (74) representing other national teams, both males and females representing (16) countries in this first class event. The frequency of injury, reasons of occurrence & affected organs were reported through a questionnaire to define the reasons for injury through personal interviewing.

The most important results of this study can be briefed as follows:

The most frequent injury for the Egyptian players occurred in the spine with a percentage of (28.3%) for males and (15.3%) for females followed by shoulder injuries with a percentage of (17.5%) for males and (14%) for females.

And for the other participating teams the most frequent injury occurred in the spine also with a percentage of (25%) for males and (23.7%) for females followed by shoulder injuries with a percentage of (23.7%) for males and (22.9%).

Conclusions: We can conclude form these results that the most affecting reasons for injury occurrence for the Egyptian players was due to the unorganized planning for training loads which causes the players to burn out or feel fatigue. Comes next the weakness of physical preparation programs. Also, the non-presence of a physiotherapist with the participating teams even during first class world events. Besides the lack of information about first aid.

For other players representing other countries, they suffered from the high intensity of training and unorganized sessions in addition to not applying the first aid quickly that causes some injuries to turn into chronic ones.

Key words: *table tennis, injuries*

In the sport of table tennis & according to circumstances, the player can be engaged either in an individual or a team event. The length of the competition may vary from a few hours to several days (at international level, some competitions are spread over 8 days like world championships and 10 days like the Olympic Games).

During a single day, a player may be brought to play up to 4 or 5 matches and sometimes even more. Besides the duration of a single match is extremely variable depending on the number of games and points played, which is considered to be an additional physical, psychological and physiological load on TT players. (5) These loads play a significant role in injury occurrence.

TT injuries constitute a real challenge for the technical management bodies due to the diversity of the predisposing and causative factors. (13) Despite the fact that TT sport is characterized by being the least world sport concerning the percentages and rates of injury; however, we find constant complaint from all players especially players in international contests.

Furthermore, juniors receive the least medical care in their clubs or national teams; however, this care can be intensive for international and professional players as they always receive the best medical service. For this reason training juniors and their medical treatment is mostly self-dependant, which in turn makes them more exposed to injuries. (14)

In all organizing sports establishments we find juniors to be the main basis supplying seniors and high-level teams with well-prepared players. Thus, they must receive maximum care and their problems should be studied seriously as injury of a junior might be a very dangerous factor that might end his sports career even before it actually starts. (6)

Next comes the importance of first aid that helps in reducing the recovery period and preventing side effects of injuries as well. (11)

Some coaches make big mistakes when they train all players in the same way and within the same program without paying any attention to the individual differences between those players. In addition, most coaches do not pay much attention to psychological and sociological preparation as a main art of their training programs as these aspects have very high importance the same as physical and technical preparation have. (2)

Some other coaches lack information about first aid that might reduce the severity and effects of injury especially when there are no physicians or physiotherapists in the place of training or competition.

The well-prepared training program helps also in reducing injuries (injury reduction percentage is approx. 50%) that occurs during sports activities under normal circumstances. (11)

From all the above-mentioned, it is clear that daily and intensive training causes a lot of pressure on the junior's body, which leads him to fatigue and injuries.

Sports injuries in TT is a main obstacle facing the development of juniors' talents especially when we know that the least care is paid to them when we see some coaches who do not attend all training sessions, or when we find no physiotherapist accompanying the team in training and competition which causes juniors to be injured and some times severely.

When we move to talk about TT Egyptian juniors, their injury rates have not been studied yet neither the causes of injuries nor the prevention strategies which pushed the researchers to define sports injuries, their causes for Egyptian and foreign TT juniors participating in the TT World Cup for juniors that was held in Cairo – Egypt 2006.

Thus, this study is conducted to achieve better understanding for strategies that might help in reducing injuries and developing the prevention culture for both coaches and players, in addition to clarify some other recommendations related to the factors that might cause injury.

Research aims:

Defining the types of injuries that occur in TT, reasons, causes and frequent affected organs for Egyptian and foreign TT juniors participating in the TT world cup for juniors - that was held in Cairo – Egypt 2006. This aim can be achieved through some branched aims:

1- Defining most frequent injuries for Egyptian & foreign TT juniors (males – females).
2- Defining most frequent injured organs for Egyptian & foreign TT juniors (males – females).
3- Defining the reasons for injury occurrence for Egyptian & foreign TT juniors (males – females).

Research procedures:

Research method:

In view of the research aims and assumptions, the researchers used the surveying descriptive method for its suitability to the nature of the research.

Research sample:

Table (1) shows the distribution of research sample.

Table no. 1: Distribution of the sample on the Egyptian clubs and the foreign national teams participating in the TT juniors' world cup 2006 in Egypt

S	Egyptian juniors			S	Foreign juniors		
	Club	N=			Country	N=	
		Males	Females			Males	Females
1	Al-Ahly	6	4	1	China	3	4
2	Zamalek	5	4	2	Japan	2	3
3	ASC	5	4	3	Germany	2	4
4	El-Giesh	3	-	4	France	2	4
5	El-Shams	2	4	5	UK	2	3
6	Maadi	2	2	6	Canada	3	3
7	GASCO	2	-	7	Spain	2	2
8	El-Sharkeya	1	2	8	Russia	2	4
9	Desouk	2	-	9	India	3	3
10	Damahour	2	-	10	Slovenia	2	3
11	El-Gezira	2	2	11	Ukraine	2	3
				12	Australia	3	-
				13	Slovakia	2	4
				14	Sweden	2	2
				15	USA	2	-
Total		**32**	**22**	**Total**		**32**	**42**

Table (2) shows the description of research sample according to biological age – training age – no. of daily training hours – no. of daily training sessions.

Table no. 2: Description of the research sample according to some basic variables

S	Sample / Variables	Egyptian juniors						Foreign juniors					
		Males N = 32			Females N= 22			Males N = 32			Females N= 42		
		AM	SD	SK	AM	SD	SK	AM	SD	SK	AM	SD	SK
1	Biological age	16.5	3.01	1.13	16.09	2.73	1.34	16.87	2.13	1.34	16.15	2.73	1.63
2	Training age	8.75	2.03	0.34	7.83	1.13	1.03	9.31	1.05	0.30	8.65	1.45	0.42
3	No. of daily training hours	3.68	0.63	0.48	3.54	0.34	0.94	5.25	0.55	0.95	5.20	0.66	0.55
4	No. of daily training sessions	1.37	0.13	1.05	1.20	0.25	0.35	2.00	0.56	0.74	2.00	0.54	0.47

AM: Arithematic mean SD: Standard deviation SK: Skewness

Research time range:

The research was conducted in the period from July 2006 to Feb 2007 and the basic study was performed during the Egyptian TT national league for juniors and the TT juniors' world cup that was held in Cairo – Egypt from 10 to 17.12.2006.

***Research place*:**

Smouha sporting club
Arena complex (Cairo stadium – Egypt)

First: Designing the research questionnaire:

After referring to several scientific references in TT and sports injuries and after performing some personal interviews with some coaches and TT juniors, researchers were able to determine the 4 major elements of the questionnaire (attachment 8).
The validity and reliability of the questionnaire were confirmed after being applied o a sample of 20 junior TT players (excluding the research sample).

1- Validity: It was calculated through finding the common factors between the questionnaires' sentences and the sum of elements that the sentences belong to. (Table 3) (Attachment 2)

Table no.3: Correlation coefficient between each statement and the sum of the element it belongs to in the research questionnaire

Training load		Medical care		Sports culture		Player	
Statement no.	**R**	**Statement no.**	**R**	**Statement no.**	**R**	**Statement no.**	**R**
1	0.59	**1**	0.56	**1**	0.48	**1**	0.69
2	0.78	**2**	0.60	**2**	0.88	**2**	0.61
3	0.72	**3**	0.71	**3**	0.57	**3**	0.55
4	0.51	**4**	0.84	**4**	0.91	**4**	0.46
5	0.63	**5**	0.95	**5**	0.49	**5**	0.56
6	0.47	**6**	0.66				
7	0.65						
8	0.81						

2- Reliability: Which was calculated using alpha cronbach's factor & spearman's factor on (n= 20) (Table 4) (Attachment 2).

Table no.4: Questionnaire reliability using Alpha Cronbach and spearman's Coefficient

Statistical processing	Alpha Cronbach	Correlation coefficient	Spearman's Coefficient
Variables	0.96	0.84	0.91

Table no.4 clarifies the reliability of the research's questionnaire using Alpha Cronbach & spearman coefficient

Second: Basic study:

The questionnaire was distributed in some personal interviews over 2 stages, the first one was during the finals of the Egyptian TT juniors league that was held in Smouha sporting club in Alexandria over 4 days & the second stage was during the TT juniors world cup that was held in Cairo stadium over 8 days.
After data collection, statistical processing was applied.

Third: statistical analysis:

Statistical analysis was performed through using the following statistical processing means:

- Alpha cronbach's coefficient
- Spearman's coefficient
- Arithmetic mean
- Standard deviation
- Correlation coefficient
- Percentage

Results discussion:

To answer the question that says: what are the most frequent injuries for TT Egyptian male and female juniors? We used the sum of frequencies and the percentage as clarified in table no. (5) (Attachment 3), where the Cramp took the first place with a percentage of (25.2%) for males and (33.3%) for females, traumas came in the last place with a percentage of (3%) for males and (6.1%) for females.

Table no.5: Frequency and percentages for the most frequent injuries for TT Egyptian juniors

Sample	S	Most frequent sports injuries	Frequency	%
TT junior males, N= 32	**1**	Muscular cramp	33	25.2
	2	Chronic and acute pain	32	24.4
	3	Chronic inflammation	27	20.6
	4	Ruptures	15	11.5
	5	Sprains	12	9.2
	6	Strains	8	6.1
	7	Trauma	4	3
		Total	131	100%
TT junior females, N= 22	**1**	Muscular cramp	33	33.3
	2	Chronic inflammation	17	17.2
	3	Chronic and acute pain	16	16.1
	4	Ruptures	15	15.2
	5	Sprains	12	12.1
	6	Trauma	6	6.1
		Total	**99**	**100%**

This similarity came from the common training circumstances, and competition and life in general for both groups.

Cramp came in the first place among the most frequent injuries due to the reasons of injuries as it came in the questionnaire in the elements of training and player (ex: inefficient warming up – random training – low fitness levels for juniors – starting technical and tactical training without doing enough stretching and flexibility exercises which causes injury – the lack of fitness planners for Egyptian TT juniors –lack of physiotherapists and medical care during training sessions and competition).

To answer the second question that says: what are the most frequent injuries for TT foreign male and female juniors? Table (6) (Attachment 4) shows that chronic and acute inflammation is the most frequent injury for foreign TT male juniors with a percentage of (42.1%) but for females chronic pain came in the first place with (35.8%). Traumas came in the last place for both groups males and females (3.9%) & (2.5%) consecutively.

Table no.6: Frequency and percentages for the most frequent injuries for TT foreign juniors

Sample	S	Most frequent sports injuries	Frequency	%
TT junior males, N= 32	**1**	Chronic inflammation	32	42.1
	2	Muscular cramp	19	25
	3	Sprains	14	18.4
	4	Ruptures	4	5.3
	5	Strains	4	5.3
	6	Trauma	3	3.9
		Total	**76**	**100**
TT junior females, N= 42	**1**	Chronic and acute pain	29	35.8
	2	Chronic inflammation	17	21
	3	Muscular cramp	15	18.5
	4	Sprains	14	17.3
	5	Trauma	4	4.9
	6	Ruptures	2	2.5
		Total	**81**	**100**

Researchers refer these frequent injuries to some major reasons as training for long periods which cause an extra physiological load on the body joints and muscles which makes the body more exposed to injury occurrence. In addition to continuous training in spite of feeling fatigue or pain or being injured and hiding pain symptoms from coaches which makes the situation of injury more complicated which might turn it from simple to chronic.

The above-mentioned is similar to article concerning the fact that many TT players suffer from injuries because of continuous training and over load especially when they are growing older. Also, chronic injuries are a direct result for not caring about simple and primary injuries. So TT players are advised to consult a physician when they feel pain and when the injury takes more than it needs to recover (8) (9).

Table no. 7: Most frequent affected parts of the body for Egyptian and foreign TT juniors

S	Most frequent affected parts of the body Egyptian males N= 32	Frequency	%	S	Most frequent affected parts of the body Egyptian females N= 22	Frequency	%
1	Lumbar	37	28.2	**1**	Lumbar	20	20.3
2	RT shoulder	23	17.5	**2**	RT shoulder	19	19.3
3	Hamstrings	13	10	**3**	RT ankle	13	13.1
4	Quadriceps	12	9.1	**4**	Hamstrings	12	12.1
5	Triceps	11	8.4	**5**	Quadriceps	11	11.1
6	Biceps	7	5.3	**6**	Calf	10	10.1
7	RT knee	6	4.6	**7**	RT knee	4	4
8	RT ankle	6	4.6	**8**	RT wrist	4	4
9	RT Achilles tendon	4	3.1	**9**	RT hand fingers	4	4
10	RT hand fingers	4	3.1	**10**	LT hand fingers	2	2
11	RT adductor muscle	3	2.3				
12	LT adductor muscle	3	2.3				
13	Calf	2	1.5				
TOTAL		**131**	**100**	**TOTAL**		**99**	**100**

Continue Table no. 7: Most frequent affected parts of the body for Egyptian and foreign TT juniors

S	Most frequent affected parts of the body Foreign males N= 32	Frequency	%	S	Most frequent affected parts of the body Foreign females N= 42	Frequency	%
1	Lumbar	16	21.1	**1**	Lumbar	20	24.7
2	RT shoulder	13	17	**2**	RT shoulder	18	22.2
3	RT knee	10	13.1	**3**	RT knee	10	12.4
4	Shoulder muscles	5	6.6	**4**	Biceps	7	8.6
5	Hamstrings	5	6.6	**5**	Calf	6	7.4
6	Quadriceps	5	6.6	**6**	RT Wrist	5	6.2
7	Biceps	4	5.3	**7**	RT ankle	4	4.9
8	Calf	4	5.3	**8**	RT Achilles tendon	4	4.9
9	RT ankle	4	5.3	**9**	Triceps	3	3.7
10	RT wrist	4	5.3	**10**	Hamstrings	2	2.5
11	Neck vertebrae	3	3.9	**11**	RT hand fingers	2	2.5
12	RT hand fingers	3	3.9				
TOTAL		**76**	**100**	**TOTAL**		**81**	**100**

Both junior male groups were common in the injuries occurring in the muscles working on the thigh and the arm took the 3rd place, and both junior female groups were common in the injuries occurring in the nee joint which took the third place.

Then in the last place, the fingers of the right hand came as the least injured part of the body for TT juniors either males or females.

Researchers refer the high exposure of the lumbar region and the shoulder joint to the nature of performance in TT which has special demands for strength and speed which in turn makes a bog load on both regions as the lumbar region and the shoulder joint are the main sources of all TT strokes. This agrees with what Antonio J. et al (2003) had stated as they proved that the development of the technical performance during the match is mainly affected by trunk and shoulder movements. (4)

Furthermore, Al-Atoom (2005) confirms the high frequency of shoulder injuries in TT which can be referred to the free movement of this joint as it moves in all direction which in turn is reflected negatively on the joint to cause injuries finally (1).

It is now clear that we need to analyze different playing skills and to put the most appropriate exercises to help in injury prevention. Also we need to suggest specific rehabilitation programs for the injured parts.

Ann G (1995) adds that understanding the effects of natural phenomena like gravity, movement and balance helps in the body safety and helps in planning training programs (3).

This agrees with what the above-mentioned article stated concerning the most frequent TT injuries as follows: Shoulder – Elbow – Low back pain – Lower extremities injuries (8).

Also Koulopoulos (2006) agrees with the above-mentioned as he stated that the injuries of shoulder joint are the most common and frequent injuries in TT and it occurs due to the over training load (9).

We rarely find researches or studies about injuries in table tennis which pushed the researchers to count on a questionnaire to define these injuries and to define also the reasons for injury occurrence.

It is clear from the answers of the sample members in tables no. (8) & (9) (Attachment 6, 7) that the first reason for injury occurrence for TT Egyptian juniors in the training element was the over training load with a percentage of (87.5%) for males and (81.8%) for females. The lack of fitness planners came in the second place with a percentage of (75%) for males and (72.6%) for females. Comes next ignoring the periodic examination for fitness levels for juniors with a percentage of (68.8%) for males and (45.5%) for females. Then random training which is not done according to a specific training program or schedule with a percentage of (62.5%) for males & (36.4%) for females.

Table (8): The reasons for injury occurrence for the Egyptian male TT juniors

Element / Statistical Processing	Egyptian male juniors						X2
	Yes		Sometimes		No		
	Freq.	%	Freq.	%	Freq.	%	
Are you trained according to a prepared training time schedule?	8	25	4	12.5	20	62.5	13
Do you think that the recovery periods are taken into consideration during your training sessions?	8	25	24	75	--	--	8
Do you feel over load during training?	28	87.5	2	6.3	2	6.3	42
Does your coach tests the fitness levels for his players?	--	--	10	31.3	22	68.8	4.5
Does your coach uses weight training in physical preparation phase?	6	18.8	6	18.8	20	62.5	12.25
Have you been injured because of weight training?	4	12.5	14	43.8	14	43.8	6.25
Are competition injuries more than training injuries?	4	12.5	--	--	28	87.5	18
Do you have a fitness planner in your team?	2	6.3	6	18.8	24	75	25.43
Have you been applied through a full medical check up before the season starts?	--	--	--	--	32	100	--
Do you have a physiotherapist in your team during training sessions?	2	6.3	--	--	30	93.8	24.5
Do you apply first aid as soon as you are injured?	2	6.3	12	37.5	18	56.3	12.25
Is the first aid kit always available during training and competition?	6	18.8	--	--	26	81.3	12.5
Is ice always available when injury occurs?	6	18.8	6	18.8	20	62.5	12.5
Are massage and sauna applied during the season as recovery means?	4	12.5	--	--	28	87.5	18
Do you care to hold new knowledge about all the modern aspects of your game?	22	68.8	4	12.5	6	18.8	18.25
Does your federation organize lectures about first aid and injury?	--	--	6	18.8	26	81.3	12.5
Do you have information about first aid and field injuries?	6	18.8	8	25	18	56.3	7.75
Do you have information about the type and quantities of ideal nutrition that is needed during training and competitions?	14	43.8	--	--	18	56.3	5.
Do you have information about the importance of recovery means?	2	6.3	4	12.5	26	81.3	33.25
Do you stop performing when you feel tired of fatigue?	4	12.5	14	43.8	14	43.8	6.25
Do you stop performing when an injury occurs or when you feel pain?	8	25	6	18.8	18	56.3	7.75
When the coach is changed during the season, can this be a reason for injury occurrence?	14	43.8	4	12.5	14	43.8	6.25
Do you hide your pains from your coach in order not to be suspended from participating in competitions?	2	6.3	10	31.3	20	62.5	15.25
Do you follow an ideal nutritional program during training and competition?	2	6.3	--	--	30	93.8	24.5

Contin. Table (8): The reasons for injury occurrence for the Egyptian female TT juniors

Statistical Processing / Element	Egyptian female juniors						X2
	Yes		Sometimes		No		
	Freq.	%	Freq.	%	Freq.	%	
Are you trained according to a prepared training time schedule?	10	45.5	4	18.2	8	36.4	2.55
Do you think that the recovery periods are taken into consideration during your training sessions?	8	36.4	--	--	14	63.6	1.64
Do you feel over load during training?	18	81.8	2	9.1	2	9.1	23.27
Does your coach tests the fitness levels for his players?	6	27.3	6	27.3	10	45.5	1.45
Does your coach uses weight training in physical preparation phase?	4	18.2	8	36.4	10	45.5	2.55
Have you been injured because of weight training?	2	9.1	6	37.3	14	63.6	10.18
Are competition injuries more than training injuries?	4	18.2	4	18.2	14	63.6	9.09
Do you have a fitness planner in your team?	2	9.1	4	18.2	16	72.6	15.64
Have you been applied through a full medical check up before the season starts?	--	--	--	--	22	100	--
Do you have a physiotherapist in your team during training sessions?	--	--	--	--	22	100	--
Do you apply first aid as soon as you are injured?	6	27.3	2	9.1	14	63.6	10.18
Is the first aid kit always available during training and competition?	2	9.1	--	--	20	90.9	14.73
Is ice always available when injury occurs?	2	9.1	--	--	20	90.9	14.73
Are massage and sauna applied during the season as recovery means?	2	9.1	--	--	20	90.9	14.73
Do you care to hold new knowledge about all the modern aspects of your game?	14	63.6	6	27.3	2	9.1	10.18
Does your federation organize lectures about first aid and injury?	2	9.1	--	--	20	90.9	14.73
Do you have information about first aid and field injuries?	4	18.2	6	27.3	12	54.5	4.73
Do you have information about the type and quantities of ideal nutrition that is needed during training and competitions?	--	--	4	18.2	18	81.8	8.91
Do you have information about the importance of recovery means?	2	9.1	4	18.2	16	72.7	15.64
Do you stop performing when you feel tired of fatigue?	8	36.4	6	27.3	8	36.4	.36
Do you stop performing when an injury occurs or when you feel pain?	2	9.1	2	9.1	18		23.27
When the coach is changed during the season, can this be a reason for injury occurrence?	2	9.1	6	27.3	14	63.6	10.18
Do you hide your pains from your coach in order not to be suspended from participating in competitions?	6	27.3	6	27.3	10	45.5	1.54
Do you follow an ideal nutritional program during training and competition?	2	9.1	--	--	20	90.9	14.73

Table (9): The reasons for injury occurrence for the foreign male TT juniors

Statistical Processing / Element	Foreign male juniors						X2
	Yes		Sometimes		No		
	Freq.	%	Freq.	%	Freq.	%	
Are you trained according to a prepared training time schedule?	24	75	--	--	8	25	8
Do you think that the recovery periods are taken into consideration during your training sessions?	18	56.3	--	--	14	43.8	50.
Do you feel over load during training?	10	31.3	2	6.3	20	62.5	15.25
Does your coach tests the fitness levels for his players?	22	68.8	--	--	10	31.3	4.5
Does your coach uses weight training in physical preparation phase?	24	75	--	--	8	25	8
Have you been injured because of weight training?	6	18.8	--	--	26	81.3	12.5
Are competition injuries more than training injuries?	2	6.3	--	--	30	93.8	24.5
Do you have a fitness planner in your team?	24	75	--	--	8	25	8
Have you been applied through a full medical check up before the season starts?	12	37.5	20	62.5	--	--	2
Do you have a physiotherapist in your team during training sessions?	6	18.8	--	--	26	81.3	12.5
Do you apply first aid as soon as you are injured?	26	81.3	--	--	6	18.8	12.5
Is the first aid kit always available during training and competition?	16	50	--	--	16	50	0
Is ice always available when injury occurs?	12	37.5	--	--	20	\62.5	2
Are massage and sauna applied during the season as recovery means?	22	68.8	--	--	10	31.3	4.5
Do you care to hold new knowledge about all the modern aspects of your game?	24	75	--	--	8	25	125.5
Does your federation organize lectures about first aid and injury?	8	25	--	--	24	75	12.5
Do you have information about first aid and field injuries?	22	68.8	--	--	10	31.3	18
Do you have information about the type and quantities of ideal nutrition that is needed during training and competitions?	26	81.3	--	--	6	18.8	4.5
Do you have information about the importance of recovery means?	26	81.3	--	--	6	18.8	12.5
Do you stop performing when you feel tired of fatigue?	4	12.5	--	--	28	87.5	18
Do you stop performing when an injury occurs or when you feel pain?	10	31.3	--	--	22	68.8	4.5
When the coach is changed during the season, can this be a reason for injury occurrence?	6	18.8	--	--	26	81.3	12.5
Do you hide your pains from your coach in order not to be suspended from participating in competitions?	16	50	--	--	16	50	0
Do you follow an ideal nutritional program during training and competition?	14	43.8	--	--	18	56.3	5.

Continues Table (9): The reasons for injury occurrence for the foreign female TT juniors

Statistical Processing / Element	Foreign female juniors						X2
	Yes		Sometimes		No		
	Freq.	%	Freq.	%	Freq.	%	
Are you trained according to a prepared training time schedule?	36	85.7	--	--	6	14.3	21
Do you think that the recovery periods are taken into consideration during your training sessions?	26	61.9	--	--	16	.38	2.38
Do you feel over load during training?	18	42.9	--	--	24	57.1	.85
Does your coach tests the fitness levels for his players?	26	61.9	--	--	16	38.1	2.38
Does your coach uses weight training in physical preparation phase?	30	71.4	--	--	12	28.6	7.71
Have you been injured because of weight training?	22	52.4	--	--	20	47.6	.09
Are competition injuries more than training injuries?	2	4.8	--	--	40	95.2	34.38
Do you have a fitness planner in your team?	26	61.9	--	--	8	19	15.43
Have you been applied through a full medical check up before the season starts?	22	52.4	--	--	20	47.6	10
Do you have a physiotherapist in your team during training sessions?	16	38.1	--	--	26	61.9	34.38
Do you apply first aid as soon as you are injured?	40	95.2	--	--	2	4.8	7.71
Is the first aid kit always available during training and competition?	30	71.4	--	--	12	28.6	.86
Is ice always available when injury occurs?	24	57.1	--	--	18	42.9	27.52
Are massage and sauna applied during the season as recovery means?	38	90.5	--	--	4	9.5	.10
Do you care to hold new knowledge about all the modern aspects of your game?	22	52.4	--	--	20	47.6	.10
Does your federation organize lectures about first aid and injury?	12	28.6	--	--	28	66.7	24.57
Do you have information about first aid and field injuries?	26	61.9	--	--	16	38.1	2.38
Do you have information about the type and quantities of ideal nutrition that is needed during training and competitions?	26	61.9	--	--	16	38.1	2.38
Do you have information about the importance of recovery means?	36	85.7	--	--	6	14.3	21.43
Do you stop performing when you feel tired of fatigue?	14	33.3	--	--	28	66.7	4.67
Do you stop performing when an injury occurs or when you feel pain?	14	33.3	--	--	28	66.7	4.67
When the coach is changed during the season, can this be a reason for injury occurrence?	2	4.8	--	--	40	95.2	34.38
Do you hide your pains from your coach in order not to be suspended from participating in competitions?	16	38.1.	--	--	26	61.9	2.38
Do you follow an ideal nutritional program during training and competition?	10	23.8	--	--	32	76.2	11.52

In the player's element, the improper nutritional programs during season came as the first reason for injury occurrence with a percentage of (93.8%) for males and (90.9%) for females. Then hiding pain symptoms from coaches with a percentage of (62.5%) for males and (45.5%) for females. Then continuing training even after injury or fatigue with a percentage of (56.3%) for males & (81.8%) for females.

In the services' element, the main reason was: not applying a full medical check on the players before the season with a percentage of (100%) for both males and females. Comes next the lack of physiotherapists with a percentage of (93.8%) for males & (100%) for females. Then the lack of using recovery means as sauna and massage with a percentage of (87.5%) for males and (90.9%) for females.

In the element of sports' culture, it is clear that most players lack information about the importance of recovery means and injury prevention. Also national federations should pay more attention to organizing lectures to coaches and players about injuries and first aid with a percentage of (81.3%) for males & (90.9%) for females. Comes next the lack of information about proper nutrition with a percentage of (81.8%) and the lack of information about the means of recovery with a percentage of (72.8%).

When comparing the reason of injury occurrence for both of Egyptian and foreign TT juniors, we can find obvious differences as the player's element was the main reason for injury occurrence for foreign juniors and the training element did not have a significant effect on injury occurrence for them. For foreign players was continuing training even after injury or fatigue with a percentage of (87%) for foreign males.

For female foreign juniors, the improper nutritional program during training or competition came in the first place with a percentage of (76.2%). Then continuing training even after injury or pain with a percentage of (68.8%) for males and (66.7%) for females, this might help in turning the simple injury into a chronic one which can be very hard to recover.

Concerning the elements of medical services and sports culture, the results of tables (8) & (9) (Attachment 6, 7) shows that there is a good care paid to medical services and sports culture as they always apply full medical check up and applying first aid as soon as injury happens. Also, using massage and sauna as recovery means for foreign players.

This points out to the importance of medical services element and training process element for the Egyptian players which is applied in a progressed way on the foreign players.

Conclusions:

1- The most frequent injuries for TT Egyptian male juniors were: cramp – chronic pain – chronic inflammation consecutively.
2- The most frequent injuries for TT Egyptian female juniors were: cramp – chronic inflammation – chronic pain consecutively.
3- The most frequent injuries for TT foreign male juniors were: chronic inflammation – cramp – sprains.
4- The most frequent injuries for TT foreign female juniors were: chronic pain– chronic inflammation – cramp consecutively.
5- The most exposed body organs to injury for all research sample were: lumbar region – and RT shoulder joint
6- The reasons for injury occurrence for Egyptian TT juniors were: over training load – lack of warming up, stretching and flexibility exercise – lack of physiotherapists during training & competition – lack of information about the importance or recovery means.
7- The reasons for injury occurrence for foreign TT juniors were: resuming performance even after fatigue or injury – the lack of physiotherapists during training and competition.

Recommendations:

1. More concentration should be applied on flexibility and stretching exercises and warming up especially for parts of the body that are more exposed to injury in TT according to the results of this study.
2. Putting a strategy for prevention of frequent injuries according to the results of this study.
3. The training program for TT junior players should include exercises for strengthening muscles, ligaments and tendons around the shoulder joint, wrist, vertebral column, knee & ankle joint.
4. Organization of lectures to increase the culture of injury and health for TT players and coaches including information about first aid procedures to prevent side effects of injuries and reduce recovery periods.
5. The availability of first aid facilities and kits in any training or competing place.
6. A connection between the medical and the coaching teams must be established in a way to find a common strategy for controlling the injuries of Egyptian junior players.

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HOW TO PREVENT THE MOST FREQUENT INJURIES OF THE FOOT IN TABLE TENNIS

Abstract

The paper is based upon three decade of personnel experience of the author as the medical doctor of national table tennis team.
This is quite enough period to notice the most often problem related to overuse injuries in the foot region. The attention is based on opening the problem and at the same time closes up with possible prevention measures.
It is clear and that is pointed out the fact that we don't have adequate standards for the table tennis shoes.
Our mutual task should be multidisciplinary approach to this issue to try to solve the problem.

Key words: *table tennis, prevention, foot injuries, foot pain, table tennis shoes*

Introduction

Muscle and tendon injuries occur with increasing frequency in amateur and professional sports.
Apart from diagnosis (overuse injuries, pulled muscles-partial or complete tear or rupture) they also require specific therapy and prophylactic measures, in addition to suitable aftercare to eliminate late sequelae.
Muscle injuries and tendon strains in table tennis are becoming increasingly common in last two three decades particularly in the foot region.
Since these are masked injuries they are often underestimated by players, trainers and even physicians.
There is a general lack of clarity in the terminology of masked muscle injuries, since the differential diagnosis of torn or pulled muscles or tendons is problematic.
Nor is there uniformity in terminology of these lesions.
Inadequate diagnosis, treatment leads to delayed healing, persistent pain and recurrence. Often, sport activity cannot be resuming for several months.
There is also considerable number of cases in which, because of their injuries, players never regain their previous performance or even have to abandon table tennis.
The treatment of both muscle and tendon injuries poses a very interesting but also a very difficult problem, which could be solved only by the close collaboration of players, trainers and doctors. Alongside adequate measure of prevention are urgently needed.

Discussion

The foot (unlike the hand, which is designed essentially for grasping) is fundamentally a weight-bearing structure.
The foot consists of three morphologic functional segments, which develop in proximodistal order in the embryo. However, from the anatomic standpoint, the foot is divided into a hind part, midpart and the forepart or anterior, middle and posterior.
Its accommodation to any surface irregularity, its versatility and speed of movements during running, jumping and walking, and its behavior as if it were a ball-and-socket unit instead of a combination of 28 bones and 57 major articulating surfaces make this structure a biomechanical marvel, which warrants more than just a passing thought.

Injuries of the foot require, therefore, a more than casual knowledge of anatomy and some practical knowledge of biomechanics.

The muscles that act upon the foot are the extrinsic muscles which originate from the lower leg and attach the foot, and intrinsic muscles, which originate and insert within a foot.

The nerve supply of the lower leg and the foot are brunches of the sciatic nerve (L4-L5 and S1, S2 and S3)

According to that the normal foot must confirm the following criteria;

- it must be pain free
- it must have normal muscle balance
- it must have no contractures
- the heel must be central
- the toes must be straight and mobile
- during gait and stance must have three sites of weight bearing

Foot pain, when noted during standing, can be considered static and, when noted during walking, can be considered kinetic.

The majority of painful conditions of the foot originate in the soft tissue; muscles, ligaments, tendons, nerves, blood vessels and tissues of the joint spaces. In most cases of the foot and ankle pain local lesion can be implicated, and it can be result of trauma and stress.

Foot strain may be acute, sub acute or chronic. Here, as in so many painful musculoskeletal states the rule of causes applies:

- abnormal stress upon normal structure
- normal stress upon abnormal structure
- normal stress upon normal structure that is not at that moment prepared to receive the stress.

In table tennis the main problem is the chronic stress. Repeated trauma leads to mechanical effect on all structures which begins with strain and ends with deformation. The first symptom of overuse lesion is related to ligamentous inflammation with resultant pain.

Persistent stress can cause ligamentous elongation and even some degeneration. Support of the joint is lost and the joint undergoes excessive motion or malalignment. The stress inflames the joint capsule, a condition that also causes pain. Persistence of joint irritation causes structural damage to the aerticular surfaces, and degenerative arthritis results. This sequence interrupted early may be reversed but if allowed to proceed may lead to irreversible damage.

Prevention of the following states is essential;

- metatarsalgia is condition in which there is the pain and tenderness of the planar head of the metatarsals. This usually occurs when the anterior transverse arch is depressed and cause excessive weight bearing upon the metatarsal heads. The physiologic response to stress is increased osteoclastic activity associated with increased osteoblastic activity with means increased calcific metabolic turnover.
- March fracture is again stress injury of a metatarsal shaft caused by overused conditions most commonly seen in poorly trained players.

All mentioned states can be avoided by proper shoe wear with insertion of silicone shoe inserts.

- The pain in the region of the heel may arise from the tissue behind and under the calacaneus or within the bones and joints, as well as from referred sites distant to heel.
- Plantar fascitis is most often seen in the player who trains in the soft shoes on hard surfaces. The examination reveals deep tenderness of the anteromedial aspect of the calcaneus which is the site of attachment of plantar fascia. The different sorts of silicone inserts can be of great help but under the supervision of educated medical staff.

- Rupture of the Achilles tendon may occur from overuse, microtraumata, poor foot posture, hard floor, bad footwear, focal infection or previous partial tear.

Tearing occurs usually in the narrowest portion of the tendon approximately two inches above the point of attachment.

The purpose of this paper is to conclude that we still don't have world standards concerning to table tennis shoe wear.

It is of utmost importance to understand that this is the mutual task which can be solved as soon as possible by the wide approach of multidisciplinary team.

References can be obtained from authors upon personnel request.

The 10th Anniversary ITTF Sports Science Congress

Part four:

Match analysis of table tennis

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REAL PLAY TIME IN TABLE TENNIS MATCHES IN THE XXVIII OLYMPIC GAMES «ATHENS 2004»

Abstract

The modifications of Table Tennis regulations, with more important the end of games to 11 than to 21 points change appears to have changed the duration of match, with regard to both the total and also the real play time. The purpose of this study was to record the real play time that is required in order to come to an end a Table Tennis match as well as it realises, the existed changes in the real play time between the Men and the Women that took part in XXVII Olympic Games of Athens (2004). The play time differences at the development of organisation by the phase of first round up to the Quarterfinals were also studied. As sample was used the total of games that was carried out at the duration of Olympic Games in Athens (n=120), in Men (n=60) and Women (n=60) singles. The results showed, that the real play time of sets oscillated from 3:7'' until 6:6'' in total. The mean of duration of set was increased at the development of organisation up to the Quarterfinals. Men's pure play time was from 3:8'' to 4:4'' and Women's from 3:7'' to 6:6''. A difference in pure play time was noticed in Women and this might be a result of style of play. The real play time that was presented can be used as tool to training process.

Key words: *table tennis, real play time, Olympic Games*.

Introduction

Since October 2001 new regulations have been implemented by the International Table Tennis Federation (ITTF). The beginning was marked with the use of the bigger ball, from 38 to 40 mm and was followed by the scoring system which was increased to 11 points instead of 21 for each set, as well as the regulation related to service. Aim of these changes was to increase the attractiveness and popularity of the sport. The bigger and heavier ball would increase the length of time of rallies; the new scoring system would make players play their best from the beginning while service return would be easier. "The new scoring system might lead a narrower gap between the strong and the weak," said Chinese men's team coach Yin Xiao. "The new scoring system has disturbed the strategies that expert table tennis players habitually employ to determine effective strokes" said Seve, Poisat (2001).

XXVI "Athens 2004" was the first Olympic Games that were organized with new regulations. The fact that the rally time seems to be changed both in Men and Women must be in mind for individual technical and tactical players training programs.

Methods

The total of games that were carried out at the duration of Olympic Games in Athens (n=120), in Men (n=60) and Women (n=60) singles from groups to quarter-finals was used as a sample. Data was received from the official "Athens 2004" web page http://www.athens.olympic.org. DVD and video tapes verification was also conducted.

The process of collection of data was the following: each time an athlete that made service took the basic service position and simultaneously threw of the ball, was placed in use a digital chronometer. Stop of measurement was when ball fell on the ground, on the body of athletes or on the net. Time data collection was conducted with precision of seconds for set and minutes for games and was recorded on to special result form. No data collection was recorded in other cases of interrupt of the game such as let. No other factors such as time-out, changes of table side between sets were counted.

Results

From the analysis of the results it appeared that the mean of rally time is 4:18''±0:75'' in sets and 22:5''±5:56'' in Men games (table 1) and 5:04''±0:81'' in set and 26:3''±7:29'' in Women games. Respectively to duration the biggest matches took 38 and 41 minutes for Men and Women and the shortest were 9 minutes both for Men and Women. Table 1 and 2 show the detailed results of each round.

Table 1. Real play time (min) in Men.

Men	Play Time MAX	Play Time MIN	Set/Round (X±SD) SEC	Match/Round (X±SD) SEC
1st Round	38'	9'	3:8''±1:27''	18:3''±7:90''
2nd Round	34'	12'	4:17''±0:78''	22:1''±6:06''
3rd Round	33'	17'	4:31''±0:72''	23:1''±6:58''
4th Round	31'	18'	4:4''±0:74''	25:8''±5:23''
5th Round	25'	21'	4:2''±0:14''	23:3''±2:06''
Total	**Games Max**	**Games Min**	**Mean/Set**	**Mean/Games**
	38'	9'	4:18''±0:73''	22:5''±5:56''

Fig.1 Real Play time (Games)/Round – Men.

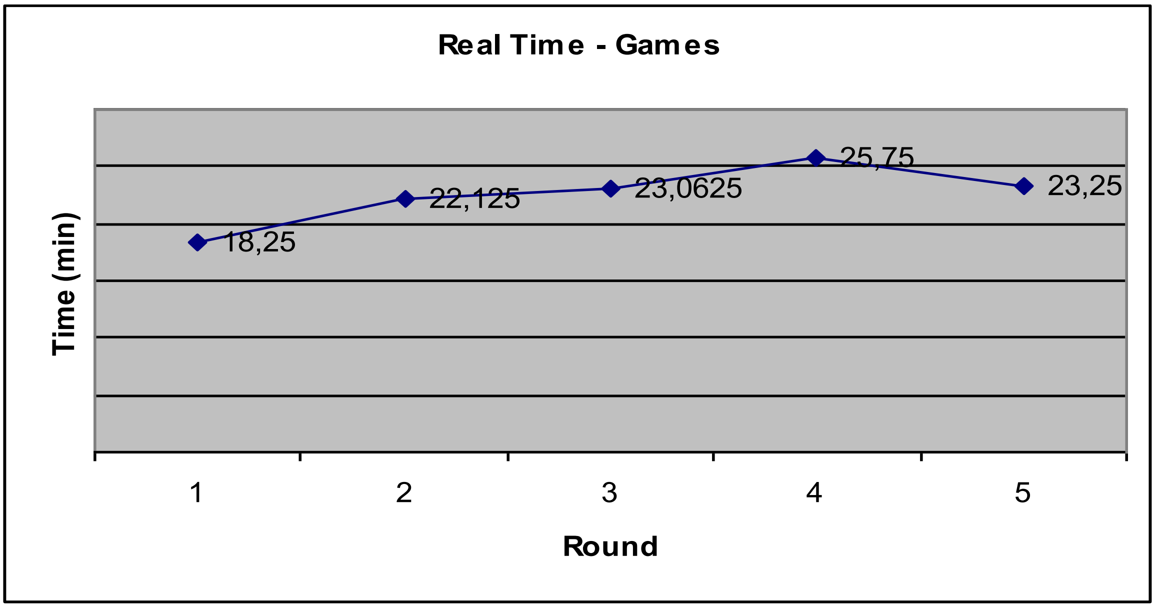


Fig.2 Real Play time (Set)/Round – Men.

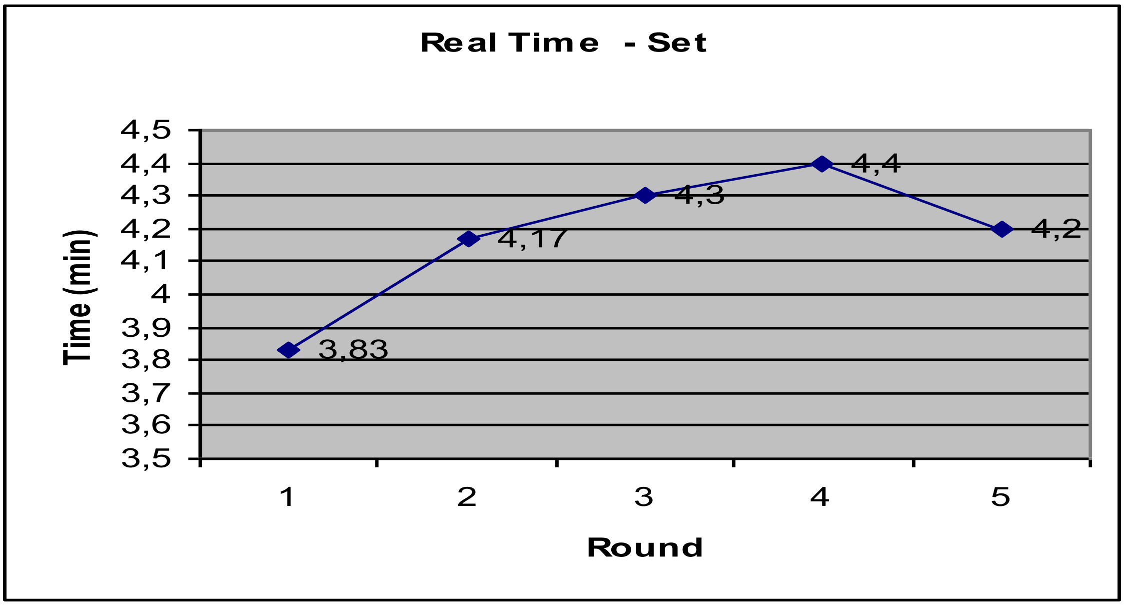


Table 2. Real Play Time (min) in Women.

Women	Play Time (X±SD) MAX	Play Time (X±SD) MIN	Set/Round (X±SD) SEC	Match/Round (X±SD) SEC
1st Round	33'	9'	3:7''±0:82''	18:4''±7:32''
2nd Round	35'	18'	4:5''±0:69''	25:1''±5:99''
3rd Round	39'	16'	4:8''±0:72''	26:3''±7:09''
4th Round	39'	17'	5:6''±1:09''	28:5''±8:38''
5th Round	41'	24'	6:6''±0:76''	33:2''±7:71''
Total	Games Max	Games Min	Mean/Set	Mean/Games
	41'	9'	5:04''±0:81''	26:3''±7:29''

Fig.3 Real Play time (Games)/Round – Women

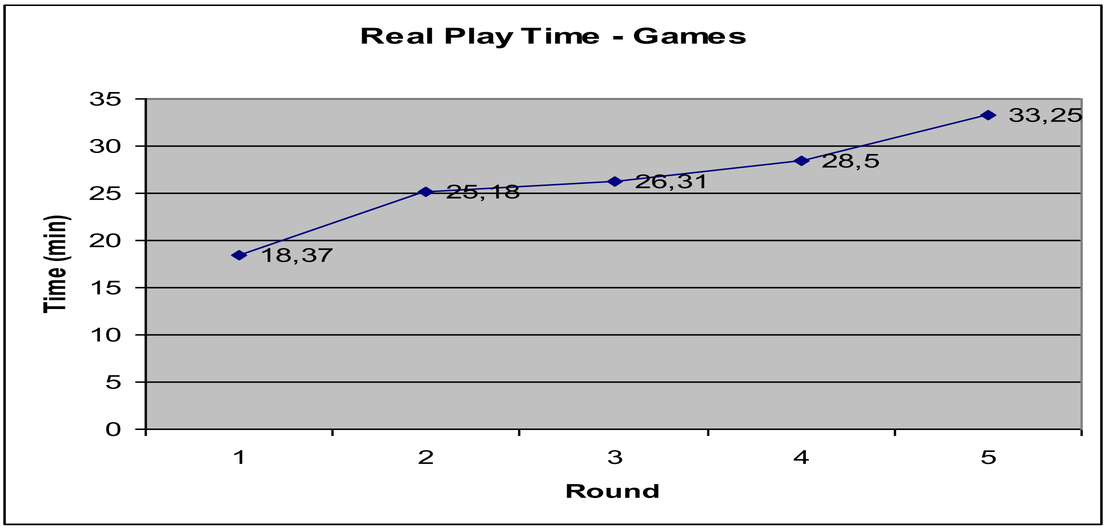
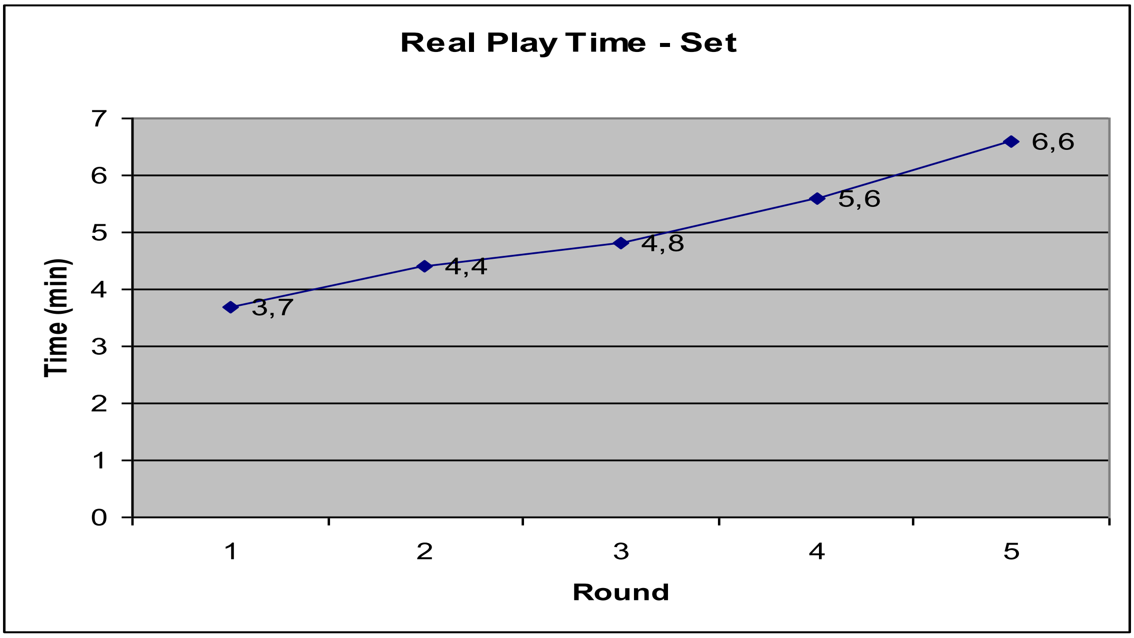


Fig.3 Real Play time (Set)/Round – Women



Discussion

The mean time of duration of set was increased during Olympic Games up to the Quarterfinals in both Men and Women. For example, in the first round of Men games mean real play time was 3:8'' in sets and 18:3''in matches while real play time increased to 4:4'' and 25:8'' in set and matches in round of 16. For Women mean of real play time in the first round was 3:7''in sets and 18:4'' in match and it increased to 5:6'' and 28:5'' in round of 16. The augmentation of real play time could be accounted for the "knock out" system in which more high quality players play against each other after a few round, so matches take more time to finish.

Mean of rally time never goes under 20 minutes after the 1st round and this leads to the fact that tactical situation change more often, Zhang et al. (2003) which does not allow easy finishing or easy mistakes. Regarding to new regulations the status of server and receiver can not longer get information about opponent play Seve, (2003) and maybe this is one more reason that justifies the increase of rally time.

Women matches are longer than Men's. Although the mean of set duration in Women is almost the same as Men there is a difference in the mean of real play time of games. This difference becomes bigger after the first round of games and it is getting almost 2 minutes more in every round culminating in the quarter finals where the difference in mean is almost 10 (min). According to Takeuchi et al.(2001); Seve, (2001); Yquei,(2001); Zhang et al. (2001), it seems that there is an increase in rally time with the new 40mm ball which is bigger in Women's games, Takeuchi et al.(2001). From these maybe justified the fact that Women matches in Olympics Games were longer than Men. Also the technical and tactical style of Women is a factor that influences duration of games, Tang et al. (2001).

Duration of rally time has become longer thus the increase of total real play time. According to Yuza et al.(1992) a Table Tennis Match (best of 3, 38mm ball, 21 points) takes 28:40'' ± 7:35'' to finish. Comparing it with current results we observe than mean of match of Olympic Games are 22:5'' and 26:3''. Respectively to Men and Women the max and min matches are 38˙& 9˙ and 41˙& 9˙. So, maybe this is a clue that new counting system regulations have achieved longer rallies but shorter matches which probably lead to a more attractive sport.

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QUALITATIVE GAME ANALYSIS IN TABLE TENNIS

Abstract

A workflow for assisting table tennis players during a tournament has been worked out. It is based on a qualitative approach, similar to that described by Lames and Hansen (2001). In cooperation with trainers and players of the Austrian national team a comprehensive model was developed for a process oriented description of the match (Baca et al., 2004). In order to fulfil practical needs, the game characterising parameters were reduced to the very essential ones for the coaching process. A hard- and software system was then developed for data collection and presentation. In addition to frame and initial data (grip, left/right-hander, first server etc.) values for the following attributes have to be registered only:

- *type of stroke (forehand/backhand, topspin, block, defence, etc.)*
- *impact position of the ball on the table*
- *instant of service and moment when the point is finished*
- *type of error (out, net, etc.)*

Additional variables are derived from the primary attributes and some initial information, automatically (e.g., by indicating the type of error on the respective side of the interactive table the system determines which player made the point).
Matches are recorded on video and, if possible, observed on location. Video capturing and rough evaluation may be done during the game enabling to give immediate video-assisted feedback afterwards. Beginning and end of rallies are thereby recorded by registering the respective time code. Further analysis of individual strokes can only be performed offline.

The results of the analysis, together with the impressions of the match observer, constitute the basis for the qualitative analysis. Assisted by the interactive video component of the software tool used, all scenes of interest may be selectively accessed and presented. Coach and player(s) try to interpret the selected scenes and to find peculiarities or reasons for conspicuous quantitative results.

Key words: *table tennis, process oriented model, interactive video*

Introduction

In today's world of sports, computer-aided video and game analysis tools have become standard tools for preparing and analysing competitions, and for training use. Lames and Hansen (2001) discuss the methodical way of day-to-day use of such systems for game sports in general, while Dufour (2000) and Leser (2006) give concrete examples of how these systems can be used in soccer and fistball. Depending on the approach chosen, the analysis processes focus on different criteria. All these concepts share, however, some fundamental elements.

Baca, Baron, Leser and Kain (2004) introduce a process oriented approach to analyze and improve the behaviour of table tennis players. Through reducing the game characterising parameters of the data collection system to the very essential ones for the coaching process this method was adapted for the implementation in practice.

An overview of the modified system is presented in the sequel. One possible scenario for using this system to support coaches and athletes in preparing for a competitive opponent (e.g., whilst a tournament) is exemplified. (cf. Leser & Baca, 2006)

Method

Figure 1 illustrates the general procedure for analyzing table tennis matches by the method proposed.

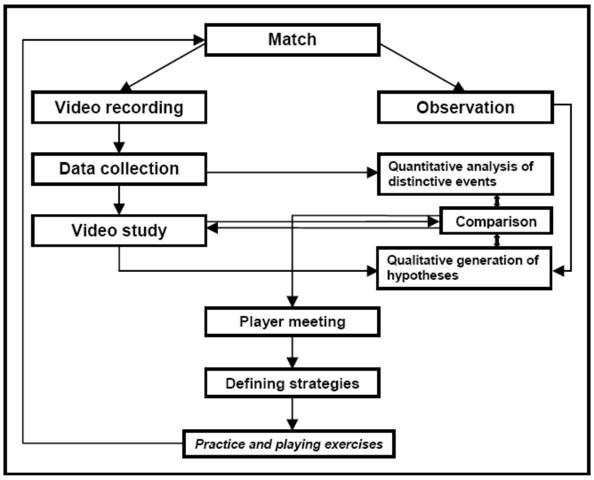

Figure 1 *Workflow of applied match analysis in table tennis*

Matches are recorded on video and, if possible, additionally observed on location. A standard perspective from the long side of the table including an adequate view of the players' action areas is recommended for positioning the video camera (see coverage angle in Figure 2 from the video window).

The total video recording of the game is basis for a quantitative data analysis. The results, together with the subjective impressions of the match observer, are properly used in the subsequent qualitative analysis. Finally, the results are incorporated into the training plan during a video-aided meeting with the player.

Data Collection

Figure 2 shows the data collection screen of the software developed. It comprises three areas: form for *point information*, form for *stroke information* and video window. Special attention was given to the usability of the system – e.g., using graphical input assistances for some parameters instead of having to write long attribute lists.

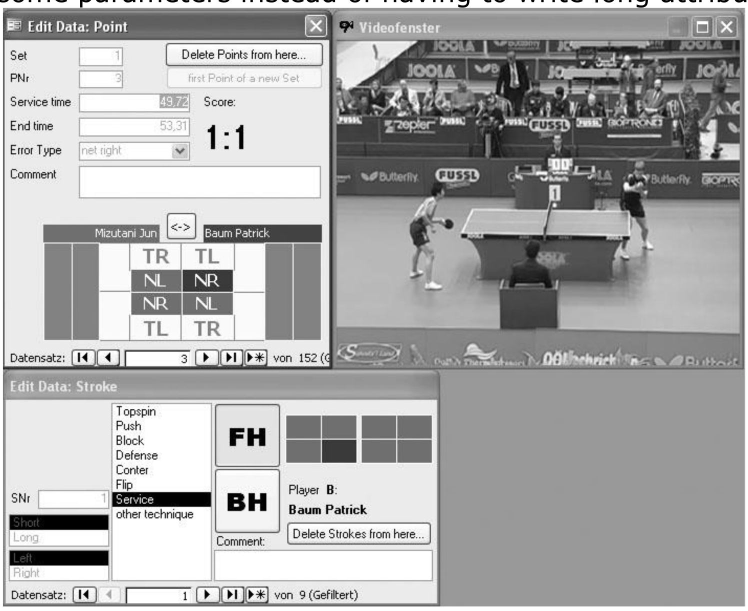

Figure 2 *Data collection screen*

Only a reduced set of game and performance parameters describing a table tennis match has to be gathered manually by mouse action or, alternatively, per keyboard-shortcut:

- type of stroke (forehand/backhand, topspin, conter, block, defense, etc.)
- impact position of the ball on the table
- instant of service and moment when the point is finished
- type of error (out, net, etc.)

Additional parameters that are required for the analysis are derived automatically from some initial information entered into the program at the beginning of the match and from the parameters listed above (e.g., by marking the type of error on the correct side of the interactive table the system determines, which player made the point):

- number of set
- number of point
- current score
- number of stroke
- server
- receiver
- length and direction of the stroke (short/long, left/right)
- winner of the point

Video capturing and entering the information into the *point form* may be done during the game. Consequently, video feedback (selective access to all rallies/points) and elementary statistics (regarding to *point information*) are available immediately after the game. Further analyses (regarding to *stroke information*) require entering the parameters characterizing each individual stroke. Since this process is very time consuming, it can only be done offline (after the match, using the digital game-video). Depending on the duration of the game this procedure lasts between one and two working hours.

Analysis Process

In the next step, standard evaluations of the collected data are presented to the user in an easily comprehensible manner (figures, tables, diagrams, etc.). Evaluations relate primarily to certain structural features of the match (e.g., distribution of stroke types) and success and failure-related statistics (e.g., type and number of faults, type and number of scoring strokes, etc.). A comparison of results against reference values allows to filter differing results automatically and to be studied in greater detail. The diagram in Figure 3, for instance, contains the success rate of an athlete (player A) showing that he/she scored a point in 90 % of all rallies he/she had started with a long service.

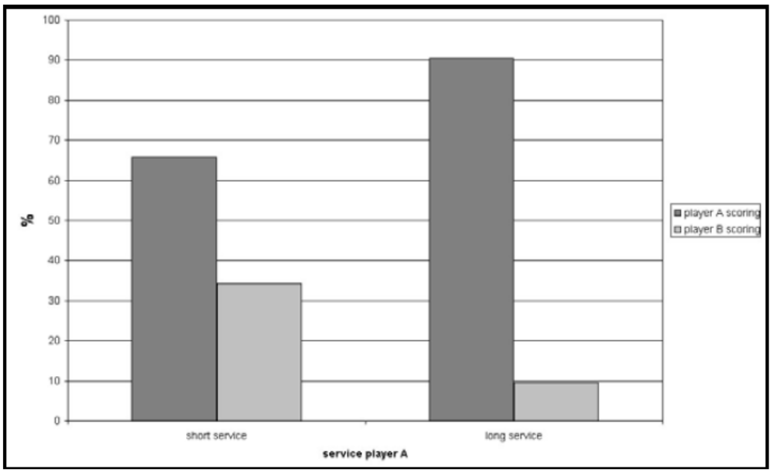

Figure 3 *Success and failure of player A when starting a rally with his own service*

Assisted by the video feedback tool, qualitative analyses are performed to access the playing pattern of the player/players of interest. Simultaneously, conclusions from the quantitative evaluations are drawn. An example is shown in Figure 4. All sequences, which might be helpful to understand the reason for the significant result described above (Figure 3), were filtered from all rallies ("Player A serving" AND "Player A scoring").

In addition, attention is paid to any of the on location observer's assumptions about specific player actions but the video is also studied for any other conspicuity. When this process is completed, the subjective discoveries are worded as hypotheses, e.g., "The player returns fast topspin strokes to the side very well but he has problems, when they are placed in the centre."

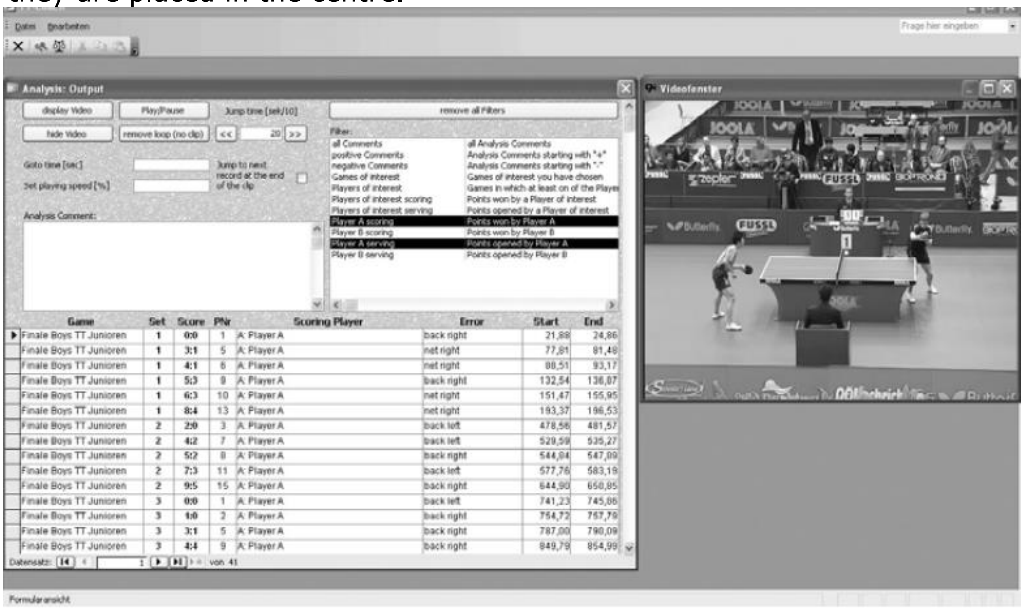

Figure 4 *Video feedback screen*

The software tool used for video analysis provides selective access to all scenes of interest. About two thirds of total video time may be saved by replaying only the net (real) playing time, as the start and end points of each rally can be accessed directly. This economic aspect is most beneficial when the system is used in situations where little time is available for analysis (e.g., between two rounds of a tournament).

Practical Training

When applying the system in practical training, the first step is a video-aided meeting of the coach with the athlete. Again, the video feedback tool with the benefits mentioned above can be extremely helpful. However, in order to save time and because intensive study of video content may cause quick fatigue of the central nervous system, the coach should not use all the video sequences used for the preliminary analysis, but rather selected sequences.

For didactic reasons, coach and player should jointly work out the analysis (part of the second step) and a consequent strategy (e.g., for the match against the next opponent). Concrete instructions that might result from the analysis of the examples given earlier might be, "Respond to long services of your opponent as passively as you can because he/she usually scores on active returns! Then try to place topspin strokes right in the centre!"

If there is enough time between completing the entire match analysis and the next competition, the competition strategy and concrete tactical instructions for the various game situations may be appropriately drilled with practice and playing exercises during the training sessions. In this sense the results of the analysis are implemented into the training, e.g., positioning fast topspin strokes rather to the middle of the table than to the side.

Perspectives and Outlook

A practice-oriented method to analyze table tennis competition performance and to assist coaches and athletes in the preparation for competitions and during tournaments has been developed. It is intended to establish the system in professional table tennis. However, from the authors' experience it can be said that top-level athletes follow deeply rooted training and competition routines and are hardly willing to make the slightest change to them. For that reason, a different approach has been chosen to establish the method in sports practice. Several (Austrian) performance centres for youth table tennis players have been provided with the analysis software. Selected talents exercising at these centres are introduced to the system and method early on. In addition, the system is used in actual training. The objective is to give highly talented athletes a competitive edge through using this type of support and to make them familiar with this training aid at an early stage.

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NOTATIONAL ANALYSIS FOR COMPETITION IN TABLE TENNIS (PART I): BASED FORMAT ANALYSIS

Abstract

The supporting tools for table tennis player strategic direction during competition are mainly related to pre-competition studies, video-analysis and coach's judgement during match. However, it is evident a lack of tools for quantitative data collection in match analysis. In this first part of the work a compilation, description and usage of formats for notational analysis of Table Tennis is presented. The obtained quantitative information is then used to perform basic statistical analysis for developing strategies for direction during competition.

Key words: *notational analysis, table tennis, real time, competition, format*

1. Introduction

In [2], notational analysis is defined in the context of racket sports as "*the process of recording and analyzing players during play*". In the general case of table tennis, mainly this process is developed by coaches using video records, but the process of real time quantitative data collection is barely employed during competition, reducing the task to qualitative analysis based on perception of the match.

The fact that in table tennis this process is carried in that way is due to the complexity of the game, in which a great variety of technical, tactical, and psychological factors become crucial in very small laps of time. All these concepts can be reduced to one word "speed". It is the main factor that makes difficult the process of data collection in real time, and what makes challenging to search tools for improving the development of table tennis in this aspect.

Notational analysis (as a discipline) in sports is a new topic of research; as a result, there is not enough written support for table tennis. In general ball sports, cricket, soccer, golf and baseball are the most studied, whereas for racket sports, the major attempts have been developed to squash, tennis and badminton.

In the case of table tennis, some studies can be found in [4,3], but in general there is a lack of literature for this discipline. Furthermore, the fact that the term notational analysis has been recently introduced, makes difficult the search of previous studies on applied statistic to table tennis or systems of notation used on it. Due to these facts, this work pretends to establish a written support for future studies on this sport based on the research carried by the authors, the references cited, and information collected from racket sports in general.

The present article is structured in the following way. Section 2 presents a motivation to the notational analysis in table tennis, in which the main characteristics of the topic are described. After that, two formats that can be used to get table tennis data in competition are introduced. The work finishes with conclusions about format methods for notational analysis in table tennis.

2. Notational Analysis in Table Tennis

In table tennis, as in any discipline, statistics play a important role in terms of data handling and analysis, with it, we can understand in a quantitative way the system that is the center of attention, in this case, the table tennis match; but this understanding depends in great proportion on the quality of the information that is used to improve the performance of the players. For that reason, the process of real time data collection becomes important for people interested in improving its results on competition, that added to the subsequent analysis makes what is called "Notational analysis for competition in table tennis".

To design notational analysis tools for table tennis, it is necessary to define the characteristics of the game in order to determine the strategy that can be used to get the information. In this case, the following characteristics are suggested to develop a tool for notational analysis:

- The structure of the match (sets)
- The structure of the set.
- The kind of strokes (offensive, defensive, transition)
- The style of the player.
- The different strokes.

In addition, the most important feature of the game, "speed", is taken into account. In table tennis the rallies are very fast, and the process of data collecting has to be made in very small laps of time. Then, the methods should be designed in a way that the analyst can obtain the more reliable information with the simplest method, otherwise the process becomes greatly complex.

One of the benefits of table tennis as a sport is that players can talk with its coaches between the sets. Usually, that time is employed by the coach to give advices to the player, looking for the best performance during the match. More often, those directions are based on the perception of the coach during the game, and generally its character is qualitative. Based on that statement, what it is presented in this work is a way to get quantitative data from the matches, looking for objective information during the matches or competition.

The following section presents a method to get quantitative information from table tennis matches, which is based in formats that can be designed for each analyst depending on the factors that want to be analyzed.

3. Format Methods

To establish a foundation for notational analysis during competition in Table Tennis, two types of formats are presented, which are separated by levels depending on the degree of complexity of the analysis.

i. Level 1

This is a simple format that can be used for Table Tennis. Its goal is to obtain specific information of one single stroke during the match. Usually this format can be used for the first stages of the rallies and the information is correlated with the final result of those (win or lost).

As an illustrative example, format 1 is used to analyze the relation between the service of one player and the final result of the point. The match between Michael MAZE and Lin MA in the World Table Tennis Championship of Shanghai, China, in 2005 was selected and the analysis corresponds to MAZE service. This format uses the table as a notational surface, which is divided in six zones where the information is collected, in this case each zone represents the location where the ball bounce after the net. Note that the same analysis can be made e.g. for reception, third ball, last ball.

Format 1: Single specific match information

x						x
	x✓✓✓✓x x	xx			x✓x✓xx	x

NET

a) Set 1 b) Set 2

✓		✓				x✓✓
	xx	✓x✓✓xx	NET		✓xxx	x✓x

c) Set 3 d) Set 4

Due to the simplicity of the scheme, what it is looked here are patrons of game in order to discover strong or weak points in the player or opponent, and based on that, build an strategy to play the next game or match.

For these kind of formats, data collection is performed without inconvenient due to its specific properties, but in many cases if the coach wants to have better information that allows him analyze the match, these formats are not sufficient. Based on that reason, in what follows is presented a format which presents better features to gather table tennis data.

ii. Level 2

The goal for a good table tennis match analysis during competition is to obtain more information from the games. The level 1 format allows to get a modest quantity of information, very reliable, but in some cases insufficient for a deep analysis. If instead of one single stroke, more strokes during the rallies are recorded, more information can be analyzed, and better strategies could be suggested to the player during the competition.

The following format presents a compilation of the most common situations in which a player can be exposed during the game. In this case the idea is to obtain a register of strokes, and if it is possible, to relate those strokes with the success of it (win or lost). In any case, the format can be designed for each coach, depending the type of analysis that will be developed. The most information, the most complex is the analysis, and less reliable is the information gathered during the match.

As in the level 1 format case, the match between Michael MAZE and Lin MA in the World Table Tennis Championship of Shanghai, China, in 2005 is analyzed.

Format 2: General match information

<table>
<tr><th colspan="7">Data sheet for offensive players</th></tr>
<tr><td></td><td></td><td>Set # 1</td><td>Set # 2</td><td>Set # 3</td><td>Set # 4</td><td>Set # 5</td></tr>
<tr><td rowspan="3">Service</td><td>Long</td><td>|</td><td>|</td><td>++</td><td>|++</td><td></td></tr>
<tr><td>Short</td><td>||||||||</td><td>|+|||||</td><td>||||||||</td><td>+||||+|</td><td></td></tr>
<tr><td>Bad service</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Reception</td><td>Drop Shot</td><td>|-||||</td><td>|||+|||</td><td>|-|||||</td><td>|||||</td><td></td></tr>
<tr><td>Lifted</td><td>||</td><td>-|</td><td>|||</td><td>|-|||</td><td></td></tr>
<tr><td>Attack</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Transition</td><td>Drop Shot</td><td>|-|++||-</td><td>+||||-|-</td><td>+|||-||</td><td>|||--</td><td></td></tr>
<tr><td>Push</td><td>||</td><td>|</td><td></td><td></td><td></td></tr>
<tr><td>Middle distance</td><td>-</td><td></td><td>-|</td><td></td><td></td></tr>
<tr><td rowspan="3">Starting attack</td><td>Topspin</td><td>--</td><td>|-|---</td><td>+-|</td><td>-|++|</td><td></td></tr>
<tr><td>Push</td><td></td><td>-</td><td></td><td>|-|-</td><td></td></tr>
<tr><td>Fast topspin</td><td>|-++||--</td><td>+-</td><td>-++++</td><td>|++</td><td></td></tr>
<tr><td rowspan="3">Continuous attack</td><td>Push</td><td>|</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fast topspin</td><td>+|+</td><td>-||+</td><td></td><td>||+</td><td></td></tr>
<tr><td>Smash</td><td></td><td></td><td></td><td>|||-</td><td></td></tr>
<tr><td rowspan="3">Defense</td><td>Block</td><td>-+</td><td>-|||</td><td>--+-|-</td><td>---||</td><td></td></tr>
<tr><td>Lob</td><td>||</td><td>|</td><td>|-</td><td>-||</td><td></td></tr>
<tr><td>Counter attack</td><td>-</td><td>+</td><td>||-</td><td>|</td><td></td></tr>
<tr><td rowspan="2">Lucky</td><td>Net or edge</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mistakes</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Score</td><td></td><td>7:11</td><td>6:11</td><td>9:11</td><td>9:11</td><td></td></tr>
</table>

Three kinds of symbols were used for the data collection in this case:

- "+" represents that the player won the rally.
- "-" represents that the player lose the rally
- "|" represents that was an intermediate stroke.

With those symbols is possible to have a general perspective of the sets/game, which allows to identify what are the strong and weak strokes of the player, as well as the strategies that can be suggested for the following game/match.

Although the method provides an easy way to get information during the match, there is not possible to register the sequence of movements during a single rally, which means that each stroke is independent, and the development of game tactics based on combination of strokes during a rally cannot be elaborated.

4. Concluding remarks

Notational analysis for table tennis is a useful topic to improve player's performance during competition. The way in which this discipline is applied has to take into account the complexity of the game that in some extent is due to its inherent speed.

In this work, a method to gather real time information from table tennis matches was presented, which is based in formats. In general format based methods are reliable tools to collect data due to its easy handling and simplicity of the notational system.

Further research has to be done in methods that capture the information with the same confidence that formats, but also the complete sequence of movements during the rallies. Additionally, if all these aspects can be extended to computational tools, the evolution of player's efficacy during the competition will be reinforced.

As a final remark, the goal of these methods is to obtain quantitative information from matches, which come from player's physical actions. Fortunately, table tennis is more than that, mental components are as important as physical ones, that is why table tennis science community have to pursue more researches for developing tools to handle both components in an efficient form.

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[5] Wu & Escobar-Vargas. Notational analysis for competition in table tennis (Part II): Non format method. *Proceedings of the X International Table Tennis Federation Sports Science Congress.*

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NOTATIONAL ANALYSIS FOR COMPETITION IN TABLE TENNIS (PART II): NON-FORMAT METHOD

Abstract

Speed is one of the aspects that make difficult quantitative data collection in Table Tennis. Some methods for data collecting are based on formats, but game dynamics cannot be completely registered. In this work a method for data collecting without format is proposed, which allows a complete record of the plays during a match. The method is designed to get the information of the match in an easier way for the match analyst. The description and usage of this method is explained in detail, and an example showing a practical application of the method is described as well. Finally, an additional modification to the method is presented in order to show the flexibility of this method.

Key words: *Notational Analysis, Table Tennis, Competition, Non-Format method.*

1. Introduction

Notational analysis for competition in Table Tennis can be regarded as the process of recording real time quantitative data from matches looking for an objective measure of the player's performance. This information can be gathered in different ways: with pre-designed formats [5] for specific strokes, video recording or with the method presented in this work. The main goal of these techniques is to analyze that quantitative information, looking for the best direction for players during the matches.

Although some of the techniques mentioned before are applied to improve the objectivity of match analysis, in most of the cases those analysis are based in subjective analysis made by coaches, which basically are based in their experience and perception of the game. It can be supported due to that inherent characteristics of the game, like speed, spin and complexity of the movements performed during a rally, make difficult a quantitative data collecting. All that was mentioned before without taking into account the psychological factors that affect the performance of players during competition, and that cannot be measured from a quantitative point of view.

Taking into account the lack of methods that allow coaches obtain quantitative technical information from table tennis matches, this work presents a new tool which is designed to gather that kind of information, looking for an improvement of player's performance during competition.

Like it is mentioned in [5], the major attempts on notational analysis in racket sports have been made for squash and tennis [1]. Specific studies to table tennis can be found in [3,4]. It should be mentioned that Huges in [1] presents a method for tennis match analysis that in some extent is similar to what is proposed in this work.

In what follows the work is organized in the following way: Section 1 presents the basis of the non format method, which is applied to a case in section 2 through a specific example. Section 3 describes some features of the method that allow to perform modifications that can be implemented looking for specific or advanced targets. In section 4 a real time case is presented to show how this information looks like, and based on that, the differences between real time data and complete data are established. A discussion of the method is proposed in order to show the advantages and disadvantages of it, and also some particularities that have to be taken into account due to Table Tennis complexity. The work finishes with conclusions and some remarks.

2. The Method

In this section the non format method, its features and main characteristics are presented.

The main idea of the method is to obtain the more quantity of information by rally during a table tennis match in real time. This collecting process should be made in the simplest way due to the speed of the game and the complexity of the movements involved in table tennis. For that reason a structured categorization of the different strokes has to be developed in order to manage in the most efficient way match information.

Three kind of strokes are established: Forehand strokes (A), backhand strokes (B) and pivot strokes (P); being the last one a forehand performed from the left side of the table for right handed players, or from the right side of the table for left handed players. Each one of these strokes will be denoted by the letters A, B and P respectively. Within each one of these kinds of strokes three categories of movements are defined: offensive, defensive and transition ones. Table 1 summarizes the basic table tennis's strokes used for the development of this work.

Table 1. Strokes by category

TABLE OF STROKES BY CATEGORY		
OFFENSIVE	TRANSITION	DEFENSIVE
Fast Topspin	Forehand-Backhand	Chop
Smash	Loop	Lob
Contra-topspin	Flip	Block
Flip	Drop shot	
Loop	Backspin	
Kuai-dai	Sidespin strokes	
	Kuai-Dai	
	Lower Lob	

Note that the definition of the movements can be selected arbitrarily, and some movements can be within two categories like the case of loop or flip. Also, if a specific analysis has to be made, just some of these strokes can be taken into account.

Once the movements are defined, it is necessary to assign a label for each one of them. In this case numbers for the movements and the symbols previously stated for the kind of strokes will be the labels for the match analysis. Table 2 presents the compilation of strokes, movements and labels. It will be the base of the match analysis. As an example of the labelling used in table 2, a notation of the type "A3" means a fast forehand topspin developed from the right side of the table (for right handed players), whereas the stroke "P6" represents a forehand loop performed from the left side of the table.

Table 2. Types of strokes, movements and their respective label

TABLE OF STROKES		
LABEL	DESCRIPTION	TYPE
A-B-P-1	Classic stroke	Transition
A-B-P-2	Block	Deffensive
A-B-P-3	Fast Topspin	Offensive
A-B-P-4	Backspin	Transition
A-B-P-5	Smash - push	Offensive
A-B-P-6	Loop	Off-Trans
A-B-P-7	Drop-shot	Transition
A-B-P-8	Flip	Off-Trans
A-B-P-9	Side-spin movements	Transition
A-B-P-10	Kuai-Dai	Off-Trans
A-B-P-11	Chop	Defensive
A-B-P-12	Contra-attack far	Offensive
A-B-P-13	Contra-attack close	Offensive
A-B-P-14	Fish (Low lob)	Trans-Def
A-B-P-15	Lob	Defensive

In this moment, a structure that allows us to catch any kind of stroke during the rallies in a very simple way is stated. Then it just needs paper and a pencil to collect match information. Each movement made by players can be registered with the corresponding label. The most strokes can be recorded, the better information for advice the player during the competition.

Additional symbols can be added to represent if the player win or lost the rally, and also if the location of the ball of the final stroke want to be registered. In this work the symbols "+" and "-" are used to say that the rally was successful or not.

In order to show an example of the method, the following section presents a real case of application.

3. Example of application.

In this section the non-format method is applied to a specific match, and based on the collected information, the match analysis is presented.

As an application example the match between Michael MAZE (DEN) and Lin MA (CHN), one of the semi-finals in the World Championship at Shanghai, China (2005) is analyzed. The match information is based on the labels of the strokes presented in table 2 and it is presented in Table 3.

Table 3. Complete data from the match MAZE Michael – MA Lin , Shanghai 2005

MICHAEL MAZE VS MA LIN. WTTC 2005, SHANGHAI, CHINA

	SET 1	SET 2	SET 3	SET 4
Score	7:11	6:11	9:11	9:11
1	PA7A7A-	B10-	PA7+	B10B-
2	PA7A3B1-	A4A12+	PP3-	A7P6-
3	A7P3-	PA6A3-	A7A-	P+
4	A7-	P+	B10B10-	PA3P3P5A5A5A5A5-
5	PB10A-	B4A7+	PA3+	A7B2+
6	PA3+	A7P4A-	P+	A7A-
7	A4A2-	PA6-	A7-	PA8B2-
8	A7A9B4+	PA6A3A3B1A6+	A7B10P3+	PB4B14-
9	PB10+	B4+	PA6+	B10-
10	PB2+	A8A12B3+	P+	A7B2A6P3+
11	B6A3B10P3+	PB2A4B5-	A7B9A-	PA7A7B9-
12	A7A3P3P3+	PA4B11B15A4-	A7B2+	P+
13	PA7+	A7A12A6-	PA7A-	A8A3+
14	PA7B14B14A13-	A7B3-	PA7A7-	A8A3+
15	A7A7P3-	PA4P6-	A7A3+	PA7-
16	A8A3-	PB4-	A7B2A13A13A13-	PA6+
17	PA4A6-	A4A6-	PA7A15B-	B10A6+
18	PB2A6-		PA7B6-	A7B6B2P13B15B15B4-
19			B10A6B3+	P+
20			B10B2-	PA8A9-

Note that the information presented in table 3 has three additional characters, two of them are the signs positive and negative, which represents if the rally was won (+) or lost (-). Also some cases appear a letter in the first position of the lines, in this case was "P", which means the position from which the service was performed. For this example, can be viewed that Michael MAZE did 100% of his services from the pivot position.

The way data should be understood can be exemplified with the explanation of a single rally, i.e. 12th point of the first set "A7A3P3P3+", which means: MAZE received the service with his forehand performing a drop-shot, after that he hits the ball from his forehand with a fast topspin, next he moves to the right side of the table and executes two fast topspins, and with those strokes he won the rally.

Based on the information collected in this way, some statistical analysis can be made to show the performance of the player during the match, and based on the results, to decide what strategy can be made for the following set, match or tournament. This information also can be viewed like a register of the performance of the player during the tournament. Table 4 presents a basic descriptive analysis made to this example.

Table 4. Match analysis for application example

MATCH ANALYSIS. Michael MAZE vs Lin MA. WTTC 2005, SHANGHAI, CHINA					
	SET 1	**SET 2**	**SET 3**	**SET 4**	**TOTAL**
Score	**7:11**	**6:11**	**9:11**	**9:11**	
Mean of strokes per rally w/o service	2—3	2—3	2—3	2—3	2—3
Longest rally	4	5	5	7	5
Shortest rally	1	1	1	1	1
Unforced errors	7	9	6	7	7
Number of strokes in the set	39	36	34	42	38
Transition-defensive strokes	61.54%	72.22%	76.47%	73.81%	71.01%
Offensive strokes	38.46%	27.78%	23.53%	26.19%	28.99%
Winning points in service	40.00%	25.00%	50.00%	40.00%	38.75%
Winning points receiving	37.50%	44.44%	40.00%	50.00%	42.99%
Offensive winning points	42.86%	33.33%	44.44%	33.33%	38.49%
Transition-Defensive winning points	57.14%	66.67%	55.56%	66.67%	61.51%
Initiative	50.00%	47.06%	45.00%	55.00%	49.26%
Effectiveness	33.33%	25.00%	55.56%	45.45%	39.84%

In order to understand the results presented in Table 4, it is important to define some of the aspects taken into account during the analysis:

- Unforced errors: Any kind of stroke performed with negative implications. This aspect strongly depends on the style of the player.
- Initiative: Number of times in which he player begun the attack aver the total number of points in the game.
- Effectiveness: Directly related with initiative and was defined as the number of winning points over the number of times that player took the initiative during the game.

More complex analysis can be done for the match data, and those can be part of another study, the aim of this paper is to show a tool to gather data directly from matches.

Until now, a method to analyze table tennis matches has been resented based on a structured table of strokes. But what can be done if the coach wants to get more information or a specific one during the match. Based on that aspect, next section presents some modifications or additions that can be made to the tool in order to obtain more detailed information.

4. Additional features of the method

Sometimes, it is important to get additional information from the matches, depend on the opponent or the stage of the training plan of the player. In these cases an additional labels can be taken into account for the analysis.

An example of an additional label can be the location of the ball after the stroke. To develop this label it is possible to divide the table in six zones, and assign one label to each one. The result can look like figure 1.

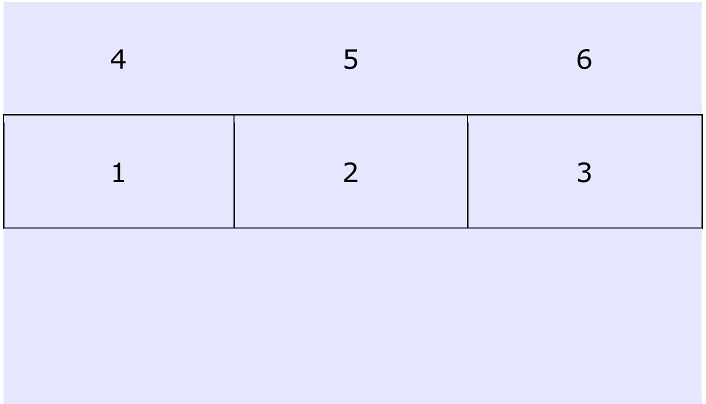


Figure 1. Labels for different locations of the ball after a stroke

Clearly, at most labels, most complex will be the analysis, but the balance depends on the specific targets of the coach. Table 5 presents the data for the same match analyzed before, but taking into account the location of each stroke during the match.

With this data, additional information can be analyzed. For example now, we can know in what zone the opponent has a weak point, or a strong point. In the case of the player it is possible to know what kind of location in each stroke has to be improved, or what kind of location is better to win a rally with a definitive stroke.

As a parallel with the example presented in section 3, about how to read the data, the 12th point of the first "A72A36P34P36+" set should be read as: MAZE received the service with his forehand performing a drop-shot to the center of the table, after that he hits the ball from his forehand with a fast topspin to the opposite corner, next he moves to the right side of the table and executes two fast topspins, one to the opposite corner and the last one parallel, and with those strokes he won the rally.

Any kind of modification can be done to the method, the easier the adopted labels, the better information can be collected during the matches, and more analysis can be performed with the data.

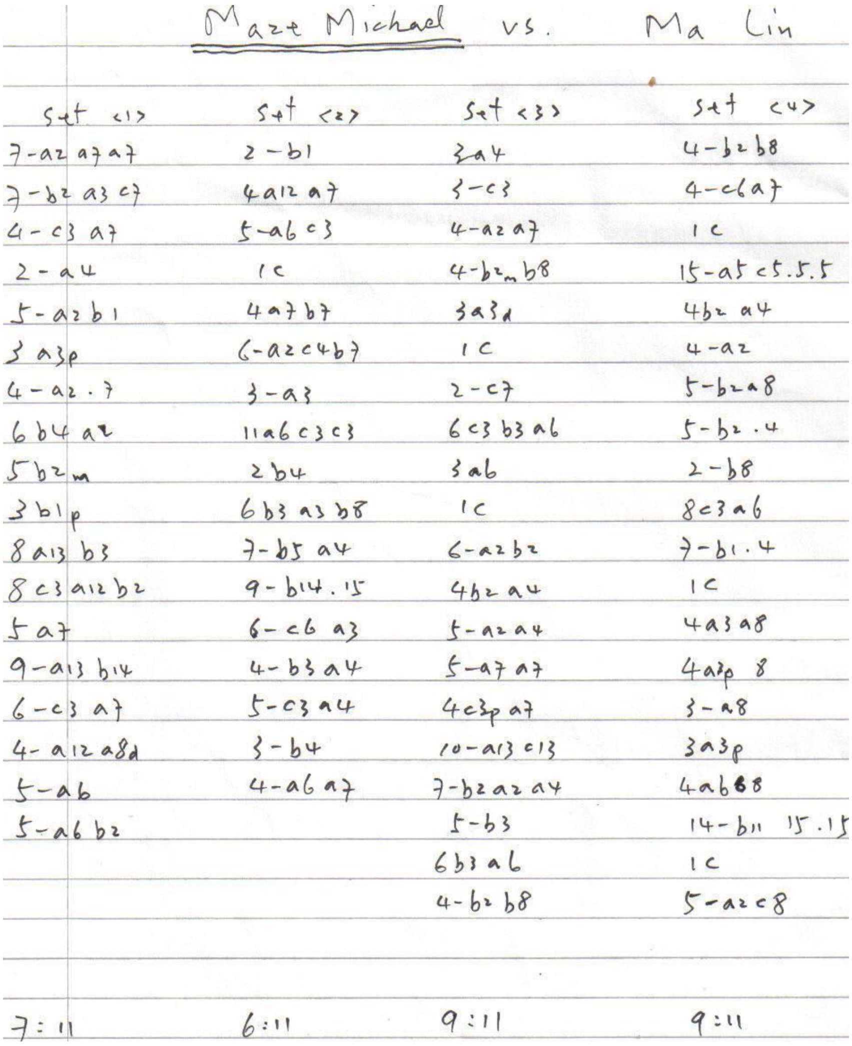
Table 5. Data with location of the ball after each stroke

	MICHAEL MAZE VS MA LIN. WTTC 2005, SHANGHAI, CHINA			
	SET 1	SET 2	SET 3	SET 4
	7:11	6:11	9:11	9:11
1	P3A73A76A-	B10-	P3A76+	B106B-
2	P2A73A36B1-	A43A126+	P3P3-	A71P6-
3	A71P3-	P2A66A3-	A73A-	P2+
4	A7-	P2+	B106B10-	P6A36P36P56A56A56A56A5-
5	P3B106A-	B42A72+	P3A36+	A76B24+
6	P2A35+	A74P46A-	P4+	A73A-
7	A46A2-	P2A6-	A7-	P2A86B2-
8	A71A94B44+	P2A66A36A36B16A66+	A73B104P34+	P2B45B14-
9	P2B106+	B46+	P3A66+	B10-
10	P2B25+	A86A126B34+	P6+	A71B26A65P34+
11	B66A36B106P35+	P2B26A46B5-	A71B96A-	P2A72A72B9-
12	A72A36P34P36+	P2A46B116B156A4-	A73B26+	P6+
13	P2A74+	A73A126A6-	P3A75A-	A86A36+
14	P2A76B144B146A13-	A76B3-	P3A72A7-	A86A34+
15	A72A76P3-	P6A46P6-	A72A34+	P3A7-
16	A86A3-	P3B4-	A71B26A135A135A13-	P6A64+
17	P2A46A6-	A43A6-	P2A75A145B-	B106A66+
18	P4B26A6-		P2A72B6-	A71B64B25P135B155B155B4-
19			B106A66B34+	P3+
20			B106B2-	P3A84A9-

Until this section, we have not mentioned that table tennis is an extremely fast sport, and for that reason the data collection in real time is a complex task. What we have shown is a complete data set of a match analyzed by video. How a real time data looks like? The following section presents this idea.

5. *From theory to practice*

The data presented until now, is the result of a detailed observation of the match in video. In real time, cannot be expected a complete register of the information. The aim of this section is to compare the complete data with a real time data register in order to validate the tool like effective tool for match analysis during competition. Table 6 presents the data gathered during the match.



Maze Michael vs. Ma Lin

Set <1>	Set <2>	Set <3>	Set <4>
7-a2 a7 a7	2-b1	3a4	4-b2 b8
7-b2 a3 c7	4a12 a7	3-c3	4-c6 a7
4-c3 a7	5-a6 c3	4-a2 a7	1c
2-a4	1c	4-b2m b8	15-a5 c5.5.5
5-a2 b1	4a7 b7	3a3d	4b2 a4
3 a3p	6-a2 c4 b7	1c	4-a2
4-a2.7	3-a3	2-c7	5-b2 a8
6 b4 a2	11a6 c3 c3	6 c3 b3 a6	5-b2.4
5 b2m	2 b4	3 a6	2-b8
3 b1p	6 b3 a3 b8	1c	8c3 a6
8 a13 b3	7-b5 a4	6-a2 b2	7-b1.4
8 c3 a12 b2	9-b14.15	4b2 a4	1c
5 a7	6-c6 a3	5-a2 a4	4a3 a8
9-a13 b14	4-b3 a4	5-a7 a7	4a3p 8
6-c3 a7	5-c3 a4	4c3p a7	3-a8
4-a12 a8d	3-b4	10-a13 c13	3a3p
5-a6	4-a6 a7	7-b2 a2 a4	4a6 b8
5-a6 b2		5-b3	14-b11 15.15
		6b3 a6	1c
		4-b2 b8	5-a2 c8
7:11	6:11	9:11	9:11

Table 6. Real time data match Michael MAZE vs Lin MA

Note that in this sheet, the notation is briefly different to the notation presented in the document. In this case the data is taken from the last strokes to early strokes, the number that is in the beginning of each line represents the total number of strokes developed during the rally for both players which becomes an indicator if the rally was won or lose.

The comparison between real time data and complete data shows that more than 80% of the data were collected during the match. The remaining 20% was information of the early stages of rallies longer that 6 strokes approximately, which makes not a big difference for the analysis.

An important fact was observed during the comparison: Transition strokes are very susceptible to different kind of perceptions of the analyst. The main differences were observed between the strokes 7-4(drop chop, and chop close to the table), 2-1 (block and classic stroke), 2-10 (block and kuai-dai) and 1-10 (classic stroke and kuai-dai). This point has to be taken into account for the generalization of the method, because although it is possible to collect quantitative data, it is collected by people with different perceptions of the different kind of strokes performed during the matches.

Concerning the quality of the information it can be said that basically depends on the degree of expertise of the analyst and also the degree of concentration during the data collecting. From the real time data presented in table 6, less that 10% of the information was erroneous.

Based on this general analysis of the method, was proved that it is a good tool to get quantitative information during matches, which can be analyzed to give player instructions during the breaks and also during the competition.

In many cases due to the complexity of the task, or the duration of one rally, cannot be possible to get completely the information of the point, then for these cases is recommended to take the information of the last strokes, and also if it is possible the number of strokes that your played did during the rally, like is presented in Table 6.

Being finished the description of the main features of the non format method, the following section presents a discussion about the method.

6. Discussion

In this section some additional remarks of the non format method are presented. Basically, the advantages and disadvantages of the method are described, as well as some additional remark concerning with it.

First of all, should be clear that the non format method have to be viewed like a tool to gather quantitative data from real time table tennis matches. The way information is analyzed depends on the analyst.

Some of the advantages and disadvantages of the non format method are summarized as follows:

Advantages:

- ➢ It is possible to gather real time quantitative data from table tennis games.
- ➢ The method is absolutely flexible and can be applied in the way the coach wants to get the information.
- ➢ Analysis based on this information allows objective conclusions for the game or match.
- ➢ The information can be used to plan future matches during and after competition.
- ➢ An historical record of the player is obtained if the method is applied constantly.

Disadvantages:

- ➢ The process of gather information requires concentration, memory and natural skills.
- ➢ In the cases of long rallies, the information cannot be completely recorded.
- ➢ Transition strokes collecting process are susceptible to different perceptions.
- ➢ Although the data is collected in real time, some technological improvements have to be done to analyze the information completely in seconds.
- ➢ Due to the complexity of the task, and the degree of concentration that is needed to perform reliable data collection, some qualitative factors (psychology, intuition) cannot be observed if the data is gathered by the coach.

Having quantitative match information, is open the possibility to analyze players in a detailed base (weak and strong points). And for that reason the method can also be used to develop analysis post-competition.

With historical information, player's development is measured objectively. Training plans can be elaborated based on the growing performance of each player, and in some extent forecast analysis can be realized.

Based on the characteristics of the method mentioned above, it is important to mention what can be improved in the future.

- In order to have a strong tool to analyze real time data, it is necessary to develop a software for table tennis match analysis, in a way that coaches can store match information, and analyze it with pre-designed statistical algorithms.

- Transition strokes can be reduced, because those strokes can be perceived differently for the analysts.
- A tool to design training plans based on the information collected during competition.
- Any additional idea, please contact jae47@cornell.edu

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The 10th Anniversary ITTF Sports Science Congress

Part five:

Requisites and materials in table tennis

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RESEARCH REGARDING POSSIBILITIES OF MARKING THE BALL IN ORDER TO MAKE SPIN VISIBLE

Abstract

Marked balls should enable the players to see more clearly the rotation of the ball, particularly when receiving the service. Marked balls should be helpful as well in coaching, to teach young players to watch the ball all the time.
To find out whether a ball marked with lines or otherwise could help the players to see more clearly whether the ball had or had no rotation and even determine which rotation the ball had. This could be a help to players specially when returning the service and so reduce mistakes in returns, but be helpful in rallies as well.
After test with different markings it seems that the best visible marking on white and orange balls are black lines (2 mm width) – three black lines on the equator of the ball placed so that each line is on the right angle to each other line. Another good possibility seems to be marking similar to that of basket balls.
After short practice players were able to see clearly whether the ball in play has rotation or has no rotation. Due to it «floating» services, services without rotation caused almost no returns mistakes.

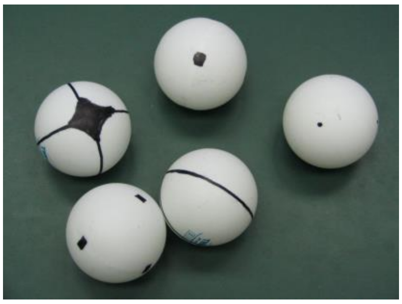
Key words: *table tennis, marked balls, visible spin*

1. Reason for the experiment

Marked balls should enable the players to see more clearly the rotation of the ball, particularly when receiving the service. Marked balls should be helpful as well in coaching, to teach young players to watch the ball all the time.
It was planned to analyse videos from different tournaments to find out the approximate percentage of return mistakes made because the receiver did not see that the ball had no rotation. We did not make such an analysis because it was not possible to produce clear criteria for students which are supposed to make the analysis. The first results showed quite big differences.
Many experienced coaches told us that in spite of some changes of service rule and of bigger ball many mistakes are still made because the receiver is not able to «read» the rotation, can not see if there is any or no rotation. It differs quite a lot from game to game – when players know each other well there are less such mistakes, some players can generally «read» better the opponents service and so on. The fact remains that service without rotation and even balls without rotation in rallies cause quite some errors. A good illustration of this problem was the men final game of the first Pro-tour tournament of the year 2005 – Pro-tour Slovenia, which was televised live even into Russia and in which both players made a lot of return mistakes because they did not realise that the service had no rotation. The result was for the spectators a very pure game.

The goal of the experiment

To find out whether a ball marked with lines or otherwise could help the players to see more clearly whether the ball had or had no rotation and even determine which rotation the ball had. This could be a help to players specially when returning the service and so reduce mistakes in returns, but be helpful in rallies as well.



2. Procedure

We marked balls in many different ways, players of lower, middle and high level in Zagreb and in Ljubljana played in practice and in test tournaments with such balls.

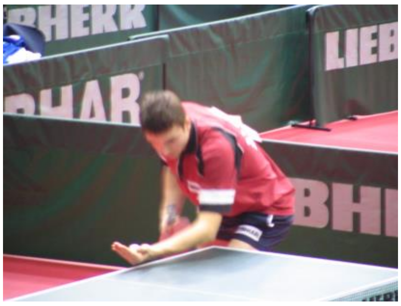
After test with different markings it seems that the best visible marking on white and orange balls are black lines (2 mm width) – three black lines on the equator of the ball placed so that each line is on the right angle to each other line. Another good possibility seems to be marking similar to that of basket balls.

The players got used to marked balls very quickly, had no problems so far when playing with such a ball for a longer time (tiredness or such).

Games and practice recorded with cameras showed no significantly reduced visibility of the ball – when the ball has big rotation the ball becomes slightly grey, but it did not seriously influence the visibility.

After short practice players were able to see clearly whether the ball in play has rotation or has no rotation. Due to it «floating» services, services without rotation caused almost no returns mistakes.

We tried to let the advanced beginners practice with marked balls and teach them to watch the ball all the time and say when the marking lines are visible and when not. It seems to be a good possibility to teach the beginners watch consciously the ball all the time.



The big problem is the technical problem of marking the balls. We developed as a test a small device which made possible marking the balls with lines on ball equator. Marking with such a device must be made by hand and takes some time, so it is unthinkable that such a device could be used for industrial ball production. All the ball makers that we asked for advice were not able to propose an acceptable price.

3. Summary

a. Conducted tests:

- ball colour: white, orange balls
- marking colour: black, blue, red, green marking
- different test markings: two circles on equator of the ball under right angle; one circle on the equator of the ball; three circles on the equator of the ball, each circle under right angle to each other; one circle on the equator of the ball and two smaller circles parallel to the circle on the equator, several pips evenly distributed on the ball (different size, shape and number of pips)
- different width of the marking lines: 1 mm, 2 mm, 3 mm, 4 mm

b. Results:

- The best variant proved to be the variant with three circles on the equator of the ball, each circle under right angle to other circles. Optimal lines are black lines, width 2 mm, either on white or orange balls.
- The marked ball is not disturbing the player during the rallies.
- There are no problems with the visibility of the marked ball for spectators, on video or TV screen. The visibility of the ball for the spectators is even better.
- Many players involved into these tests reported that the marked ball when in play seemed to them to be bigger than regular white or yellow ball. To them it was an advantage, as the ball was better visible.

c. Advantage:

- It can be clearly seen if the ball has a rotation or has not any rotation. During the service or during the rallies this can be seen at the same moment in which the ball is leaving the racket after point of impact racket-ball.
- It is even possible to estimate how strong the rotation is.
- Most of players reported that they could see not only if the ball had rotation or had no rotation but they were able to see if the ball had right or left sidespin.

d. Possibilities of utilization:

- Marked ball as tournament ball to reduce the mistakes of the receiver. Possible proposition – as test to nominate several test tournaments to be played with such a ball.
- Usage of marked balls to teach young players watches the ball carefully and gets feedback accordingly all the time. Could as well be tested with parallel groups of beginners.

e. Open questions:

- Technical solution for mass production of marked balls and price of such production
- Manufacturing of a smaller quantity of marked balls for official test tournaments and tests with groups of advanced beginners.

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CHARACTERIZATION OF THE FRICTION BEHAVIOR OF TABLE TENNIS RUBBERS

Abstract

Recently, novel polymeric materials (bulk elastomers, elastomer foams, fibers and fiber reinforced composites) were developed and are frequently used for racket sport equipments. These materials reveal highly non-linear, time and temperature dependent mechanical behaviour and the material performance is highly influenced by the environmental conditions (temperature, humidity, pollution). Hence, to support both material development efforts and novel design procedures for high performance racket sport equipments, novel tests methods and procedures to characterize the bulk and surface mechanical behaviour were developed, implemented and applied.

The main objective of this paper is the characterization of the surface behaviour of both pimple in and pimple-out table tennis rubbers. Hence, the friction between table tennis ball and rubber surfaces was measured under various sliding motion conditions and the results are described and discussed in the paper. Special emphasis was devoted to the proper definition of the friction and the determination of the main influence parameters on the friction.

The rubber friction is widely investigated over a wide range of test conditions and is described and the results discussed in many scientific papers. The main driving force of these investigations was the characterization of tire rubber friction/traction under dry and especially wet conditions. The friction force for rubber is a sum of the contribution of two essentially different physical processes; the adhesion between rubber and solid counterpart and the deformation of the elastomers which is described as the hysteretic deformation of the rubber

$$F_r = F_{adh} + F_{hyst} \quad (1)$$

Where F_r is the friction force, F_{adh} the adhesion force component and F_{hyst} is the hysteretic deformation force component. While the hysteretic component can be derived from the dynamic mechanical test performed and described in the previous paper, the determination of the adhesion component remains a challenging task.

To gain more insight into the complex surface behaviour of rubbers friction tests were performed using a universal microtribometer (UMT, CETR, Campbell, CA, USA). The table tennis ball was glued into a fixture and this was positioned in the upper moving part of the UMT. The test specimen was the rest of the cut table tennis rubber sponge and was glued to a steel plate fixed in the lower stationary drive of the UMT. The table tennis ball was first pressed with a controlled normal force (F_z) into the rubber surface and subsequently a linear sliding motion with controlled rate was applied. The normal force was varied as 1, 2, 5 and 10 N and the sliding rate was 0.1 and 1 mm/s in the experiments.

Both the normal (F_z) and the friction force (F_x) was continuously measured and recorded during the test. The coefficient of friction (COF) was then calculated in the test software.

The results of these investigations are described and discussed as:

- *Influence of the normal load and sliding rate on the friction behaviour of table tennis rubbers,*
- *Effect of the surface cleanness on the friction behaviour,*
- *Recognition of the modification of the surface by additional treatment and*
- *Comparison of the friction characteristic of various commercial table tennis rubber sponges.*

Key words: *table tennis, pimple-in and pimple out table tennis rubbers, friction behaviour, sliding rate and load dependence, cleanness, material comparison*

In addition to the bulk elasticity, the surface friction plays an extraordinary important role in the behavior of table tennis rubbers. Hence, the friction between table tennis ball and rubber surfaces was measured under various sliding motion conditions and the results are described and discussed in the paper. Special emphasis was devoted to the proper definition of the friction and the determination of the main influence parameters on the friction. Furthermore, dynamic mechanical analysis (DMA) tests were also performed to estimate the hysteretic contribution to the friction and compare various rubber types. Finally, instrumented rebound tests were performed and the time dependent change of the advancing and receding angle (rebound) was measured and compared for various rubber types for clean and for dirty surface conditions.

1 Introduction, scope and objectives

In table tennis recently, complex racket designs are used consisting of a wooden or glass or carbon fibber reinforced racket frame with multi-layer rubber/foam covers with special top surface properties. Various rubber compounds and glues (adhesives) are applied in the build up of the multi-layer rubber foam cover to impart greater spin or speed onto the celluloid ball. In terms of material characteristics, important aspects of a successful table tennis racket design are related to the elasticity and damping of the entire sandwich system and the specific surface properties that generate the spin of the celluloid ball upon the impact contact with the rubber surface. Despite the high interest of applying scientific concepts to table tennis, there is currently no widely accepted methodology available to characterize and to determine the performance profile of table tennis rackets as a whole or of individual or combined polymeric material layers in terms of their viscoelastic properties and property functions (Harrison and Gustavsen, 2002). In systematically characterizing table tennis racket materials, various aspects need to be considered. While the monotonic and cyclic small strain bulk deformation behavior of several sandwich rubber types was characterized and the results were presented and discussed in the previous paper (Major, 2005), the surface behavior was characterized in this study.

With similar bulk properties of rubber sheets, pimple-in and pimple-out rubbers might reveal significantly different surface properties. Moreover, for pimple-in rubbers the friction properties are of special importance, which are a complex product of the adhesion capability and the surface deformation behavior on a local scale (Charmet et al., 1999).

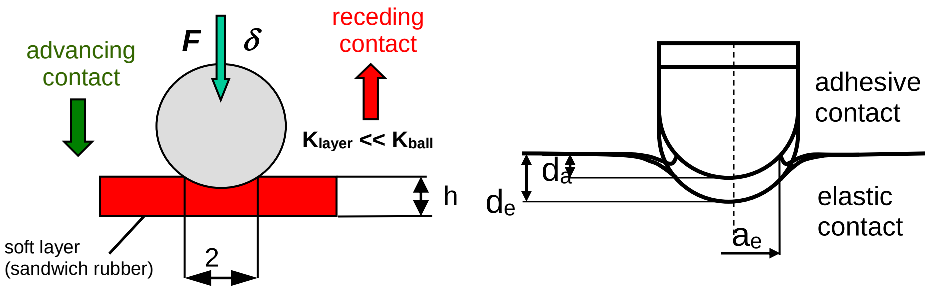
It is assumed that the dynamic motion performance of the ball after the rubber contact is a complex function of the rubber elasticity (stress-strain curve and hysteretic behavior) and the adhesion behavior of the rubber. The rubber friction is widely investigated over a wide range of test conditions and is described and the results discussed in many scientific papers (Uitz and Wiedermeyer, 1984). The main driving force of these investigations was the characterization of tire rubber friction/traction under dry and especially wet conditions. The friction force for rubber is a sum of the contribution of two essentially different physical processes; the adhesion between rubber and solid counterpart and the deformation of the elastomers which is described as the hysteretic deformation.

$$F_r = F_{adh} + F_{hyst} \quad (1)$$

Where F_r is the friction force, F_{adh} the adhesion force component and F_{hyst} is the hysteretic deformation force component. While the hysteretic component can be derived from the dynamic mechanical test performed and described in the previous paper, the determination of the adhesion component remains a challenging task, especially under highly dynamic conditions.

The dynamic contact (advancing and receding phase) of elastic and viscoelastic bodies with and without adhesion is studied and is described in various papers (i.e., Charmet et al., 1999). The schematic presentation of the contact situation is seen in

Fig. 1 where K_{layer} is the stiffness of the viscoelastic layer and K_{ball} is the stiffness of the impactor (ball).



(a) (b)

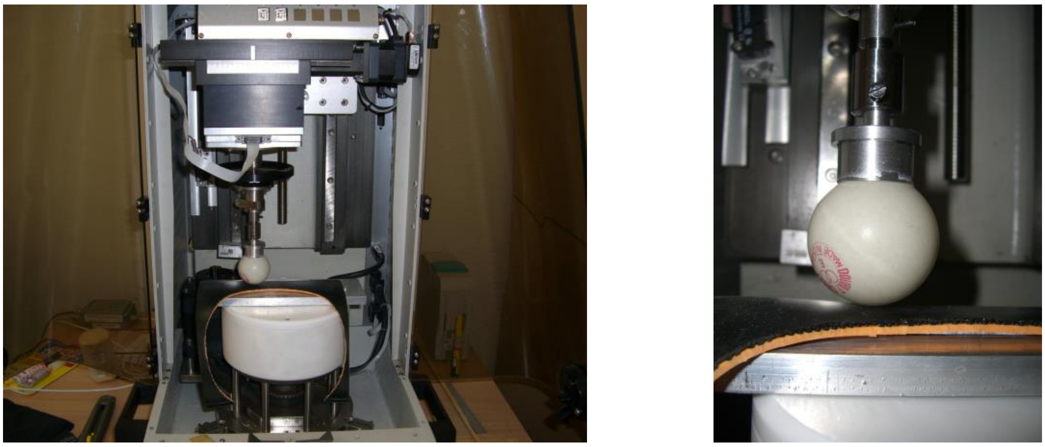
Fig. 1: *Table tennis ball (ideal rigid) and rubber sheet (non-linear elastic) in the contact situation (a) and (b) the surface profile in pure elastic contact compared to adhesive contact.*

The main objective of this study was the characterization of the friction behavior of table tennis sandwich rubbers consisting of specific rubber cover sheets (pimple-in) and sponge (cellular) rubbers under both monotonic and cyclic loading conditions.

2 Experimental

2.1 *Friction test using a tribometer*

Friction tests were performed using a universal microtribometer (UMT, CETR, Campbell, CA, USA). The test set-up is shown in Fig. 2. The counterpart was an unclean table tennis ball. The table tennis ball was glued into a fixture and this was positioned in the upper moving part of the UMT. The local contact situation is seen in Fig. 2b.



(a) (b)

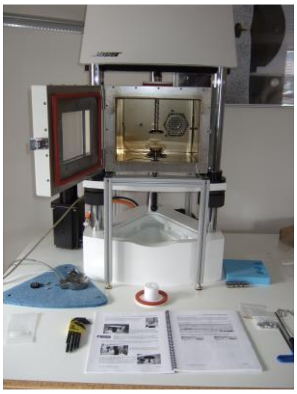
Fig. 2: *Friction tests with table tennis ball and sandwich rubber on a tribometer; (a) tribometer test set-up and (b) local contact.*

The test specimen was the rest of the cut table tennis rubber sponge. The test specimen was glued to a steel plate fixed in the lower stationary drive of the UMT. The table tennis ball was first pressed with a controlled normal force (F_z) into the rubber surface and subsequently a linear sliding motion with controlled rate was applied. The normal force was varied as 1, 2, 5 and 10 N and the sliding rate was 0.1 and 1 mm/s in the experiments. Both the normal (F_z) and the friction force (F_x) was continuously measured and recorded during the test. The coefficient of friction (COF) was than calculated in the test software. The data were transferred into scientific calculation software (OriginPro7, OriginLab Co, MA, USA) and the diagrams were constructed and plotted.

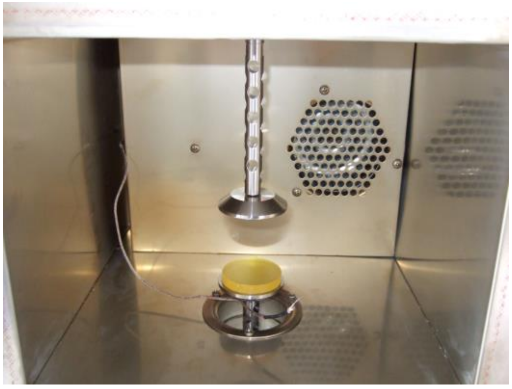
Two different groups of the pimple-in rubbers were investigated. While in the first test series the rubber types provided by the producers without additional cover film were tested, covered with a transparent cover film were applied in the second. In the first case the rubbers were stored in a sport bag about 1 month long before testing. These rubbers were than tested without and with additional surface cleaning. The cleaning was realized using isopropanol alcohol. In the second case the cover film was removed only immediately before the test. This surface was tested only in this state and was assumed as clean. In addition, two pimple-out rubber types were also tested. One of them was tested also after additional manipulation of the pimple surface.

2.2 *Dynamic mechanical analysis*

Monotonic and small scale cyclic compression tests (DMA) were performed using disc shaped specimens with a diameter of 34 mm cut from the original rubber sheet. The tests were performed both between parallel compression platens (uniaxial tests) and using ball shaped indenter (indentation type tests). The experimental work involved various table tennis sandwich rubber types from different producers with different thicknesses.



(a)



(b)

Fig. 3: *Monotonic compression and dynamic mechanical analysis test set-up on an electrodynamical test system; test system and (b) compression platens.*

To determine the hysteretic component of the friction the DMA experiments is of special importance. Hence, these tests are described and analyzed briefly in this chapter.

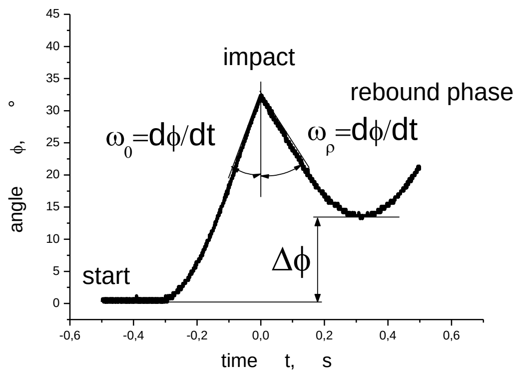
Dynamic characterization tests were performed under cyclic compression over a wide frequency range to determine the frequency dependence of the complex dynamic stiffness, K^*, the visco-elastic damping, $\tan\delta$. All of the above tests were performed at room temperature (23 °C) and at 50% relative humidity using either a high rate servohydraulic polymer test system (MTS 831.59 Polymer Test System, MTS Systems Corp., MN, USA) or an electrodynamic test system (BOSE 3200, MN, USA).

During the cyclic experiments the frequency was swept from 1 to 100 Hz, the mean load was force controlled having two values and the dynamic amplitude was displacement controlled also having two selected values (one represents smaller the other larger deformations).

2.3 *Impact rebound tests*

To simulate the real impact contact between ball and rubber sheet, impact rebound tests on various rubber types were also performed. A novel instrumented rebound test system was used in these experiments. This system was developed on the basis of a conventional pendulum (Zwick, Ulm, D) and modified and instrumented for impact rebound tests. The instrumentation involves both the measurement of the angle (advancing and receding) by an inductive RVDT (Positek P500.60DJ, Cheltenham, UK) and contact forces. A 3D piezoelectric load cell (Kistler 9347B, Winthertur, Ch) along with three charge amplifiers (Kistler 5001) is able to simultaneously measure not only the normal load (z) but also the shear component in-plane in both directions (x and y). The signals are recorded by a storage oscilloscope (Tektronix TDS2004B, Baeverton, OR USA) and the data transferred via USB to PC and analyzed by scientific data analysis software (Origin 7.5, OriginLab, MA, USA). The test system is shown in Fig. 4a and a typical rebound signal is plotted in Fig. 4b.

(a)



(b)

Fig. 4: *Rebound tests; (a) test system and (b) the angle signal with the various stages of the impact and rebound process.*

Disc shaped specimens with diameters from 32 to 40 mm were cut from the remaining part of the rubber sponges. All types of rubber were tested first in a clean state and the surface was made dirty by fine powder at the second set of the specimens. Furthermore, the rebound was characterized with specimens positioned at 90°, 67 °, 45° and 22° regarding to the horizontal plane. The impact test rate was about 1 m/s, corresponds to a starting angle of 31.2°.

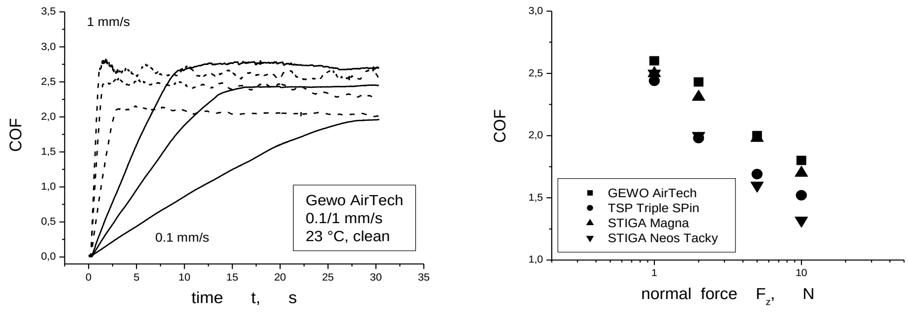
3 Results and Discussion

3.1 *Friction tests*

The results of these investigations are described and discussed in terms of

- Influence of the normal load and sliding rate on the friction behaviour of table tennis rubbers,
- Effect of the surface cleanness on the friction behaviour ,
- Recognition of the modification of the surface by additional treatment and
- Comparison of the friction characteristic of various commercial table tennis rubber sponges.

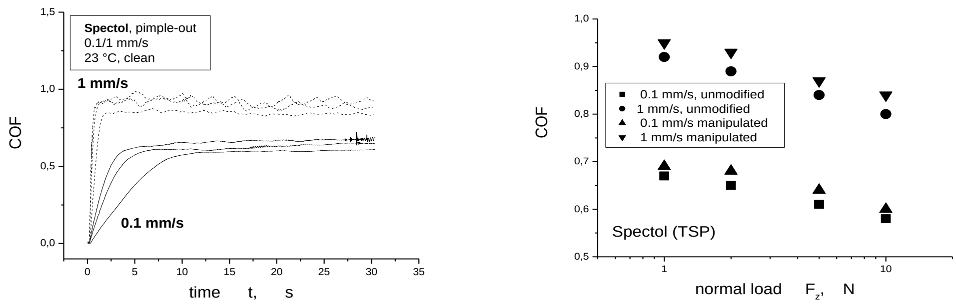
The sliding rate and normal load dependent COF-time curves are plotted in Fig. 5a for a pimple-in rubber type (AirTech^R, GEWO) and a comparison of four rubbers in Fig. 5b. In general, a negligible sliding rate dependence of the COF was observed for all type of rubbers (Airtech^R, TripleSpin^R (TSP), NeosTacky^R and Magna^R (STIGA)) with protecting cover film. The protecting cover film was of course removed immediately before the friction tests.



(a) (b)

Fig. 5: *Sliding rate and normal load dependent COF-time curves for a pimple-in rubbers; (a) Rubber type (AirTech^R, GEWO) and (b) comparison of various rubbers.*

The sliding rate and normal load dependent COF-time curves are plotted in Fig. 6a for a pimple-out rubber type (Spectol^R, TSP). As it was expected the COF values are significantly lower (in the range from 0.6 to 0.9) for pimple-out than for pimple-in rubbers. Furthermore, higher sliding rate dependence and a negligible normal load dependence was observed.



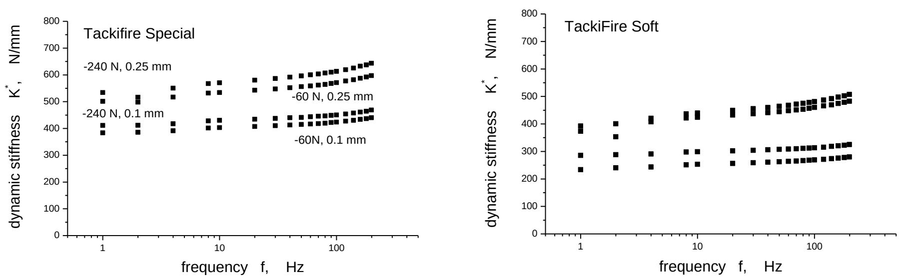
(a) (b)

Fig. 6: *COF functions of a pimple-out rubber for unmodified and for modified state.*

Moreover, as it is clearly seen in Fig. 6b even a small degree of manipulation of the rubber surface can be detected using this method. Finally, the difference between the pimple-out rubbers was also determined, the China pimple-out rubber type revealed slightly (but with clear tendency) higher COF values than Spectol.

3.2 *Dynamic mechanical analysis*

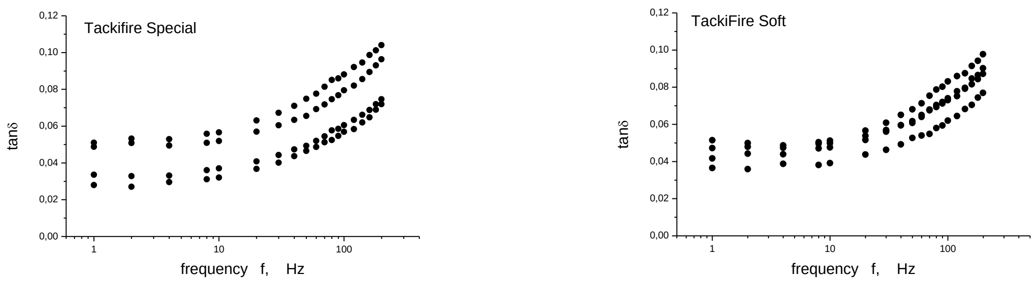
The results of this investigation are discussed in terms of frequency dependent material property functions (K*, tanδ). The frequency and load level dependence of K*, tanδ determined in dynamic experiments are depicted in Figs. 7 and 8 and are subsequently discussed.



(a) (b)

Fig. 7: *Frequency dependence of the dynamic stiffness for two rubber types; (a) Tackifire Special and (b) Tackifire Soft.*

The **stiffness** (geometry dependent) is the ratio of change of force to the corresponding change in deformation of an elastic element. The frequency dependence of the complex dynamic stiffness, K* is shown in Fig. 7. Moderate frequency dependence and due to the nonlinearity a more pronounced mean load and dynamic amplitude dependence were obtained. Tackifire Special^{R} (TF, Butterfly) reveal about 20-25 % higher stiffness in the frequency range than Tackifire Soft^{R} (TFS, Butterfly). Moreover, TFS reveal more load dependence than TF. The stiffness of the sandwich rubber should be correlated to the speed rating.



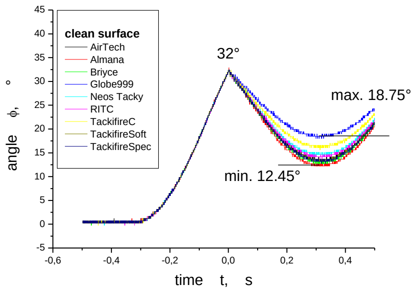
(a) (b)

Fig. 8: *Frequency dependence of tanδ values for two rubber types selected from product group 1; (a) Tackifire Special and (b) Tackifire Soft.*

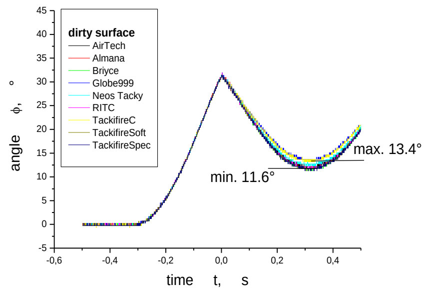
The **value of tanδ** is the tangent function of the phase angle difference between load/stress and displacement/strain. The value of tanδ is a very important viscoelastic parameter and proportional to the damping properties of a material. It is interesting to note, that TF reveal a more pronounced load level dependence than TFS. Significant frequency dependence of tanδ is observed for both materials (see Fig. 8).The tanδ should be correlated to the control characteristics of the sandwich rubber, in hand due to the bulk damping and due to the contribution of the hysteretic friction on the other.

3.3 *Impact rebound test*

For simplicity, only the change of the angle are plotted and analyzed for various rubber types at 90°.



(a)



(b)

Fig. 9: *Change of the rebound angle for various rubber types for; (a) clean and (b) dirty surfaces.*

Based on the angle difference the height difference and thus the energy difference could later be calculated. The change of the rebound angle for various rubber types investigated is shown in Fig. 9. The minimum and maximum values are lower and the $\Delta\phi$ (max-min) significantly higher for the clean surfaces. That is, the rebound behaviour is clearly influenced by the adhesion of the surface and this influence depends on the material grade.

4 Conclusions and Future Work

The results of these characterization methods reveal significant differences in both the bulk mechanical behavior as well as in the surface behavior of the various table tennis rubber types investigated.

Nevertheless, more detailed investigations are needed to characterize the effect of surface properties (wear, reduction of adhesion) and their relationship with the bulk properties on the overall performance of the sandwich rubbers. What is also particularly needed, is a thorough comparison between polymer sciences based properties and property functions and subjective performance evaluations by top players. In establishing correlations between subjective (player based) and objective (polymer science based) material rankings, a powerful tool may be made available to support future product development efforts.

Acknowledgments

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DESIGN OF AN ELECTRONIC SCOREBOARD FOR TABLE TENNIS

This paper talks about a design of Table Tennis electronic scoreboard, with multiples functions and benefits, like: automatic server indication; automatic change of side indication for the last set and change of score side; Time-out indication; time for rest between sets; at the end of match, it shows scores and times for each set. The table tennis rules are embedded in the scoreboard.

This design has non-volatile memory in case of loss of energy, it keeping the current score in memory. A battery can be used for continuous use even if the main energy source is lost.

Many electronics scoreboards can be network connected, in order to shows in several places the same score ("mirror" scoreboard). Also many electronic scoreboards (to 255 scoreboards) can be network connected for several match scores and they can be monitored from a main computer (PC) for scores concentration. All the scores sequences for each match with the time (hour: minutes: seconds) for each point can be filed and used for statistical. Internet displaying of the scores can be done by the PC used for monitoring.

This scoreboard can be used in table tennis instruction for easy learning of scoring. It has the option of to place pads in the table for training and counting the balls hitting over the pads.

The scoreboard can be used in tournaments, clubs and home; for professional use and for entertainment (recreational) use.

It is based in a microcontroller using CAN bus for network communication, it use LEDs for display the score (Points, Sets, Server and End of match). It uses a serial EEPROM to save the scores; configuration and other important information. The keyboard uses only 4 keys for an easy management.

Key words: *electronic scoreboard, microcontroller, network, CAN, learning, training, embedded rules.*

1- Introduction

In a table tennis match, it is needed to take the score, in order to make it easy, pre-printed scoreboard are used. In general, electronic scoreboards are used only in national, international or in professional tournaments or in first world countries.

The introduction of electronic scoreboards in local tournaments implies higher costs and problems to obtain the scoreboards. The commercial scoreboards are designed thinking in its use in other sports with more demand, like basketball, volleyball, football, etc., in consequence its design takes into account others needs, different from table tennis.

Even that some commercial electronic scoreboards are for multi-sports use, they don't full fit the table tennis special requirements.

The present work is about the design of an electronic scoreboard it thinking on full fit all the table tennis specific requirements, for tournament applications also as for teaching and learning the sport and its rules; also as it helping in the training. A key point of this design is the easiness of use, it reducing to the lowest quantity the number of keys of the control keyboard.

The design here presented it takes into account the expansion possibility, for interconnect several scoreboards and to have a network of scoreboards. Inside of this network we can have several use options; like that some group of scoreboards show the same information of a match, it placing them in different places for better vision of players, judges and spectators. Also a network node with a personal computer (PC) can be used to read all the scoreboards in the network and write all the information of a tournament into a file. In the event of a power fail, the information of each scoreboard is stored in a non-volatile memory inside of the scoreboard and in the PC.

The implementation of this work takes into account the modularity, and it can be removed some parts in order to reduce the cost, without the loss of basic functions.

The next section will talk about the hardware needed and the optional parts. The third section will describe the considerations taken in the design of the software and its modular structure. The fourth section will show the installing way and wiring for a correct use of the scoreboard. The fifth section shows the applications of this work. The sixth section will show some comparisons with commercial scoreboards. Finally the last section will show the conclusions of this work and the improvements to implement in the future.

2- Hardware

The implementation of an electronic scoreboard for any sport needs the use of digital electronic devices; programmable devices are best suited in order to have a versatile and reprogrammable design.

The digital electronic devices can be classified in two large groups: The Processors and the Programmable Logic. Inside of the first group are the microprocessors (uP), the microcontrollers (uC) and the DSP (Digital Signal Processor). In the second group are the SPLD (Simple Programmable Logic Devices), the CPLD (Complex Programmable Logic Devices) and the FPGA (Field Programmable Gate Array).

The use of programmable logic and in special the FPGA gives an enormous versatility to the design, because that all the pins can be used for any function in any direction. Also the processing power that can be achieved is higher than with other options because all the work is done in hardware and it can be done in parallel, only limited by the quantity of gates available in the chosen device. There are device with several millions of gates. The design with FPGA is little more complex than with microprocessors, because that the start point is the use of basic elements like gates and the use of some pre-designed blocks, named Cores. There is also the option of implement a processor inside of the FPGA, it using cores or it using a real processor integrated from factory in the FPGA, like the PowerPC in some Xilinx FPGAs.

The microcontrollers are microprocessor integrated with RAM and ROM memory and common used peripheral, like timers; analog to digital and digital to analog converters; serial ports; etc. The DSP are microcontrollers with the hardware and the instruction set needed for digital signal processing, where multiplication and accumulation is a basic operation.

The control of an electronic scoreboard do not require the power processing of a DSP but RAM, ROM and peripherals are needed, then the use of a microcontroller is a good and enough option for this application.

There are a large number of microcontrollers available with different quantities of integrated RAM and ROM memory; with several types of ROM; and with spread type and quantity of integrated peripherals devices.

For the control of an electronic scoreboard is not necessary a high power of processing, but the following elements are required:

- Enough quantity of RAM memory for storing the variables of table tennis scoring (points in each set for each player; server order; time of match, etc.) and for the stack used in subroutines. At least 128 bytes of RAM are needed. If the software is written in a high level programming language 1 K byte is recommended.
- Enough quantity of ROM memory to hold the control program. If the software is development in assembler, 2 K bytes of ROM are needed. If the software is written with a high level language more than 8 K bytes are recommended. The ROM memory suggested is Flash, in order to have an easy and quickly change in the control program when updates are needed.

- One timer (at least) with interrupt generation. The timer is useful for measuring game time; rest time; and for timing the multiplexing in the LED (Light Emitter Diode) display.
- Three parallel ports are required, two for a seven segments LED display control and one port for connecting a control keyboard.
- A serial port for add special peripherals. There are several types of serial ports, but SPI (Serial Peripheral Interface) and UART (Universal Asynchronous Receiver Transmitter) are recommended.
- A type of network connection, in order to have intercommunication between the scoreboard and others scoreboards and/or a personal computer.

Also the price and availability is an important factor to take into account in the selection of the microcontroller, and even if the chosen uC does not have some peripheral needed, we need to consider the option of add it externally.

The microcontroller chosen for this work was AT89S53 from Atmel. This is an uC compatible with the Intel 51 family. It has 12 K bytes of Flash ROM; 256 bytes of RAM; 4 8-bits parallel ports; 3 16-bits timers; 1 UART Serial Port; 1 SPI Serial Port; 9 interruption sources. The maximal work frequency of this circuit is 24 MHz.

For displaying the score a 7-segments LEDs array was chosen, with 6 digits: two pairs of digits are for display the points of the current playing set for each player. Another two digits are for display the sets won for each player. Additionally there are LEDs to show which player is serving and for indicate the end of set; change of side and end of match. The six digits are multiplexed in the time, and for their control they require 2 8-bits parallel ports of the microcontroller. With these two ports we would be able to have to 8 digits of 8 segments with time multiplexing. The figure 1 shows the LED array of the scoreboard display, indicating the function of each digit.

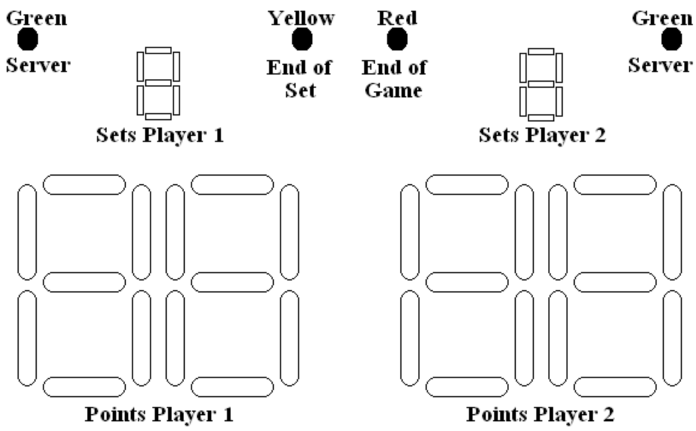

Figure 1 Scoreboard Display.

For the scoreboard control a keyboard with only 4 keys was chosen. For connect this keyboard to microcontroller, it is needed a 4-bits input port. Using an 8-bit input port it can be connected a keyboard with 16 keys. A 4 key keyboard was chosen in order to facilitating the use to the judge and avoiding confusions. The figure 2 shows this keyboard with the names of each key.

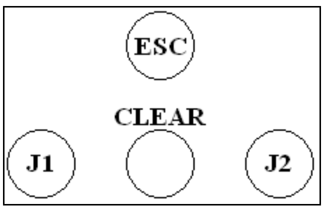

Figure 2 Scoreboard Control Keyboard.

For the network connection of the scoreboards a CAN (Controller Area Network) bus was chosen. This standard was selected because its simplicity of wiring, its noise immunity and the availability of drivers and controllers with SPI interface, reducing the number of wires for interconnecting the controller with the microcontroller. In CAN standard mailboxes are used, it identifying them by an 11-bit number or address using Standard Data Frames, but in this design only 8-bit are used, therefore only 255 scoreboards can be connected in the network. A node of the network can be used to capture the information from all the mailbox addresses, and therefore it taking all the scores from all the scoreboards. This node can be used by a personal computer.

An external EEPROM memory was added to the design in order to not lose the scoring in case of power fail, when there is not a backup battery. This memory has SPI interface and therefore does not it need additional terminals that the used by the CAN controller.

The figure 3 shows a block diagram of the scoreboard.

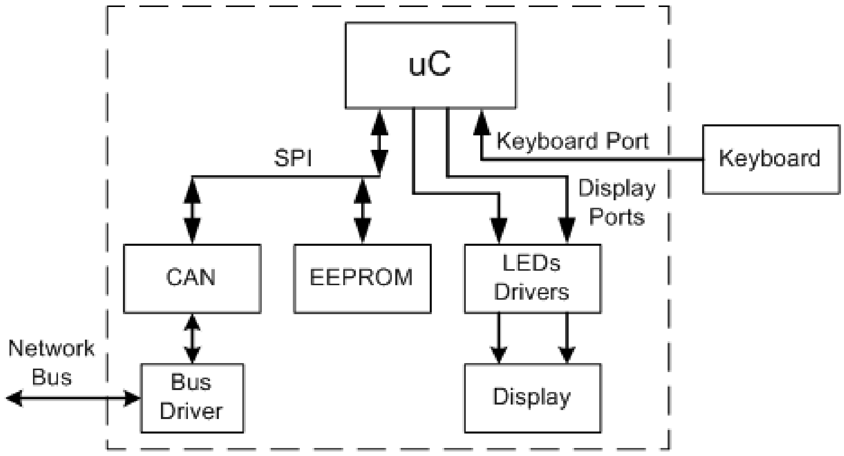

Figure 3 Scoreboard Block Diagram

The EEPROM memory is optional, because it is not needed when a backup battery is used, and therefore it can be or not connected, without any loss of functionality of the scoreboard. In the same way, if we do not wish the network interconnection, the CAN driver and controller can be removed without alteration of the scoreboard performance. Then the cost of the system can be reduced.

With all the options included and without battery, the scoreboard consumes 0.1A at 110v of AC. It has a weight of 1.2 Kg when an acrylic box is used to hold the system. The dimensions are 34cm x 22cm x 15cm.

3- Software

With the purpose to reduce the quantity of RAM and ROM required by the software and taking advantage of my experience writing programs in assembler language for several microprocessors and microcontrollers, I wrote the software in assembler. For future versions I will write the software in “C”, it thinking in the option of changes of microcontroller used and because a high level language like “C” need less changes to use in other uC, but requiring more quantity of RAM and ROM.

One of the objectives when the software was designed, it was simplifying the management of the scoreboard, it integrating and complying the table tennis rules, like the order of the services, the rest times in a set (under request of each player) and between sets (automatic), it showing the time in descending form, so that the players be aware. At the end of a match the software hold the partial results for each set also as the total and partial time duration.

The software design was modular, structured and generic, and easily the main parameters can be modified, as the points by set; services by turn for each player, etc.

The software has many routines; some of them are mentioned in the next lines:

- Updating the display: This routine is responsible of showing the data for each digit during a period of time avoiding that the blinking (caused by time multiplexing of the digits) be seen. This routine is executed by timer interruption.
- Keyboard read: It is responsible of to read the keys pressed in the control keyboard.
- Keys Decoder: This routine takes the decision of which routine should be executed in function of the key pressed.
- Routines for each basic function: Increment or Decrement of points for each player; verification of player that should have the service; end of set and end of match verification; time update; time of game update.
- Start of Game: Routine used to clear all the counters and to choose the maximum number of set to play (3, 5 or 7).
- Network communication: Routine needed to send and receive the scores to or from the network.
- EEPROM communication: Routines for write and read the scores to or from the external backup memory.
- Initialization routines: It is used for programming and configuring all the internal and external peripherals.
- Change of parameters: Routine used to modify the numbers assigned to the scoreboard in the network, for broadcast and for reception (CAN mailbox addresses).
- Time routine: It is for display time (min:sec) in descending form for 1, 2 or 3 minutes in time-out.
- Work in Stopwatch mode: It is to shows the time (hour:min:sec), it is useful for training.
- Work in reception or mirror mode: This routine is used to show the score received from other scoreboard in the network, from the address chosen.

4- Wiring

The scoreboard needs 3 sets of cables for its use. One of these sets is for power supply; another is for the control keyboard and another one optional is for the network interconnection.

For the power supply is needed a pair of wires that provide 110v of AC with 0.2A of current.

For the control keyboard connection is needed a telephonic or network cable, with 5 wires (or 3 pair of wires). The maximal current in these wires will be of 5 mA. The maximal length is of 50 meters.

For the network connection is needed a cable with a pair of wires to interconnect all the scoreboards. The maximal length for this bus is 500 meters. In the extremes sides of this bus a 120 ohms at ¼ w termination resistors are needed.

The figure 4 shows an example of the wiring for several scoreboards.

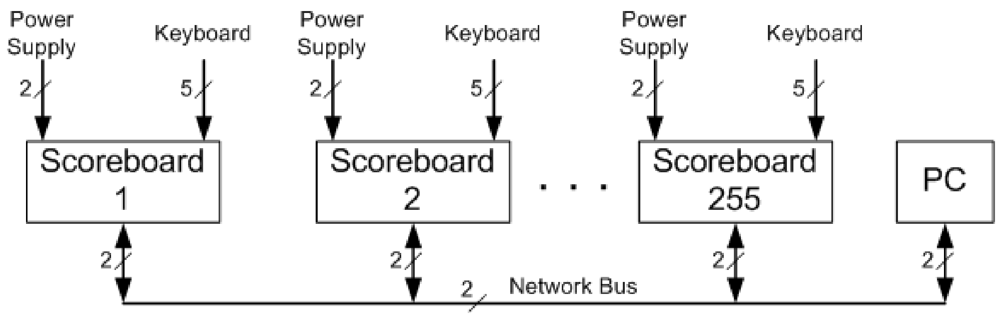

Figure 4 Scoreboard Wiring.

5- Applications

This scoreboard can be used in table tennis matches in tournaments, connecting a network of several of them; selectively some of them can be configured in reception or mirror mode to show the same score from a match, it placing them in various places for better vision of players, judges and spectators. For different tables the scoreboards work in independent form, it assigning them the same number that the tables.

Since the scoreboard shows automatically the time of rest between sets, the players, coaches, judges and public are aware of the remaining time.

A personal computer can be connected in a network node to concentrate and to register the information of all the tables (scoreboards). A computer file will have the point sequence of each table, along with the time (hour:min:sec) in which each point occurred. With this information, statistic can be generated also as a "replaying a game" can be done subsequently.

In table tennis clubs the scoreboard can be utilized with a third player carrying the count, or placing the keys of the keyboard under the table in each side, so that the players carry its own count.

Also it can be used for teaching to children, since the operation is very simple, once explained this, the children can carry their own count and the sequence of services.

With the use of additional pads placed over the table in specific places, training exercises can be done.

In fact, this scoreboard is useful for family use; in clubs; in training also as in tournaments. It can be used alone or to 255 scoreboards connected in network, it concentrating the information in a PC.

6- Comparisons

The majority of the commercial electronic scoreboards that have been found utilize screen of LEDs, generally with a greater quantity of digits (necessary for other sports) and some with wireless remote control and with sounds.

But none has the table tennis rules embedded, as the automatic indication of the player serving; the change of side in the last one set; the option of connection in network of to 255 scoreboards; the option of configuration in reception or mirror mode. These characteristics are special and unique in this design.

The cost of a commercial electronic scoreboard is greater than 300 USD. The cost of this design manufactured in small quantities is of less than 260 USD.

Because this design is specific for table tennis, it was done putting the useful indicators for this sport, avoiding showing more information that would cause confusions.

The keyboard was organized with the smaller quantity of keys in order to do it less confused and easy to use.

Although this version does not include sounds neither wireless keyboard, these are improvements to include in future versions.

7- Conclusions and Future Improvements

An electronic scoreboard specifically designed for table tennis facilitates its management and clarifies the information shown. In this work the table tennis rules were embedded.

The options added to this scoreboard are unique and they are not available in other commercial electronic scoreboards. They do it ideal for tournaments (the network connection; reception or mirror mode; the use of a PC to register and to monitor to all the scoreboards) also as for use in clubs (for teaching and training) and for family or recreational use.

This design is ready for the evolution and improvement. Already it is in test of a wireless remote control. Also sound will be added to indicate or to call the attention of players and judges in situations that require it. Also it is considered to include a blinking in the display when occurs a change of the scoring.

In the training mode, the option of pauses will be added, as well as the count of these pauses, for the count of exercises repetitions.

The observations and criticisms of the users are welcomes and they are taken into account to improve the operation of this design.

To future also an intelligent control (judge console) will be implemented, in order to show the score with a small LCD display to the judge or person who carries the scoreboard. This console would communicate with the scoreboard through CAN, in such a way that the scoreboard will need to be in reception or mirror mode to show the score of the judge console. Because it use the CAN bus then the console can control all the scoreboards that be desired, showing the same information and allowing a better view to the spectators and to the players.

8- References

[1] Atmel 8-Bit Microcontroller with 12K Bytes Flash, Rev. 0787D-06/00.
[2] Atmel SPI Serial EEPROMs 8K, 16K, 32K, 64K, Rev. 0675F-08/01.
[3] ITTF Handbook, Chapter 2: Laws 2001-2002.

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FACTS ABOUT SPEED GLUE

Abstract

In its environmental charter, "Agenda 21 of the Olympic Movement", the IOC defines its stance on hazardous substances in sports products as follows:
"...the members of the Olympic Movement undertake ..... to avoid using products recognized as being hazardous or toxic to humans or environmentally polluting."
As a member of the Olympic Movement, the ITTF has decided to introduce a ban on the organic solvents used in speed gluing with effect from September 2007. The authors of this report have set themselves the task of presenting facts associated with the following aspects of speed gluing and the use of organic solvents: current actual speed gluing practice and the quantities of solvents used and released into the air, the statutory provisions regarding organic solvents in Europe, the actual risk potential and the hazardousness of organic solvents.
Speed gluing is currently characterised by the desire of players to "tune" their rubbers to the point of maximum performance using speed glue. To do this, more than 20g of organic solvents is needed for one rubber. 85% of this escape into the air. Having looked at all the relevant safety datasheets, it has been established that all organic solvents are dangerous to health. They are toxicologically effective and many of them also damage the environment. In Europe, speed glues have to carry a warning notice on the packaging stating that they "must be kept out of reach of children". Under the terms of Germany's Youth Employment Protection Act, young people under the age of 18 and children may not be exposed to organic solvents at all unless it is necessary, and even then only if supervised. A factor that has so far gone largely unheeded is the tendency of organic solvents to form explosive mixtures when combined with air. Using a simple model calculation it was possible to show that, in unfavourable circumstances, it is entirely possible for explosive mixtures to form during speed gluing. Finally, data was gathered showing the extent of "glue sniffing" in Europe and the third world. The findings of one international study show that in many European countries 10-20% of schoolchildren have "sniffed" at least once. In the third world, a large proportion of homeless children are dependent on glue sniffing.
The authors consider it their task to assemble these facts. The evaluation of the facts and the requisite decisions are in the hands of the ITTF and the national associations.

Key words: *table tennis, glue, speed glue*

The purpose of this research

Speed gluing started in the 1970s, its invention being attributed to the Hungarian Tibor Klampar. It is said that this ingenious player's partners were astonished by the sound his bat made during training and, using espionage-like techniques, discovered that before every training session he secretly applied his rubber to the bat afresh, gluing it over again. Since that time the practice of speed gluing has spread widely. These days when children are being coached, the question arises as to whether they should start to play using speed glue, or whether they should first learn the basics of the technique. The reason for this radical change in our sport lies in the special sound of a "speed glued" bat and in the ceremonial aura surrounding speed gluing.

Opponents of speed gluing complain about the odour pollution in the changing rooms and the risk to health. The subject is a highly emotional one.

The ITTF's Board of Directors has ruled that from September 2007 the use of organic solvents to attach the rubber to the bat will be banned. The emotion that is characteristic of speed gluing has naturally taken over the discussion about this decision. It was for this reason that the authors of this report set themselves the task of assembling only such aspects of the debate as are based on fact. Facts and data have been gathered from various groups involved with speed gluing. This information should help the decision-making body to reach a conclusion about speed gluing that is good for the future of the sport of table tennis. The authors have endeavoured to refrain from any value judgements and to report only factual information.

1. What causes the speed gluing effect in table tennis rubbers?

The speed glues currently still approved by the ITTF consist of two fundamentally different chemical components:

Main component, 85-90%:	organic solvents
Actual glue 10-15%:	natural rubber/resin mix

The organic solvents alone are responsible for the speed-enhancing and spin-enhancing effects of speed gluing. The natural rubber/resin component is neutral in terms of its effect on the rubber.

The speed gluing effect could therefore also be achieved purely through solvents, which is the case in practice to some extent already.

When speed gluing is carried out, some of the organic solvents evaporate into the air and some enter the rubber (quantitative analyses of this are shown below). This causes a change in the physical characteristics of the rubber. In practical terms, it causes the ball to rebound from the bat during play with greater speed and more spin. Since the effect does not last long, the procedure has to be repeated at regular intervals.

2. Speed gluing in practice

2.1. Peak performance of a table tennis rubber that has been "speed glued"

Tibor Klampar had noticed that a freshly glued bat was faster in play than the same bat one week later. For this reason, he tried to repeat the gluing process. It is no surprise that the performance-enhancing effect of the organic solvents is dependent on the quantity used. In practice, players know this: the more you glue, the faster the bat becomes. It is also a well-known fact that the effect does not continue indefinitely and starts to decrease at a certain point. We have investigated these assumptions scientifically and conducted the following experiment. The glue quantities were measured using a laboratory scale:

1st gluing: 1.5g of an approved, well-known European glue with fairly high adhesion (a somewhat lower proportion of solvent) was applied first (for the purposes of later adhesion on the blade). Then 4g of approved, fluid speed glue, also European, (with a high solvent content) was applied. All further gluing procedures were carried out using this glue. Once the glue ceased to draw threads when touched, another 3g of speed glue was applied. The rubber was then measured using the "Wassing Dom" device (see [1] for technical details) to determine its spin/speed performance. And a trial game was played to produce a comparison with actual practice.

2nd gluing: 3g of speed glue was applied. After ventilation, the gluing procedure using 3g was repeated. Measurements were then taken using the Wassing Dom device and a game was played.

3rd – 6th gluing: Repetitions of stage 2.

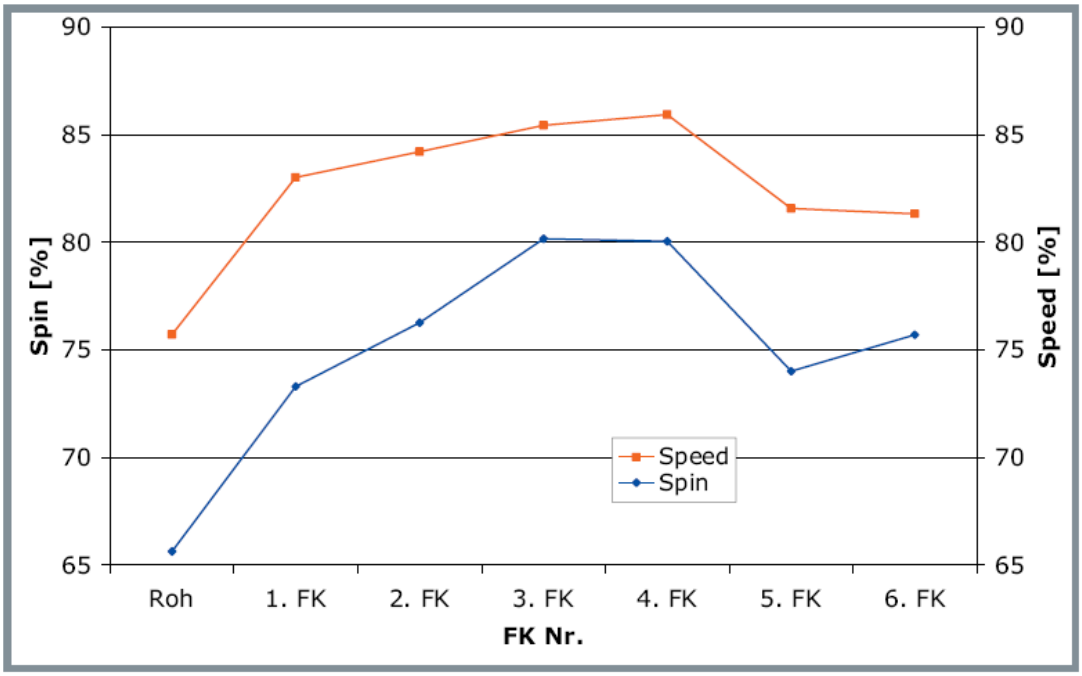

Diagram 1: Spin and speed in relation to the respective number of speed glue applications

Diagram (1) shows spin and speed in relation to the respective number of speed glue applications. It can be seen that both the speed and particularly the spin increase until the third gluing procedure, stay more or less the same with the fourth, and then decrease.

These findings are in line with the professionals' speed gluing experience. They make several applications using a large quantity of speed glue before playing for the first time. They then use only moderate quantities of glue and change the rubber after only a few training sessions. In this way they maintain the rubber at its peak during the brief period of use.

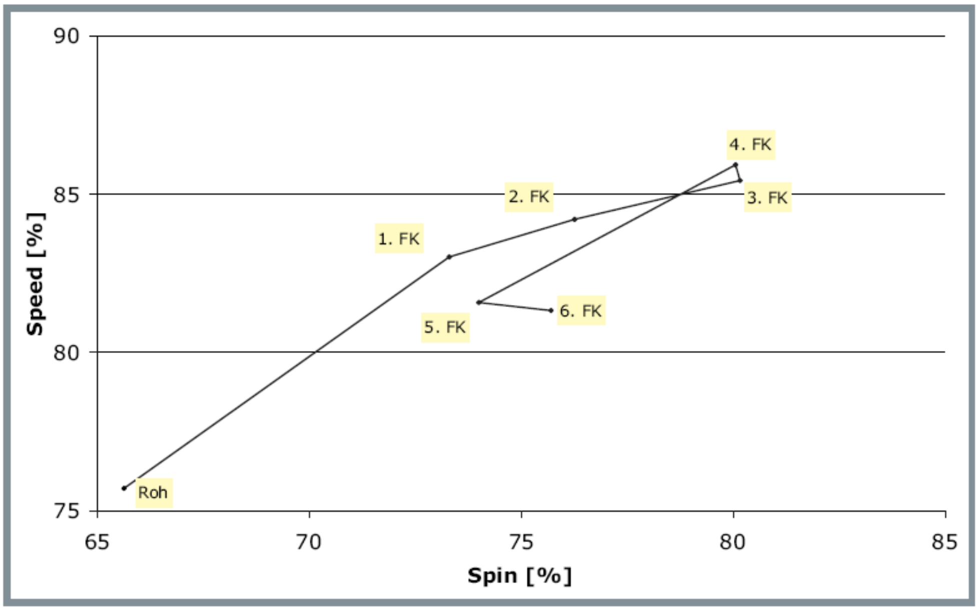

Diagram 2: Performance enhancement by speed gluing in spin/speed relationship

It is also possible to show spin in direct relation to speed as shown in the diagram (2). The enhancement of and the decrease in performance can then be seen even more clearly.

This type of measurement using exactly the same gluing procedure was carried out on all rubbers currently on the market. The behaviour of the rubbers essentially follows the same pattern. It was also repeated using different approved glues and in these cases also followed the same pattern. The measurements taken for spin and speed were regularly in line with the impressions reported by the test individuals.

It can be affirmed that a minimum quantity of 20g of speed glue is always needed in order to bring a traditional rubber backed with sponge of 2.0 – 2.2mm depth to its peak performance.

2.2. The speed gluing procedure practised by a professional

A young player at national level (amongst the top 80 male players in the world) from a leading country has described to us his personal speed gluing procedure as follows:

- I glue 2 new rubbers the night before a match
- I glue 5 coats of speed glue onto each rubber
- I leave the glue to take effect for a short while in between each coat
- After the 5th coat I apply a coat of glue onto the blade and attach the rubber to it whilst wet and allow it to soak in overnight. (A film is placed over the rubber to prevent the solvent from escaping, and the entire bat is placed in a bag).
- On the morning of a match I break in the rubber by playing, because it doesn't reach its full potential the first time you play.
- Before breaking it in, I always attach the rubber with 3 coats of speed glue, allowing the speed glue to soak in between each coat, and after the final coat I apply a coat to the blade. When it's all touch-dry, I attach the rubber to the blade.
- Before a competition I then apply a further 3 coats in the same way.
- With my style of speed gluing, the rubber reaches its optimum potential after 11 coats.

Considering the process described from a scientific perspective and from the point of view of establishing facts, this empirical procedure is unsatisfactory because no quantitative data has been gathered about the glue used. For this reason, we conducted an experiment in conjunction with Philippe Saive, a professional player, in which Saive carried out the gluing procedure in his own way and we were able to gather and document the quantitative data.

It emerged that the total quantity of speed glue used over every stage of the procedure in order to tune the rubber to its performance peak was >20g.

Based on the experiences of the professional players and our own measurements as described in 2.1, we developed a standard speed gluing procedure, using which we are able to bring rubbers to their performance peak in a reliable, reproducible manner. Using the organic solvents currently approved by the ITTF, a quantity >20g of speed glue is always necessary. The effect obtained with 11 applications by the young professional quoted above can be obtained by more or fewer coats depending on the dosage. In our standard procedure (see 2.1), we use 7 applications. It is a fact that one application does not bring the rubber to its peak and that it needs >20g speed glue to bring it to this point.

There is a further aspect of the professionals' gluing practice: where does a player actually carry out his first gluing procedure "the night before"? The DTTB has banned speed gluing in confined spaces. Does this mean that players carry out their preparation the night before in the open air? The practice of bringing the rubber up to its performance peak in several gluing phases is not confined to professionals. We know from our experience and many conversations with players that this practice has become very widespread over the years. The fact that a rubber needs >20g glue in order to develop maximum performance inevitably gives rise to the idea of pre-gluing.

The process of pre-gluing raises yet another question: where does the player store the bats that he has soaked with solvents? Since we are only dealing with facts here, we will leave this as an unanswered question.

2.3. The amount of solvent that escapes into the air

The standard gluing procedure was carried out and at each stage of the process the weight of the rubber was also measured at intervals.

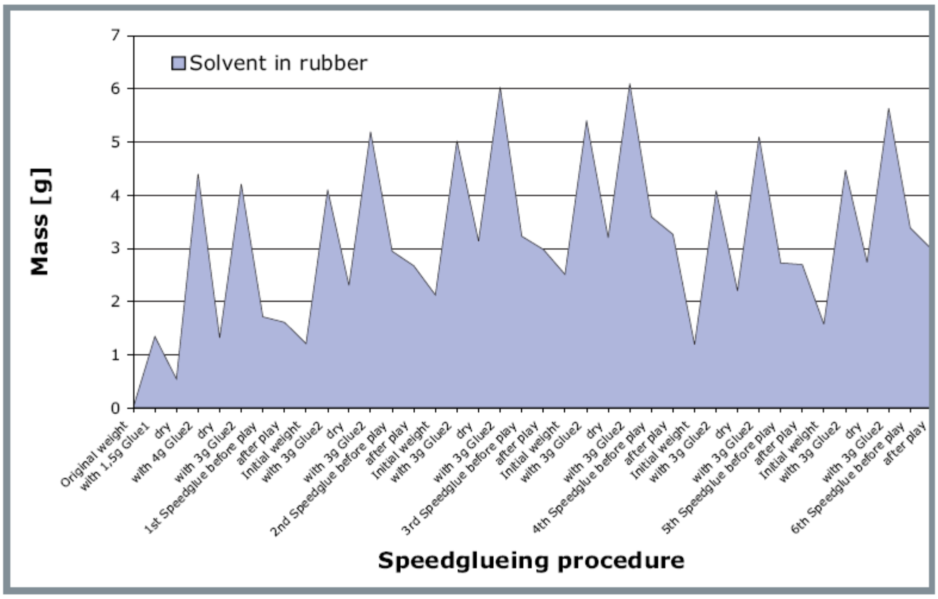

Diagram 3: Quantity of solvents in relation to individual stages of gluing procedure

This provides, first and foremost, information about the quantity of effective solvent. In diagram (3) this quantity is shown in relation to the individual stages of the procedure. It is possible to see how the solvent is absorbed by the rubber and then volatilises again. This also explains the reduction in playing characteristics after a lengthy break.

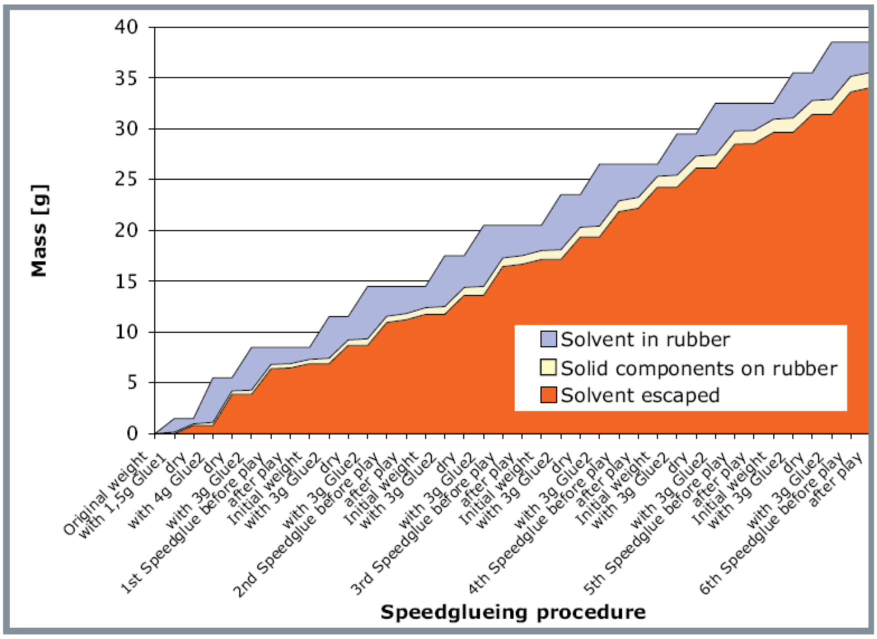

Diagram 4: Quantity of solvent remaining in the rubber and escaping into the air

In diagram (4) it is possible to see and calculate how much solvent proportionally remains in the rubber and how much escapes into the air. The latter is particularly important in terms of this study. At the start of the speed gluing procedure, a great deal of solvent is absorbed by the rubber, but the quantity absorbed becomes more or less constant later, and most escapes into the air. When a rubber has reached its performance peak, some 15-20% of the solvent has been absorbed and 80-85% has escaped into the air.

3. Organic solvents and their potential risk

In an analysis conducted by the DIK (*Deutsches Institut für Kautschuktechnologie*/German Institute of Rubber Technology) in 2001, a study was conducted on two speed glues, one from Belgium and one from Germany, The following findings were recorded:

Belgian glues: the main components of the solvent mixture are C_7-hydrocarbons (trimethylbutane, dimethylpentane, 2-methylhexane, 3-methylhexane, heptane, methylcyclohexane and ethylcyclopentane). Additionally, the C_8-alkane dimethylhexane, tetramethylbutane and octane were also found.

German glue: this glue also contains a mixture of C_7-hydrocarbons (trimethylbutane, methylhexane, heptane, ethylcyclopentane, dimethylpentane and isopropylcyclobutane) with a high proportion of n-heptane as principal solvent. Additionally, the C_6-alkane 2-methylpentane, hexane and propylcyclopropane, the C_8-alkane dimethylhexane, and aldehyde (hexenal) and an unsaturated hydrocarbon were detected.

According to a study published by the Federal Institute for Risk Assessment dated 15.04.2004 [2], the following are currently used: cyclohexane, heptane and isomers (see above), the organic ester n-butylacetate and ethylacetate, and also hydrocarbons such as special grades of petroleum spirit, naphtha (petroleum) hydrotreated light, and hydrocarbon solvent (aliphatic), not specified through citation of a CAS number.

Classification of organic solvents

The organic solvents can, essentially, be subdivided into four groups:

- aliphatic hydrocarbons
- esters
- aromatic hydrocarbons
- halogenated hydrocarbons

The current ITTF regulation on approved glues

According to a communication from the ITTF Equipment Committees dated 8.10.2004, the following solvents are currently not permitted:

- aromatic hydrocarbons
- halogenated hydrocarbons
- n-hexane

We do not wish to embark on any discussion about aromatic and halogenated hydrocarbons as they are already banned.

N-hexane is an aliphatic hydrocarbon and we cannot understand why it is not approved when all other aliphates are permitted. The potential risk of these substances is essentially similar. See further discussion below.

Material safety data sheets and the risk potential

Under the terms of Germany's Chemicals Act, ChemG, and the Hazardous Substances Ordinance, GefStoffV, all organic solvents belong to the category of hazardous substances. All manufacturers of such substances must enclose a so-called material safety data sheet (MSDS) when supplying such substances. A material safety data sheet must accompany every shipment. These data sheets contain every product-related notice, particularly any relating to health risks and toxicology. Material safety data sheets concerning organic solvents can be found in [3].

We have worked systematically through the material safety data sheets for organic solvents and have made the following findings:

<u>Aliphatic hydrocarbons</u>

The material safety data sheet of the principal components of n-heptane can be found in Annex (a).

Like the isomeric C_7 hydrocarbons and the C_6 and C_8 alkanes, the preparation is highly flammable and harmful, is a skin irritant, and highly toxic for aquatic organisms (dangerous for the environment).

These substances irritate the skin, the vapours irritate the mucous membranes in the nose and the respiratory tract, and they can cause drowsiness and dizziness. People exposed to higher concentrations may suffer from CNS depression, headaches, nausea, dizziness, confusion, behavioural disorders, inebriation, coordination disorders, cardiac rhythm disorders, disorders of consciousness and breathing difficulties.

Generally speaking it is true to say that aliphatic hydrocarbons containing 6-18 carbon atoms, if inhaled directly, can also cause pneumonia and sometimes even pulmonary oedema.

Details are provided about acute toxicity (LD50, LC50 values: these are values from animal experiments quoted in the MSDS's, explaining at what dosage of the respective chemical in the animal experiments 50% of the animals died a specified time after ingestion) in relation to swallowing, inhaling and absorption through the eyes and skin. These are clearly toxic preparations. Hands and eyes must be protected when handling them (gloves, goggles). Contaminated clothing must be changed immediately.

When hydrocarbons are disposed of, certain disposal regulations have to be observed. It is special kind of refuse which falls into the "Hazardous waste" category (91/689/EG).

All these substances are subject to an "S02 notice": "Must be kept out of reach of children".

Esters

Compared with the saturated hydrocarbons, some of the organic esters also used are not directly classified as harmful in the sense of the hazard symbol X_n, but these substances also have toxicological threshold values in respect of oral and inhalational absorption above which 50% of the test animals died. Esters irritate the skin and the mucous membranes. Due to their frequently high vapour pressure (e.g. ethyl acetate), a harmful concentration in respiratory air is reached rapidly. In places where there are high concentrations (gluing rooms!), a narcotic effect can be generated. Esters also have the major disadvantage of being extreme odour pollutants, as they smell very strongly even in low **concentrations.**

Overall assessment of currently approved organic solvents

All organic solvents are fluids which may differ in their toxicity but, notwithstanding their actual classification, they are all toxicologically effective.

A study carried out by Germany's Federal Institute for Risk Assessment (or BfR) [2] investigated not only esters but also alkanes and cycloalkanes in terms of potential risk if used as speed glues. The following recommendations were made as a result:

1. Gluing rooms should be equipped with ventilation devices.
2. Gluing should only be permitted in the open air.
3. Children should be banned from gluing.

When asked, the BfR confirmed to us that these recommendations apply not only to the three substances investigated (butylacetate, n-heptane, cyclohexane) but also to all other organic solvents, to which even more stringent restrictions would be applied (e.g. benzene, toluene). There are no organic solvents that are not harmful to a greater or lesser extent.

4. Statutory provisions in Europe regulating the handling of harmful substances

4.1. Speed glue must be kept out of reach of children

The Chemicals Act is harmonised throughout Europe and applies to the whole of the EU. Within the category of chemicals, organic solvents are classified as hazardous substances. The categorisation and handling of these substances is regulated in Germany by the Hazardous Substances Ordinance GefStoffV.

Speed glues are preparations based on hazardous substances. According to Section 4 Subs. 1 GefStoffV, preparations are conglomerates, mixtures and solutions comprising 2 or more substances and which display at least one of the following hazardous features. We compiled these features in the following table, taken from the MSDS's of a number of organic solvents:

	Feature	Applies to speed glues and/or organic solvents present in speed glues
1.	explosive	no
2.	oxidising	no
3.	extremely flammable	some
4.	highly inflammable	all
5.	inflammable	generally in fact highly inflammable (Class 4)
6.	highly poisonous	no
7.	poisonous	no
8.	harmful	mostly
9.	caustic	no
10.	irritant	some
11.	sensitising	no
12.	carcinogenic	no
13.	toxic to reproduction	no
14.	mutagenic	no
15.	environmentally dangerous	mostly

Table 1. Preparations displaying at least one of these 15 features are hazardous.

In Germany, a set of guidelines entitled TRGS 200 [technical guideline for hazardous substances] [4] provides information about the categorisation and labelling of such substances. The TRGS is published in Germany by the Hazardous Substances Committee of the Federal Institute for Occupational Safety and Health.

Paragraph 6.16 of TRGS 200 deals with preparations obtainable by anyone and states that preparations containing organic solvents must always bear the warning notice:

"MUST BE KEPT OUT OF REACH OF CHILDREN".

One of the above criteria must be fulfilled in order for this to apply. We did not find a single organic solvent which failed to fulfil at least one of the hazard criteria.

The possible consequences of this for parents, trainers, table tennis dealers, clubs and associations right up to the ITTF itself do not fall within the remit of this report.

The harmful and toxic character of organic solvents has given rise to a series of statutorily prescribed notices on the packaging used for speed glues. These are known as R (risk) and S (safety) clauses.

In the case of n-heptane, taken here as an example (see MSDS in Annex (a)), the following notices must appear on the packaging:

- highly flammable
- irritates the skin
- harmful: possible lung damage if swallowed
- vapours may cause drowsiness and numbness
- highly poisonous for water organisms; may have harmful effects on water supplies in the longer term.

All organic solvents must carry a set of similar warnings on the product packaging.

4.2. The MAK value and the Youth Employment Protection Act

When the hazard levels occasioned by speed gluing need to be measured, the so-called MAK value is frequently quoted. This is a concept from the world of employment. The MAK value indicates the maximum permissible concentration of hazardous substances in the workplace.

The MAK values of all known hazardous substances are listed in the TRGS 900 [5]. When quoting these values, it must be noted that special protection conditions are specified for children and young people in Germany's Youth Employment Protection Act JArbSchG. The permissible levels for children and young people under the age of 18 are stipulated as follows in Section 22: "Young people may not be employed......in positions in which they would be exposed to the harmful effects of hazardous substances within the meaning of the Chemicals Act". This is the case with speed glues. According to JarbSchG Section 22, the application of MAK values is only relevant for young persons subject to the proviso that such exposure is necessary for educational purposes and then only if the supervisory services of a technical specialist are provided for their protection.

It must be asked to what extent the practice of children and youngsters playing table tennis can be equated with the exercise of a profession. The answer to this question provides an indication as to whether applying MAK values is helpful and whether or not the provisions of Section 22 JArbSchG are relevant. A further question must also be answered: the question of whether it is necessary for young people to use speed glue and whether it can be ensured that speed gluing is always carried out under the supervision of an expert. Providing answers to these questions falls outside the remit of this report.

5. Estimated formation of explosive solvent-gas mixtures through the use of speed glues

During speed gluing, quantities of solvent vapour are released, which are sometimes quite considerable. The question arises as to whether such mixing with air can produce an explosive gas mixture. The so-called lower explosive limit indicates how much solvent must be mixed with air in order to produce an explosive mix. In this part of the study, consideration was given to the circumstances in which solvent-air mixtures causing an explosion can be produced through the use of speed glue. The problem associated with exceeding the lower explosive limit is well known in the glue industry. In the past it has resulted in serious accidents.

In order to be able to carry out a model flashover calculation, various facts were assembled and one or two assumptions made.

Explosive concentration:
The material safety data sheets applicable to the solvents used in the speed glues show that a risk of explosion exists where there is a weight proportion of solvent to air of between 1% and 2%, depending on the substance involved. For our purposes, for the sake of simplicity, we used a figure of 1%.

Air density:
The density of air is 1.29 kg/m^3 or 1.29g/l.

With solvent quantities released during speed gluing:

In a strong speed gluing process, standardised for laboratory purposes, 8.5g of glue is applied to the reverse side of the rubber; before it is applied to the blade, 6.5g of this evaporates and can still be found in the ambient air in the vapour phase.

Usual container sizes:
Table tennis players normally use glue containers with a capacity of 275ml and therefore a content of some 200g.

Volume of a car interior:
The interior volume of a car is estimated to be $3m^3$. Even though speed gluing in cars could theoretically be banned immediately in Germany by the DTTB, the model calculation for speed gluing in a car was still carried out, by way of a worst-case-scenario. Since such an explosion would constitute a very serious accident, a scenario where the rules are ignored must also be investigated.

Results of the flashover calculation for speed gluing in a car:

6.5g of solvent evaporates. A volume of 500 litres would be explosive.

If evenly distributed within a car interior, there will be a solvent concentration of 0.17%.

The quantity of speed glue needed to produce a 1% explosive air-solvent vapour mixture in a car interior, given even distribution, is 40g. This quantity corresponds roughly to the simultaneous speed gluing of 6 rubbers, in other words 3 bats, inside the car.

40g of glue corresponds to 20% of the contents of one speed glue container.

Conclusions:

In a one-off standard speed gluing procedure carried out on one side of the bat in a small space such as a car interior, the concentration of solvent released, given even distribution of the vapours in the car interior, is not sufficient by a factor of 6 to produce an explosive mixture.

However, these circumstances can easily change if several rubbers are glued at the same time. If 6 rubbers are treated simultaneously (a finished bat comprising two rubbers), the total quantity of gas in the interior can be transformed into an explosive mixture. This scenario may appear to be an unlikely one. However, this is a worst-case-scenario in terms of explosion. Even in such unlikely conditions, no such explosion may occur.

But there is a further danger since an even mix cannot be expected to form immediately in the car interior. An explosive mixture may form in a particular area, and an explosion might be caused there through contact with an ignition source (e.g. a cigarette).

There is also a danger that carelessness (e.g. tipping the glue container over) may result in enough solvent being released to change the air in the car interior into an explosive mixture. The leakage of 40g, or 1/5 of the content of a glue container, would be enough to produce an explosion if there were to be contact with a spark.

This scenario illustrates that, when speed gluing in restricted spaces, there is a potential risk in exceeding the lower explosive limit that has hitherto been virtually ignored and which deserves more investigation.

6. Glue sniffing and speed gluing

In its issue dated 1.3.2000, the magazine "*Phänomen Farbe*" reported: "Roland Schulz, Human Resources Director of Henkel KgaA, signalled recently that ethical responsibility would become a central theme in the years to come. Rules and self-regulation, would be needed, as free economic forces would otherwise produce distortions. A practical example of this new orientation, he said, was the replacement of solvent-based glues with water-based products. This decision was also taken because children were getting hold of glue in order to sniff solvent."

The North Rhine Westphalian Regional Co-ordination Office for Addiction Prevention describes the procedure for glue sniffing like this: "Addicts pour the liquid into a plastic bag or onto a handkerchief and inhale the gas. In this way the solvent gets into the bloodstream very quickly. After just a few seconds a brief inebriation period starts. If this process is repeated frequently *(sniffing, inhalation)*, the inebriation periods can be maintained for hours at a time."

Intake of these substances directly through injection *(intravenously)* or swallowing *(orally)* would result in life-threatening poisoning. Because of their chemical composition, the substances that have entered the body are deposited primarily in the fatty brain tissues and in the nerve fibres.

Since there is no data available regarding any direct connection between speed gluing and glue sniffing, the topic lies outside the ambit of this study. The authors were concerned only to look at some of the literature written about glue sniffing in order to establish whether this is a negligible phenomenon or one which is relevant to the current practice of speed gluing in table tennis and must be considered seriously.

Glue sniffing in Europe
In 1999, ESPAD (European School Survey Project on Alcohol and other Drugs) [5] presented a study in which children attending European Schools in 30 countries were systematically questioned about their use of drugs. The study included inhalants and sniffing. The respondents were asked whether they had ever sniffed inhalants. The answers can be seen in Table 2.

Country	% of respondents
Bulgaria	3
Croatia	13
Czech Republic	7
Denmark	7
Estonia	7
Faroe Islands	5
Finland	5
France ..	11
FYROM	4
Greece	14
Greenland	19
Hungary	4
Iceland	11
Ireland	22
Italy	6
Latvia	6
Lithuania	10
Malta	16
Norway	6
Poland	9

Portugal	3
Romania	1
Russia (Moscow)	9
Slovak Republic	7
Slovenia	14
Sweden	8
Ukraine	8
United Kingdom	15

Table 2 The table gives the percentage of students in the respective countries who admitted, when asked, that they had taken inhalants at least once.

In Croatia, France, Greece, Greenland, Iceland, Ireland, Lithuania, Malta, Slovenia and England an average of over 10% had sniffed inhalants at least once.

Glue sniffing in the Third World

The South American website disinfo.com [6] estimates that of the 40 million homeless children in South America, 50%, or 20 million, are dependent on glue sniffing.

The website of CWIN [7], a Nepalese children's rights organisation cites a similar figure of 52% for Nepal. It describes glue sniffing as a beginner's drug, which often leads on to hardcore drugs.

The Asian Human Rights Commission [8] does not cite any specific figures, but describes glue sniffing as an ever-increasing problem in Thailand, Indonesia, Cambodia, Malaysia, Pakistan, India and the Philippines.

We found similar comments regarding Pakistan and Afghanistan. See list of websites [9] [10].

As stated at the outset, the authors do not believe it to be their task to evaluate the facts found. This is up to the ITTF and the national associations.

7. Speed gluing and the environmental charter of the IOC, the International Olympic Committees

Table tennis is part of the Olympic Movement. It is no longer possible to imagine the sport without such Olympic Movement participation.

On the occasion of the 3rd World Conference on Sport and the Environment in Rio de Janeiro in October 1999, the Olympic Movement's Agenda 21 [11] came into force. This regulates the position of the Olympic Movement on sport and environmental issues.

One of the sections in Agenda 21 concerns itself directly with the position of the Olympic Movement on the use of harmful products. Here is the original text:

3.2.9 Management of hazardous products, waste and pollution

In most human activities, potentially hazardous products may be used and waste and, sometimes, pollutants, are produced. This is equally true of activities associated with sport. In order to avoid the lasting harmful effects which potentially hazardous products and wastes may have on the *environment and human health, the members of the Olympic Movement undertake:*

- *to avoid using products recognized as being hazardous or toxic to humans or environmentally polluting;*
- *not to encourage practices, manufacturing or agricultural techniques which require the use of such products;*
- *to minimize all forms of pollution, particularly noise pollution;*

Members of the Olympic Movement do not use any hazardous or toxic or environmentally harmful products. Speed glues based on organic solvents are damaging to health, toxicologically effective and environmentally harmful.

At this point, we wish to reiterate that it is not our task to make any evaluation. It is important for us to elaborate further the Olympic Movement's view on the use in sport of products that are damaging to health. It is the task of the ITTF and the national associations to draw the correct conclusions from these facts.

Annex:
(a) N-heptane material safety data sheet

References:

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INFLUENCE OF GLUE ON BALL SPEED
(Comparison between speed glue and aqueous glue)

Abstract

The purpose of the present study is to clarify the difference in ball speed due to different glue. Many players, particularly offensive players, prefer the speed glue.
Ball speed was measured in the actual play where players hit the ball practically. Data were processed by statistical treatment. The present report describes the results obtained nearly one year ago. One year ago, aqueous glue was quite limited to only a few kinds. As long as we see the results of one year ago, it is shown that ball speed is in general higher in the case of speed glue than aqueous glue. Now the number of aqueous glue is increasing and many efforts are being made to improve the elasticity. It is expected that aqueous glue with no significant difference from speed glue is available.

Key words: *table tennis, glue, organic solvent, aqueous glue, ball speed*

1. Introduction

Increasing ball speed is a great concern for table tennis players. For increasing the ball speed, manufacturers have been making various efforts to make sponge rubber more elastic. The elasticity of rubber depends not only on the materials of rubber itself, but also on how to bond the rubber with the blade which is usually made of wood or plywood. It is well known that organic solvent contained in some glue makes sponge rubber swell because solvent volatilizes in the sponge for a few hours after bonding (1),(2). As a result, sponge rubber becomes more elastic. This kind of glue is called "speed glue". Unfortunately, such organic solvent is toxic more or less. Therefore, the influence of organic solvent on players' health has been a big issue in the table tennis world. ITTF BOD decided in 2004 that the speed glue with organic solvent should be prohibited from September 1, 2007. However, this decision was modified and the date of starting prohibition was extended to September 1, 2008.

Responding to these decisions, some Japanese manufacturers have developed aqueous glue without using organic solvent. Some of the aqueous glue are authorized by JTTA and already sold in shops. The aqueous glue developed so far does not have any swelling effect on sponge rubber.

Under the circumstances mentioned above, player and coaches are anxious about the influence of glue regulation on play. JTTA SMSC (JTTA Sports and Medical Science Committee) has organized a project team in June, 2005. The aim of this study is to clarify the influence of glue on ball speed. Particular interest is comparison between speed glue and aqueous glue.

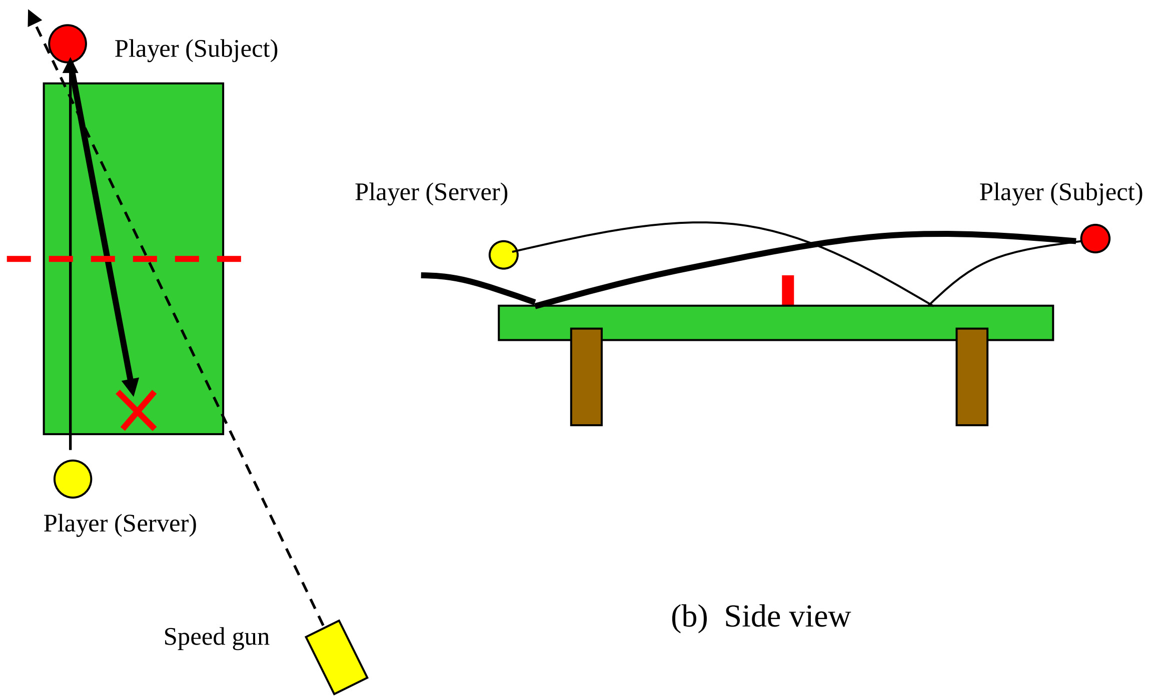
It is expected that if players are forced to use the aqueous glue, they will use it combined with a booster. The booster is a harmless chemical which has the swelling effect on the sponge rubber. In this study, the effect of the booster on speed was also investigated by applying the booster to aqueous glue and glue sheet.

2. Method

The test took place in the gymnasium of Waseda University on February 15th, 2006. The subjects in the test were 4 male students of the university team. All of them are top student players in Japan. We made each player use the same kinds of blade and rubber as he uses usually in the match. Table 1 shows blades and rubbers used by them.

The following 5 kinds of glue were tested: (1) Speed glue (A, B and C), (2) Aqueous glue (A, B and C) and (3) Glue sheet

In the test of aqueous glue, measurements were made for both cases with and without booster. The booster was always used for the test of the glue sheet. To avoid mixing of different glues, the blade and rubber used for one case was replaced with new ones for another case.



(a) Top view

(b) Side view

Fig.1 Test set up

Table 1 Blades and rubbers

Player	Blade			Rubber		
	Maker	**Model**	**Glip**	**Maker**	**Model**	**Thickness**
M1	Butterfly	Primorac	CO	X	A	Large
M2	Butterfly	Korbel	CO	X	B	Large
M3	Nittaku	Ludeack	ST	Y	C	Large
				Y	D	Large
M4	Butterfly	Timo Boll Spirit	ST	Z	E	Large
				Z	F	Medium

Table 2 shows the combination of subjects and glue. The subjects were not informed which kinds of glue were used in the test blades. Another player served a ball with small top spin to the subject. The subject was ordered to strike the ball with full swing. The height of the ball at the point of the subject was so suitable that he was able to hit the ball satisfactorily. The speed of fed ball was 20 km/h. Under this ball speed, the subject can afford to strike the ball with full swing. Figure 1 shows the set up of the test. Stoke was limited to forehand in the test. Measurements were made for both drive and smash. Subjects M3 and M4 used the two kinds of rubber and thus measurement was made for each rubber.

Table 2 Test Glue

M1, M2	M3	M4
(1) Speed glue A (2) Aqueous glue A (3) Aqueous glue A with booster (4) Aqueous glue C (5) Glue sheet with booster	(1) Speed glue B (2) Aqueous glue A (3) Glue sheet with booster	(1) Speed glue C (2) Aqueous glue B (3) Aqueous glue B with booster

Aqueous glue A: JUIC Aqua Effect,
Aqueous glue B: TSP Water Glue,
Aqueous glue C: JUIC Aqua Stick
Glue sheet: JUIC Sheet,
Booster: JUIC Ecolo Expander II

The ball speed was measured by a speed gun (Applied Concept Inc., Stalker Pro). The measurable range of the speed gun is 1 to 480 km/h. Measurements under the same condition were repeated 30 times. Highest 5 and lowest 5 values were omitted from the 30 data. Average ball speed was obtained by averaging the remaining 20 data. Statistical treatment was applied to data processing for precise criteria whether difference is significant. The significance level p was assumed 0.0001. We collected comments of players immediately after the test of each case.

3. Results

Table 3 to 6 show numerical data of measured results.

Table 3 Ball speed (km/h) of Subject M1

Glue	Drive	Smash
	Average SD	Average SD
(1) Speed glue	81.8 ± 1.2	92.9 ± 1.9
(2) Aqueous glue A	78.4 ± 1.6	91.2 ± 1.3
(3) Aqueous glue A with booster	77.6 ± 1.7	90.9 ± 1.8
(4) Aqueous glue C	78.4 ± 1.1	90.9 ± 1.3
(5) Glue sheet with booster	78.2 ± 1.1	90.9 ± 1.3

SD: Standard deviation

Table 4 Ball speed (km/h) of Subject M2

Glue	Drive	Smash
	Average SD	**Average SD**
(1) Speed glue	76.8 ± 1.6	91.9 ± 1.4
(3) Aqueous glue A	71.5 ± 1.7	83.2 ± 1.9
(4) Aqueous glue A with booster	72.8 ± 0.8	86.4 ± 2.1
(5) Aqueous glue C	73.8 ± 1.0	84.1 ± 2.1
(5) Glue sheet with booster	73.4 ± 1.2	86.3 ± 2.6

SD: Standard deviation

Table 5 Ball speed (km/h) of Subject M3

Rubber		Drive	Smash
		Average SD	**Average SD**
C	(1) Speed glue	74.1 ± 1.7	91.1 ± 2.3
	(2) Aqueous glue A	69.2 ± 1.7	90.3 ± 1.4
	(3) Glue sheet with booster	71.7 ± 1.5	86.4 ± 2.2
D	(1) Speed glue	73.7 ± 1.5	87.2 ± 1.2
	(2) Aqueous glue A	71,2 ± 1.4	86.7 ± 1.5
	(3) Glue sheet with booster	73.4 ± 2.1	87.8 ± 1.2

SD: Standard deviation

Table 6 Ball speed (km/h) of Subject M4

Rubber		Drive	Smash
		Average SD	**Average SD**
E	(1) Speed glue	77.1 ± 1.3	89.9 ± 1.1
	(2) Aqueous glue B	77.2 ± 1.9	90.8 ± 1.9
	(3) Aqueous glue B with booster	72.9 ± 1.3	90.8 ± 0.7
F	(1) Speed glue	71.4 ± 1.6	91.1 ± 2.1
	(2) Aqueous glue B	68.1 ± 1.8	87.4 ± 1.5
	(3) Glue sheet with booster	69.9 ± 1.8	92.3 ± 1.9

SD: Standard deviation

Figs. 2 to 13 show graphs. As described above, the significance of these data are tested by using statistical theory. The asterisk mark "*" and the symbol "n.s" are shown in figure 2 to 12. The asterisk "*" means that the difference between two data can be admitted. This situation is described in technical terms of statistical theory that the difference is significant. The symbol "n.s" stands for "no significance" which means that the difference between two data can not be admitted statistically even if numerical data are different.

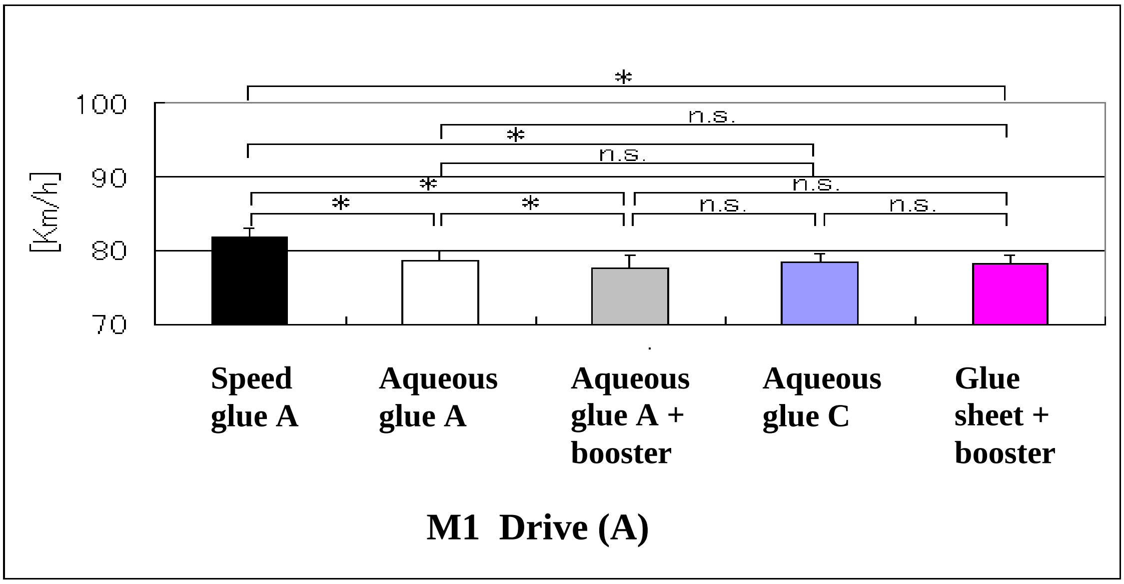


Fig. 2 Speed of drive ball struck by Subject M1

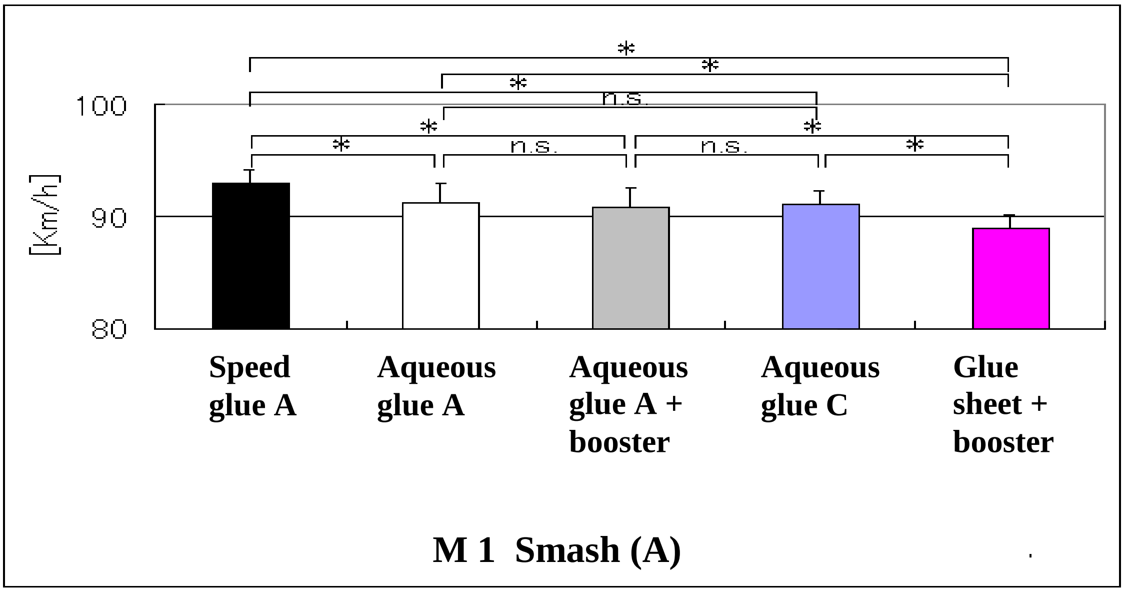


Fig. 3 Speed of smash ball struck by Subject M1

In the results of drive, the speed with Speed glue A is 4 to 5 % higher than all other data. It can be said that there is no difference in cases of three aqueous glues. In the results of smash, the difference between the speed with Speed glue A and speeds with other glues becomes less; the difference is about 2 %.

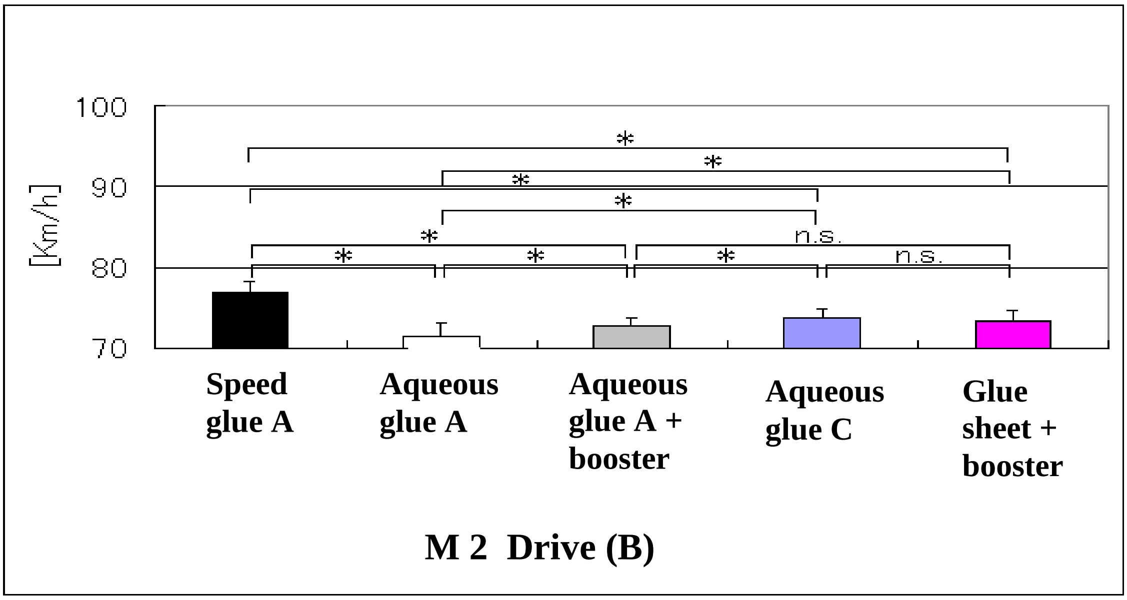


Fig. 4 Speed of drive ball struck by Subject M2

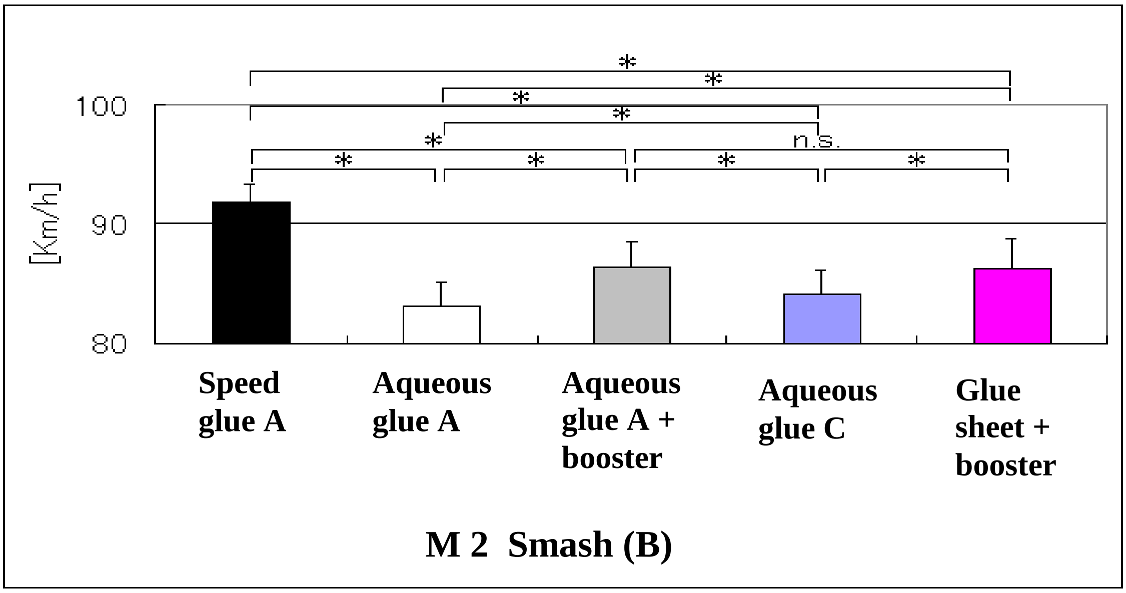


Fig. 5 Speed of smash ball struck by Subject M2

In the results of Subject M2, the difference between the case with Speed glue A and other cases is more remarkable. The speed with Aqueous glue A is remarkably lower than the speed with Speed glue A, but the effect of the booster is obvious for Aqueous glue A. That is, the 7 % difference in drive ball speed between Aqueous glue A and Speed glue A changes to 5% when the Aqueous glue A is combined with the booster. In the smash stroke, the difference changes from 9 % to 6 %.

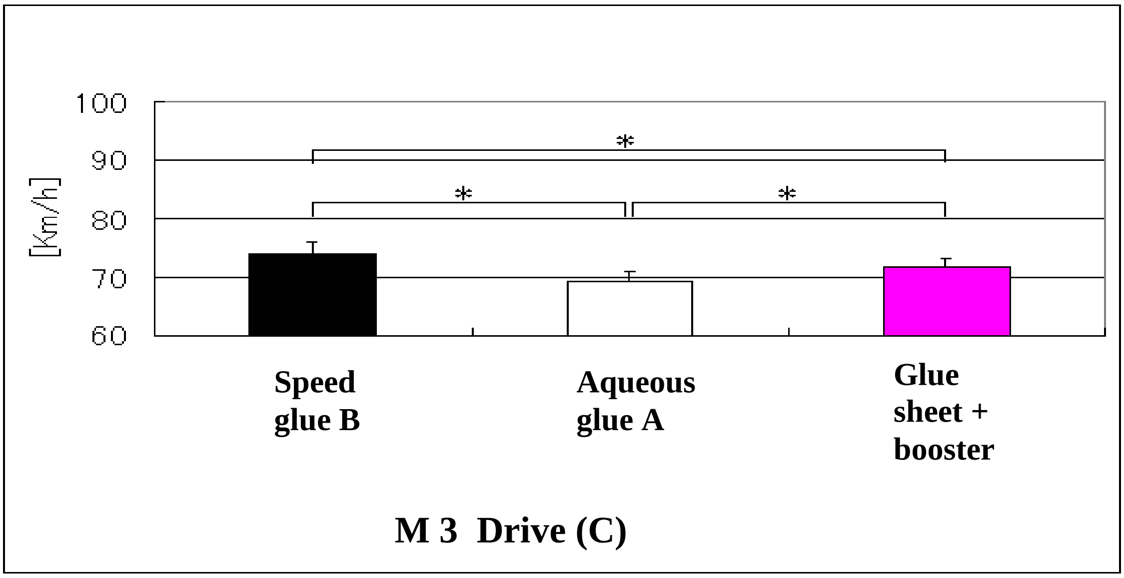


Fig. 6 Speed of drive ball struck by Subject M3

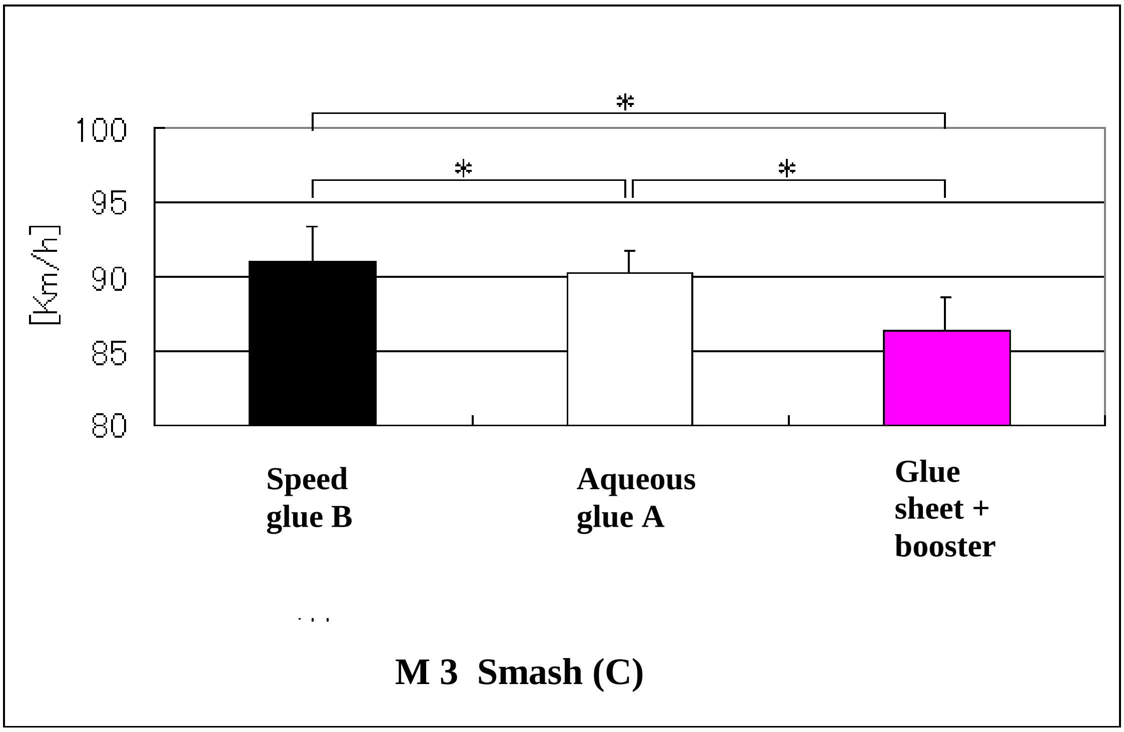


Fig. 7 Speed of smash ball struck by Subject M3

Figs. 6 and 7 show the results for the rubber “C”. In the results of drive, the speed with Speed glue B is obviously high compared with other cases, but in the results of smash, the difference between the case of Speed glue B and the case of Aqueous glue A is quite small.

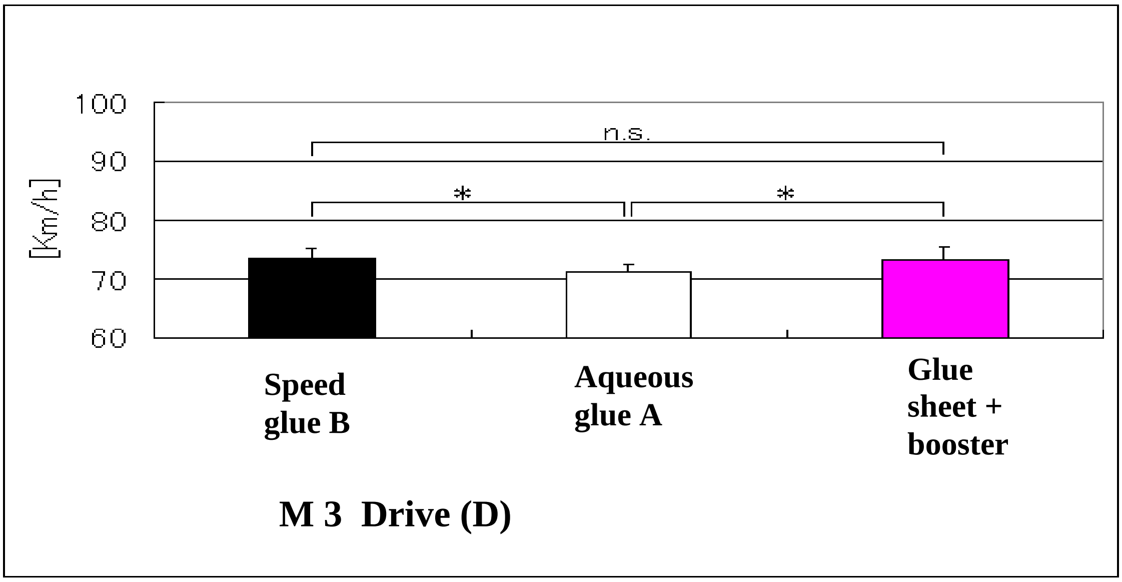


Fig. 8 Speed of drive ball struck by Subject M3

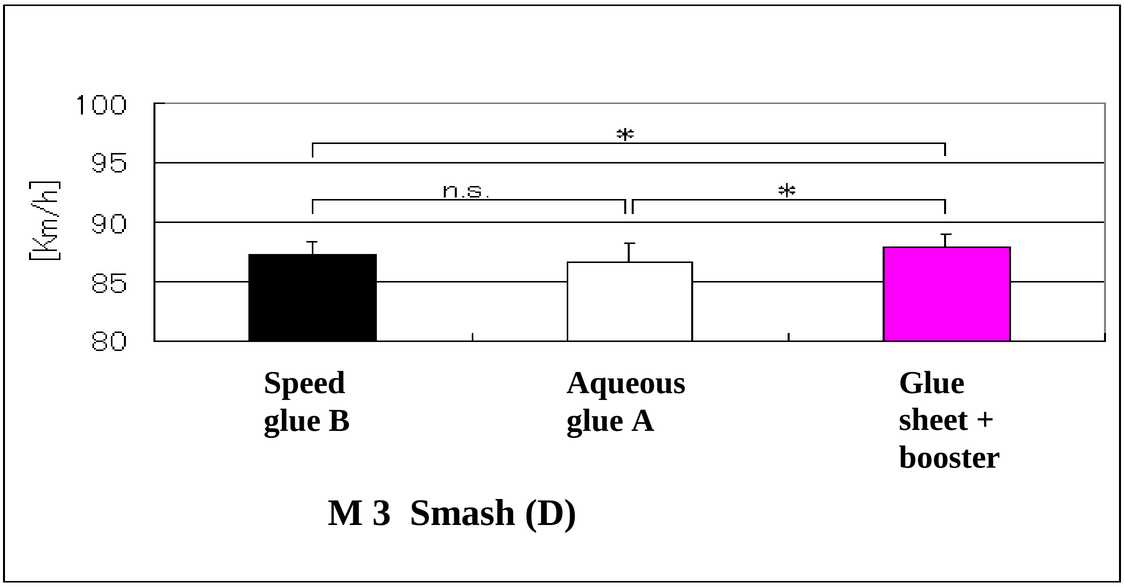


Fig. 9 Speed of smash ball struck by Subject M3

Figs. 8 and 9 show the results of Subject M3 using the rubber "D". The difference between the case of Speed glue B and Aqueous glue A is small. Statistically it can be said that there is no difference between both cases. The speed with Glue sheet + booster which is low or lowest in the test of other subjects is high in this test of subject M3.

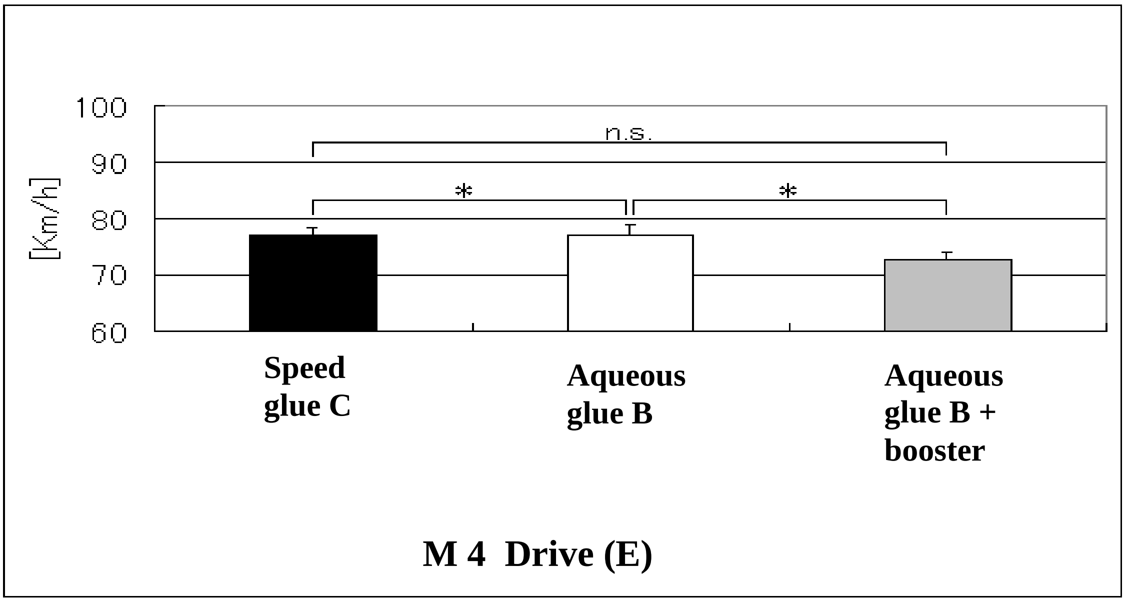


Fig. 10 Speed of drive ball struck by Subject M4

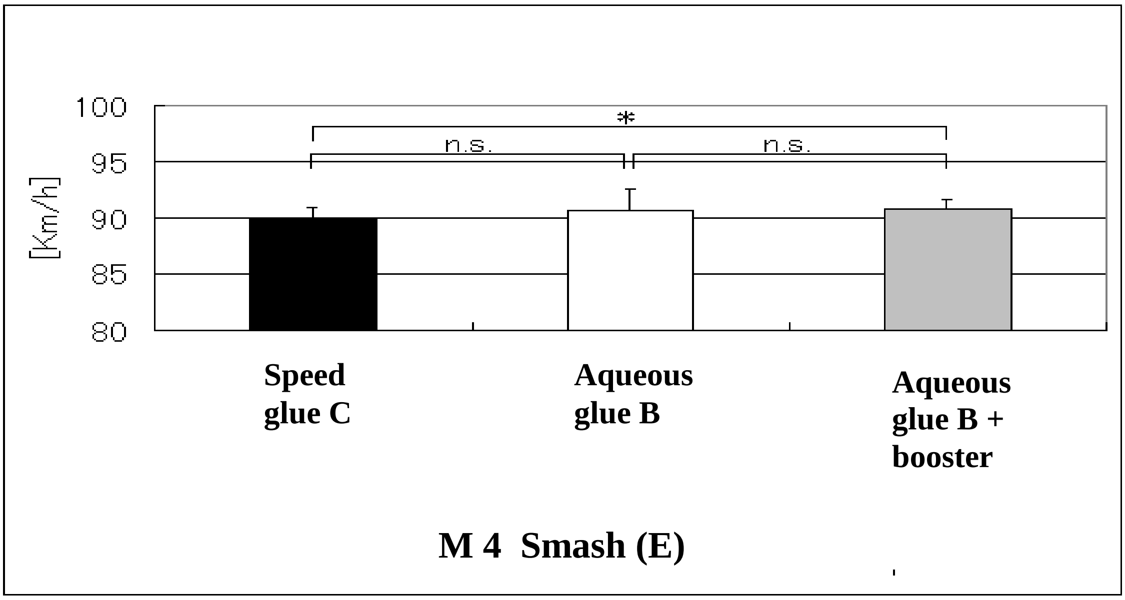


Fig. 11 Speed of smash ball struck by Subject M4

The results in Figs. 10 and 11 are unexpected with respect to two aspects. First, the speed with speed glue is not highest as shown in Fig. 11, but the aqueous glue gives higher speed. Second, the booster does not have the positive effect on ball speed as shown in Fig. 10. If these results are accepted as the truth, the Aqueous glue B is better than the Speed glue C and the booster is not effective for the Aqueous glue B. However, we must consider another possibility. That is, weariness of the subjects during the test may cause these results. The test lasted for a few hours and we found that players felt tired near the end of the test.

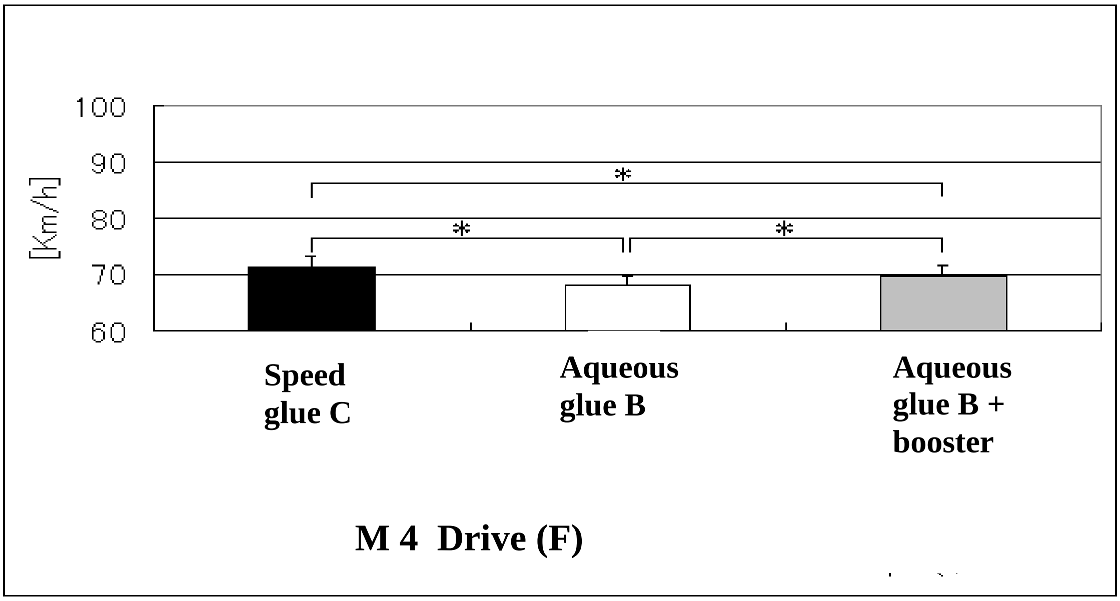


Fig. 12 Speed of smash ball struck by Subject M4

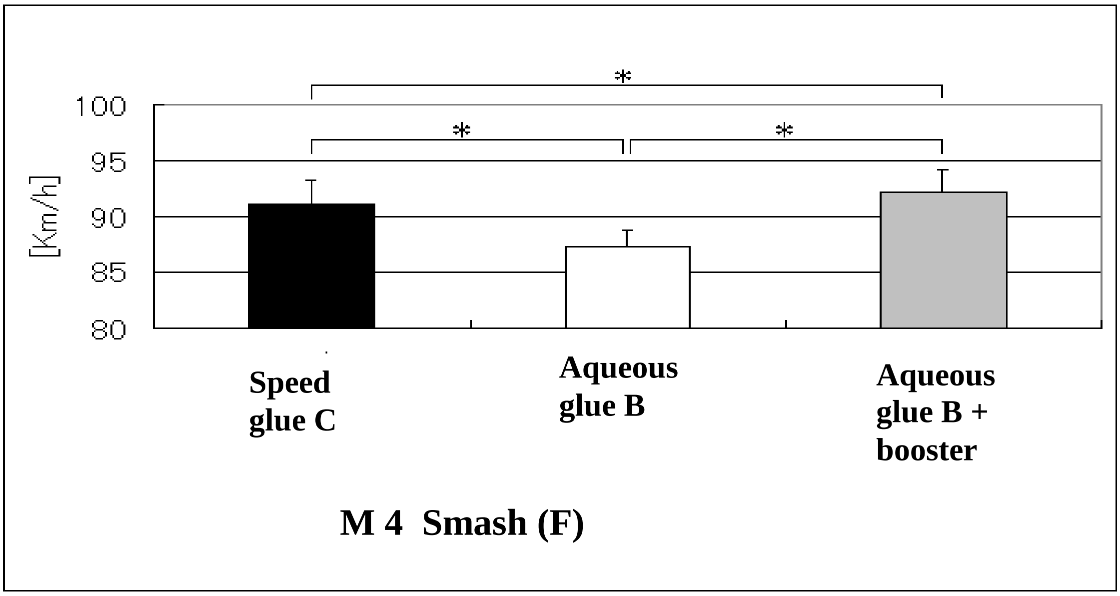


Fig. 13 Speed of smash ball struck by Subject M4

In the drive stroke, the result of Aqueous glue B + booster is almost the same as the result of Speed glue C. In the smash stroke, the speed with Aqueous glue B + booster is highest.

The players' comments concerning aqueous glue are as follows. In general, the subjects felt that the drive ball speed is lower in aqueous glue but the smash ball speed is not so much different between the speed glue and aqueous glue. These comments coincide with measured results. A subject had an ill feeling and another one had a good feeling for the aqueous glue. Most of them agreed that the aqueous glue is bearable.

Finally, it must be stated that the aqueous glue which was available one year ago was limited. Now several aqueous glues have been developed and sold. Many efforts are being made to improve the elasticity. We found through private communication that results of some new aqueous glue indicate no significant difference from those of speed glue.

Concluding remarks

The results are summarized as follows. In general, the ball speed with speed glue is higher than the speed with other kinds of glue in the drive stroke. The difference was at most 7%. However, in some cases, the difference is negligible or even the opposite tendency was observed; that is, the aqueous glue gave higher speed than the speed glue.

In general, the difference between the speed glue and aqueous glue is small or not obvious in the smash stroke compared with the drive stroke. Also in some smash strokes, the aqueous glue or glue sheet combined with the booster gave higher speed than the speed glue. Thus it can be said that the difference between the speed glue and other glues is delicate. That depends on the combination of rubbers and glues and also depends on players' weariness during the test. It is also found from comments of players that they did not have a strong negative feeling for the aqueous glue, particularly in the smash stroke.

Acknowledgement

The present authors are much indebted to Mr. N. Shirakawa, Mr. T. Akutsu, Mr. A. Sasai for help with the experiments. Also, they would like to thank players of Waseda University for cooperation in this work.

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Part six:

Physiology and antropometrics of table tennis

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COMPARATIVE STUDY OF MUSCLE FATIGUE IN TABLE TENNIS TRAINING - AN OUTLINE

Abstract

Table tennis is characterized with intermittent intervals of explosive (anaerobic) muscle activity, being the cause for use of interval training as the most suitable training method. Performance in the game is a function of the state of the neuromuscular system, i.e. its condition of (non)fatigue. A study has been conceptualized where top young players are monitored through kinematic, kinetic and surface EMG variables when performing a repetitive maximal forehand top-spin movement, practicing with a table tennis robot, in such a dynamics and duration as to induce fatigue. Sequences of 12 shots are followed by 10 second rest periods, and this is to be repeated during an overall time of 20 intervals. M. deltoideus anterior, m. deltoideus medialis, m. biceps brachii and m. pectoralis major are to be monitored, unilaterally. Kinematics of the upper body is to be measured using an ELITE system (Zagreb) or a VICON system (Vienna) respectively, ground reaction forces (GRF) using force plates (Kistler). Changes in time patterning of EMG signal waveforms are expected, while the decrease of the median frequency of the surface EMG power spectrum is to be used as a criterion of local muscle fatigue. Modifications of both, neuro-muscular and kinematic / kinetic patterns, together with decrease of performance are expected to appear with fatigue.

Key words: *table tennis, muscle fatigue, EMG power spectrum, 3D kinematics, GRF*

Introduction

Evaluation of the individual table tennis player in terms of physical preparation provides important information about his strengths and weaknesses. Testing is important for the player and for the coach to the conditioning programme because it allows determination of the entry level of fitness, comparisons to other players and provides information regarding the current fitness level. When developing table tennis-specific tests, it is essential that the test protocol accurately reflects physiological and technical demands of table tennis. Even though table tennis is considered as anaerobic in nature, players still need to have a high level of aerobic abilities.

In table tennis performance diagnosis of the aerobic capacity, using standard bicycle ergometer, treadmill or field test, are common (Kondrič, 2002). These procedures have the advantage in delivering a large number of qualitative and comparative data. But there are also disadvantages because the tests are not specific for racket sports. Changes between load and recovery in table tennis and also in other racket sports are mostly overlooked in such test procedures (Baum et all, 1996; Ellwood, 1992). Therefore, we think that it is necessary to develop tests that are specific to the demands of table tennis. Without proper time for recovery fatigue, overtraining and injury could result. The player's body needs time for rest and repair, both within an exercise session and between sessions (Chandler, 1998). In order to find out the amount of recovery time, we have first to determine the intensity of the exercise. Intensity depends also from the structure of the tissue that is stressed.

The purpose of this paper was to establish a standardised protocol of surface myoelectric (ME) signal measurement and analysis with the aim to evaluate muscle fatigue during cyclic dynamic contractions of M. deltoideus anterior, m. deltoideus medialis, m. biceps brachii, m. pectoralis major and m. quadriceps executing top spin strokes in table tennis. The criteria for the test design were that it should be performed in match-play situation and composed so that the test would be practical to use in the training situation.

Method

System Setup

The test system for table tennis consists of a table, a ball machine, balls, a force plate (Kistler), a kinematic system (ELITE / VICON), two video cameras usual in trade, a surface EMG system (DelSys) and a heart rate monitor (POLAR S610/S725X). All table tennis devices have to be ITTF approved. Fig.1 presents the measurement devices – without cameras for kinematic measurements. They are included into the ELITE system or the VICON system and, depending on the number of available cameras (a minimum number of 8 is recommended), are placed in a manner that markers can be detected as accurately as possible.

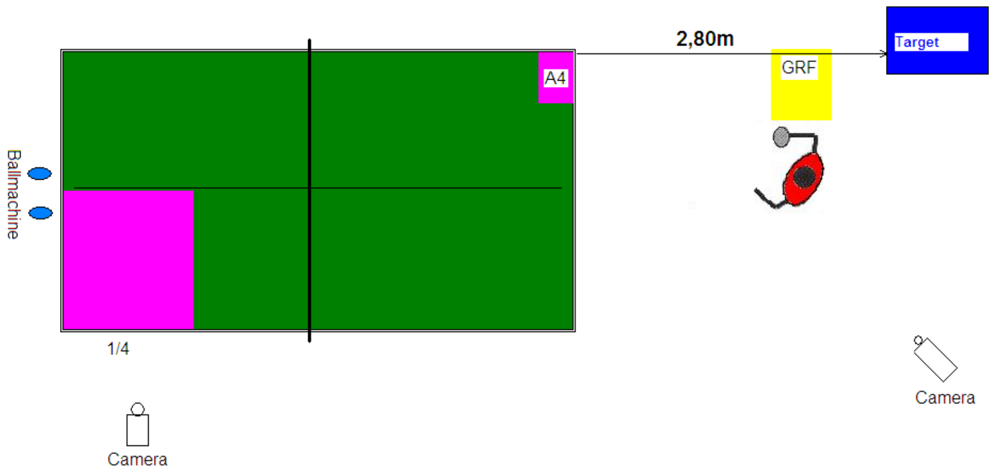

Fig. 1 Schematic drawing of the system setup

In order to put a reliable and objective spin on the ball, it is recommended to place and adjust the machine as follows: the ball hits the table at x = 21cm and y = 30cm (A4 paper), the second impact hits on the floor at x = 280cm (double A4 paper: 42 x 60cm). The ball frequency should be 60 balls per minute. The two Digital Video Cameras should be placed one beside the table (as high as possible, at least 2 m) to detect impact positions, the other one to monitor the player. Three-dimensional ground reaction forces F_x, F_y and F_z should be acquired at a sampling rate of 1kHz, using the force plate located 2m distant from the table. Heart rate has to be monitored during the whole session.

Test procedure

The subject has to perform top spin strokes from the FH corner (right handed) using the own bat / rubber. After warm up the player executes 12 topspin strokes, standing with the right foot on the force plate. The first two strokes are test strokes for familiarisation, the following 10 have to be analysed. After having executed all strokes, there is 1 minute rest. Afterwards, the same procedure is repeated. Next, the procedure for fatigued condition is started (12 top spin strokes, 10 seconds rest – 20 series, see Fig. 2). Data gathered from the two series with 1 minute rest and from the first series of the fatiguing protocol are used for analysing the non fatigued condition.

The last three series are assigned to the fatigued condition (above all, the time dependence of the fatiguing protocol is supposed to be interesting).

The balls are projected from a ball machine into the right corner of the table. The player has to stand on the force plate. The player has to hit the target on the opposite side of the table (1/4 of the table) with maximal ball velocity. If he/she is not successful in 30% of his/her strokes (manually observed) than the player has to finish the test.

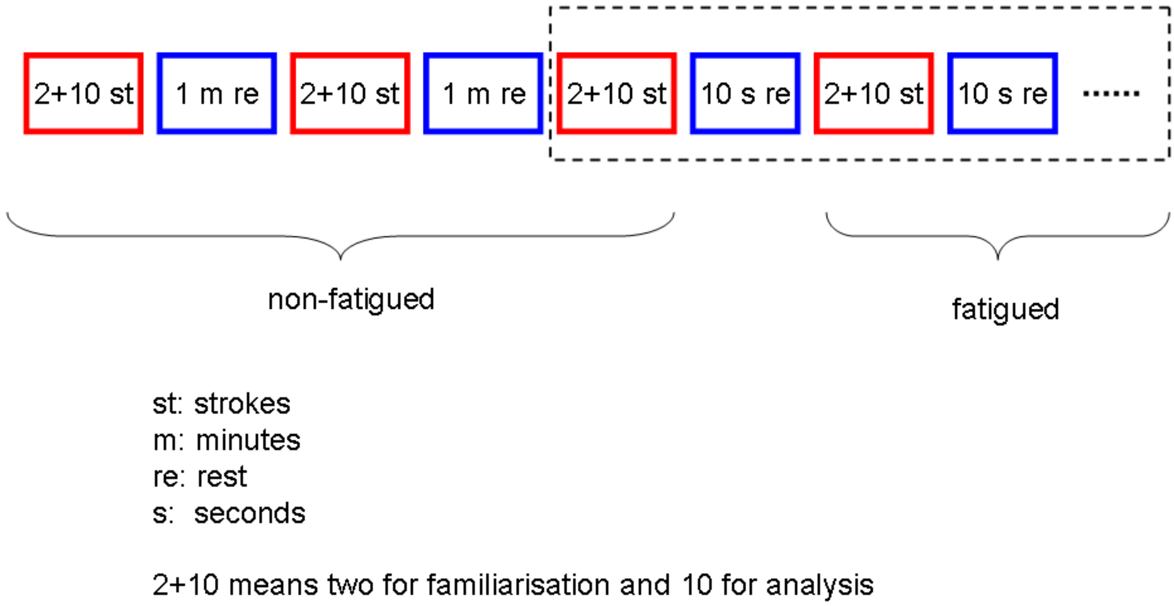

Fig. 2: Fatigue protocol

According to the SENIAM protocol (Hermens et all. 2000), surface EMG signals from m. deltoideus anterior, m. deltoideus medialis, m. biceps brachii, m. pectoralis major and m. quadriceps femoris (optional) are acquired and analysed with respect to time-, amplitude- and frequency characteristics (onset, RMS, median frequency). Two experienced human observers detect the onset of muscle activity from the EMG recordings.

At least 8 250-Hz infrared cameras are used to capture the kinematic movement of the markers (Plug-in-Gait Marker Set: upper body or complete set plus bat with three pin markers). After selection of at least three regular trials at the beginning and the end of the protocol, trails have to be tracked and analysed (stroke lengths, movement velocities and accelerations, joint angles of the upper right part (right handed) of the body). After that, the following four variables have to be calculated to identify the kinematic characteristics of the movement:

- stroke length,
- peak velocity of the bat (calculated as the centre of the minor axis)
- vertical component of the upper extremity
- acceleration peaks and distances

Hypotheses

Changes in muscular activity. In particular, in m. deltoideus after fatiguing conditions - increase of the activity level of the medial part because of permanent contractions.

Changes in kinematics: more vertical components in the upper extremity, motion is less harmonical (high acceleration peaks), shorter acceleration distances.

Changes in GRF: only upper body movement, less changes within the GRF of one stroke, no real "swing phase".

Because of the higher anaerobic load we expect higher heart rate. On the other hand with measuring heart beats we control loads during the experiment.

Discussion

The principles of the exercise programme design refer to adaptation, specificity, recovery, variety, individuality and progression and are important both to maximise performance and to modify injury risk (Chandler, 1995). Fatigue of the table tennis player depends on the number of strokes accomplished in one point. A very important factor is speed. The speed of the top spin stroke depends on the stroke frequency and the stroke length. Stroke frequency is a neural drive, causing the muscles to contract and relax as rapidly as possible. Speed is also a function of the stroke length (swing), which depends on the kinematic chain.

The movement that the player has to perform is similar to those used when he/she is actually playing in match (Kondrič, Furjan-Mandić, Medved 2006). Therefore, players that have a good level of endurance fitness specific to the demands of table tennis should be able to perform well on this test.

Players should perform top spin strokes starting from the ankle (kinematic chain) and not just from the arm. To explore, if the player has actually performed top spin strokes from the ankle, ground reaction forces are analysed. To check the player's efforts, we also have to check the heart rate (acquisition of heart rate).

We also recommend to measure (if possible) blood lactate concentration after performing the test.

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FUNCTIONAL DIAGNOSTICS OF TOP TABLE TENNIS PLAYERS

Abstract

In order to achieve top sport result multidiscipline approach is needed as well as viewing the players' ability from different aspects. Modern table tennis demands high level of functional and motor abilities in player. With functional diagnostic of athlete will be able to provide tests and programs geared to meet specific goals and to improve performance. Our sport-specific tests use the latest in technology to identify individual strengths and weaknesses in aerobic capacity, anaerobic power, speed, strength, technique, and more. The term "functional diagnostics" implies determining of the basic anthropometrical characteristics (and their analysis), evaluation of functional abilities (the battery of tests) and evaluation of functional abilities of the athlete.

The functional diagnostic aims to: 1) Provide and monitor highly specialist training methodologies to high performance athletes, 2) Assess and devise fitness programs for sports people, 3) Promote the importance of sports medicine including diet, nutrition and exercise.

The importance of the functional diagnostics of the athletes is success of the training program is largely dependent upon satisfying the performance aims associated with it.

Testing and measurement are the means of collecting information upon which subsequent performance evaluations and decisions are made.

Functional diagnostics of the table tennis players includes the following analyses: 1) BOD POD Body Composition Analysis , 2) Anthropometrics data, 3) VO2 max (Maximal Oxygen Uptake), 4) Blood Lactate Analysis, 5) HR Training Zones & Training Intensities, 6) Dynamic Bike Fit & Treadmill Analysis, 7) Sub-maximal Testing, 8) Anaerobic Power and Capacity, 9) Nutritional Analysis, 10) Scientifically-Based Training Programs correction, 11) Training Log Reviews, 12) Speed of reaction and Explosive Power Analysis, 13) Bio Chemical substrate Analysis, 14) Pulmonary (Spirometry) Analysis, 15) Muscle Strength and endurance (upper & lower) Analysis.

Some analyses are interpreted on the basis of age-long work with the senior national team of Yugoslavia (Serbia and Montenegro). The results in certain periods of time and their consequential relation with the achieved results at big competitions (European and World championships) were analyzed.

Importance of recording the information: For the coach it is important to monitor the program of work, so as to maintain progression in terms of the volume of work and its intensity. Both coach and athlete must keep their own training records. A training diary can give an enormous amount of information about what has happened in the past and how training has gone in the past. When planning future training cycles, information of this kind is absolutely invaluable.

Key words: *table tennis, functional diagnostics, Anthropometrics, VO2max, Anaerobic Threshold, Lactate analyses*

1 Introduction

In order to achieve top sport result multidiscipline approach is needed as well as viewing the players' ability from different aspects. Modern table tennis demands high level of functional and motor abilities in player. With functional diagnostic of athlete will be able to provide tests and programs geared to meet specific goals and to improve performance. Our sport-specific tests use the latest in technology to identify individual strengths and weaknesses in aerobic capacity, anaerobic power, speed, strength, technique, and more. The term "functional diagnostics" implies determining of the basic anthropometrical characteristics (and their analysis), evaluation of functional abilities (the battery of tests) and evaluation of functional abilities of the athlete.

2 Methods

Analyses of these parameters were done in period 1997/98 to 2004/2005. We used to take these data in pre season period (before start of championships) or at the beginning of summer and winter National Team preparation.

2.1 Participants

Sample of players were the National Teams (all categories) of Yugoslavia-Serbia&Montenegro – 87 players. Also, some of results were taken in season 2001/2002 with senior National Team of India – 12 players.

2.2 Procedure

All results were analyzed as a group results and as individual results. Standard statistical methods were used:

- Arithmetic Middle
- Standard Deviation
- Variation (Maximum and Minimum results)
- Simple and relative Frequency

3 Results

The functional diagnostic aims to:

1) Provide and monitor highly specialist training methodologies to high performance athletes,
2) Assess and devise fitness programs for players,
3) Promote the importance of sports medicine including diet, nutrition and exercise.

The importance of the functional diagnostics of the players is success of the training program is largely dependent upon satisfying the performance aims associated with it.

Functional diagnostics of the table tennis players includes the following analyses:

1) BOD POD Body Composition Analysis , 2) Anthropometrics data, 3) VO2 max (Maximal Oxygen Uptake), 4) Blood Lactate Analysis, 5) HR Training Zones & Training Intensities, 6) Dynamic Bike Fit & Treadmill Analysis, 7) Sub-maximal Testing, 8) Anaerobic Power and Capacity, 9) Nutritional Analysis, 10) Scientifically-Based Training Programs correction, 11) Training Log Reviews, 12) Speed of reaction and Explosive Power Analysis, 13) Bio Chemical substrate Analysis, 14) Pulmonary (Spirometry) Analysis, 15) Muscle Strength and endurance (upper & lower) Analysis.

Just some of them, most important will be interpreted in this work.

3.1 Body Composition Analysis

For measurement of body fat we used two methods. Previously, we used Durnin&Womersley method (the percent of body fat was determined from the sum of four skin folds) and later we used Body fat analyses with BIA method (Bioelectrical Impedance Analysis) because is considered as one of the most exact and accessible methods of screening body fat. Also, for all players we calculate and following parameters:

- Body Mass Index (BMI = Body mass in kilograms ÷ (Height x Height in meters))
- Ideal weight

Here are some results of measurements of man senior Team of Yugoslavia and India, and junior and cadet Teams.

Table 1 *Average value of Body fat and Body Mass index of Teams*

Teams	Year	Age	Body Fat (%)	BMI
Men senior Team (YUG)	2000	27.0	15.3	24.2
Men senior Team (IND)	2001	19.0	15.5	21.7
Junior boys (YUG)	2001/2002	15.6	11.9	21.1
Cadet boys (YUG)	2001/2002	13.6	11.2	17.7
Junior girls (YUG)	2001/2002	16.5	14.2	21.5
Cadet girls (YUG)	2001/2002	14.0	15.0	21.9

It is interesting that players with high percentage of body fat make very good results at European Championship in Bremen (2000). Lupulesku I. won silver medal in double (Body fat was 22.5%) and Karakasevic A. won gold medal in mix double (Body fat was 20.1%).

Body composition measurement is important specially in pre season period, because considering this data training program (and supplement or dietary program if it's necessary) can be much more quality and with high efficacy. Body fat percentage is related with very important functional and motoric abilities as aerobic and anaerobic capacity, explosive strength, speed and agility.

3.2 Anthropometrics data

Anthropometry (def.): The field that deals with the physical dimensions, proportions, and composition of the human body, as well as the study of related variables that affects them.

Basic Anthropometrical measures in this program include:

- Height
- Weight
- Body circumference

Measurement of the anthropometrical characteristics is done by standardized methodology of International biological program**.**

Table 2 *Average value of Height and Weight of Teams*

Teams	Year	Age	Height (cm)	Weight (kg)
Men senior Team (YUG)	1998-2004	25.5	176.3	73.7
Men senior Team (IND)	2001	19.0	171.4	63.8
Junior boys (YUG)	1998-2004	15.6	176.1	65.7
Cadet boys (YUG)	1998-2004	13.6	167.1	50.6
Junior girls (YUG)	1998-2004	16.5	165.6	59.1
Cadet girls (YUG)	1998-2004	14.0	161.0	65.7

Body circumference is very important because table tennis is unilateral sport. From experience, these data can show a lot about work at physical prepare of players and their work in this field. During work with National Teams, I had some cases (mostly in female teams) that values of difference in Biceps circumference (extended and flexed) were about 0 in non playing arm. Also, there are evident differences in circumference of legs after surgeon of knees, which must be equalized soon as possible, because this problem can spread in back pain or more injuries.

3.3 VO2 max (Maximal Oxygen Uptake)

VO2 is the rate of oxygen uptake, or consumption, measured during exercise. The maximum rate of oxygen uptake is called the VO2max or maximum VO2. VO2 is the ultimate measure of fitness and is reported in milliliters of oxygen per kilogram of body weight per minute or ml/Kg/min.

In National Teams during summer and winter prepare we used mostly Astrand Cycle Ergometer Test for evaluation of maximal oxygen uptake. Also, if there was not condition for doing this test we used to do Cooper test (which have some benefits with younger categories in way of motivation in equalized groups).

Table 3 *Results (average) of absolute and relative values of VO2max of Teams*

Teams	**Year**	**Age**	**VO2max** (l/min)	**VO2max** (ml/kg)
Men senior Team (YUG)	2001	26.5	3.94	55.88
Men senior Team (IND)	2002	19.0	3.73	57.13
Junior boys (YUG)	2003	15.6	3.24	49.06
Cadet boys (YUG)	2003	13.6	2.55	52.58
Junior girls (YUG)	2003	16.5	2.46	41.76
Cadet girls (YUG)	2003	14.0	2.91	51.46

In Yugoslav National Teams we start with systematic work from season 1997/98 with all categories. What we notice, that in pre season there is a space for development of aerobic capacity, and also in winter break period. Start of prepare for big championships (senior WC, EC, Olympics and Youth Championships) should start with practice in aerobic regimes. It helps recovery of players after league competitions, and development is successful in periods of only 10-14 days, for continue of prepare and competition.

Table 4 *Results (average) of VO2max in period 1998-2003*

Teams (YUG)	**VO2max (ml/kg)**					
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Men Senior Team	57.75	58.21	54.05	55.88	56.73	53.48
Junior boys	48.24	59.75	62.63	55.36	52.54	49.06
Cadet boys	42.67	47.77	49.04	48.92	47.90	49.06
Junior girls	36.00	49.86	42.08	44.12	43.41	41.76
Cadet girls	34.49	46.76	44.55	41.03	47.04	51.46

3.4 Blood Lactate Analysis

Lactate measurement we used to accurately determine Heart Rate training zones, recovery and much more. The blood lactate level increases with exercise intensity and shows clearly the transition from aerobic to anaerobic activity. Since the measurement is completely individual it gives a precise method for testing and monitoring training intensity and recovery.

We use Lactate Scout (EKF diagnostics). Also, we used and POLAR heart rate monitor during practice, to know exactly HR in moment of taking sample of blood.

We made our own test protocol during the table tennis exercise. In this protocol intensity and quality of sparing during test is very important.

Measured values during table tennis practice show that younger players have less resistance in anaerobic work.

Table 5 *Average values of Lactate of Teams*

Teams (YUG)	**Age**	**Lactate mmol/l**	**bp/min**
Men Senior Team	26.5	6.1	176.0
Junior boys	15.6	4.2	172.0
Cadet boys	13.6	3.1	173.3
Junior girls	16.5	3.7	177.1
Cadet girls	14.0	3.5	176.2

3.5 HR Training Zones & Training Intensities

Lactate measurement is far more precise than the outdated and inaccurate method of using percentages of maximum heart rate to set training zones. Heart rate is an individual response; heart rate training zones need to be determined by measurement of physiological variables not set by mathematical formulas. Lactate measurement differs from, and is complimentary to VO2max testing. VO2max is a great tool for identifying anaerobic threshold and calculating training zones. The training zones are then used to determine training intensity from recovery to max effort intervals.

From experience, at the beginning we use heart rate monitors on players, to get used to practice in adequate training zones. After two weeks, well trained players, are able to practice in adequate intensity without heart monitor.

3.6 LT – Lactate Threshold

In National Team we used Conconi-Test to define Lactate Threshold LT (as Heart Rate or Power Level at the anaerobic/aerobic threshold) under realistic circumstances to then be used to define your Training Zones.

We used protocol in POLAR PRECISION PERFORMANCE SW 4.0 SOFTWARE. Now, we are going to put in procedure new test with table tennis robot in stead of individual concept of play. About this, will be in some next presentation.

Table 6 *Average values of Lactate Threshold of Teams*

Teams (YUG)	**% of HR max**	**bp/min**
Men Senior Team	87%	168.2
Junior boys	82%	157.0
Cadet boys	80%	156.0
Junior girls	75%	148.8
Cadet girls	77%	150.0

3.7 Resting Metabolic Rate Testing (RMR)

Metabolic rate, or metabolism, is the rate at which the body expends energy. This is also referred to as the "caloric burn rate". Energy expenditure can be divided into three groups of calories:

1) Resting Calories – Calories that are burned while the body is at rest. These calories are needed just to maintain life. The majority of all calories burned (about 70-80%) are burned at the resting level.

2) Activity Calories – Calories that are burned because of normal daily activities are "Activity Calories". Normal daily activities such as walking, eating (digesting food), typing, etc. are included in activity calories.

3) Exercise Calories – These calories are burned because of exercise.

The sum of all of these groups of calories is the total metabolic rate. Evaluation of these parameters is done with 10 minute breath test

3.8 Pulmonary (Spirometry) Analysis

Spirometry (Collins Cybermedic Classic TLi Total Lung Analyzer)
- Measurements of lung volumes and capacities
- Helium-dilution method for measurement of functional residual capacity.

The measurements which are usually made are:
1. VC (vital capacity) - maximum volume of air which can be exhaled or inspired during either a forced (FVC) or a slow (VC) manoeuvre.
2. FEV_1 (forced expired volume in one second) - volume expired in the first second of maximal expiration after a maximal inspiration and is a useful measure of how quickly full lungs can be emptied.
3. FEV_1/VC - FEV_1 expressed as a percentage of the VC or FVC (whichever volume is larger) and gives a clinically useful index of airflow limitation.
4. $FEF_{25-75\%}$ - average expired flow over the middle half of the FVC manoeuvre and is regarded as a more sensitive measure of small airways narrowing than FEV_1.
5. PEF (peak expiratory flow) - maximal expiratory flow rate achieved and this occurs very early in the forced expiratory manoeuvre
6. $FEF_{50\%}$ and $FEF_{75\%}$ (forced expiratory flow at 50% or 75% FVC) - maximal expiratory flow measured at the point where 50% of the FVC has been expired ($FEF_{50\%}$) and after 75% has been expired ($FEF_{75\%}$). Both indices have a wide range of normality but are usually reproducible in a given subject provided the FVC is reproducible.

Table 6 *Results of Vital capacity of senior players*

Teams	age	height	weight	VC (ccm)
Men Senior Team (YUG)	23.89	174.53±0.64	62.90±1.00	4623±40.94

3.9 Strength assessment via dynamometry and one-repetition max tests

We use following equipments for measuring strength of upper and lower extremities.
- Takei Digital Hand Grip Dynamometer Model 884150
- Lafayette Hand Dynamometer Model 78010
- Takei Back-Leg Dynamometer TKK-5002
- Apollo 4 Multi-station Gym

4 Discussion/Conclusion

Testing and measurement are the means of collecting information upon which subsequent performance evaluations and decisions are made.

Importance of recording the information: For the coach it is important to monitor the program of work, so as to maintain progression in terms of the volume of work and its intensity. Both coach and athlete must keep their own training records. A training diary can give an enormous amount of information about what has happened in the past and how training has gone in the past. When planning future training cycles, information of this kind is absolutely invaluable.

Also for National Teams is important timing of tests. So it should be at least two or three time per season. At the beginning of season, in winter break (half season) and at the end of the season.

At the beginning it should give the clear picture of the players, and guide for creating of training program. At the half season, we can check efficacy of training program and make plans for the next period, and at the end of season, we can see complete season and analyze it. Also, with these data, we can start planning new season and new goals.

Creating data base, we have more data to compare, and some of taken data can be important, because they may give us information about some factors which can cause achieving results in competition. Unfortunately, we didn't have in past abilities to do these tests when we wonted, but we were finding best solutions. With portable laboratory for functional diagnostics of athletes, which is my next project, I believe that this job will be done with much more efficacies, because it will be done in less time period and precise in time point when it should be done. Practically, for one Team (8-10 players) all this measurements can be done in two days.

All of this information should be in service of practice work in training with players, and integral part of training process and activities of National Teams.

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TESTING, PERFECTION AND MONITORING OF MOTOR ABILITIES OF TABLE TENNIS PLAYERS

Abstract

The study of table tennis structure represents the first step towards its scientific view working with top table tennis players.

Physiological aspects of modern table tennis are analyzed and defined.

The battery of tests is chosen on the bases of the analysis of structure and physiological requirements of modern table tennis.

Period of testing – during one competition season (July – may (June)) the following time points of motor abilities testing:

- *Summer preparations (work on basic motor abilities) two testing (in the beginning and at the end of the preparations)*
- *Testing before the beginning of the competition season*
- *Winter preparations (two testing (in the beginning and at the end of the preparations)*
- *Testing before preparations for big competitions (World and European championship)*
- *Testing at the end of the competition season*

The influence of motor abilities on the game results – the analysis of the test results of motor abilities during the longer period of time (national team of Serbia and Montenegro) and comparison with the results achieved at big competitions and rank of the players at the World Rang List:

- *comparison and analysis of the results of Ilija Lupulesku, Slobodan Grujic, Aleksandar Karakasevic and Rade Markovic*
- *the analysis of the results of Erdelji Ana-Marija (European cadet champion in 2000 and in 2003 the final junior year)*
- *the analysis of the results of the male senior national team of India in the beginning of the competition season of 2001/2002 and before the performance at the Commonwealth Games 2002 (the bronze medals in team, pair and single competitions)*
- *the analysis of the results of Marko Jeftovic and Pete Zolt (key players of the junior national team of Serbia and Montenegro before the European championship in Novi Sad 2003 (11th place as team) and the European championship in Budapest 2004 (second place (silver medal) as team)*
- *Comparison senior, cadet and junior players*

Key words: *table tennis, motor abilities, tests, monitoring*

1 Introduction

Modern table tennis demands from players optimal psychophysical qualities, since a time when good technique and tactics belong to past. The study of table tennis structure represents the first step towards its scientific view working with top table tennis players. The process of training contains several elementary aspects - technique, tactics and strength, physical, then psychological preparation and the process of forming a sporting character. These elements form a unique whole in the process of training which leads to top form. There are connections between some of these elements which, when synchronized represent condition for the optimal realization of all abilities. Analyzing the matches of leading World and European competitions, we can determine motoric needs in modern table tennis. During one match a player makes about 100-110 lateral (side) movements (hops - stressing the left-right direction), about 50 so-called deep movements (back and forth direction), about 90-100 forehand swings, and about 60-70 backhand swings (Djokic, Z.: "Basic and special physical preparation of top table tennis players", ITTF Sport Science Congress, Paris, 2003).

So, the dominant motor abilities in modern table tennis are: strength, speed, agility, coordination, precision, endurance and flexibility.

Also, using new technology we determine and physiological aspects of table tennis players during matches (Djokic, Z.: "Heart rate monitors in table tennis", ITTF Sport Science Congress, Paris, 2003). During the table tennis match the increasing of the heart beats is noticed as the game goes on. So the maximum value of the pulse rate marked through the ending and at the moments which decided the winner of the set and match. The average values of the pulse rate during the match were from 162 to 172 beats per minute (6 time measurement of the matches at official competitions – European League). From this information we can make conclusion that table tennis game is more than 75% of the game in anaerobic zone, and at the end of the game near and in maximal zone.

2 Methods

Tests and analysis of motor and functional abilities of players were done during period from 1998 – 2005. Data base of this data were used. These data were taken in pre season period (summer and winter National Team preparation), on start and during prepare for World, European Championships and Olympic Games.

2.1 Participants

Sample of players were the National Teams (all categories) of Yugoslavia-Serbia&Montenegro – 98 players. Also, some of results were taken in season 2001/2002 with senior National Team of India – 12 players.

2.2 Procedure

All results were analyzed as a group results and as individual results. Standard statistical methods were used:

- Arithmetic Middle
- Standard Deviation
- Variation (Maximum and Minimum results)
- Simple and relative Frequency

3 Results

For the establishment of the initial condition of a player the tests for basic and specific motor abilities were applied. For that purpose the most adequate were collection of 15-20 tests for the estimation of basic motor abilities and 3 tests for estimation of specific motor abilities (related to the table tennis itself).Motor abilities tests are so-called field in stead of functional (laboratory). For the estimation of all relevant motor abilities, which will be explained below, adequate standardized tests were made, namely, the basis of data exist and are formed in last 8 years, to which the results can be compared. With the analysis of the got results we get the actual picture of the condition of the player, the basis for planning and programming the training process.

Functional abilities:

1. Astrand test (ergocycle) – Maximal Oxygen Uptake (VO2 max)
2. Conconi test (treadmill or athletic track) – Lactate Threshold

Basic motor abilities:

Strength – General

1) Push Up Test (PUSHT)
2) Sit Ups Test -30 sec (SITUT)
3) Curl-Up Test (CURLT)
4) Medicine ball javelin quadratlon
   These entire tests are standardized.

Table 1 *Results (average) of tests for evaluation of general strength*

Teams (YUG)	**Age**	**PUSHT**	**SITUT**	**CURLT**
Men Senior	27.0	30.8 (56)	32.5 (38)	92.0 (142)
Women Senior	22.6	17.3 (27)	21.3 (35)	65.8 (105)
Junior boys	15.6	26.5 (41)	32.0 (35)	65.0 (93)
Cadet boys	13.6	11.0 (20)	26.2 (28)	49.4 (67)
Junior girls	16.5	10.3 (21)	26.3 (31)	83.5 (109)
Cadet girls	14.0	11.0 (21)	27.0 (30)	60.2 (200)

* - maximal result in test in data base.

Strength – explosive

5) Standing Long Jump Test (SLJUM)
6) Triple Long Jump Test (from spot) (3JUMP)
7) Sergeant (vertical) Jump Test

Table 2 *Results (average) of tests for evaluation of strength - explosive*

Teams (YUG)	**Age**	**SLJUM**	**3JUMP**
Men Senior	27.0	227.6 (265.0)	6.63 (7.35)
Women Senior	22.6	177.5 (198.0)	5.40 (6.00)
Junior boys	15.6	224.0 (235.0)	5.80 (6.05)
Cadet boys	13.6	181.7 (215.0)	5.21 (5.80)
Junior girls	16.5	167.6 (180.0)	5.05 (5.90)
Cadet girls	14.0	174.2 (185.0)	5.10 (5.50)

Speed and Power

8) 10 meter sprint test (start is from squat position backward in stead of finish line)
9) 30 m speed test
10) Flying 30 m speed test

Agility

11) 6X4m Side Movement (6X4MS)
12) Hexagonal Obstacle Agility Test
13) Two triangle Test (2TRIT)
14) Lateral Change of Direction test

Table 3 *Results (average) of tests for evaluation of agility*

Teams (YUG)	**Age**	**6X4MS**	**2TRIT**
Men Senior	27.0	10.04 (8.50)	9.31 (8.80)
Women Senior	22.6	11.21 (10.94)	10.00 (9.65)
Junior boys	15.6	10.14 (8.86)	9.95 (8.98)
Cadet boys	13.6	10.48 (9.19)	10.88 (10.13)
Junior girls	16.5	10.86 (10.48)	11.14 (10.67)
Cadet girls	14.0	10.31 (9.91)	11.18 (10.81)

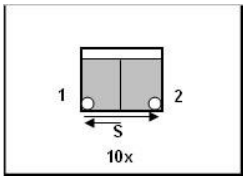
Flexibility & Balance

15) Sit and Reach Test
16) Static Flexibility Tests – Hip&Trunk, Shoulder&Wrist, Trunk&Neck

Specific (table tennis) motor abilities tests

1) Specific test (speed of arm movements) (TAPP1)

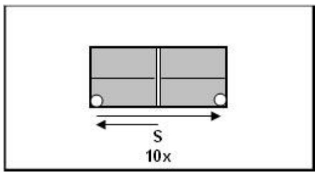
Picture 1 *TAPP1*



Start position is near the table in front of central line (S). Player chooses which side to start. With different hand from the side of marker he touch marker (left side with right arm). Measure of time start with sound signal for start, the end of test is after player makes 10 contacts with marker.

2) Sideways TT movements (TAPP 2)

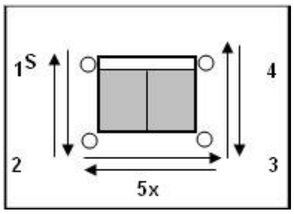
Picture 2 *TAPP2*



Start position is near the table in front of net line (S). Player choose which side to start. With different hand from the side of marker he touch marker (left side with right arm). Measure of time start with sound signal for start, the end of test is after player makes 10 contacts with marker.

3) Combined footwork movements (left-right-forward-backward) (COMMV)

Picture 3 *COMMV*



Start position is near the table in front of net line (S). 1-2 backward movement; 2-3 side movement; 3-4 forward movement, and back – it repeats five times. Measure of time start with sound signal for start, the end of test is after player make cross the hypothetically net line for the fifth time.

Table 4 *Average values of specific tests*

Teams (YUG)	**Age**	**TAPP1**	**TAPP2**	**COMMV**
Men Senior	27.0	3.18 (2.91)	7.72 (7.25)	13.02 (12.69)
Women Senior	22.6	3.81 (3.48)	8.87 (8.71)	15.02 (14.88)
Junior boys	15.6	3.20 (2.97)	8.05 (6.88)	13.52 (11.46)
Cadet boys	13.6	3.94 (3.21)	9.20 (7.76)	14.73 (13.33)
Junior girls	16.5	3.88 (3.50)	8.99 (8.95)	15.85 (15.01)
Cadet girls	14.0	3.73 (3.50)	9.20 (8.97)	15.60 (14.92)

The battery of tests is chosen on the bases of the analysis of structure and physiological requirements of modern table tennis.

Period of testing – during one competition season (July – May (June)) the following time points of motor abilities testing:

Summer preparations (work on basic motor abilities) two testing (in the beginning and at the end of the preparations)

This is the only period which gives use enough time to work on the basic abilities. Usually, it last from 14-21 days. In first 7-10 days, we don't include table tennis in training schedule. First two days are provided for battery of motor tests (and if it is possible, functional/medical tests). Full battery of tests should be done. Control tests should be done about two days before prepare finish (reduced number of tests). Day before control test, we give light aerobic training.

Testing before the beginning of the competition season

In period immediately before start of championships (competition season) some of the functional tests (as VO2max, Lactate Threshold) and some specific tests (explosive strength and table tennis tests), should be done. Not more than 5-6 tests. These tests can be again repeated during the season.

Winter preparations (two testing (in the beginning and at the end of the preparations)

Usually, for this prepare we have 7-10 days before New Year (after the end of championships), and eventually 7-10 days after New Year holidays. In first part of prepare, we used to do battery of tests and not to involve table tennis practices in first 3-4 days. Control test should be done at the end of the second prepare period.

Testing before preparations for big competitions (World and European championship)

Period from about 20-25 days is ordinary for National Team prepare before European and World Championships (for Olympics we have much more time, about 2 month prepare). Tests are done in first 3 days of prepare.

Testing at the end of the competition season

At the end of the competing season, tests should be done. Especially for players of National Team. So, active recovery and rest time is on them, and at the gathering of

National Team at the summer prepare, we have complete picture about their level of fitness, and also, about quality of their break from playing.

The influence of motor abilities on the game results – the analysis of the test results of motor abilities during the longer period of time (National Team of Serbia and Montenegro) and comparison with the results achieved at big competitions:

Comparison and analysis of the test results of Lupulesku Ilija, Grujic Slobodan, Karakasevic Aleksandar and Markovic Rade

These players were the best senior in period 1998-2005 (in period that data base of motor abilities exist). In this period they achieved very good results. 1998.-EC medalists; 2000.-EC medalists, ¼ finalists Olympic Games; 2001.-Mediterranean Games medalists; 2002.-EC medalists 2003.-EC medalists 2004.- ¼ finalist Olympic Games; 2005.-Mediterranean Games medalist, EC medalists.

Table 5 *Results (average) of motoric and functional tests*

test	Lupulesku I.	Grujic S.	Karakasevic A.	Markovic R.
PUSHT	21	29	15	38
SITUT	35	38	31	34
CURLT	53	114	70	120
3JUMP	7.03	7.24	6.54	7.30
6X4MS	9.94	10.21	10.50	8.92
TAPPH*	4.66	4.37	4.84	4.59
VO2max	56.50	64.37	42.74	62.91

* TAPPH – classic Tapping Test

It is important to know that in this period Lupulesku was at the end of his playing career in Yugoslav Team. So, his results don't represent his abilities, because he was known as one of the most efficacy player in area of motor abilities. Also, Karakasevic is always under standards in motor and functional abilities, but, studying of his training and playing demands, he's more rational in stead of other players, with much less movement, and energy expenditure. Grujic and Markovic are always in high level of all motor and functional abilities.

Analysis of the test results of Erdelji Ana-Marija (European cadet champion in 2000 and in 2003 the final junior year)

Player Ana Marija Erdelji won European cadet single champion title at EC 2000. In Bratislava, in Team competition as junior she won bronze medal at EC 2003 in Novi Sad. Complete National Team is in system of monitoring and development of functional and motor abilities since 1998.

Table 6 *Results of tests in season 2001 and 2003*

	test	2000-1	2000-2	2003
strength	**PUSHT**	3	8	6
	SITUT	30	31	25
	CURLT	159	200	55
strength explosive (m)	**SLJUM**	1.63	1.74	1.70
	3JUMP	5.50	58.5	5.80
agility (sec)	**6X4MS**	10.49	10.40	10.48
specific (sec)	**TAPP1**	3.92	3.50	3.88
	TAPP2	9.16	8.95	9.09
	COMMV	15.87	14.92	15.95
endurance (ml/kg)	**VO2max**	43.40	48.18	45.57

In season 2002/2003 (first half of season) Erdelji had injury of shoulder. This is one of the reasons why results are on lower level that usual, but also, it is obviously and influence of this to final results at competition.

Analysis of the test results of the male senior National Team of India in the beginning of the competition season of 20001/2002 and before the performance at the Commonwealth Games 2002 (bronze medalists-Team, double and single)

Initial tests were done in December 2001. Control tests were done in March and July 2002 (C. Games were held in August).

Table 7 *Results (average) of motoric and functional tests in 2001 and 2002*

	test	2001	2002
strength	**PUSHT**	34.8 (38)	39.5 (47)
	SITUT	27.8 (34)	29.8 (35)
strength explosive (m)	**SLJUM**	2.15 (2.50)	2.21 (2.52)
	SARDZ	0.49 (0.69)	0.51 (0.70)
agility (sec)	**6X4MS**	11.04 (10.57)	10.68 (10.21)
specific (sec)	**TAPP1**	3.82 (3.35)	3.80 (3.27)
	TAPP2	9.39 (8.68)	9.28 (8.70)
	COMMV	15.18 (14.91)	15.07 (14.89)
endurance (ml/kg)	**VO2max**	57.13	59.18

In stead of Yugoslav players, specific abilities and explosive strength (specifically of the upper body) were inferior. In period of six month we compensate this deficiency with systematic work and control in area of physical prepare.

Analysis of the test results of Jevtovic M. and Pete Z. (key players of the junior National Team of Serbia and Montenegro before the European Championships-Novi Sad 2003 (11^{th} Team) and the EC-Budapest 2004 (2^{nd} place) Team)

These two players are in system of monitoring and development since 1999. It is interesting to compare results of functional and motor tests in year 2003 and 2004, to see where is quality difference which cause achieving great result at European Championship in Budapest.

Table 8 *Results of motoric and functional tests in 2003 and 2004*

		Pete Z.		Jevtovic M.	
	test	**2003**	**2004**	**2003**	**2004**
strength	**PUSHT**	8	20	28	34
	SITUT	24	28	27	30
	CURLT	44	65	80	93
strength explosive (m)	**SLJUM**	1.90	1.97	2.10	2.21
	3JUMP	5.70	5.90	5.80	6.02
agility (sec)	**6X4MS**	10.17	9.76	10.18	9.88
specific (sec)	**TAPP1**	3.73	3.71	3.69	3.45
	TAPP2	9.06	8.92	9.12	8.15
	COMMV	14.52	14.15	14.22	13.89
endurance (ml/kg)	**VO2max**	46.86	53.22	53.4	61.02

These two players in one year considerably increase their motor abilities, also one of the reasons was and playing full competing season in senior National championships as key players in their clubs.

4 Discussion/Conclusion

Tests of motor abilities are also with functional tests integral part of every serious work in modern sport. From these tests we can make conclusions, guide our training program and monitor development of our players. Especially this procedure is necessary when we work with National Teams.

After test results analyses, we can directly and with high efficacy to influence to development of our players. It is important at the beginning of season, and also, at the beginning of final preparation for big competitions.

Forming database for all categories is necessary for quality evaluation of results. We can also; check some new types of training and their effects to player's abilities.

Some special type of specific practice which have influence on improving of physical prepare level through techical&tactical elements (so called "transformation" training) is in progress. After enough proof of their efficacy (on adequate sample of players) they will be published. Monitoring and check of their efficacy will be through this battery of tests. The aim is that this type of specific physical conditioning can start in early age of players, with less time for practice and more efficacies.

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THE DETERMINATION OF ANTHROPOMETRIC CHARACTERISTICS OF TURKISH CHILDREN TENDS TO BE TABLE TENNIS PLAYERS

Abstract

As a result of the age of starting to do sports decreases day by day, the issue of determining the appropriate person models at early ages has emerged recently. It results from that all of the scientific efforts to develop the performance of the ones who were encouraged to participate in inappropriate fields prove to be insufficient.

The purpose of the study was to examine the anthropometric features of Turkish athletes who are candidates to become table-tennis players. In order to examine the anthropometric features of the research groups who are 8±1 years and 205 people; age, height, weight, thickness of 5 skin folds, 2 width and 2 circumference measurements were taken.

According to the consequence of the study, there emerges to be a significant discrepancy between the width of knees (p<0.001) and the width of (p<0.05) among genders.

***Key Words**: Somatotype, Anthropometry, Children*

INTRODUCTION

The Significant developments in all of the fields of sports are the products of the evaluation of athletes' general and specific anthropometric and kinesiology-related features.

Body measurements and physical body composition are important factors that affect physical performance.

In previous studies conducted about anthropometric features, suitable for certain fields were discussed and it was searched as to what extent they might have influence on the selection of talents for some sports.

The type of the body has a great role on the selection of suitable candidates for competitive sports.

Anthropometry is a systematic measurement technique which reflects the values of the body in terms of outer physical dimensions.

The purpose of the research conducted was to examine the anthropometric features of Turkish athletes who are candidates to become table-tennis players.

MATERIALS AND METHOD

This study was conducted in 2006 including 205 Turkish athletes who are candidates to become table-tennis players.

In line with the techniques that IBP (International Biological Programme) and ISAK (International Society for the Advancement of Kinanthropometry) stipulate, the athletes in the research group were measured in terms of 11 anthropometric features. The weight was measured by using a digital scale with a 100 gram precision. The height was measured with a Martin™ type anthropometer. The width of knees and elbows was measured with a small diameter compasses. Biceps and foot calf circumferences were measured with a strap meter, triceps, biceps, subscapular,

suprailiac and the thickness of calf skin fold (TSC) was measured with a Holtain skin fold and the values were recorded in millimeter.
A care was taken to minimize the operator error by carefully following procedures required.

RESULTS

Average values and standard deviation values of anthropometric features of 205 Turkish athletes who are candidates to become tennis players are given in Table 1 and Table 2.

Table 1. Anthropometric Values of Males

n=109	***M***	***SD***
Height	130.63	6.79
Weight	29.27	6.53
BMI	42.76	2.10
Triceps	11.02	3.44
Biceps	8.50	3.03
Subscapular	8.13	3.51
Suprailiac	7.65	3.85
Calf	15.43	5.03
Biceps Per.	19.40	2.22
Calf Per.	27.18	2.76
Width of Elbow	5.45	0.63
Width of Knee	8.19	0.58

Table 2. Anthropometric Values of Females

n=96	***M***	***SD***
Height	129.43	6.58
Weight	27.66	5.78
BMI	43.14	2.36
Triceps	11.03	3.30
Biceps	8.68	3.51
Subscapular	8.77	4.24
Suprailiac	8.01	3.67
Calf	15.59	5.00
Biceps Per.	19.04	2.06
Calf Per.	26.61	2.58
Width of Elbow	5.28	0.39
Width of Knee	7.82	0.57

In this study, average weight of females was found to be (n:96) 27.66 ± 5.78 kg and average weight of males was found as (n:109) 29.27 ± 6.53 kg (Table 1,2). In the computation of growing and progress, another one of the mostly used measurements along with the weight is the height. In this study, average height of females (n:96) was 129.43 ± 6.58 cm and average of males height (n:109) was 130.63 ± 6.76 cm (Table 1,2). Another anthropometric variable is the thickness of triceps skin fold. This was measured as 11.03 ± 3.30 mm for females (n:96) and as 11.02 ± 3.44 mm for males (n:109) (Table 1.2). One of the measurements used to determine the body fat is the thickness of biceps skin fold. It was found as 8.68 ± 3.51 mm for females (n:96) and as 8.50 ± 3.03 mm for males (n:109) (Table 1,2). Especially, the thickness of subscapular skin fold is significant in terms of giving the fat amount which is at the center of the body. In this study, the thickness of subscapular skin fold was calculated as 8.77 ± 4.24 mm for females (n:96) and as 8.13 ± 3.51 mm for males (n:109) (Table 1,2). Another variable that reflects the amount of fat which takes place at the center of the body is the thickness of suprailiac skin fold. It was defined as 8.01 ± 3.67 mm for females (n:96) and as 7.65 ± 3.85 mm for males (n:109) (Table 1,2). The thickness of calf skin fold was 15.59 ± 5.00 mm for female (n:96) and is15.43 ± 5.03 mm for males (n:109) (Table 1,2). In the measurement of biceps pentameter, it was found as 19.04 ± 2.06 cm for females (n:96) and as 19.40 ± 2.22 cm for males (n:109) (Table 1,2). As the other measurement of pentameter, that is calf pentameter, it was determined 26.61 ± 2.58 cm for females (n:96) where it was 27.18 ± 2.76 cm for males (n:109) (Table 1,2). In the width measurements which are the other anthropometric measurements in this study, the width of elbow was measured as 0.28 ± 0.396 cm for females (n:96) and as 5.45 ± 0.63 cm for males (n:109) (Table 1,2). Another width measurement is the width of knee, which was found as 7.82 ± 0.57 cm for females (n:96) and as 8.19 ± 0.58 cm for males (n:109) (Table 1,2).

According to the results of the "t Test", there seems to be a significant difference only between the width of knee ($p<0.001$) and the width of elbow ($p<0.05$) among genders.

Table 3. Correlations between Anthropometric Measures of Male and Female Players

		Height	**Weight**	**Triceps TSC**	**Biceps TSC**	**Subscapular TSC**	**Iliac TSC**	**Calf TSC**	**Biceps PEN.**	**Calf PEN.**	**Width of Knee**	**Width of Elbow**	**BMI**	
MALES	**Weigth**	**1.00**	**0.56**	**0.70****	**0.68**	**0.77****	**0.76****	**0.77****	**0.92****	**0.91****	**0.62**	**0.76****	**-0.67**	**FEMALES**
	Height	0.68	**1.00**	**0.13**	**0.16**	**0.12**	**0.21**	**0.19**	**0.40**	**0.42**	**0.60**	**0.53**	**0.22**	
	Triceps TSC	0.74**	0.34	**1.00**	**0.90****	**0.79****	**0.86****	**0.80****	**0.80****	**0.68**	**0.40**	**0.47**	**-0.70****	
	Biceps TSC	0.69	0.30	0.86**	**1.00**	**0.78****	**0.79****	**0.74****	**0.78****	**0.68**	**0.44**	**0.47**	**-0.63**	
	Subscapula TSC	0.81**	0.30	0.83**	0.75**	**1.00**	**0.86****	**0.78****	**0.81****	**0.74****	**0.36**	**0.50**	**-0.77****	
	Suprailiac TSC	0.75**	0.27	0.79**	0.75**	0.89**	**1.00**	**0.82****	**0.82**	**0.73****	**0.46**	**0.58**	**-0.71****	
	Calf TSC	0.79**	0.43	0.81**	0.77**	0.77**	0.76**	**1.00**	**0.78**	**0.76****	**0.42**	**0.62**	**-0.73****	
	Biceps PEN.	0.93**	0.53	0.85**	0.77**	0.84**	0.79**	0.85**	**1.00**	**0.88****	**0.61**	**0.68**	**-0.72****	
	Calf PEN.	0.92**	0.61	0.77**	0.70**	0.78**	0.73**	0.80**	0.92**	**1.00**	**0.55**	**0.73****	**-0.70****	
	Width of Knee	0.52	0.35	0.45	0.33	0.46	0.34	0.34	0.53	0.53	**1.00**	**0.56**	**-0.19**	
	Width of Elbow	0.82**	0.61	0.64	0.56	0.64	0.60	0.62	0.79**	0.81**	0.64	**1.00**	**-0.43**	
	BMI	-0.71**	0.01	-0.70**	-0.67	-0.80**	-0.75**	-0.67	-0.77**	-0.69	-0.40	-0.55	**1.00**	

The correlations between male and female players are shown in table 3. When anthropometric features were examined, one of the most important measurements used in the evaluation of development and body structure is the weight. There was a highly positive relationship between weight and triceps TSC (r = 0.70), between weight and subscapular TSC (r = 0.77), between weight and subrailiac TSC (r = 0.76), between weight and calf TSC (r = 0.77), between weight and biceps pentameter (r = 0.92) and between weight and calf pentameter of females. Especially, the thickness of subscapular skin fold is important in terms of indicating the amount of fat at the center of the body. Also, there was a highly positive relationship between subscapular TSC and triceps TSC (r = 0.79), subscapular TSC and biceps TSC (r = 0.78). Today, mostly BMI is used to determine the obesity. There seems to be a negative relationship between BMI and triceps TSC (r = -0.70), BMI and subscapular TSC (r = -0.77) of females. However, there was a highly positive relationship between weight and biceps pentameter (r = 0.93), between weight and calf pentameter (r = 0.92) of males. Also, there was a highly positive relationship between biceps pentameter and triceps TSC (r = 0.85), between biceps pentameter and calf TSC (r = 0.85), between biceps pentameter and subscapular TSC (r = 0.84). There was a highly positive relationship between calf pentameter and biceps TSC (r = 0.92), between calf pentameter and calf TSC (r = 0.80), and between calf pentameter and subscapular TSC (r = 0.78). There was a negative relationship between BMI and subscapular TSC (r = -0.80).

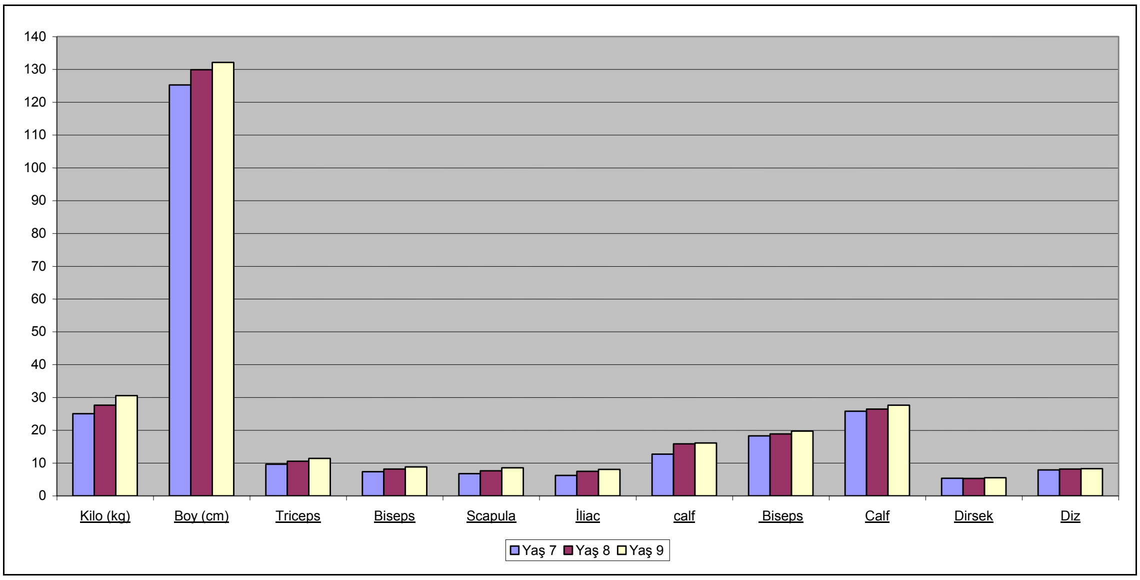

Figure 1. Male Students' Anthropometric Assessment Distribution Graph with Age)

In figure 1 the anthropometric assessment distribution of Turkish athletes who are candidates to become male table-tennis players was indicated along with their age levels.

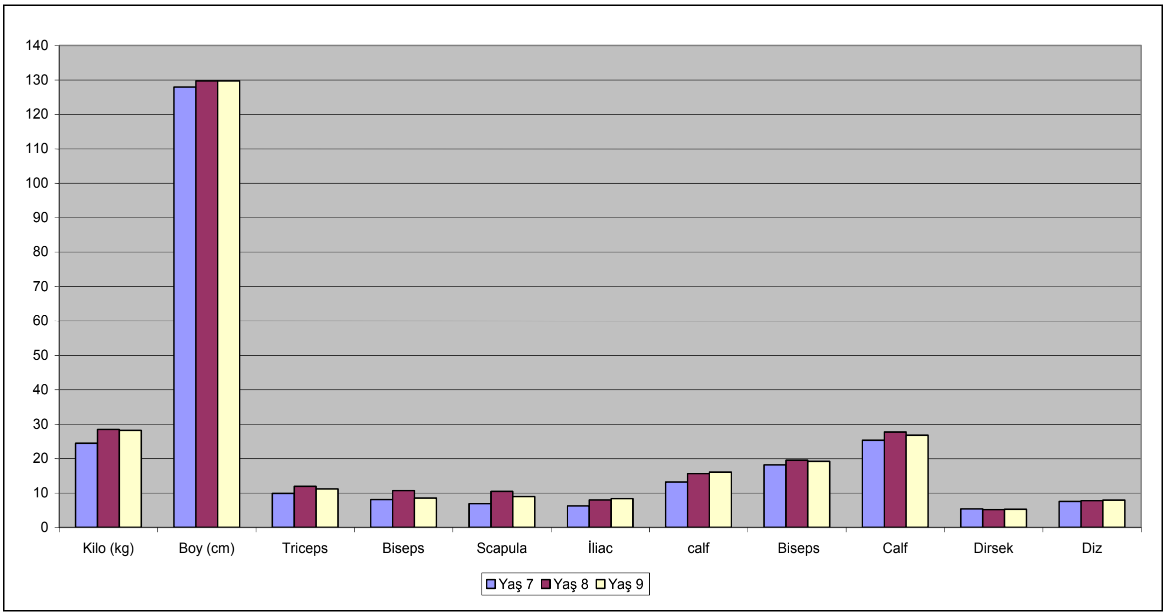

Figure 2. Male Students' Anthropometric Assessment Distribution Graph with Age)

In figure 2 the anthropometric assessment distribution of Turkish athletes who are nominees to become female table-tennis players was indicated along with their age levels.

DISCUSSION AND CONCLUSION

The adaptation skills to environmental conditions of human body which is shaped by mutual interactions between genetic and environmental factors are quite high. Trainings which are done according to the sport branch help body gain the intended shape, which increases the performance and makes the body shape mechanically more advantageous.

In all sports, the aim is to achieve success. In our country, increasing scientific researches affects the success in a positive way. Through the researches, it is seen that body's anatomical features show differences between different sport branches and different subcategories of the same sport branches. The data collected through researches carry great importance in athletes' being directed to branches, athletes' education and elite athletes' trainings and their performances' being increased. That is why, it is pretty important to determine morphological and psychological characteristics of athletes.

That is why, anthropometric measurements (height, body weight, length measurements, etc.) which are taken at the early periods of starting the sport becomes helpful in the choice of skill. 11 anthropometric measurements of 205 Turkish athletes which are candidates to become table tennis players were taken during our survey that we conducted for that purpose.

Height is one of the anthropometric measurements and is generally used with weight to evaluate a person's growth and development. Length is important in the development period of the person especially for the chronic eating disorders. Changes in weight are much more dependent on the society's eating attitudes, and sometimes, decrease in body mass indicates the poor nutrition of society.

The average weight and average height of female athletes was found (n=96) 27.66±5.78 kg and 129.43±6.58 cm, respectively (Table 2) whereas in other studies which Balcı[22] and colleagues have conducted, the averages were found 31.8±8.1 kg and 133.1±8.1 cm. These averages are found higher than the averages in this study, the reason of which is that length is related much more with genetic factors than with environmental factors and that environmental factors have more influence on body weight than genetic factors.

In this study, the values for triceps TSF of females used to determine the body fat were found (n=96) 11.03±3.30 mm (Table 2), however they were found to be 12.4±5.1 mm in the study of Balcı[22] and colleagues (2004). The subscapula skin fold thickness is the most effective measure that shows the fat rate of the body's central area. [6,16,17] In this study, the subscapula TSF was found 8.77±4.24 mm (Table 2), but it was found 8.1±4.3 mm in the study of Balcı[22] and colleagues (2004). Another measure showing the fat rate of the body's central area is the suprailiac skin fold thickness. [5] While, in this study, the suprailiac TSF of females was found 8.01±3.67 mm (Table 2), it was stated as 8.4±5.4 mm in the study of Balcı[22] and colleagues (2004). The calf TSF gives an idea about the fat in the organs. [5] In this study, the calf TSF for female students was found 15.59±5.0 mm (Table 2); however, it is found 13.0±5.5 mm in the study of Balcı[22] and colleagues (2004). In the circumference measurement which is one of the anthropometric measurements, the circumference of biceps for girls was found 19.04±2.06 cm (Table 2) in our study whereas it was found 20.8±3.0 cm in the study of Balcı[22] and colleagues (2004). As another circumference measurement, the circumference of the calf for female students was found 26.61±2.58 cm (Table 2) in our study while it was found 27.9±3.5 cm in the study of Balcı[22] and colleagues (2004). In width measurement which is one of the anthropometric measurements used in our study, the elbow width of girls was found 5.28±0.39 cm (Table 2), but it was estimated at 5.2±0.5 cm in the study of Balcı[22] and colleagues (2004). The knee width for girls was found 7.82±0.57 cm (Table 2) in our study; however, it was found 8.0±1.0 cm in the study of Balcı[22] and colleagues (2004).

The difference in the skin fold thickness, the circumference measurements and the width measurements is thought to result from the cultural and socio-economic status differences and the life style of families, and connected with these issues, results from the differences in the growth, development and body shape of the person.

Based on the data that we obtained during our study, the average weight and the average height of male athletes' in our test subject group was found (n=109) 29.27±6.53 kg and 130.63±6.79 cm (Table 1) respectively. In the study of Özgün[14], the average weight and the average height of 9 year old males was estimated as 31.05±7.66 kg and 130.42±6.99 cm respectively. These values are higher than our values of average weight, but there is similarity between the values of average height. The reason of this, which is thought similar to the female test subject group, is that the length is dependent much more on the genetic factors than on the environmental factors and that the environmental factors are more effective on the body weight than the genetic factors.

The measures of triceps TSF which is used for determining the body fat for male students was found (n=109) 11.02±3.44 mm (Table 1), but it was estimated at 8.96±3.05 mm in the study of Özbar, N[21] and colleagues (2004). The subscapula skin fold thickness is the best anthropometric measurement that gives the amount of the fat in the central area of the body. [6,16,17] In this study, the subscapula TSF of male students (n=109) was found 8.13±3.51 mm (Table 1), but it was estimated at 9.35±3.30 mm in the study of Özbar, N[21] and colleagues (2004). Another measure which exists in the central area of the body and gives the amount of fat in the center is the suprailiac skin fold thickness. [5] in our study, the suprailiac TSF for males was found 7.65±3.85 mm (Table 1); however, it was estimated at 7.58±3.86 mm in the study of Özbar, N[21] and colleagues (2004). The calf TSF gives an idea about the fat in the organs. [5] In this study, the calf TSF for males (n=109) was found 15.43±5.03 mm (Table 1) while it was estimated at 18.85±4.34 mm in the study of Özbar, N[21] and colleagues (2004). In the circumference measurement, which is examined in the category of anthropometric measurements in our study, the biceps circumference of male students was found 19.40±2.22 cm (Table 1) whereas it was found 28.71±2.67 cm in the study of Özbar, N[21] and colleagues (2004). As another circumference measurement, the calf circumference of male students (n=109) was found 27.18±2.76 cm in our study (Table 1) while it was estimated at 35.46±2.58 cm in the study of Özbar, N[21] and colleagues (2004). In the width measurements of our study's anthropometric measurements, the elbow width was found 5.45±0.63 cm (Table 1), but it was found 7.35±1.13 cm in the study of Özbar, N[21] and colleagues (2004). While the knee width of male students was found 8.19±0.58 cm in our study, it was estimated at 10.34±1.23 cm in the study of Özbar, N[21] and colleagues (2004).

The difference in the skin fold thickness, the circumference measurements and the width measurements for males is thought to result from the cultural and socio-economic status differences and the life style of families, and connected with these issues, results from the differences in the growth, development and body shape of the person.

It is thought that the differences between the findings of our study and the findings of other studies result from not only nutrition factors but also those measurements' being collected from different cities and regions and in different dates. Also, it is thought that these differences result from the fact that the average age of the students in our test subject group are younger than the average age of other studies' test subject groups.

To sum up, children who are chosen by the skill choice model of candidate Turkish athletes of table tennis player were measured during this study. This study is the first measurement that is conducted on this group, and the measures which will be gained after a lot of measurements in the future will be quite helpful in forming the normative values of choosing Turkish table tennis players. For these comparisons and conclusions, the norms that are determined by longitudinal studies are required in terms of putting forward the athletes' features of body types which are peculiar to the branches and their distinctive body shape. These norms being created carry great importance on the choice of skills.

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THE EFFECTS OF SOME ANTHROPOMETRICS ELEMENTS ON THE WORLD RANKING OF 32 TOP WOMEN TABLE TENNIS PLAYERS IN ATHENS' 2004 OLYMPIC GAMES

Abstract

This study aims to examine the impact of some anthropometrics elements of 32 top Women Table Tennis Players in Athens' 2004 Olympic Games.

Anthropometrics has been considered as the most influential factors of Talent Identification in different sports. Thus, the researcher is attempting to find out whether anthropometrics could be applied as the basis for recognizing talented table tennis players as well.

In this correlational research, the anthropometric characteristics of 32 top women table tennis players who participated in Athens' 2004 Olympic Games, were analyzed to indicate any significant correlation with their world ranking.

The data including the measurement of some anthropometric features such as weight, height, body mass index, etc. of the above mentioned qualified players were collected from ITTF website. These data were analyzed through correlational statistics, and in order to examine the correlation of the variables, Spearman's Rank Order Correlation Coefficient was applied.

Results:

Statistical analysis indicated the mean values of height, weight, and body mass index as 165.45cm, 57.64kg, and 21 respectively.

The correlation coefficient between height and world ranking of the subjects was calculated as $r=0.217$ ($p=0.332 > \alpha=0.05$), which demonstrates no significant relation between the mentioned variables.

Furthermore, the correlation coefficient of weight and the world ranking of the players was $r=0.180$ ($p=0.422 > \alpha=0.05$), which does not suggest a meaningful value, either.

Finally, the correlation coefficient between body mass index and world ranking came to as $r=0.189$ ($p=0.412 > \alpha=0.05$), which is not significant as well.

Key words: *Talent Identification, Antropometric elements, Body Mass Index, Women Table Tennis Players*

1. Introduction

Talent Identification (TID) is both an Art and Science involving a complex blend of scientific knowledge and assessment, alongside coaching art. The scientific approach of identifying talent involves a series of rigorous assessments and filters to detect individuals that have 'higher probability' for podium success (TI, 2007).

Talent Identification in sports is a process in which individuals, who are more likely to prosper in a given sport, are identified according to the results of the tests of specific factors (Hadavi, 2000).

According to some studies, researchers categorize the effective characteristics in talent identification into six groups: l. *physiological* and *bio-mechanical* 2.

anthropometric, 3. *biological* 4. *genetic* 5. *psychological* 6. *sociological* (Thomson 1992, Hanson 1989, Bevis 1985, Ward 1981).

Limoochi (1996) reported that the main factors that are considered in selecting talented players in Beijing Sport School are *anthropometrics*, *psychological* and *physical-motor* factors.

Jurgen Kozel (1996) describes talent as "extremely complex attribute, genetically determined, complicated in structure and subject to environmental conditions." (Stojanovic, 1997)

Limoochi (2005) in her report from China Table Tennis Association claimed that in China 'height of the parents' was one of the important factors in choosing talented players, that is, they required that the mothers' height be between 163 to 168, and fathers' height be between 175 to 180.

This study aims to examine the impact of some anthropometric elements of 32 top Women Table Tennis Players in Athens' 2004 Olympic Games.

Anthropometric elements have been considered as the most influential factors of Talent Identification in different sports. Thus, the researcher is attempting to find out whether anthropometrics could be applied as the basis for recognizing talented table tennis players as well.

2. Method and Procedures

In this correlational research, the anthropometric characteristics of 32 top women table tennis players who participated in Athens' 2004 Olympic Games were analyzed to indicate any significant correlation with their world ranking.

The data including the measurement of some anthropometric features such as weight, height, and body mass index of the above mentioned qualified players were collected from ITTF website.

These data were analyzed through correlational statistics, and in order to examine the correlation of the variables, Pearson Correlation was applied.

Table 1. Descriptive Statistics of Rank, height, and Weight

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Rank Valid N	32 22	1.00	33.00	15.5919	10.02691	100.539
Height Valid N	32 22	155.00	176.00	165.4545	5.01167	25.117
Weight Valid N	32 22	47.00	69.00	57.6364	5.70334	32.528

3. Results

Statistical analysis indicated the mean values of *height*, *weight*, and *body mass index* as 165.45cm, 57.64kg, and 21 respectively.

Table 2: Correlations

		Height	Weight	Body Mass Index
Rank	Pearson Correlation Sig. (2-tailed)	.217 .332	.180 .422	.189 .412

The correlation coefficient between *height* and *world ranking* of the subjects was calculated as r=0.217 ($p=0.332 > \alpha=0.05$), which demonstrates no significant relation between the mentioned variables.

Furthermore, the correlation coefficient of *weight* and the *world ranking* of the players was r=0.180 (p=0.422 > α=0.05), which does not suggest a meaningful value, either.
Finally, the correlation coefficient between *body mass index* and *world ranking* came to as r=0.189 (p=0.412> α=0.05), which is not significant as well.

Table 3. Correlations

		Rank	Height	Weight
Rank	Pearson Correlation	1	0.217	0.180
	Sig. (2-tailed)		0.332	0.422
	Sum of Squares and Cross-Products	2111.318	229.091	216.727
	Covariance	100.539	10.909	10.320
	N	22	22	22
Height	Pearson Correlation	0.217	1	0.626**
	Sig. (2-tailed)	0.332		0.002
	Sum of Squares and Cross-Products	229.091	527.455	375.636
	Covariance	10.909	25.117	17.887
	N	22	22	22
Weight	Pearson Correlation	0.180	0.626**	1
	Sig. (2-tailed)	0.422	0.002	
	Sum of Squares and Cross-Products	216.727	375.636	683.091
	Covariance	10.320	17.887	32.528
	N	22	22	22

**. *Correlation is significant at the 0.01 level (2-tailed).*

However, even though the study results did not suggest any significant correlation between *height, weight*, and *body mass index* of the mentioned subjects and their *championship rank*, it was noticed that there was a meaningful relation between *height* and *weight* considering the variables' values as r=0.626 (p=0.002< α=0.05).

4. Conclusion

The findings of this study indicated no relation between the three anthropometric factors of height, weight, and body mass index of the 32 top Women Table Tennis Players in Athens' 2004 Olympic Games and their world ranking. This is quite contrary to the results which were achieved by another research by Limoochi (2005). There, it was concluded that height and weight, according to the international coaches' opinions, were the most important anthropometric elements in Talent Identification.

On the other hand, agility and coordination play an effective role in table tennis. Aule & Loko (1983) advocated that agility and coordination of the shorter athletes are more than the taller ones.

Of course, the results of the present research cannot be generalized to all different groups of players and also should not be accounted for other anthropometric characteristics. Similar studies have to be conducted upon males as well as other female groups. Besides, perhaps the study of other anthropometric factors such as height in sitting position, length of stretched arm, width of pelvis, etc. would result in significant correlation with the world ranking.

5. Acknowledgement

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The 10th Anniversary ITTF Sports Science Congress

Part seven:

Psychology of table tennis

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THE TABLE TENNIS CURRICULUM SELECTS ELECTIVE COURSES - THE RESEARCH OF CONSIDERATION

Abstract

The main objective of this research is to investigate the consideration factors that affect undergraduates to take the table tennis courses. The research objects are 299 students taking the table tennis courses in National Chiao-Tung University (NCTU) and Ta Hwa Institute of Technology (THIT). We used statistic analysis, item analysis, factor analysis, t test, and ANOVA to analyze the acquired data. According to the analysis result, we found that there are three consideration factors, which affect students to take the table tennis courses, including personal feeling, environmental equipments and fashion, and experience and convenience. The consideration factors, which affect students to decide what courses to take, rank as personal feeing, environmental equipment and fashion, and experience and convenience. Those three factors show more obviousness in students in THIT than students in NCTU. The factors, Environmental equipment and fashion, shows more obviousness in male students than in female students. The factor, Personal Feeling, shows more obviousness in students who have families who are table tennis enthusiast than in students who don't have. The two factors, Environmental equipment and fashion and Personal feeling, shows more obviousness in students who have friends who are table tennis enthusiast than in students who don't have. The factor, Environmental equipment and fashion, shows more obviousness in students who live in the rented house outside school than in students who live in school dormitory. To combine all above, we can know that Personal feeling and environmental equipment and fashion are main factors which affect parts of students to select courses. Consideration factors which affect students to choose courses are also affected by intimate related people, friends, and personal background. Hope that this analysis result can provide other teachers in school as a reference to proceed with their research.

Key words: *table-tennis courses, Select elective courses consideration*

1.Introduction

1.1 Main Objective

The physical education curriculum in Taiwan is not the required course anymore within the four years in the university since University Law Enforcement Rules were adopted in 1994; it depends on each university instead. To rise the rate of curriculum selection, the final purpose (Tzuan De Li, Guan Shiu Chen in 2004), in physical education and interest items, every university pays more and more attentions to the student demands, and related researches come out, such as the demands for physical education curriculum, the motives, the consideration, the satisfaction, and so on. According to the research of Jr Feng Li and Ching Nan Yang in 2003, the curriculum selection rate of physical education for college students is quite low, and the fun offered by the course is not enjoyable enough for students. Therefore, the top priority in the physical education curriculum plan is to understand the demands and expectations of students and offer the course which can meet their demands. The investigation into current curriculum selection of senior students in colleges ranked the consideration of selecting elective courses: the course items, the time arrangement, the instructors, the amount of sports ground, the number of students in class, and other factors. From above-mentioned result, we can learn that sport items are important factor for students to consider when selecting elective courses. Wen & Kong & Lee (2005) pointed out that table tennis is one of available physical education courses in most of colleges. Many students will select this course, which is the activity they often participate in after school, as well as an overall-expanded sport with intelligence and physical strength. The advantages of table tennis include place, simple and convenient facilities, easy rules, the flexible sport time and low rate of injury, variableness with much fun. Moreover, table tennis is an indoor sport without the influence of weather and also highly convenient (Shu Yuan Shiu, 1986). Consequently, it is important to know how to attract students to select table tennis elective course and understand their considerations, so that we can satisfy their demands of selecting elective course effectively.

1.2 Study Assumption

1.2.1 Is there no different considerations among students from different colleges when selecting courses?

1.2.2 Is there no different considerations among different gender when selecting courses?

1.2.3 Is there no different considerations among students who have families as table tennis enthusiasts when selecting courses?

1.2.4 Is there no different considerations among students who have friends as table tennis enthusiasts when selecting courses?

1.2.5 Is there no different considerations among students have different living conditions?

2.Research Method

2.1 Research Target

The research targets at 170 students who take the table tennis courses in Ta Hwa Institute of Technology (THIT) and 129 students in National Chiao-Tung University (NCTU). There are 297 valid samples, which has 170 males (56.9%)and 127 females (42.5%), and the average age is 19.74±1.28. There are 144 students (48.16%) who have families as table tennis enthusiasts and 153 students (51.17%) who have no families as table tennis enthusiasts. There are 246 students (82.27%) who have friends as table tennis enthusiasts and 50 students (16.72%) who have no friends as table tennis enthusiasts. There are 4 students (1.34%) who live in their relatives' houses, 132 students (44.15%) who live in their own houses, 19 students (6.35%) who live outside in rented houses, and 140 students (46.82%) who live in the school dormitories. The Figure 1 is in more detail.

Figure 1: Analysis of basic data of sample

Variable Items	Detail Items	Number of People	Percent
School	THIT	170	56.86
	NCTU	129	43.14
Gender	Male	170	56.86
	Female	127	42.47
Age	19.74±1.28		
Families as table tennis enthusiasts	Yes	144	48.16
	No	153	51.17
Friends	Yes	246	82.27
	No	50	16.72
Living Condition	Relatives' Houses	4	1.34
	One's own Houses	132	44.15
	Rented Houses	19	6.35
	Dormitories	140	46.82

2.2 Research Tool

The main tool in this research is the figure of selecting consideration of table tennis course. The figure mainly refers to the consideration factors, written by Chiung Wen Shiu (1992), of selecting leisure activities in National Taiwan University (NTU). It also fits the table tennis curriculum in real situations and has 13 topics. First of all, we use item analysis to test the discrimination of the figure, which is highly discriminated in Figure 2, for all DP being greater than 0.4 and all CR being greater than 3, so that the figure can differentiate the topics (Ebel, 1979;Wolman, 1989). Second, from the R2 value, we know that the relevant values in all the topics in the two figures can get up to the standard obviously. At last, the R1 value inspected in all the topics can meet the high intermediate demand of being greater than 0.4. And Cronbach α is 0.87, which shows the good reliability in the figure. Then, sample the KMO (Kaiser-Meyer-Olkin measure of sampling adequacy), which is 0.874, to judge that if we need factor analysis. According to Kaiser (1970;1974), the closer to 1 the KMO value is, the more fitter to use factor analysis, which is conducted by Principal Component in the way of Direct Oblimin and unlimited factors . As the abstract of the factor analysis result, figure 3, shows topic 10 to 13 are in first common factor called "personal feeling factor," whose eigenvalue is 4.77, explained variability is 36.66% ; topic 3, 6, 1, 5, and 4 are in second common factor called "experience and convenience factor," whose eigenvalue is 1.63, explained variability is 12.52% ; topic 7, 9, 8, and 2 are in third common factor called "environmental equipments and popularity factor," whose eigenvalue is 1.15, explained is 8.84% . However, the eigenvalue must be greater than 1.00 so that its same factors can be kept. For this reason, we get the three same factors and the variability accumulated by them is 58.02%. After that, test the internal correspondence among the general scale and subscales with Cronbach α liability coefficient. Generally, the higher, the better. But for the research in the purpose of application, the smallest or lowest acceptable liability is 0.80. The standard can be much lower for the basic researcher, and the lowest acceptable value is 0.50 (Guilford, 1954; Nunnally, 1967). As a result, the coefficient of Cronbach α is 0.84 in the general scale, and is 0.79, 0.75, 0.69 in subscales. The above-mentioned results point out that the figure of selecting consideration of table tennis course has the acceptable reliability of internal correspondence. The Figure 3 is in more detail.

Figure2 Abstract of item analysis of selecting consideration of table tennis course

Topic	DP	CR	R1	R2
1. Time	0.88	7.28	0.51**	0.43**
2. Money	1.13	7.43	0.5**	0.39**
3. Course Contents and Teaching Style	0.97	9.58	0.65**	0.59**
4. People in the Course	1.01	9.8	0.59**	0.52**
5. Convenience	1.12	11.92	0.64**	0.58**
6. Experiences and Evaluations from Others	1.08	9.16	0.6**	0.53**
7. Weather	1.25	9.7	0.56**	0.47**
8. Equipment	1.13	10.06	0.57**	0.49**
9. Popularity	1.03	7.12	0.53**	0.43**
10. Personal Interest	0.95	8.4	0.55**	0.48**
11. Familiarity with the activity	1.15	11.36	0.66**	0.6**
12. Ability and Health Condition	1.11	10.48	0.65**	0.58**
13. Space	1.35	13.65	0.69**	0.63**

Figure3 Abstract of factor analysis of selecting consideration of table tennis course

Topic	Personal Feelings	Experience and Convenience	Environmental Equipment and Popularity
10. Personal Interest	**0.80**	0.20	-0.09
11. Familiarity with the activity	**0.77**	0.19	0.25
12. Ability and Health Condition	**0.68**	0.35	0.13
13. Space	**0.54**	0.24	0.48
3. Course Contents and Teaching Style	0.31	**0.68**	0.13
6. Others' Experiences and Evaluations	0.25	**0.65**	0.11
1. Time	-0.06	**0.64**	0.31
5. Convenience	0.40	**0.64**	0.06
4. People in the Course	0.39	**0.58**	0.07
7. Weather	0.08	0.15	**0.79**
9. Popularity	0.10	0.14	**0.69**
8. Equipment	0.44	-0.06	**0.64**
2. Money	-0.20	0.44	**0.59**
Eigenvalue	**4.77**	**1.63**	**1.15**
Explained Variability	**36.66**	**12.52**	**8.84**
General Explained Variability		**58.02**	
Subscales Cronbach's Alpha	**0.79**	**0.75**	**0.69**
General Scale Cronbach's Alpha		**0.845**	

2.3 Processing of the data

After the questionnaire finished, statistic software spss version 13.0 is used as the analysis of this material. In the beginning, item analysis and exploring factor analysis are used to test the reliability and validity of the research tool. The variance analysis results from t-test, One-Way ANOVA, and checked by Scheffe afterward. The obviousness standard of the research on statistic test is made α=.05.

3 Consequences and Discussion

3.1 Description Analysis of Consideration Factors

Figure 4 shows the ranking of the considerations of selecting elective courses from students: personal feelings factor (M= 4.90), environmental equipment and popularity factor (M= 4.03), and experience and convenience (M= 2.78). It explains that personal feelings factor is the most important influential factor in the course selection of table tennis. Hence, the personal interest, the familiarity with table tennis, capability, the health condition, and the sport space are top important considerations when it comes to course selection. The environmental and popularity factor, including weather, popularity, equipment, and money are the secondary factor. The least factor in this research is the experience and convenience factor, including the class content, teaching style, experiences and evaluations from others, time, convenience, and people in class. From Figure 4, we know the average value in experience and convenience is 2.78, which is the factor students put less considerations during course selection. And the factors they give more considerations are personal feelings, and equipment and popularity.

Figure 4: The Rank of Considerations

Factor	Average of the Sum	Numbers of Topic	Average of Each Topic	Rank
Personal Feelings	19.59	4	4.90	1
Environmental Equipment and Popularity	16.12	4	4.03	2
Experience and Convenience	13.90	5	2.78	3

3.2 Variance Analysis of the Course Selection Considerations of Table Tennis Curriculum

3.2.1 Variance Analysis of students from different universities

Figure 5 shows when selecting elective courses, students from different universities like THIT and NCTU, the values in the factors of experience and convenience, equipment and popularity, and personal feelings the former are apparently higher than the latter. This kind of result probably because of the differences in the two schools themselves. THIT is an institute of technology, the scores to get the permission of it is medium-ranked. But NCTU is generally a comprehensive university, the scores to get the permission is top three in the Join College Entrance Exams (JCEE). Thus, there is an intelligence gap between the students from the two schools, and the demand of the schoolwork is also quite different to a certain extent.

Figure 5: Abstract of Variance Analysis of the Considerations that Students from Different Schools When Facing the Table Tennis Course Selection

Factor	School	Number of people	Average	Standard Deviation	DF	T Value	P Value
Experience and Convenience	THIT	170	19.88	2.62	297	2.32*	0.02
	NCTU	129	19.22	2.15			
Environmental Equipment and Popularity	THIT	170	14.61	2.42	297	5.87*	0.01
	NCTU	129	12.97	2.36			
Personal Feelings	THIT	170	16.49	2.20	297	3.38*	0.01
	NCTU	129	15.64	2.15			

3.2.2 Variance Analysis of Students in Different Gender

Figure 6 shows in the considerations of table tennis course selection, the factor environmental equipment and popularity, shows more obviousness in male students than in female students. It explains that male students will focus more on this factor when considering the course selection. Thus, we can say different factors of the considerations of course selection can be resulted from different gender.

Figure 6: Analysis of Variance Analysis of the Considerations that Student in Different Gender When Facing the Table Tennis Course Selection

Factor	Gender	Number of	Average number	Standard deviation	df	T value	P value
Experience and Convenience	Male	170	19.55	2.59	295	-0.38	0.71
	Female	127	19.66	2.26			
Environmental Equipment and Popularity	Male	170	14.29	2.57	295	3.21*	0.001
	Female	127	13.35	2.39			
Personal Feelings	Male	170	16.19	2.23	295	0.63	0.53
	Female	127	16.03	2.20			

3.2.3 Variance Analysis of the Considerations that Student who Have Families as Table Tennis Enthusiast When Facing the Table Tennis Course

Figure 7 shows in the considerations of table tennis course selection, the factor personal feeling, shows more obviousness in students who have families as table tennis enthusiast than those who don't have. Since a person was born, he/she interacts continually with people around him/her. Especially the family members, they are people we get along with the earliest and being so important in our life. Hence, the preferences of parents and family members will make direct effect on personal feelings and intentions.

Figure 7: Abstract of Variance Analysis of the Considerations that Student who Have Families as Table Tennis Enthusiast When Facing the Table Tennis Course Selection

Factor	Families as Table Tennis Enthusiasts	Number of people	Average number	Standard Deviation	DF	T Value	P Value
Experience and Convenience	Yes	144	19.83	2.43	295	1.53	0.13
	No	153	19.40	2.45			
Environmental Equipment and Popularity	Yes	144	14.01	2.51	295	0.71	0.48
	No	153	13.80	2.56			
Personal Feelings	Yes	144	16.48	2.19	295	2.70*	0.01
	No	153	15.79	2.19			

3.2.4 From Figure 8, in the considerations of table tennis course selection, the two factors environmental equipment and fashion and personal feeling, shows more obviousness in students who have friends as table tennis enthusiast than those who don't have. Chun Hsing Chang (1993) pointed out that the relationship is established on the interpersonal attractions. Thus, people who have similar interests and attitudes tend to participate in the same kind of activities and have the same thought. When these people get along with together, it will be easier to communicate with each other. And it's comprehensible that they have greater selecting desire in the above-mentioned two factors because of the good past. In addition, statistic analysis in the basic material of the research discovers that students who have friends as table tennis enthusiast counts to 82.27%, which also explains the influence power among the peers to a certain extent.

Figure 8: Abstract of Variance Analysis of the Considerations that Student who Have Friends as Table Tennis Enthusiast When Facing the Table Tennis Course Selection

Factor	Friends as Table Tennis Enthusiasts	Number of people	Average number	Standard deviation	df	T value	P value
Experience and Convenience	Yes	246	19.79	2.42	294	2.91*	0.01
	No	50	18.70	2.38			
Environmental Equipment and Popularity	Yes	246	13.83	2.59	294	-0.95	0.34
	No	50	14.20	2.25			
Personal Feelings	Yes	246	16.27	2.21	294	2.61*	0.01
	No	50	15.38	2.12			

3.2.5 In Figure 9, the environmental equipment and popularity factors show more obviousness in students who live in the rented house outside school than those live in school dormitories. According to the research of Jr Feng Li, Ching Nan Yang (2003), Jang Hung Hung, and Rung Ji Su (2004), peers and relationship are important factors that make influence on the course selection. It probably also because of the more interactions with fellows in the dormitories and the available activities of more kinds, these will effect the willingness of course selection. In comparison, students who live in their home and a rented house outside have less interactions with fellows, they will emphasize more on the factor environmental equipment and popularity.

Figure 9: Abstract of Variance Analysis of the Considerations that Students in Different Living Condition When Facing the Table Tennis Course Selection

Factor	Living condition	Number of people	Average number	Standard deviation	F value	P value	significant difference
Experience and Convenience	Relatives' houses	4.00	18.50	2.65	2.12	0.10	
	One's own houses	132.00	19.87	2.59			
	Rented houses	19.00	20.26	2.56			
	Dormitories	140.00	19.27	2.28			
Environmen-tal Equipment and Popularity	Relatives' houses	4.00	14.50	2.38	9.73*	0.01	2>4
	One's own houses	132.00	14.55	2.33			3>4
	Rented houses	19.00	15.11	2.11			
	Dormitories	140.00	13.11	2.53			
Personal Feelings	Relatives' houses	4.00	16.75	3.59	4.03	0.01	
	One's own houses	132.00	16.40	2.13			
	Rented houses	19.00	17.16	2.01			
	Dormitories	140.00	15.69	2.23			

4 Conclusions and Suggestion

4.1 Conclusion

The research targets at 297 students taking the table tennis courses in Ta Hwa Institute of Technology (THIT) and National Chiao-Tung University (NCTU). After discussion and generalization, conclusion comes out as follows:

4.1.1 The main factors in the considerations of course selection of students are personal feelings and environmental equipment and popularity.

4.1.2 The three factors experience and convenience, environmental equipment and popularity, and personal feelings, students in THIT effected apparently more than those in NCTU.

4.1.3 The factor environmental equipment and popularity in male students is apparently more than female students.

4.1.4 The factor personal feelings, students who have families as table tennis enthusiast effected apparently more than those who don't have.

4.1.5 The factor personal feelings, students who have friends as table tennis enthusiast effected apparently more than those who don't have.

4.1.6 The factor environmental equipment and popularity, students who live in their homes or rented houses effected apparently more than those who live in dormitories.

4.2 Suggestion

4.2.1 Cultivation of personal participation interest should be the main line to let students have good personal feelings in class, so that we can enhance the students' motives of course selection, also the main point of the course plan. Thus, we can enhance the re-selecting willingness of students.

4.2.2 To let students be in a good environment of class, also the important factor of course selection, update the sports equipment and educational hardware is necessary. There is a suggestion for school authorities to put more attentions to such sports hardware as gymnasium in the important working list to satisfy the demands of students when the campus plan started.

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THE TABLE TENNIS CURRICULUM GETS INVOLVED THE RESEARCH OF DEGREE

Abstract
A research on the degree of involvement (DI) in table-tennis courses among college students is investigated in this work. Total 299 students in Ta Hwa Institute of Technology (THIT) and National Chiao-Tung University (NCTU) are explored as the sample population. The reliability and validity of collected data are confirmed first according to the item analysis and confirmatory factor analysis. Afterward, the description-statistics, t-testing, and one-way analysis of variance (ANOVA) are further applied for data analysis. By the statistics, it is found that the students in THIT have much higher DI than those in NCTU. Moreover, male students, people with table-tennis lovers in family or in their friends, and those living at home or renting houses have obviously higher DI than the female ones, those without table-tennis lovers, and those living in the campus, respectively. As a result, it is concluded that the students, belonging to the classification of THIT, male, people with table-tennis lovers in family / in their friends or living at home / renting houses outside campuses, possess higher DI. This statistics result is expected to be the reference for school instructors or any further researches.

Key words: *table-tennis courses, Get involved degree, Confirmatory factor analysis*

I.Introduction

1.1 Main Object

Presently, table- tennis courses are one of the physical education courses that most colleges offer. It's the optional course that a lot of students take, and it is also the exercise which most students participate in when they are in their leisure time. The main Object of physical education of colleges is none other than cultivating the habit and skill of exercise for life of the students; and further, advancing their health (Yi-Qun, Liu2004). According to the research of Wen & Kong & Lee (2005), it doesn't mean that we can benefit only from participating in exercises. It takes" appropriate invest" to gain the advantage of exercise when in the process of involving in the exercise. The "appropriate invest" includes time, energy, money and invest in physical vigor (Jun-Xiong, Gao Ching-Tsai, Wen 1997). Having well participation can get more leisure benefit; it is the concept of so-called leisure involvement. Wen and et cetera (2005) probed into the level of leisure involvement of college students who take table –tennis courses and the relationship of leisure benefit, and found students who get more involved in table-tennis courses (following is called the level of table-tennis involvement for short) can feel more leisure benefit; on the contrary, those who have lower level of involvement feel less leisure benefit. Consequently, level of table-tennis involvement is a problem which should be highly thought. The research will extend the related research about table-tennis in the past, and aim at the differences of the level of involvement of students who take table-tennis courses in different properties, that will do further research.

1.2 The Hypothesis of the Research

1.2.1 Is there no difference of get involved degree of students among different schools?

1.2.2 Is there no difference of get involved degree of students among different gender?

1.2.3 Is there no difference of get involved degree of students with or without lovers of table-tennis in family?

1.2.4 Is there no difference of get involved degree of students with or without lovers of table-tennis in friends?
1.2.5 Is there no difference of get involved degree of students among different living condition?
1.3 The Account of Nouns
1.3.1Get involved degree of table tennis : It is the degree of an individuals' insist or arousal when participating in table tennis courses (Sherif etc.1965).The research means the value core, the importance, the happiness, the interest, and how much do college students care about their self-expression when they participate in table-tennis(Selin&Howard,1988). Its operational definition means the score which shows in the scale of the involvement in table-tennis. Getting higher score shows more attention on the variable than getting lower score does.
1.3.2Confirmatory Factor Analysis
It's a statistic skill used to simplify the variable and analyze the group relationship of them, or to find the common potential respects behind the variables. Furthermore, supposing a specific hypothesis about structural relations. It is usually used to ensure whether the mode of the data is what the researcher anticipates or not. It works as examination and confirmation for the theory.

2. The Method of the Research
2.1The Target of the Research
The research targets at 170 students in Ta Hwa Institute of Technology (THIT) and129 students in National Chiao Tung University (NCTU), who take table-tennis courses. The valid sample is 197 students, including 170 male (56.9%) and 127 female (42.5%), and the average age is19.74±1.28 years old. There are 144 (48.16%) students with lovers of table-tennis in family; and there are 153 students (51.17%) without lovers of table-tennis in family. There are 246 students (82.27%) with lovers of table-tennis in friends; and there are 50 students (16.27%) without lovers of table tennis in friends. As depicted in graph 1, there are 4(1.34%) students live in friends' or relatives' house, and there are 132 (44.15%) students live in their own house. There are 19(6.35%) rent houses outside the campus, and there are 140 (46.82%) live in school dormitory. Figure 1 is in more details.

Figure 1: The Analysis of Basic Data of Sample

Variable	Detail	Number of People	%
School	THIT	170	56.86
	NCTU	129	43.14
Gender	Male	170	56.86
	Female	127	42.47
Age	19.74±1.28		
With table-tennis lovers in family	Yes	144	48.16
	No	153	51.17
With table-tennis lovers in friends	Yes	246	82.27
	No	50	16.72
The living condition	In relatives' or friends' house	4	1.34
	In their own house	132	44.15
	Rent houses outside the campus	19	6.35
	In school dormitory	140	46.82

2.2 The Instrument of the Research

The instrument of the research is the scale of the involvement in table-tennis. Firstly, testifying the evaluation of the scale by item analysis. We know that the scale has well evaluation from Figure 2 (DP are all more than 0.4, and CR are all more than 3). Secondly, we know the related value of the topics in the scale all reach a remarkable level according to the R2 value.

Lastly, examining through R1 value, the R1value of the entire questions meet the high-middle related request for more than 4.0, the Cronbach α is 0.852, showing the well reliability of the scale. And then, calculating the 7 observed variable's peakedness and skewness by PRELIS. The result shows as Figure 3.We know the coefficient of the 7 observed variable's peakedness and skewness all between ±2. According to Mardias(1985)'s research, observed variable has to fit in with normal distribution, its coefficient of peakedness and skewness had better between ±2. Afterward, testing the validity by confirmatory factor analysis; almost of evaluation index reach the range of acceptability according to Figure 4. To sum up, we can know that the scale of the involvement in table-tennis has acceptable reliability and validity.

Figure 2: Abstract of the analysis of the scale of the level of involvement in table-tennis course

Questions	DP	CR	R1	R2
1. I act well when I participate in table-tennis.	1.40	11.53	0.68	0.54
2. I have a lot of fun with classmates when I participate in table-tennis.	1.13	11.86	0.69	0.59
3. I comprehend well about the character, the content, and the process of table-tennis.	1.45	16.02	0.75	0.65
4. I almost forget what besides the exercise when I participate in table-tennis.	1.83	16.73	0.78	0.67
5. Although I can't win the table-tennis contest, I still like to participate in it.	1.33	12.35	0.72	0.61
6. Sometimes I will get involved in it when I participate in table-tennis.	1.49	15.45	0.79	0.70
7. I will be aware of the condition of the paddle, the rubber and adjust it anytime when I participate in table-tennis.	1.48	12.26	0.71	0.57

Figure 3: Abstract of each observation index Skewness and Kurtosis

Observed Variable	X1	X2	X3	X4	X5	X6	X7
Skewness	-0.08	-0.54	0.01	-0.34	-0.73	-0.30	-0.26
Kurtosis	-0.05	1.52	-0.42	-0.19	1.78	0.14	-0.16

Figure 4: Abstract of the analysis of the confirmatory factor of the scale of the involvement in table-tennis.

The index of evaluation	X^2/ df	GFI	AGFI	NFI	NNFI	RMR
The research	3.38	0.95	0.91	0.96	0.96	0.02
The standard of acceptability	1.0~3.0	>0.90	>0.90	>0.90	>0.90	<0.05

2.3 The Processing of the Data

When the investigation of the questionnaires is completed, we analyze the data by the statistic software spss 13.0 and LISREL 8.54 version. Firstly, testing the reliability and validity of instruments of the research by analyzing the data and the confirmatory factor; afterward, analyzing the differences by t-test and One- Way ANOVA ,and after-check by Scheffe. The significant difference of the statistic testing of the research is set at α=.05.

3. The Result and Discussion

3.1 The Analysis of the Differences among Students in Different Schools

According to Figure 5, the level of involvement of students among different schools, which in THIT is obviously higher than those in NCTU. Whereas, the possible reason of the condition is the two schools' difference as such. THIT belongs to the system of technical schools; the ranking of students is in the middle in the system of technical schools. While NCTU belongs to generally integrated university, the standard of students' entrance results is top 3 in the entrance examination of generally universities. As a result, there is a gap between students about the standard when they entered school as such. Furthermore, there is stronger pressure of schoolwork on students in NCTU than students in THIT.

Figure 5: Abstract of analysis of the differences in the get-involved degree of table-tennis among students in different schools

Name of the school	Number of people	average number	standard deviation	df	T value	P value
THIT	170	27.16	3.83	297	5.85＊	0.01
NCTU	129	24.57	3.76			

3.2 The Analysis of Differences among Students in Different Gender

According to Figure 6, it is obviously that the level of involvement of male students is higher than female students among different gender. It indicates that male students have stronger level of involvement. The possible reason is the difference between the role play of female and male traditionally. It results in the difference of the two genders' participations and cognition toward the exercise. The society tends to anticipate and request female to match up, to take care of, and to serve others, having lower mobility. Parents supervise female much more, they watch TV and novels at home. On the other hand, what events does the society encourage male and female to do is different. There is much ban for female; therefore, male have higher level of involvement than female.

Figure 6: Abstract of analysis of the difference in the get-involved degree of table-tennis among students in different genders

Gender	Number of people	average number	standard deviation	df	T value	P value
Male	170	26.95	3.86	295	4.72＊	0.01
Female	127	24.80	3.91			

3.3 The Analysis of Differences among Students With/Without Lovers of Table-tennis in Family

According to Figure 7, in the aspect of the level of involvement with lovers of table-tennis in family, who has lovers of table-tennis in family is obviously higher than who doesn't have lovers of table-tennis in family. It shows that who has lovers of table-tennis in family has better level of involvement. The possible reason is that people interact continuously with others around them since they were born. Parents and family members are people who everyone contacts the earliest, and are the most important another person in one's whole life. As a result, parents and family members' love to something will cause children's learning and imitation. So, having lovers of table-tennis in family is also the reason that influences the level of table-tennis involvement being higher.

Figure 7: The Analysis of Differences among Students With/Without Lovers of Table-tennis in Family

Lovers of table-tennis in family	Number of people	average number	standard deviation	df	T value	P value
Yes	144	26.67	4.02	295	2.71＊	0.01
No	153	25.42	3.93			

3.4 The Analysis of Differences among Students With/Without lovers of Table-tennis in Friends

According to graph 8, in the aspect of the level of involvement with lovers of table-tennis in friends, who has lovers of table-tennis in friends is obviously higher than who doesn't have lovers of table-tennis in friends. It shows that who has lovers of table-tennis in friends has better level of involvement. In terms of the viewpoint of Developmental Psychology, a group of intimate friends narrows gradually in the period of university; while the range of making friends broadens gradually. The interest in friends of the same sex starts to turn to the interest in friends of the opposite sex. The group which consists of intimate friends and friends of the opposite sex accounts for an important status in social activities. It is usually composed of people who have the same interest; they usually participate in related activities together. As a result, having lovers of table-tennis in friends is also the reason that influences the level of table-tennis involvement being higher (Wei Cheng Chu, 1991).

Figure 8: Abstract of the Analysis of Differences With/Without Lovers of Table-tennis in friends

Lovers of table-tennis in friends	Number of people	average number	standard deviation	df	T value	P value
Yes	246	26.39	3.99	294	3.55*	0.01
No	50	24.22	3.71			

3.5 The Analysis of Differences among Students in Different Living Condition

According to Figure 9, in the aspect of the level of involvement among students in different living condition, who live in their own house or rent houses outside the campus is obviously higher than those who live in school dormitory. It shows that who live in their own house or rent houses outside the campus has better level of involvement. The possible reason is that the interaction with classmates is more intimate when living in school dormitory, there is much exercise which can be attended comparatively. Instead, under this situation, table-tennis can't attract these students, and results in lower level of involvement.

Figure 9: Abstract of the Analysis of Differences among Students in Different Living Condition

The living condition	Number of people	average number	standard deviation	F value	P value	significant difference
In relatives' or friends' house	4	26	6.68	9.16*	0.01	
In their own house	132	26.93	3.68			2>4
Rent houses outside the campus	19	28.32	4.63			3>4
In school dormitory	140	24.83	3.83			

4. Conclusion and Suggestion

4.1Conclusion

The research mainly discusses college students of different variables of population statistics about the differences of the level of involvement when they take table-tennis courses. We know that students in THIT, male students, who with lovers of table-tennis in family, who with lovers of table-tennis in friends, and who live in their own house and rent houses outside the campus have better level of involvement according to the statistic analysis and discussion. While in the aspect of education, the main point is how to enhance the get involved degree of students who have a lower one as students in NCTU, female students, who without lovers of table-tennis, and who without lovers of table-tennis.

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THE EFFECTS OF MULTIMEDIA ASSISTED INSTRUCTION AND TRADITIONAL INSTRUCTION ON STUDENTS' LEARNING MOTIVATION AND TABLE TENNIS LEARNING ACHIEVEMENT

Abstract

More recent motivational research focuses on the identification of effective techniques for enhancing instructional design and improving student learning. A general model for motivational design of instruction is described and reviewed in terms of its application to college physical education contexts. Learning-motivation researchers are applying some of the same theories and concepts found to be effective in industry to the development of motivational models that enhance the teaching-learning environment. One such model is the ARCS Model of Motivational Design developed by John M. Keller (Keller, 1983, 1987). An ARCS is a systematic model for designing motivating instruction. This digest will describe the ARCS Model, and will outline some of the ways in which Attention, Relevance, Confidence, Satisfaction components may be applied to instructional design. Therefore, the purpose of this research was to investigate the effects of multimedia assisted instruction (MAI) and traditional instruction (TI) on students' learning motivation and table tennis learning achievement.

Two undergraduate table tennis sessions were selected as the research samples. One session was randomly assigned to be taught by using MAI and the other session was by TI. Based on the result of ARCS Survey for learning motivation, the data was examined the difference on several factors before and after the teaching and across different methods. Basically, four findings were observed. First, for each group, the learning achievement, motivation, attention, confidence, and satisfaction of students are better or higher than untrained. However, the relevance perception about motivation was not significant before or after the teaching. Second, across two control groups, students in the MAI group perform significantly better in forth mentioned factors. Nevertheless, the relevance perception about motivation was not significant between groups. Third, for the MAI group, forth mentioned factors are significantly positively related after the teaching, except the relevance perception about motivation. Lastly, the results pointed out that the satisfaction factor from the ARCS Survey could be used to predict the table tennis learning achievement. In conclusion, the results suggested the ARCS Model of Motivational Design which is an easy-to-apply, heuristic approach to increasing the motivational appeal of instruction in college physical education. An ARCS Model provides a useful framework for both the design and improvement of the motivational quality of table tennis activity increases the likelihood that these entities will be used and enjoyed in college physical education.

Key words: *Multimedia Assisted Instruction, Traditional Instruction, Learning Motivation, Table Tennis*

Introduction

A strong paradigmatic belief can be noted in the benevolent effects of multimedia for a wide variety of application domains, not in the last place Multimedia Assisted Instruction (Heller, 1990). In literature and multimedia projects (Hoogeveen, 1994) one can recognize a set of convictions, based on observations and experimental findings, with regard to the effectiveness of multimedia which is described below in the form of the multimedia paradigm. The multimedia paradigm is the dominant conviction that adding multimedia functionality to information systems leads to improved information and knowledge transfer to people. In other words, the multimedia paradigm is about the vision of computers as effective "tools for the mind" (Marmolin, 1991). The interaction of independent multimedia variables is supposed to lead to a number of psychological responses:

1. a high level of stimulation of the senses, at least with regard to the auditory and visual perception systems;
2. a high level of involvement, attention, concentration;
3. emotional arousal, e.g., fun; the word arousal is used in the internal arousal, related to arousal of the nervous system;
4. strong recognition effects, using mental reference models.

From those view points, one such model is the ARCS Model of Motivational Design developed by John M. Keller of Florida State University (Keller, 1983, 1987). An ARCS is a systematic model for designing motivating instruction. The ARCS Model of Motivational Design is a well-known and widely applied model of instructional design. Simple, yet powerful, the ARCS Model is rooted in a number of motivational theories and concepts, (Keller, 1983) most notably expectancy-value theory (Vroom, 1964; Porter & Lawler, 1968). The ARCS Model identifies four essential strategy components for motivating instruction (Keller, 1983, 1996) including attention, relevance, confidence, and satisfaction.

Attention: The first and single most important aspect of the ARCS model is gaining and keeping the learner's attention. Keller's strategies for attention include sensory stimuli (as discussed previously), inquiry arousal (thought provoking questions), and variability (variance in exercises and use of media).

Relevance: Attention and motivation will not be maintained, however, unless the learner believes the training is relevant. Put simply, the training program should answer the critical question, "What's in it for me?" Benefits should be clearly stated. For a sales training program, the benefit might be to help representatives increase their sales and personal commissions. For a physical activity program, the benefit might be to reduce the number of people getting poor fitness condition. For a table tennis activity program, the benefit to users could be to make them higher skill performance in game activities.

Confidence: The confidence aspect of the ARCS model is required so that students feel that they should put a good faith effort into the program. If they think they are incapable of achieving the objectives or that it will take too much time or effort, their motivation will decrease. In physical education programs, students should be given estimates of the time required to complete lessons or a measure of their progress through the program.

Satisfaction: Finally, learners must obtain some type of satisfaction or reward from the learning experience. This can be in the form of entertainment or a sense of achievement. A self-assessment game, for example, might end with an animation sequence acknowledging the player's high score. A passing grade on a post-test might be rewarded with a completion certificate. Other forms of external rewards would include praise from a supervisor, a raise, or a promotion. Ultimately, though, the best way for learners to achieve satisfaction is for them to find their new skills immediately useful and beneficial on their job.

However, an area of concern for physical education teachers is the motivation of students to participate in physical activities. Motivation for involvement in physical education is clearly a concern for physical education teachers. Although, motivation has been studied for over thirty years in classroom or competitive sport settings, there is a deficiency of research relating to motivation for participation in school physical education.

Statement of the Problem

The purpose of this study was to investigate the effects of multimedia assisted instruction (MAI) and traditional instruction (TI) on students' learning motivation and table tennis learning achievement. The research questions were as follow:

1. Compare the MAI and TI with table tennis on students' attention, relevance,

confidence, satisfaction of learning motivation in college physical education.
2. Compare the MAI and TI with table tennis on students' skill of table tennis in college physical education.
3. analyze the effect of students' attention, relevance, confidence, satisfaction of learning motivation on their skill of table tennis in college physical education in the MAI.

Assumptions

The following assumptions were made regarding this study:
1. ARCS Survey in Physical Education and Table Tennis Skill Test are valid and reliable measures.
2. The students have sufficient background in the physical education experience to make meaningful, evaluative responses.
3. The students are capable of understanding and interpreting the ARCS Survey in Physical Education and Table Tennis Skill Test.
4. The students are truthful in responding to the ARCS Survey in Physical Education and Table Tennis Skill Test.

Limitations

The participants in this study were limited to the college students and their physical education instructors in I-Lan City in Taiwan. Therefore, generalizations of the results in this study have to be cautious when applied to the other population of college students located in other cities in Taiwan. Students responding on the ARCS Survey in Physical Education and Table Tennis Skill Test may have been influenced by past experiences, emotion, mood, and social desirability.

Definition of Terms

Attention: Increase perceptual arousal with the use of novel, surprising, incongruous and uncertain events. Increase inquiry arousal by stimulating information seeking behavior; pose or have the learner generate questions or a problem to solve. Maintain interest by varying the elements of instruction.

Relevance: Emphasize relevance within the instruction to increase motivation. Use concrete language and examples with which students are familiar. Provide examples and concepts that are related to learners' previous experiences and values. Present goal orienting statements and objectives. Explain the utility of instruction for both present and future uses.

Confidence: Allow students to develop confidence by enabling them to succeed. Present a degree of challenge that allows for meaningful success under both learning and performance conditions. Show the student that his or her expended effort directly influences the consequences. Generate positive expectations. Provide feedback and support internal attributions for success. Help students estimate the probability of success by presenting performance requirements and evaluation criteria.

Satisfaction: Provide opportunities to use newly acquired knowledge or skill in a real or simulated setting. Provide feedback and reinforcements that will sustain the desired behavior. Maintain consistent standards and consequences for task accomplishments. Manage reinforcement: keep outcomes of learner's efforts consistent with expectations.

Multimedia assisted instruction: Multimedia is used here in the sense of the property of a system or object indicating that multiple information types, such as speech, music, text, graphic, still, animation and video with fundament skills of table-tennis are used in an integrated manner.

Research Methods

Participants

Two undergraduate table tennis sessions were selected as the research samples. Participants in this study were 87 Physical Education students (50 male, 37 female, age: M =20±1, 48), and they were characterized as beginners. One session was randomly assigned to be taught by using MAI including 44 students and the other session was by TI including 43 students.

Table 1 Participants

Variables	MAI Group	TI Group	Total
Number	44	43	87

Instruments

1. **The ARCS Survey in Physical Education (ARCSSPE)** was adapted from Keller's ARCS theory (1999) asks students to rate 34 ARCS-related statements in relation to the instructional materials they have just used. The ARCSSPE was rated using Likert type scales as 1 = Not True; 5 = Very True. A high degree of internal consistency for the subscales has been demonstrated in several studies (Chiu-Ju Lu, Chien-Chih Chou, Hsiu-Li Tsui, Mei-Chi Cheng, & Kuo-Chuan Tsai, 2005) with coefficients for the factors of attention, relevance, confidence, and satisfaction of .78, .82, .76, &.83. Some examples were:
   (1). These materials are eye-catching (*Attention*).
   (2). It is clear to me how the content of this material is related to things I already know (*Relevance*).
   (3). As I worked on this lesson, I was confident that I could learn the content (*Confidence)*
   (4). Completing the exercises in this lesson gave me a satisfying feeling of accomplishment (*Satisfaction*).

2. **Table Tennis Test:** The Table Tennis Skill Test included the skills of forehand drive, backhand drive, and which was designed by the National Ministry of Education (1997).

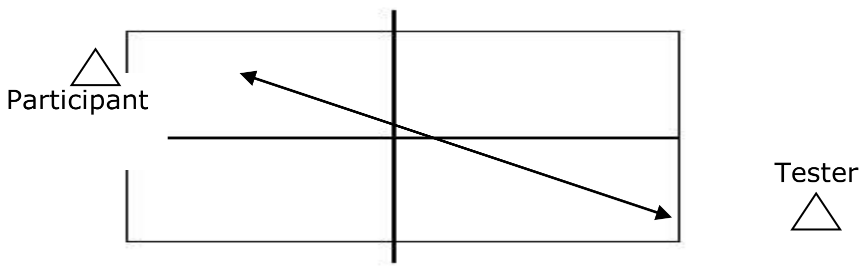

Figure 1. backhand drive

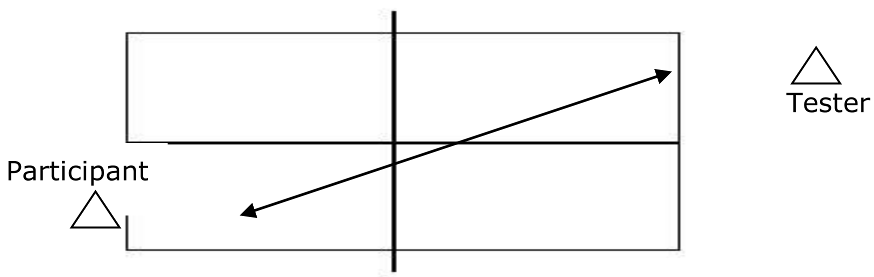

Figure 2. forehand drive

Intervention of the Treatments

1. The college students in the MAI Group received an intervention of multimedia assisted instruction with combination of table tennis. The multimedia assisted instruction was designed based on the fundamental skills of forehand and backhand skills for 10 minutes long on each class. The following equipment was used for the conduct of the study, desktop computer GIGABYTE, Pentium 4, 2.0 GHz and Mini DV camera Sony Digital Handy cam TRV40. Specific multimedia videos were developed that included the methodology of table-tennis for beginners. Electronic stopwatch (F.I.S. approved) and 42 inches Sony TV with High Definition.

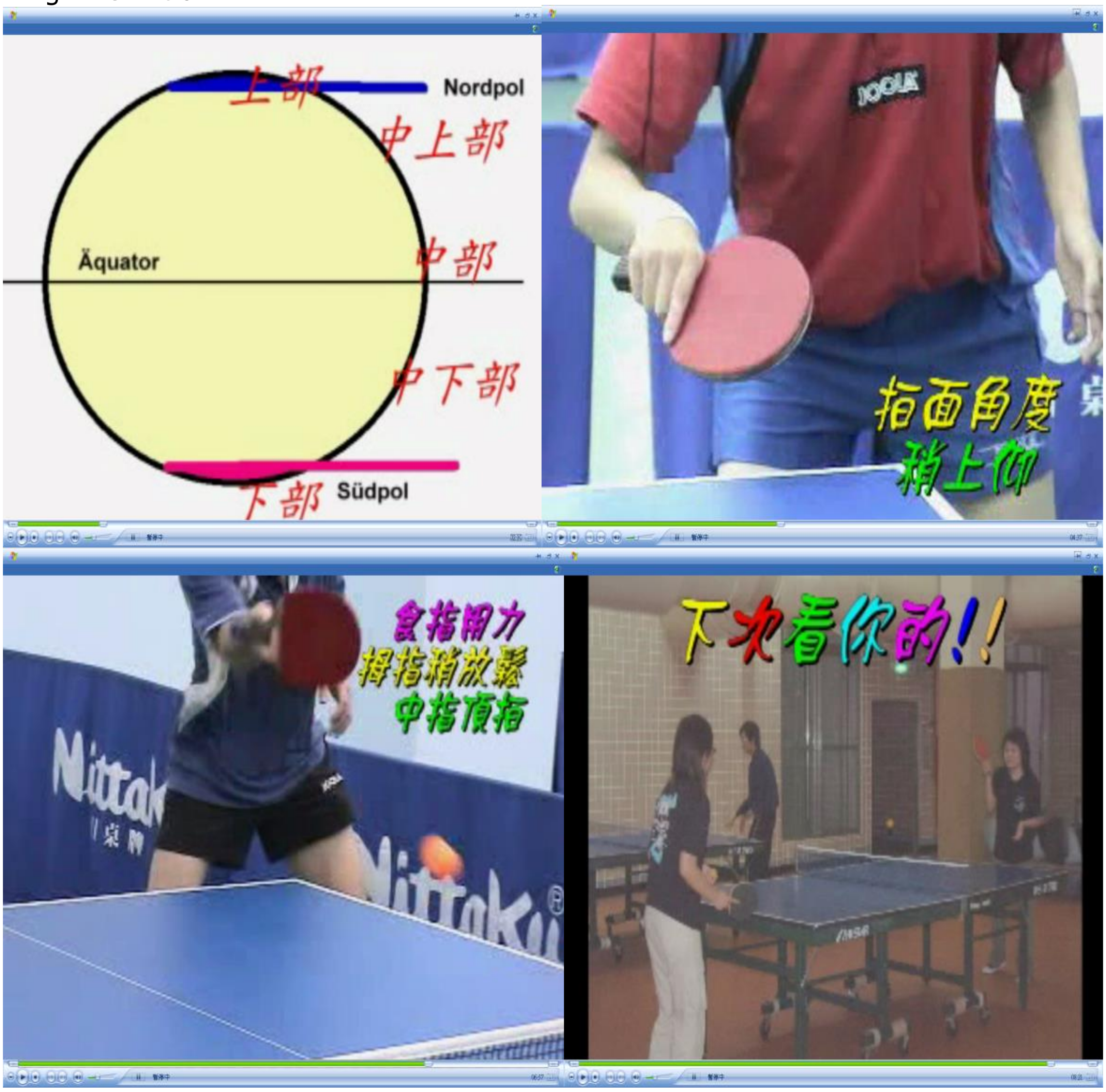

Figure 3. Example of MAI

2. The TI Group received an intervention of traditional instruction with regular table tennis during the teaching.

Procedure of Data Collection

Data were gathered from an introductory 8-week table tennis unit (sixteen introductory lessons of 40 minutes each on table tennis unit) taught to college students by a physical education teacher. The ARCSSPE and table tennis skill test were administrated to the students as measuring their skills and learning motivation in the pre-test and post-test.

Interactive Instructional videos with MCI were developed and re-edited for the needs of the study which included all the teaching objectives for beginners' table-tennis according to Level 1 Professional tennis Instructors Association of America and Taiwan. The videos were constructed in hierarchical structure. The demonstration of the drills was made by a member of Taipei Physical Education College Table-Tennis team, and recording was made by a DV camera (100HZ). Using digital video edit tool unwanted sounds of the environment were deleted and narration was added. Participants of both groups followed for eight weeks exactly the same table-tennis program in college physical education and they were taught by the same instructor. Every participant of the MCI group before every classes teaching was interacting for ten minutes with the Interactive Instructional videos under the guidance of his / hers instructor. Information about the objective of the teaching session was given to the participants by the Interactive Instructional videos in the form of text, photo, video and narration. At the same time participants of the TI were receiving ten minutes lecture, the same information but in the form of oral instructions. Teaching sessions of the MG group were recorded using a Digital Video camera and separate archives were captured for every participant of the MG group. The subjects of the MG group right after every teaching session were interacting with the interactive instructional videos for ten minutes under the guidance of their instructor and watching themselves table-tennis skill. They were receiving feedback from their instructor about their technique and their performance. At the same time participants of the TI in the same way they were receiving feedback in the form of oral instructions. On the eighth week two tests were assessed for both groups: ARCSSPE and table tennis skill test.

Data analysis

Statistical Package for the Social Sciences (SPSS/PC 10.0) was used for statistical analysis, and the .05 level ($P < .05$) was used to determine any significant differences. The statistical methods employed for data processing included independent t-test and paired-sampling t-test.

Results

Homogenous Analysis of MAI Group and TI Group on Learning Motivation in the Pre-test

As seen in Table 2: The learning motivation score before instruction showed no significant variation level, signifying the homology of variables of the two groups ($P > .05$).

Table 2. Homogenous Analysis of MAI Group and TI Group on Learning Motivation in the Pre-test

Statistical Items		Group	Mean	SD	Levene	F	Sig.
Learning Motivation		MAI	2.83	.20	.008	2.20	.929
		TI	2.77	.18			
	Sum Square	Between Group	8.10				
		Within Group	3.14				
		Total	3.22				
	Mean Square	Between Group	8.10				
		Within Group	3.69				

*** p< .05**

As seen in Table 3: The table tennis skill scores before instruction showed no significant variation level, signifying the homology of variables of the two groups (P>.05).

Table 3. Homogenous Analysis of MAI Group and TI Group on Table Tennis Skill in the Pre-test

Statistical Items		Group	Mean	SD	Levene	F	Sig.
Table Tennis Skill		MAI	4.31	4.67	.008	.05	.928
		TI	4.53	4.55			
	Sum Square	Between Group	1.02				
		Within Group	1807.03				
		Total	1808.05				
	Mean Square	Between Group	1.02				
		Within Group	21.26				

*** p< .05**

Comparison of Pre-test and Post-test on Leaning Motivation and Table Tennis Skill for MAI Group

According to table 4, The leaning motivation and table tennis skill results on the pre-test and posttest showed that even if posttest of MAI group was significant different to pre-test, but there was not significant different on the factor of relevance.

Table 4. Comparison of Pre-test and Post-test on Leaning Motivation and Table Tennis Skill for MAI Group

Factors	Test	Number	Mean	SD	df	t-value	sig
Leaning Motivation	Pre-test	44	2.83	.20	43	-2.73*	.01
	Post-test	44	2.98	.30			
Attention	Pre-test	44	2.86	.20	43	-2.04*	.05
	Post-test	44	3.02	.47			
Relevance	Pre-test	44	2.81	.23	43	- .66	.51
	Post-test	44	2.83	.26			
Confidence	Pre-test	44	2.95	.34	43	-2.01*	.05
	Post-test	44	3.10	.41			
Satisfaction	Pre-test	44	2.73	.21	43	-3.02*	.00
	Post-test	44	2.98	.51			
Table Tennis Skill	Pre-test	44	4.31	4.67	43	-9.76*	.00
	Post-test	44	31.36	19.61			

p< .05

Comparison of Pre-test and Post-test on Leaning Motivation and Table Tennis Skill for TI Group

According to table 5, The leaning motivation and table tennis skill results on the pre-test and posttest showed that even if posttest of TI group was significant different to pre-test, but there was not significant different on the factor of relevance.

Table 5. Comparison of Pre-test and Post-test on Leaning Motivation and Table Tennis Skill for TI Group

Factors	Test	Number	Mean	SD	df	t-value	sig
Leaning Motivation	Pre-test	43	2.77	.18	42	-2.69*	.01
	Post-test	43	2.85	.22			
Attention	Pre-test	43	2.75	.27	42	-2.38*	.02
	Post-test	43	2.85	.30			
Relevance	Pre-test	43	2.79	.23	42	-1.37	.18
	Post-test	43	2.84	.21			
Confidence	Pre-test	43	2.85	.29	42	-1.99*	.05
	Post-test	43	2.95	.33			
Satisfaction	Pre-test	43	2.71	.16	42	-2.18*	.03
	Post-test	43	2.78	.21			
Table Tennis Skill	Pre-test	43	4.53	4.55	42	-7.90*	.00
	Post-test	43	22.09	15.51			

$p < .05$

Comparison between MAI Group and TI Group Post-test on Leaning Motivation and Table Tennis Skill

According to table 6, the result show that after interfere of MAI group, analysis of independent t-test with posttest of the movement skill, as show in the follow: The results on the posttest showed that even if the MAI group was significant to comparison group on leaning motivation, attention, confidence, satisfaction, and table tennis skill, but there was no significantly different on the factor of relevance.

Table 6. Comparison between MAI Group and TI Group Post-test on Leaning Motivation and Table Tennis Skill

Factors	Group	Number	Mean	SD	df	t-value	sig
Leaning Motivation	MAI	44	2.98	.30	85	2.21*	.03
	TI	43	2.85	.22			
Attention	MAI	44	3.02	.47	85	2.07*	.04
	TI	43	2.85	.30			
Relevance	MAI	44	2.83	.26	85	- .18	.86
	TI	43	2.84	.21			
Confidence	MAI	44	3.10	.41	85	1.98*	.05
	TI	43	2.95	.33			
Satisfaction	MAI	44	2.98	.51	85	2.45*	.01
	TI	43	2.78	.21			
Table Tennis Skill	MAI	44	31.36	19.61	85	2.44*	.01
	TI	43	22.09	15.51			

* $p < .05$

Regression Analysis of Leaning Motivation on Table Tennis for MAI

The results from regression model indicated the factors of satisfaction on the leaning motivation could predict the students' table tennis skill when they were involved participating MAI in physical education(table 7).

Table 7. Regression Analysis of Leaning Motivation on Table Tennis for MAI

Group	R	R^2	R^2 Change	Variant analysis	Sum of square	F value	β		t-value
MAI	.53	.28	.27	regression redual total	4680.50 11849.39 16529.87	6.11	Satisfaction	0.53	4.07*

*** p< .05**

Independent Variables: attention, relevance, confidence, satisfaction
Dependent variable: Table Tennis Skill

Conclusion

Motivation may come from numerous sources, but learning motivation is particularly important in physical education and sports. MAI with table tennis units offers an approach to diagnosing students' motivational issues while teach PE in college level. As Keller (1996) defined learning motivation as the degree to which an individual chooses to participate in an activity for the pleasure derived rather than for any extrinsic reward that may be forthcoming. When people are intrinsically motivated, they experience interest and enjoyment in an activity as well as feelings of competence and control. However, Keller (1999) has developed a model of motivation that addresses four components of learning. Attention, relevance, confidence, and satisfaction are the components known as the ARCS model of motivation. Both learners and instructors use this model to effectively engage or present learning episodes. Each component is serially related; that is, student attention must be completed before relevance is addressed. Students must find relevance and engage in the learning experience before they can acquire confidence in the knowledge. Gaining confidence allows the student to utilize the task learned. Therefore, the student may feel satisfied that they engaged in the learning experience (Fernández & Dabbagh, 1999). Finally, developing life-long college students, who are motivated, display intellectual curiosity, find learning enjoyable, and continue seeking knowledge after their formal instruction which has always been a major goal of education.

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PSYCHOLOGICAL INTERVENTION IN TABLE TENNIS: SKILLS ASSESSMENT AND ENHANCEMENT IN TALENTED-YOUNG PLAYERS

Abstract

Sport performance is the result of the control and integration of the athlete's physical, technical, tactical, strategic and psychological skills and capabilities. In order to obtain a great level of control on these competences, a large amount of time and effort is destined to the athlete's formation process. The individualized identification of the players' specific needs, deficits and resources, and of their level of control in the use of skills will help in the formulation of the intervention objectives and in the design of the psychological training. The main aim of the psychological training is to develop the mental competences which are considered as relevant for each athlete, considering his/her needs, the sport modality, his/her level of knowledge, expertise, experiences and self-control, and the level of competition. Nonetheless, to approach this goal, it is necessary to previously perform an exhaustive assessment of their competences, capabilities and skills, with the aim of providing them with a psychological training, which results appropriate to their resources and needs, to enhance the athletes' sport preparation and to optimize performance in training and competition.

Inserted in the National Sport Technification Program developed by the Spanish Royal Tennis Table Federation, it has been included a psychological intervention aimed to the detection of the psychological skills of tennis table young players and to the enhancement of the personal control on these by the athletes who are participating in the above-mentioned program. This work is in accordance with the program general objective of identification, selection and formation of talented young players. This work is integrated along with the work developed in the remaining program areas, and it is adapted to the characteristics, resources and needs of the participants.

The specific goals, characteristics, structure, components and main results of the developed psychological intervention are presented in this paper. Results have indicated the suitability of considering psychological assessment and training for the complete preparation of players in order to improve psychological skills which allow them to confront adequately the increasing demands of sport participation as their implication advances. This is highly relevant in the case of individual and collective sports modalities, as well as in the identification and formation of talents, specifically in racket sports, and table tennis particularly.

Keywords: *Psychological assessment, psychological intervention, table tennis, youth sport, talented players.*

1. Introduction

Table tennis is a young and minority sport in Spain. Nevertheless, this athletic modality is chosen by non few people for both recreational and competitive practice.

This has contributed to the growing acceptance and practice of table tennis in our country.

In Spain, the Royal Table Tennis Federation has registered about 200 athletes in the National Sport Technification Program (NSTP) in all young categories. These athletes usually are trained in their local clubs with other players, but these selected ones attend NSTP national or regional concentrations in Technification and Sports Specialization Centers to optimize their formation. These concentrations occur several times a year and have duration of 4-5 days. Generally, the National Selection is formed by some of these selected athletes.

The conditions of the NSTP involve working with athletes throughout a few occasional contacts along the season and during a brief period of time. Nonetheless, during these concentrations a large, comprehensive intervention is provided to the athlete. Psychological training is also offered. Some of these selected players maintain a continuous contact with NSTP technics.

We present in this paper the rationale, objectives, structure and main results of the psychological intervention we develop as a part of the preparation process offered by the NSTP for table tennis players. We offer in first sections a brief presentation of core issues on psychological training in (youth) sport. In subsequent sections, we present our psychological intervention in the NSTP for table tennis players and main results derived from it.

2. The psychological intervention in sport

Sport performance is resultant from the control and integration of the athlete’s physical, technical, tactical, strategic and psychological skills and capabilities. In order to obtain an appropriate level of control on these competences, a large amount of time and effort is destined to the athlete’s formation process, in pursuit of the learning and consolidation of the specific competencies of the concrete athletic modality. The ultimate objective of this formative program is to increase the athletes’ opportunities of success, so that they can obtain the better results as possible in their competitions.

It is not unusual to hear a player to complain that “he/she is very nervous before a championship match”, “he/she is unable to maintain himself/herself concentrated during the whole match”, “he/she collapses after a series of failures”, “he/she is not as motivated for training sessions as for matches” or “he/she is not experiencing the expected comradeship with his/her companions”. Usually, complaints are referred to what the athlete is experiencing before or during matches. Sometimes, complaints are not referred to what happens to him/her during matches, but in trainings. Sometimes, complaints are referred to relationships with pairs, coaches or even parents. Sometimes, complaints are related to other life-domains, as when the player mentions the incompatibilities between sport dedication and school or friends demands.

All these situations reflect an important group of skills the athletes need to control adequately in order to achieve a successful participation in terms of athletic outcomes. Furthermore, these skills are also necessary to obtain the benefits supposed to be derived from a healthy, proper, enjoyable and educational sport participation. As Weinberg & Gould (2007) have pointed out, both athletes and coaches recognize that sport success is *mental* in at least a 50 percent, and for some modalities in a 95 percent. These mental skills make the difference between the “good” athletes and the “best” ones (in equal conditions, of course), or explain why an athlete varies their performance between two consecutive days. Peak performance, that above ordinary performance, can only be achieved by unifying and integrating all athlete’s capabilities. Peak performance is obtained when the athlete does his best both in physical and in mental domains (Williams, 2001).

Sport Psychology is the branch of Psychology (or of Sport Science, depending on the author) that provides answers to relevant questions about human behavior in the domain of sport (Gill, 2000). The skills we are talking about are some kind of behavior and, as behaviors, are modulated by the personal as well as the contextual factors which we psychologists know influence behavior. And, as behaviors, they are subjected to the same principles of explanation, prediction and control of behavior, which psychologists also know well. The immediate implication is obvious: These behaviors, as occurs in the case of whatever other sport skill, can be learned and managed. Furthermore, athletes can be trained for self-regulation in order to make, beyond their control, their peak performances more feasible and recurrent.

Background and tools of Psychology, and concretely of Sport Psychology, help the athletes and coaches (and the remaining people in sport arena) to self-manage successfully their psychological resources, processes and states. As Buceta (1998) has stated, the specialized knowledge of Psychology on behavior, and its methodology for assessing, understanding, explaining and modifying it can be of a great utility in increasing sport performance. In doing it, Sport Psychology considers the psychological functioning of the athlete, along with the physical, technical or strategical functioning, a central element for performance and success.

Hence, psychological training is a core ingredient of the recipe in which physical, technical and tactical enhancement are added to obtain the best (possible) from the athlete. Psychological intervention includes the *training of mental skills* which are relevant for achievement and performance both in training and competition, as well as in resting and recovering periods.

Psychological intervention in sport is aimed to train the individual to generate an ideal mental state at will. This state of maximum psychological performance has been called optimal mental state (Orlick, 2000), individual zone of optimal functioning (Hanin, 1995), psychological momentum (Cornelius, Silva, Conroy & Petersen, 1997; Taylor & Demick, 1994; Vallerand, Colavecchio & Pelletier, 1988) or flow state (Csikszentmihalyi, 1991; Jackson & Csikszentmihalyi, 1999), although the vast majority of authors just call it psychological peak, ideal or optimal state or functioning. Whatever the name used, this ideal state is a complex multivariate recipe of cognitions, emotions and physiological parameters that lead to peak performance (Gould & Udry, 1994). Psychological peak state is likely to mediate performance via cognitive and affective processes (i.e., optimism, sense of control, motivation, self-efficacy, concentration, enjoyment, energy and synchronization) as well as physiological factors (i.e. physiological arousal). In this state, psychological variables which are relevant for learning or performance are leveled to their optimal set point (or range, better).

The main goal of psychological training is to provide the athlete with a set of tools, which autonomous control and adapted to demands execution allows him/her to self-manage his/her psychological resources (Chen & Singer, 1992) and, also, other nature ones, and to obtain the maximum of him/herself in trainings, competitions or restings/break periods. Hence, psychological intervention hunts for the complete preparation of the athlete and the enhancement of his/her integral functioning.

In order to obtain this goal, psychological intervention needs to assess athlete's resources, then to facilitate the learning, practice and consolidation of required skills, uniquely customised to their sport, context, task and personal factors, and, finally, to create with the player and to automatise action plans or routines. These routines are aimed to organize his/her behavior, for the use of and by using the learned skills before, during and after training sessions or competitions.

Psychological preparation must be integrated with physical, technical or tactical preparation. Psychological training would help the learning and consolidating processes relative to sport skills (physical, technical or tactic skills), would help the athlete to tolerate the loads and demands of training for a better adjustment, to increase his perceptions of control and self-confidence, to promote his well-being, to eliminate the obstacles that interferes with his performance, and to enhance his performance in trainings and competitions. Psychological training should be integrated also in the psychological planning of the season, which includes the psychological planning of training sessions, competitions and recovering phases.

An important variable is the age of athletes. It has been argued that mental training is beneficial for athletes with any level of experience, capability, expertise or age. But if the complete, integrated preparation of the athlete, including psychological intervention, is implemented early in his sport trajectory, it could be guaranteed the consolidation of a proper base which allows him to confront successfully the diverse sport situations, and which will facilitate the conquest of a potential of peak performance and the obtention of the benefits of the practice (Williams, 2001).

At this early moment, to instruct the athletes to establish realistic but ambicious goals, to maintain the concentration focused in relevant factors, to increase their self-confidence, to visualize successful performances, to manage the activation levels, to react constructively to failures, or to deal with the stress of competition, amongst other skills, will help them for a faster and more adequate athletic as well as personal development and achievement.

On the other hand, it has been pointed out consistently in the psychological literature that it is easier to develop positive competencies -through effective training practices- when people have not previously learned and consolidated opposite behaviors, which may be neutral or even harmful. When the person has learned a damaging habit, in changing it it is necessary before to eliminate the consolidated one, and then to establish the new desirable one. Translating this to sport arena, this means that it is easier, and more appropriate, to instruct young athletes in proper competences, instead of waiting to a later moment, in which they probably will have more installed habits. The sooner the intervention, the best expected consequences it will have.

It is important to indicate at this point that psychological intervention does always follow an educational and edifying goal. It also occurs in sport arena, and it is especially important in youth sport. As authors like Weiss (1991, 1995), Smith & Smoll (2003), Danish et al. (2003) or Balagué (1993) emphasized, young athletes may be strongly enriched if they are trained in skills and competences which are useful in their sport participation but also in their daily life. Sport may constitute an appropriate context for a positive, developmental improvement of resources for life in children. The control of psychological skills learned in sport may generalize to other life-domains, and athletes can use these self-regulation skills in other everyday situations, such as school or social contexts. Furthermore, these skills for life and sport are precisely what is needed for optimal enjoyment, well-being and performance in competitive sport. In words of Vealey (1988), the educative, developmental model in which psychological training is sustained focuses the attention in rise and change to help people to obtain a greater control in their lifes and a better coping with demands abilities, both inside and outside the athletic domain.

Finally, the ultimate goal of psychological intervention is to promote the health and well-being of individuals. And this is also applicable to sport domain. Athletic success should not be get at any cost, and psychological intervention should only be offered under this perspective.

Considering the points mentioned above, a ultimate consideration should be made. It could seem that psychological intervention should be available only when athlete show any skill-deficit, concern or problem and, as a consequence, a low performance. But, on the contrary, this condition is not necessary for considering interesting or suitable the psychological intervention, since the goal may be, not to correct deficits, but to improve resources. Psychological training may be destined to promote the current control on skills and the self-regulation abilities.

3. Core elements and phases in the psychological intervention planning, programming, implementation and evaluation

Sport psychology service delivery is a complex process, and no formula can be provided for an effective intervention for all athletes in all situations. However, some aspects should be addressed for an adequate service. Psychological intervention should be completely planned and organized before its implementation if it is pretended to be appropriate and effective. Hence, objectives, tools, methods, possible outcomes or coping with results strategies should be considered for each of the phases of the process (before, during and after the intervention, each with its concrete subphases).

The planning of the intervention refers to the programming of the methodology which is going to be used for assessment, goal-setting, strategies and tools selection, resources consideration, implementation of the intervention and outcomes evaluation. It is the organization of contents and ways of implementation of the intervention in the most proper manner, so it will be as effective and useful as possible (Olmedilla, 2002).

The next proposal is based on psychological applications on several areas, on several papers published in the sport area and specifically in table tennis sport (Marí, 1997), and on main reference manuals on Sport Psychology, some of which also include psychological work with young athletes (Buceta, 1998, 2004; Cruz, 1997; Gill, 2000; Hardy, Jones & Gould, 2003; Van Raalte & Brewer, 2003; Weinberg & Gould, 2007; Williams, 2001). These sources include detailed information on psychological assessment and intervention in sport domains. Finally, it is also derived in a great extent from a work by Godoy-Izquierdo, Pradas & Vélez (in press), in which a planification of psychological work for a complete season aimed to table tennis players is presented. In this program, 45 sessions are proposed in which basic psychological work is offered.

It should be stressed that the psychological intervention should be integrated and coherently developed in association with the complete preparation of the athlete, considering the main goals of physical, technical and tactical preparation as well as the competitive schedule. This is why coaches should participate also in the psychological preparation, both for establishing objectives and for collaborating in the training itself. Not only the objectives of the preparation in physical, technical or strategical domains should be taken into account, but also the conditions of such delivery. Usually, psychological intervention does not receive the same consideration as the remaining preparation in terms of time (frequency of sessions, duration of sessions, long-term booster sessions…). It should be stressed also that a collaborative, active role is needed on behalf of the athlete to obtain maximal benefits from the intervention. Psychological peak performance can be achieved only with effort, commitment and dedication in learning and consolidating processes.

First sessions.

An important variable is time constraints-relationship with psychologist match. Since Petitpas, Danish & Giges (1999) emphasized that the quality of the relation established between the sport psychologist and the athletes is a core factor for positives outcomes derived from the intervention, because it is the most relevant factor for cooperation, this relationship must be established encouragely.

It is also important to explain the athletes what a sport psychologist is, what does he/she do, what is expectable from intervention, and what is imposible to obtain after a psychological intervention. They also have to be instructed in the role of psychological variables in athletic performance, and basic information on psychological training should be also provided. This information must be given in the first sessions in order to improve knowledge and to adjust expectations of athletes regarding the psychological work.

Assessment of deficits and resources and needs establishment.

After the introduction of psychologist and psychological work, the first step of the intervention is to explore the demands, concerns or problems of athletes, if this is the case, or just to establish their current condition. The main aim of this phase is to obtain precise, realistic, complete and relevant information regarding the psychological functioning and demands of athletes. Before beginning the intervention, it is necessary to fully understand the needs and context of needs. The individualized identification of the players' specific needs, deficits and resources and of their level of control in the use of the later will help in the formulation of the intervention objectives and in the design of the psychological training to develop the mental competences which are considered relevant for each athlete considering his/her needs, the sport modality, his/her level of knowledge, expertise, previous experiences and self-control and the level of competition. Nonetheless, to approach this goal, it is necessary to previously perform an exhaustive assessment of their competences, capabilities and skills, adaptive and maladaptive patterns of thinking, feeling or behaving, both individually and collectively, with the main aim of offering them a psychological training which is appropriate to their resources and needs and which results in an enhancement of the athletes' sport preparation and in an optimization of their performance in trainings and competitions. In other words, it is necessary to assess important variables involved in understanding and changing behavior. Several tools, such as self-reports, interviews, observation, psycho physiological registers, etc., can be used. The collected information should be completed with that given by significative others (coaches, parents, other players…). These data also should be completed with field assessment: observing athletes in real situations supplies a wealth of data on what is actually happening.

Objectives: Individualized goals for athletes and psychologists.

Intervention must be provided to increase resources of the athlete. Once we know what is happening, we set what is tried to be accomplished by both the sport psychologist and athletes. These objectives should be expressed both in terms of the outcomes we hope to bring about once the intervention will be finished (outcome objectives), and in terms of what the athlete should learn, use and get mastery on in getting the above-mentioned objectives (performance or process objectives). These objectives should be also established for a short-term, a medium-term and a long-term. That is, in the planning of the psychological intervention, goals to be achieved should be formulated in a sequential and progressive manner, considering the personal characteristics of each athlete, his/her concrete and changeable demands and his/her progresses. There are several issues concerning the proper characteristics of these intervention objectives to be appropriate and useful ones, but the most relevant are the followings: They must be specific and clear, and they must be defined operationally; they should include the expected positive result and the expected time in which they have to be achieved; and they should express the strategies which have to be used to achieve them and to assess the effectiveness or success in achieving them. The same could be said for psychologist self-planification.

Plan of action: *The planning of the training.*

Once goals of intervention have been defined, before beginning the training it is necessary to establish: a) the structure of such training, or, in other words, its contents in terms of the psychological skills to be trained and the strategies for training them, b) the program of sessions (number, duration, location in the general program of preparation, structure and contents of each one…), and c) temporization (from the beginning to the end of the training). It is also necessary to foresee obstacles and problems and to propose possible strategies for preventing, solving or controlling them.

A distinction should be made between psychological "skills" and psychological "methods" or strategies (Vealey, 1988). Psychological skills are referred to the competencies o characteristics (i.e. motivational self-regulation) which allow a person to behavior in a concrete way. Psychological strategies are the tools used to achieve such skills (i.e. goal-setting for motivational self-regulation). They are distinct completely. Nevertheless, the control and implementation of these strategies can be also viewed as psychological skills (Hardy et al., 2003). Those tools are what is offered to athletes, and they learn how to use them to self-manage properly the skills more appropriate for each demand.

Psychological training.

This phase includes properly the training in the psychological skills which have to be learned, practiced and used to generate the optimal mental state for plenum performance and for subjective well-being. These processes should be adjusted to three basic phases of learning: educative phase (what's/why psychological training?), adquisitive phase (how to learn psychological skills?), and practice phase (how to use new psychological skills in real situation?). Skills are learned throughout proper learning experiences, and Psychology also knows deeply the principles of learning and how to promote optimal learning processes. As soon as skills are learned, these must be practiced in real situations progressively more analogous to real training and competitive contexts. In this practice, action plans or routines are elaborated by the athlete with the supervision of the psychologist, and these routines are also progressively practiced in order to be automatised and completely integrated by the athlete. These routines organize the behavior, through the application of acquired psychological skills, prior, during or after the training session or competition. In preventing problems in their application to real situations, alternative action plans should also be generated. All these processes need what Ravizza (2001) named *self-consciousness.*

Final evaluation.

Improvements in performance outcomes or other relevant objective indicators should be assessed at the end of the intervention. Nevertheless, this information will be only a small part of the changes experienced by the athlete. Hence, other objective and subjective indicators of progresses should be addressed too. Amongst them, the following are very interesting: how much the athlete has progressed in his/her level of control on psychological skills; whether he/she uses currently acquired psychological skills correctly in terms of context demands, procedure or effort; whether these psychological skills are being generalized to other domains; or whether athletes and coaches are satisfied with information, interaction and instruction offered. Answers to these questions will establish the quality and effectiveness of the intervention, and may help the psychologist to adjust intervention principles for future applications.

Furthermore, once gains have been reached, it is necessary to establish new goals or to initiate the termination of the intervention. Boost or foster sessions may be required to consolidate changes.

Continuous monitoring.

The psychological intervention, as occurs with the remaining areas of preparation, is not a lineal process with only forward advances. Failures in achieving goals may be constantly present, and failures not only should be analyzed, but they also must be used for further efforts to find a solution. Other unexpected events may change initial planning, as injuries, illnesses, competitive new schedules, competitive outcomes, new goals in other domains of preparation… Besides, implementation of the psychological intervention should be monitorized. A continuous monitoring of progresses and obstacles will allow the expert to perform the proper corrections in the programmed intervention in order to adjust it to the current conditions of athletes. It also will help him or her to establish the degree in which initial goals are being reached in different moments of the intervention. A *diary* or a daily record by the athletes detailing psychological skills used, contexts of applications, effectiveness, obstacles, etc. will help the athlete and the psychologist to monitorize progresses.

4. Psychological intervention in the NSTP-Table Tennis Program

As has been mentioned earlier, inserted in the NSTP general objective of detection, selection and formation of talented young table tennis players, a psychological intervention has been included aimed to the detection of the psychological skills of athletes who are participating in such program and to the enhancement of players' self-regulation skills. This work is integrated along with the work developed in the remaining program areas, and it is adapted to the characteristics, resources and needs of the participants.

We detail in this section our work for psychological skills assessment and enhancement in selected, talented young players of table tennis in the NSTP. This is a general presentation of the administered intervention and counseling, which is actually appropriately adapted to specific athletes' circumstances and demands.

As we have stated previously, psychological intervention is sustained in the establishment of psychological variables which may exert a positive or negative effect in learning and performance both in training or competitions. The goal is to detect the psychological optimal state for each situation and to modify psychological variables for peak performance and optimal well-being of the athlete (Buceta, 1988).

This means we aim to train the athlete in a series of psychological skills which allow him/her to appraisal relevant information in sport situations, to know the status of his/her psychological states and processes, to self-manage these states and processes taken into account set goals, to compare diverse action alternatives and to choose and execute the appropriate courses of action suited to each circumstance, to evaluate the decisions adopted and their outcomes and, finally, to learn of such decisions and outcomes.

As a ultimate goal of NSTP- Psychological intervention area, we pretend selected athletes to learn and to self-regulate conveniently a set of psychological skills which will increase their successful actuations in terms of execution and outcomes, in whichever circumstance of trainings, competition or recovering periods. Nevertheless, we do not pretend only to optimize their sport development and performance, but also their personal development and achievement. Hence, generalization to other domains of learned self-regulation is also pursuited. Finally, a contribution to the promotion of satisfaction, health and well-being of athletes is also searched for. Figure 1 shows these ultimate goals of NSTP-Psychological intervention.

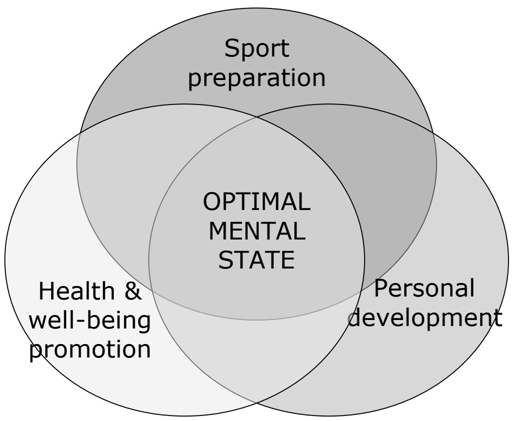

Figure 1 *Main core goals of NSTP-Psychological intervention.*

Optimal mental state is crucial for human behavior and well-being.

These ultimate's goals are detached in several short-term, specific, individualized goals. These objectives are referred to the desired changes each athlete should reach, and they establish both the level of self-control on psychological skills which is pretended to be achieved in each moment in season (mastery goals), and the performance outcomes set for each moment in season (outcome goals). This is the reason why objectives must be defined considering season structure, competition schedule and periods in which season is divided.

Season structure is divided in two macro cycles (from August to February, and from March to July), with several sub cycles which have to be considered in psychological work programming as well. Basically, during the first macrocycle, we use to perform a *basic work* for psychological preparation in which relevant psychological skills are trained and practiced in progressively more relevant competitions. During the second macro cycle, a *technification work* is performed, in which learned skills are perfectioned and applied, along with other relevant, complex skills which are trained, to more important competitions. Figure 2 shows the scheme of psychological work and its objectives in each macro cycle. In both basic and technification work, main goals are the assessment of psychological skills and the training of psychological skills which are relevant to sport, but attention to other needs outside the athletic area is also provided.

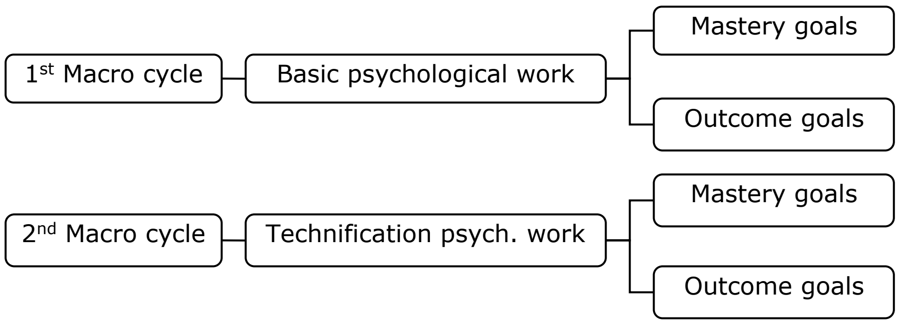

Figure 2 *Main goals of psychological intervention in macro cycles.*

Main objectives are detached in progressively more specific goals.

Main mastery objectives of both macro cycles are the following:

First Macro cycle Objectives:

- Relevant psychological skills individualized training, learning and practice.
- Learning of self-monitorization of mental status and processes.
- Learning of objective appraisals of circumstances and of resources for dealing with them.
- Early use of psychological resources suited to context demands for self-regulation of psychological variables.
- Pre-elaboration of routines.
- Progressive preparation of the athlete for the competition schedule demands.
- Promotion of physical and mental well-being.
- Promotion of sport and personal development.

Second Macro cycle Objectives

- Technification of learned psychological skills.
- Learning and practice of new complex skills.
- Precompetition, competition and postcompetition routines definitive generation and progressive practice.
- Alternative routines generation and practice.
- Extend athletes' knowledge on psychological and contextual factors of influence in performance and on self-regulation skills aplication.
- Promotion of adjustment to increasing demands of season and promotion of recovering.
- Learning generalization.
- Promotion of physical and mental well-being.
- Promotion of sport and personal development.

We now describe in the following sections psychological work in each of the macro cycles.

Basic psychological work.

Following the background detailed above, we begin psychological intervention with an introduction of psychological work. As we have just commented on, a necessary collaboration relationship should be established between athletes, coaches and psychologist in order to create the propitious climate for intervention and desired outcomes derivation. The first sessions are destined to create this climate and collaborative roles. Plays, a friendly, comfortable emotional climate and the figure of psychologist as part of coach-team –and not a foreign specialist- help in the establishment of the desirable relationship with athletes.

The first sessions are destined also to the instruction on why psychological training is relevant and what psychological training is it self. This includes to provide the athletes with a complete background on psychological skills, on the relevant role of psychological variables in sport performance and on the suitability of a psychological training in sport domain. Main objectives of psychological work (see figure 1) are also presented and discussed with them, and realistic expectatives are created. We use to use some plays and debates in presenting this information. For example, collective debates in which athletes reflect on psychological factors implicated in previous successful and non-successful performances are a proper tool for introducing the psychological intervention.

Once bases of psychological work have been well-established, we proceed with the identification of both strengths and weaknesses of players. A detailed assessment is performed in which information is acquired from athletes and coaches basically, although if it is required to implicate other relevant persons, such as parents, they are also included in the evaluation process. Tools we use for the assessment of objective and subjective parameters are varied: field-observation of performance and of use of skills (depending on the variable, when it is possible), self-reports, such as questionnaires or self-registers, interviews with athletes and coaches, or other required measures. As an example of concrete instruments we use, some of the authors created some time ago the «Psychological Skills and Behaviors in Competitive Sport Questionnaire» (CHPCDC; Godoy-Izquierdo, Vélez, Ramírez y Andréu, 2001, 2006), which is a questionnaire which assesses 20 psychological variables and allows the athlete to indicate also expectations and objectives regarding a possible psychological enhancement program for peak performance. Its version for young athletes has been found to be reliable, valid and practicable in athletes from very early ages (8 years old and older). For older athletes (18 years and above) we use the adult version. We found the information provided by this questionnaire very useful in determining both baseline levels of control on psychological skills and progressive or final levels of mastery. Based in this tool, we also have elaborated a semi-structured interview which can be used as a complement of the questionnaire. Hence, responses to the CHPCDC can be deeply completed by interviewing the athlete with that interview version.

Once the assessment process has finished, the complete obtained data is integrated and individual and collective mastery and outcome goals are proposed by psychologist and coaches. These goals are then presented to athletes and discussed with them in order to increase their motivation and adherence to psychological intervention. When athletes are invited to participate in these decision-making processes, they usually gain in commitment. In this cooperative discussion, athletes are invited to manifest their concerns, needs or personal goals, in order to include them in the intervention goal-setting.

Once individual and collective goals are set, the initial planning and programming of psychological work is revised. The sport psychologist now adjusts his or her initial plan to new information, and a psychological intervention is formulated which is completely adapted to resources, demands and circumstances.

In this fist macro cycle, only *basic* psychological work is offered. Hence, only basic psychological skills are trained. These basic psychological resources are in themselves relevant mental strengths, but they are not the only ones relevant for sport performance. Furthermore, they are destined also to be in later phases the bases of more complex psychological skills. Basic trained skills are usually:

- basic motivational self-regulation: sport, daily and competitive motivation self-regulation, goal-setting skills, decision-making abilities and problem-solving abilities.
- control of self-talk: positive thinking, self-instructions and attributions.
- self-confidence: self-efficacy and perceptions of control and mastery.
- imagery and mental rehearsal use
- activation control
- attentional/concentration self-management

With the exception of self-confidence and attentional control, which are considered as complex skills, the remaining have been considered as the four psychological basic skills for sport (Hardy et al., 2003). Nevertheless, we consider self-confidence to be pivotal for sport (and human) behavior, and its training is included early in psychological work. The same is applicable to attentional control, which also is a core leg of sport (and human) performance.

Independently of the athletic modality, collective skills are also needed in individual sports, not only in collective sports. The whole "team" is not just the sum of its parts –athletes. On the contrary, some collective skills (i.e. collective self-efficacy) are also important for cohesion, cooperation and comradeship. Basic collective skills are social skills and work-team skills. Coaches are included in this work along with athletes. These basic collective skills will be the bases of other complex collective skills.

On the other hand, there are two set of basic skills which are necessary from the beginning of the athletic trajectory. These are related to fairplay, on one hand, and to health and daily-life, on the other hand. Values, attitudes and behaviors of sportsmanship and fairplay are constantly enhanced in all the phases of psychological intervention. The same is true for health promotion behaviors (i.e. hygiene or nutrition in sport) and daily-life skills (i.e. school or social relationships).

Figure 3 shows schematically these basic skills.

Self-regulation skills in:
Motivation
Self-talk
Self-confidence
Imagery
Activation
Attention/concentration
Basic collective skills
Fairplay
Health and daily-life habits

Figure 3 Basic psychological skills domains.

Psychological skills training properly includes several elements. First, information on the skill to be trained is offered to athletes along with information on its relevance. Second, an exhaustive functional-evaluation (behavior, antecedents, outcomes) of baseline level of control on the skill is performed. Third, it is established a criterium level of control, which is the desired level of control pretended to be reached. Fourth, athletes are trained in psychological resources required for self-regulation. Learning principles and strategies are encouragely cared for. Instructions, self-instructions and modeling are used amongst other learning strategies. Fifth, athletes rehearse skill use in controlled situations. These situations are, first, imaginated ones, then, simulated ones, and, finally, actual contexts, which are initially programmed to assure successful performances. A continuous monitoring of learning, practice and effectiveness is performed both by the psychologist and coach and by the athlete himself or herself. Feedback provided to the athlete from this monitorization allows him or her to adjust process, to solve possible problems or to advance to next step. This feedback is informational feedback on his/her performance, correction feedback as well as contingent reinforcement and self-reinforcement. Next step is progressive practice in actual competition, demanding conditions. Some preliminary precompetition, competition (for every phase of competition) and postcompetition routines can be now elaborated and practiced. These new conditions of practice are actually not controlled by psychologist or athletes at all, so here it is very important to be cautelous in the application of learned skills. Because of that, actual practice should be also well-programmed with continuous testing of the skill use in progressive demanding contexts. Nevertheless, athlete's practice should continue from learning, although nothing was done explicitly by the psychologist. All this programmed and non-programmed individual practice is aimed to increase the perception of control of the athlete in his/her resources as well as his/her confidence on them. The ultimate goal is the automatisation of skills acquired the complete integration of them in the behavioral repertories of the athlete and the full inclusion of self-monitoring and self-regulating resources in sport actuations, so maintenance strategies are used at this point. Besides, generalization of learning should now be encouraged as an ideal objective of training. Figure 4 shows briefly the component and tools of psychological training.

Components of psychological training	Tools of psychological training
Self-observation Self-consciousness Self-control and self-regulation Relevant sport psychological skills Other relevant psychological skills Daily-life skills Intervention compliance Self-determination/agency	Brief speechs Written materials Observation/self-observation Instruction/self-instruction Modeling Imagery Practice in training sessions Practice in competitive settings Action plans or routines Self-monitoring Feedback, correction and reinforcement/self-reinforcement Generalization and maintenance strategies

Figure 4 *Components and tools of psychological training.*

Is at this point when Ravizza (2001) *self-consciousness* is relevant. The athlete is aimed to identify his actual states and his optimal states, then to compare them, then to decide if his actual states are in the range of optimal states, and then to self-regulate his actual states to reach optimal states, or, in the contrary case, to maintain his actual, optimal states. As the athlete achieves complete self-consciousness ability, he would detect in advance when he is not at optimal states for plenum performances. This early detection will help him to get his "optimal zone" back as soon as possible, which will increase indeed the perception of controllability.

For example, imagine we are aimed to train an athlete in activation control skill. We explain the athlete what activation is, its causes, its manifestations and its outcomes. We explain the athlete he can learn how to detect his activation states and how to self-regulate them to increase or to decrease his activation level. Then, the athlete is trained in self-observation in order to evaluate himself his current activation state. It is the beginning of *self-consciousness*. This self-evaluation includes to monitorize activation levels both in successful performances and non-successful ones, which will allow him to determine his baseline, his current states and his optimal range of activation for peak performance. Once this optimal state is well-established, athlete is trained in activation self-management (increasement, decreasement, transduction to positive energy) effective resources. The athlete then practices the use of the skill to gain mastery in its regulation. In order to facilitate the use of the skill in "real" situations, practice trials in mental rehearsal as well as in actual conditions are offered, which are progressively more analogous to competitive stressful conditions. Feedback is obtained from practice itself and from athlete's experiences, but also from others (including the psychologist monitorization), so that an evaluation of evolution can be obtained. This feedback also provides information which is useful to adjust the application of the trained skill (i.e. it is known that athlete feels a high muscular tension in the right arm, prior to start a point after several failures, which impedes him to perform well; adjustments will be destined in this case to emphasize the control of right arm muscular tension in such circumstances).

As an orientative guide, a typical working session will last for 45-60 min., as a function of its contents and evolution. It will be once per week, although some skills may require to be worked in more than one session per week. They can be collective or individual, depending on the skill. The first 5 min. can be devoted to the revision of tasks ordered in the last session. Next 10-20 min. can be devoted to the discussion of psychological factors implicated in sport performance and to debate on athletes' usual psychological functioning in trainings or competitions and on their beliefs on their performance and success. This information is derived from prior assessment. The next 30 min. can be devoted properly to the training of psychological skills. The last 5 min. are devoted to the specification of the assessment or practice tasks to be performed during the week until next session. It is indispensable that athletes practice everyday the competencies they are acquiring. After each session, sport psychologist must consider the appropriateness of contents, structure, evolution, etc. of the session in a critique, constructive manner.

The last two months of the 1st macrocycle are usually plenty of championship first competitions. It is time to practice the acquired skills in real conditions as we have stated previously. We carefully plan the psychological preparation of this part of competition schedule for an integrated, successful, enricher practice of acquired skills. Action plans or routines can also be tested at this point. Main aims of this part of the 1st macro cycle are, hence, practice, evaluation and revision of athletes' learned resources.

Technification psychological work.

The 2nd macro cycle is destined to gain mastery on using psychological skills acquired in the previous one. Players should execute these skills in an automatised and adapted to demands manner for gaining such mastery in order to use them in subsequent competitions, the more important ones.

This macro cycle starts with a recovering period (1 month) in which outcomes of previous psychological work can be reviewed and adjusted. New goals can be set. Among these new goals, technification in psychological self-regulation must be inserted. This means to increase the athlete's control and self-regulation abilities to a maximal level. An adequate mastery in using these abilities will allow the athlete to use them and to learn other complex, specific skills for coping with adversity, which include stress and anxiety control, injuries prevention or rehabilitation, withdrawal prevention or solving personal problems affecting the athletes (i.e. family problems). These coping strategies will enable them to deal with the various types of adversity that could impede ideal performance states. As a part of these coping with adversity skills we can train athletes in (success and) failures coping skills.

On the other hand, in later phases, we have to prepare the athlete for his or her confrontation to most important competitions. Principal and alternative precompetition, competition and postcompetition routines established in prior phase are reviewed, adapted and reelaborated in order to adapt them to new competition demands.

Other relevant complex skills, such as reflexivity-impulsivity styles of action, can be now examined, and considerations can be made for each match phase.

It is time also to enhance other complex collective skills, such as collective decision-making abilities, collective problem-solving abilities or collective self-efficacy.

Objectives of this macro cycle are presented in figure 5.

Technification and self-regulation skills in:

Mastery and automatization of basic skills

Routines

Coping with adversity

Stress and anxiety

Success and failures coping

Other complex skills
Complex collective skills

Fairplay

Health and daily-life
Recovering

Figure 5 Technification work domains.

Finally, once competitions are finished, outcomes should be checked and new goals can be informally established to be considered in next season. But, parallel, psychologist must work along with coaches in the recovering process of athlete.

At this moment, the final assessment of the program quality and effectiveness should be performed, and satisfaction of athletes and coaches must be taken into account also as an outcome of psychological intervention success.

The program evaluation can be achieved throughout several change indicators, as objective performance parameters or psychological assessment tools, self-reports on behalf of athletes and coaches or other relevant ones, interviews, collective and individual debates, etc. Objective and subjective information should be obtained as indicators of quality and effectiveness of psychological intervention and participant satisfaction (Weinberg & Gould, 2007; Williams, 2001). Hence, both quantitative and qualitative methods of assessment should be used.

Some questions that should be answered at this phase are the following: Have level of control on psychological skills and sport performance been increased, and how much did they increase? Have changes been maintained appropriately? Do athletes use acquired skills in new situations? Are these increases derived from the administered intervention, or perhaps other variables can explain observed changes? At what extent tools employed in the intervention are appropriate? Which tools or activities are more useful? Are collective sessions better than individual sessions, or for which goals are them preferred? Is the intervention large, broad and deep enough? Is it necessary to go on with any issue in future interventions with the same athletes? Did the psychologist do his or her best? Was him/her fully expert, communicative or accessible? Which are the strengths and weaknesses of the offered intervention? Is it necessary to add or to eliminate any element of the program? Do the athletes inform of a satisfactory fulfillment of expectations? Do they conceive intervention as useful?... Some self-reports may also be used in assessing satisfaction with the intervention, such as that by Partington & Orlick (1987a,b).

As we have commented on, continuous monitoring should also be performed. This monitorization may be performed session to session or part to part, but also at least three controls are performed: In the first recovering period between macro cycles, in the middle approximately of 2nd macro cycle, prior to most demanding competitions, and at some point in the last phase of the same macro cycle, during the most demanding competitions.

5. Main results of NSTP-Psychological intervention with Table Tennis selected athletes

Since psychological intervention in the NSTP for table tennis is very recent, we have not already enough data on its results. Nevertheless, there are some questions that can now be answered and which can be considered as the initial steps of our work in the NSTP. The questions and answers are the following:

Are young athletes sufficiently skilled in psychological area to confront sport demands?

NO. As results of performed assessments show (Godoy-Izquierdo, Vélez & Pradas, in press a,b), young players show consistently an important deficient level of control on some relevant skills such as activation and anxiety control, use of self-talk, attribution of success and failures, coping with success and failures, use of visualization, attention control, reflexivity-impulsivity style and self-confidence, although they show a higher level of control on other variables and skills such as sport motivation, daily motivation, competitive motivation, relationships with pairs, coach or parents and fairplay.

Does experience in sport necessarily increase psychological skills of players?

NO. As our results showed (Godoy-Izquierdo et al., in press a,b), players with more years of athletic and competitive experience showed lower control for several psychological skills and a lower global mental control compared to novel players. Nevertheless, no significant differences were found between more experienced players and novel players.

Does gender explain some of the differences found?

NO. Non-significant differences due to gender have been found, although girls tend to show higher deficits in some variables and higher abilities in others compared to boys and vice versa (Godoy-Izquierdo et al., in press a).

Are deficits found exclusive of table tennis young players?

NO. Comparisons to other racket sports such as badminton and to other sport modalities such as soccer tend to show the same results (Godoy-Izquierdo et al., in press b).

Are young players disposed to a psychological intervention inserted in their integral formation process?

YES. They are able to acknowledge the importance of psychological skills in sport, they are aware of their resources, deficits and needs, they recognize their need of a complete formation which includes psychological enhancement, and they found this intervention very useful (Godoy-Izquierdo et al., in press a,b; Vélez & Godoy-Izquierdo, unpublished document).

Does psychological intervention increase sport performance, self-agency and subjective satisfaction with sport?

YES. Young athletes who receive psychological intervention are more self-determined, more self-controlled, more efficacious, more successful and manifest more well-being and more satisfaction and adherence than non-skilled non-trained athletes (Vélez & Godoy-Izquierdo, unpublished document).

In conclusion, results have indicated the suitability of considering psychological assessment and training for the complete preparation of players in order to improve psychological skills which allow them to confront adequately the increasing demands of sport participation in accordance with the advancement of their implication. This is highly relevant in the case of individual and collective sports modalities, as well as in the identification and formation of talents, particularly in racket sports, and specifically in table tennis.

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COMPARISON OF TABLE TENNIS COACHES AND COACHES IN INDIVIDUAL SPORTS IN SLOVENIA

Abstract

We conducted a study of characteristics of Slovene coaches and within the scope of that investigation compared characteristics of table tennis coaches and other coaches from individual sports. 69 coaches participated in the study, 9 of them were table tennis coaches and 60 coaches worked in other individual sports (swimming, athletics, tennis, biathlon…). We measured their personality (BFQ), motivational characteristics (SMI and Costello's inventory), social skills (SSI), emotional intelligence (VEK), attitudes and leadership styles (LSS and LEAD). Table tennis coaches turned out to have different leadership styles (they use more delegating and give less feedback to their athletes), they manipulate with their athletes less and are less open to new experiences and cultures in means of personality traits. In comparison to other individual sports coaches they also seem to report somewhat more problems, related to their work. Some of the results could be contributed to sample characteristics – table tennis coaches were significantly older than other coaches.

Key words: *table tennis coaches, personality, leadership, social skills, emotional intelligence, attitudes, motivation*

INTRODUCTION

Many authors define the coach as the leading character in developing an athlete's career (Tušak and Tušak, 2001; Krevsel, 2001; Martens, 1990; Gummerson, 1992 and Sabock, 1985), while Solomon (2001) states, that only the coach's evaluation of the athlete's confidence can predict the success on the oncoming competition. Dick (1997) defines coaching as »more an art form than a science« and Everd and Selman (1989, in Popper and Lipshitz, 1992) say that coaching is a process of creating a culture of development and an atmosphere of teaching. A coach is thus clearly an important figure in the process of achieving athletic success – a complex approach by Tušak and Tušak (2001) defines 6 areas of the coach's functioning:

- *Practice planning* – this is the most demanding part of the coach's work, it requires an insight into several areas surrounding sport, such as biomechanics, psychological knowledge, sports medicine…); a coach need not be an expert in all these areas, but he has to know them well enough to be willing to include such experts into his work and to know what to expect from them;
- *Practice execution* – this is actually the most obvious part of the coach's work, it involves the execution of strength and endurance practice, technique and tactical practice… Practice is a process of delivering such information to the athlete, that he will be able to understand it - he also needs to explain the goals of practice to his *athletes.*
- *Practice success control* – a coach should supply steady and regular feedback to his athletes – this is important both for enabling them to work well and constantly correct their mistakes and also from the motivational point of view; feedback also enables comparison with rivals.
- *All-round care for the athlete* – the coach should structure the athlete's environment in such a fashion, that they will be able to do their best at practice or competition – enable positive mood states and disposition by making sure that all is taken care of during traveling, that they will have all the professional support they need, by checking the conditions of the competition, taking into account individual requests of the athletes… It also includes being able to

control the athlete's emotions and states on the site of the competition, which also includes the coach's own emotional control.

- *Counseling* - a coach should be able to help the athlete both in the matters of practice and competing as well as in private affairs (school, partner and parent relationships…)
- *Competition aspect* – a coach has to be aware that he is first and foremost a role – model for the athlete – ha has to approach the competition seriously, stay positive in all situations, be realistic, he can help the athlete with his pre-start routine, he should have a positive influence on the athlete's emotions and confidence and has to provide a thorough and objective analysis of the event afterwards.

Other authors provide similar descriptions of the coach's roles - Paranosić (1982) emphasizes his ability to cooperate with and coordinate the expert team, surrounding the athlete – an expert team can be defined as a »relatively stable group of experts, which each cooperate with the athlete on their field of expertise and help him perform better« (Kajtna, 2004).

Gould, Guinan, Greenleaf, Medbery and Peterson (1999) conducted a study of coach's characteristics according to how well their athletes performed in the Atlanta summer Olympics in 1996 and found that the key to achieving good results was a constant and regular exchange of information between the coach and the athlete. The importance of communication was confirmed also by Perez Ramirez (2002), who also found good coaches to be competent personalities, who direct their behaviour towards personal and professional success, she found them to have high achievement motivation, use clear leadership and to have good interpersonal skills. She also noted that good coaches constantly keep in mind the well being and good performance of their athletes. Kajtna (2006) states that successful coaches frequently report about problems, consequential to their work and to have strong attitudes towards achievement.

A coach's characteristics are significantly influenced also by his age – the profession of the coach is an extremely stressful one and combining the fact that table tennis is a sport, where experience is important and where success can only come after many years of experience, we should direct some attention to the differences between younger and older coaches. According to Levinson's (1986) theory of life stages (which he extends also to career stages), we find that coaches till about the age of 35 still look for the way on how to work, they are still deciding on appropriate methods, finding their place in the world of coaching. Older coaches (in the phase of settling down, after the age of 33) have stabilized their methods and can focus on working effectively, on progressing and actively functioning within his environment. Results on burnout research (Maslach and Leiter, 1997) show that burnout is not just the characteristic of the person, but of a mismatch between the person and his working environment. Coaches are frequently faced with stress and consequently burnout – the role of sex is unclear – some studies show, that female coaches experience burnout more frequently (Caccese and Mayerberg, 1984, in Dale and Weinberg, 1989), some found no differences (Wilson and co., 1986, in Dale and Weinberg, 1989). Dale and Weinberg (1989) found also, that coaches, who spend a lot of time taking care for their athletes and orient their leadership towards the well – being of athletes, are more exposed to burnout. In relation to that, Garland and Barry (1990) found coaches, which use democratic leadership style during the practice part of the season and autocratic style in the competition part (or in other stressful circumstances) to be more successful – older successful coaches, who use democratic leadership during the practice part of the season, are particularly »risky« for experiencing burnout.

There are also some differences between younger and older coaches in personality traits (Kajtna, 2006) – younger coaches score higher on the openness dimension and describe themselves as very educated, full of interest for novelties, open to new cultures, while their older colleagues prefer to keep things as they are and think rather three times than twice before changing things.

Table tennis is a highly specific sport, where precision and accuracy are combined with endurance and a large amount of tactical knowledge and coaching table tennis includes a lot of work and dedication – therefore we took to the purpose of this study to find, whether there are any differences in the traits of table tennis coaches in comparison with coaches of other individual sports.

We hypothesized, that there are differences between table tennis coaches and coaches from other individual sports.

METHOD

Participants

69 top male Slovene coaches participated in the study, 60 of them were individual sports coaches (swimming - 8, athletics - 8, alpine skiing – 6, biathlon – 5, gymnastics – 10, kayak and canoe – 4, bicycling – 6, Nordic skiing – 7, tennis – 6) and 9 were table tennis coaches. Table tennis coaches were 44 years old (SD = 7.60), while other coaches were 35.68 years old in average (SD = 7.69) – the differences in age were significant (F = 9.18; sig (F) = 0.00). Table tennis coaches had also 7.80 years more experience as other coaches, again, differences in years of experience were significant (F = 6.52; sig (F) = 0.01).

Instruments

The instruments used in the research were as follows:

- ***Big Five Questionnaire – Slovene version (BFQ)*** – Caprara, Barbaranelli, Borgogni, Bucik and Boben, 1997; The questionnaire measures five main personality dimensions (energy, acceptability, conscientiousness, emotional stability and openness) and contains a social desirability scale. Reliability analysis for the questionnaire reveals α coefficients between 0.63 and 0.82 and has a stable factor structure.
- ***Social skills inventory (SSI)*** – Riggio in Trockmorton (1986, in Lamovec, 1994); the inventory contains 7 dimensions (emotional expression, emotional sensibility, emotional control, social expression, social sensibility, social control and social manipulation). Authors report high test – retest reliability and high internal consistency of inventory's dimensions (between 0.81 and 0.96).
- ***Achievement motivation questionnaire*** - Costello (1967, in Lamovec, 1988); two dimensions pertain the questionnaire, they are the need for achieving success, based on our own work and effort and the need for achieving success regardless of our effort. Split half reliability for the test varies between 0.73 and 0.82.
- ***Self – motivation Inventory (SMI) -*** Dishman, Ickes and Morgan (1980, in Tušak, 1997) – it measures internal motivation and has high reliability coefficients.
- ***Leadership scale for sports (LSS)*** – Chelladurai and Saleh (1980); the scale is composed of five dimensions (training and instruction, democratic behaviour, autocratic behaviour, social support an positive feedback), authors report test – retest reliability coefficient between 0.72 and 0.82.
- ***Emotional competence questionnaire (VEK 45)*** - Taksič, 1998; the shorter version of emotional intelligence questionnaire contains 45 items, which converge in 3 dimensions (ability to recognize and understand emotions, ability to express and name emotions and ability to manage emotions) and is based on the Mayer -Salovey – Caruso's concept of emotional intelligence. First two dimensions have high reliability (α = 0.84 and 0.89 consecutively), the third dimensions is slightly less reliable (α = 0.67).
- ***Leader effectiveness and adaptability Description (LEAD)*** – Hersey and Blanchard, 1988; the instrument consists from 12 problem situations and measures 4 styles (telling, selling, participating and delegating) and adaptability of leadership. It is normally used for individual consulting, a research reveals fairly low reliability (α coefficients range from 0.26 to 0.36, except for the style

of telling – α = 0.65) (Kajtna, 2006). The instrument was used with the approval of the company Biro Praxis.

- ***Attitude inventory for coaches* –** Kajtna and Hvalec (2006, in Kajtna and Tušak, 2007)**;** the inventory measures some important attitudes in sport and has 3 dimensions (development, achievement and problems). Its α coefficients range from 0.69 to 0.72 for three dimensions.

Procedure

The results were gathered within the scope of the project of the Slovene Ministry of sport and education called »Leadership styles in Slovene coaches«, the participants were tested during October 2004 and September 2005, the majority of them were tested individually.

RESULTS

Table 1
Comparison of table tennis coaches and coaches from other individual sports

	Other coaches		TT coaches		A - nova	
	M	**SD**	**M**	**SD**	**F**	**Sig (F)**
Telling	3.07	2.01	3.22	2.91	0.04	0.84
Selling	5.29	1.84	5.00	1.50	0.20	0.66
Participating	2.90	1.49	2.33	1.22	1.16	0.29
Delegating	0.75	0.96	1.44	0.88	4.24	0.04*
Adaptability	7.36	11.09	4.89	10.68	0.39	0.54
Self - motivation	156.47	14.97	154.44	15.67	0.14	0.71
Achievement based on effort	7.25	1.53	7.11	1.45	0.07	0.80
Achievement regardless of effort	6.47	2.59	6.11	1.96	0.16	0.70
Training and instruction	4.39	0.37	4.35	0.38	0.07	0.79
Democratic behaviour	3.06	0.55	3.15	0.40	0.21	0.65
Autocratic behaviour	2.80	0.51	2.87	0.33	0.13	0.72
Social support	3.31	0.52	3.53	0.69	1.28	0.26
Positive feedback	4.59	0.41	4.13	0.73	7.66	0.01*
Emotional expression	76.05	14.24	69.33	15.62	1.70	0.20
Emotional sensibility	91.23	12.22	95.89	10.97	1.16	0.29
Emotional control	80.03	14.26	81.78	23.29	0.10	0.76
Social expression	82.92	18.49	91.22	20.77	1.53	0.22
Social sensibility	76.53	15.48	72.22	11.68	0.64	0.43
Social control	89.72	14.70	96.00	14.04	1.45	0.23
Social manipulation	73.15	9.60	66.11	7.77	4.39	0.04*
Recognizing emotions	57.02	7.17	55.00	8.00	0.60	0.44
Expressing emotions	45.77	6.36	45.00	6.12	0.12	0.74
Managing emotions	59.70	5.78	56.67	7.78	1.96	0.17
Social desirability scale	35.91	5.27	37.22	6.44	0.45	0.50
Energy	83.90	8.41	84.11	6.45	0.01	0.94
Acceptability	82.36	9.72	82.78	7.64	0.02	0.90
Conscientiousness	88.47	10.24	87.11	8.18	0.14	0.71
Emotional stability	76.41	11.17	78.33	10.71	0.23	0.63
Openness	84.98	8.85	77.67	12.00	4.83	0.03*
Development	97.52	5.15	98.67	5.07	0.39	0.53
Achievement	61.82	6.89	61.33	4.82	0.04	0.84
Problems	72.12	9.80	78.22	7.14	3.22	0.08

Legend: M – mean; SD – standard deviation; sig (F) – statistical significance of the F parameter; * - p ≤ 0,05

Table 1 shows us that there are some (although a few) significant differences in characteristics of table tennis coaches and coaches from other individual sports – table tennis coaches more frequently use the leadership style of delegating, give less positive feedback to their athletes, manipulate their athletes less and are less open as far as personality goes. They also somewhat more frequently report problems regarding their work.

DISCUSSION

Our results reveal that there are some significant differences in the characteristics of table tennis coaches and coaches from other individual sports. Table tennis coaches more frequently use the leadership style of delegating – this is a leadership style, which is directed low on both people and the task (Hersey and Blanchard, 1988) and can indicate successful leadership in cases, where athletes do not need a lot of socioemotional support – table tennis coaches seem to provide little support for their athletes. In cohesion with that result is also the result on the amount of positive feedback that table tennis coaches provide for their athletes, since they seem to provide less positive feedback than coaches in other individual sports. From the description of the variable we could say, that table tennis coaches don't encourage and stimulate their athletes by rewarding them for good performance both at practice and in competition (Chelladuari and Saleh, 1980).

Both these results might give the impression that Slovene table tennis coaches are somewhat detached and uninterested in their athletes in comparison to their peers from other individual sports and that would certainly be a bad information, but a different light is shed on the matter when we take into consideration the next result. Table tennis coaches do not attempt to manipulate their athletes as much as other coaches and do not "scheme" and plot in order to enable success for their athletes. Their athletes get all the information at the time when it is needed and that can be interpreted as a basis for a good relationship. It might be less warm from the perspective of emotions, but it can be more honest. Table tennis players know what to expect from their coaches and since most of the table tennis coaches work with adult athletes, a bit smaller amount of emotions need not be perceived as a problem.

Table tennis coaches are less open than coaches from other individual sports, that means that they are less open to new experience, are not very interested in novelties and might seem less informed about things (Caprara, Barbaranelli, Borgogni, Bucik and Boben, 1997) and also report of more problems related to their work – they say that their work takes too much of their time, that they have no free time, that they are not compensated enough financially… These characteristics could be attributed to their older age – also other studies (Kajtna, 2006) have shown older coaches to be less open and to complain more about their status as a coach. Perhaps further studies could show if that can be the consequence of stress in the work of a coach, since authors frequently report that stress as an important factor in the profession of coaching does take its toll (Dale and Weinberg, 1989).

On the basis of our results we can conclude that table tennis coaches are different than coaches from other individual sports, which proves our hypothesis to be right. Table tennis coaches more frequently use the leadership style of delegating and give less positive feedback to their athletes, but in return manipulate them less. This gives a basis for a somewhat less emotional relationship, but a more honest one. Table tennis coaches are also less open as far as personality goes and report of more problems related to their work – these results were attributed to their higher age.

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A STUDY OF THE UNIVERSITY STUDENTS' MOTIVATION IN TAKING THE COURSE OF TABLE TENNIS

Abstract

The research aims to understand the factors that affect the university students' motivation in taking the course of table tennis, and to provide findings for better physical education. The subjects of this research were 208 students (119 males & 89 females), who took the course of table tennis at National Chung Hsing University (NCHU). The "University Student Motivation Factor Scale" was adopted in the research to measure the students' motivation. It was divided into seven dimensions: social demand, health and fitness, release of tension, teacher's way of teaching, nature of the sport, achievement and honour, and grade consideration. The data were analyzed by descriptive statistics and t-test. The conclusions were:

1. *The top three motives in order for taking table tennis were: teacher's way of teaching, nature of the sport, and health and fitness.*
2. *Those students had higher motivation who would play table tennis at their free time than those who would not.*
3. *Students of the advanced level in table tennis skill had higher motivation than students of the basic level.*

Key words: *university students, table tennis, motivation*

1 Introduction

1.1 Background of research

Since a specializing physical education class was implemented in Taiwan's universities, every university or college starts to offer different course that can go in accordance with all universities' characteristic. The role of student has been changed from passive position in the past and gradually turns into a more active position. The process has become an important key for the development of the physical education classes (Yang, 1999). Customers' needs have been emphasized in our society nowadays. In line with this view students are relative to customers in schools, students' acceptance of physical education will influence PE course continue survival and development in universities.

However, Maslow's Theory emphasized that human behaviors have their cause from "need" or desire. If teachers can arouse students' interest, they certainly will improve the sports teaching quality in the university. Interest can help learners concentrate on a certain activity, transforming the learning process into a happy activity. In sports teaching, the teacher should first cultivate the student's interest .S/he should know students' need so that s/he can arouse their interests (Xie, 2004). We must understand students' motive because motive is what makes students to participate in sport activities, and motivation is what determines the outcome of the activities (Chen, 2004).

In universities of Taiwan physical education courses (The PE course in Taiwan's university), ball games have been always selected hotly by students. In numerous ball sports, the table tennis is one of the most popular sports for students. In view of this, this research takes the table tennis course as the object of the study; and tries to take the view of "motivation" to understand whether the students who take the course have a certain "demand" on learning table tennis. The author will also examine how the motivation factors influence different levels of table tennis players and what kind of motivation influences on students who play the sport after class. The author expects that the study can help to promote university students' participation in the sport of table tennis.

1.2 The purposes of the study

1.2.1 To understand the scores in various motivation factors of the university students who take the table tennis course;

1.2.2 To compare the difference of motivation between the players with basic and advanced skill levels;

1.2.3 To compare the difference of motivation between students who participate in the sport after class and those who do not.

2 Research Methods

2.1 Subjects of research

This research used the university students of National Chung Hsing University (NCHU) who took table tennis course in 2006 as subjects of the study. 220 questionnaires are issued, of which 208 were valid. Among them, 119 were male and 89 female. The total number was 208.

2.2 Instruments of research

This study used the "University Student Motivation Factor Scale" (Hsu, 2002) as a research tool, and Likert -type score measurement was adopted that used a scale of 5 points (Likert-type). The coefficient α was 0.93. The scale was divided into seven dimensions: social demand, health and fitness, release of tension, teacher's way of teaching, nature of the sport, achievement and honor, and grade consideration.

2.3 Data analysis

2.3.1 "Descriptive Statistic" is used to analyze the ""University Student Motivation Factor Scale" as well as the information about students' background.

2.3.2 "T Test" is used to examine the differences of motivation between students who participated in the table tennis activities after class and those who do not.

2.3.3. "T Test" is also used to examine the differences of motivation between the students with basic and advanced skill levels.

3 Results and discussions

3.1 The situation of the demography distribution on the effective sample

From the analysis of table 1 it could be obtained that the distribution of gender in this research were shown as below: men slightly exceed women, there were 119 men (57.2%) and 89 were women (42.8%). Regarding grade distribution, second grade students had the most number of people (130 people) which was equivalent to 62.5%. Third grade students were 70 people which was equivalent to 33.7%; and fourth grade students were accounted only 3.8% which in term of people were 8.

The participation number of table tennis activity after class, there were 116 participants (55.8%), and 92 people (44.2%) did not participate. This showed that besides class period there still have a lot of students engaged in table tennis activity. With regard to the item of sport skill dividing in class, students with basic level skill were 127 (61.1%) and there were 81 students in the advanced level (38.9%).

Table 1 Statistic characteristics of the effective sample distribution

Background variable		N =208 people	
		Number of people	Percentage
Gender	Male	119	57.2
	Female	89	42.8
Grade	Second grade	130	62.5
	Third grade	70	33.7
	Fourth grade	8	3.8
Participation after class	Participated	116	55.8
	Have not participated	92	44.2
Sport skill level	Basic level	127	61.1
	Advanced level	81	38.9

3.2 The statistical analysis of various motivation factors of university students

From table 2 it could be obtained that the average factor motivation score was 3.77 points. The other factor scores ranging from the highest to the lowest were as follows: Teacher's way of teaching (4.41points); Nature of the sport (3.97 points); Health and fitness (3.93 points); Grade consideration (3.72 points); Release of tension (3.68 points); Achievement and honor (3.41 points); Social demand (3.29 points).

Therefore the whole score of the university student motivation surpassed 3 points, this results showed that the whole university students had a stronger motive in taking table tennis course. They were in accordance with Maslow theory's human behavior of demand, demands make motivation become strong. In addition, the other results showed that teacher's way of teaching, nature of sport and health and fitness the scores were above the total average. Teacher's professional accomplishment was showed as the first important selecting factor while taking table tennis course. Conroy states that coaches (PE teachers) do have a strong impact on enhancing sports motivation of youth (Conroy, 2006). Secondly, people chose table tennis course because they liked it or had deep love for table tennis, this maybe resulted in popularizing the sport in Taiwan. Thirdly, participants thought that playing table tennis could reach enhancing exercise efficiency and health conditions. Apart from that playing table tennis could not only develop physiques conditions as strength, speed, sensitive and certain endurance etc., but also improve the mental wealth (Lin, 1999). From Dovey, Reeder, & Chalmers (1998) research demonstrated that more time in physical activity at age 18 was reported by participants who judged their fitness higher than their peers. The American College of Sports Medicine (2000) also endorsed regular physical activity to reduce long-term risk for disease.

Table 2 Analysis of every motive factor

Motive factor	Average	Ranking
1.Social demand	3.29	7
2.Health and fitness	3.93	3
3.Release of tension	3.68	5
4.Teacher's way of teaching	4.41	1
5.Nature of sport	3.97	2
6. Achievement and honor	3.41	6
7.Grade consideration	3.72	4
Total average	3.77	

The Impacts of the motivation factor on students who do or do not participate in the table tennis activities after class

From table 3, we can understand the impacts of the motivation factor on students who do or do not participate in the sport after class. Except for the factor of "release of tension," in which we can not find obvious differences between the two groups of students (t=.83, p>.05), great differences can be detected in the other six factors (p<.05). After further analyzing the average score of these six factors, we can find that the students who participate in the table tennis activity after class have higher scores than those who don't. This shows that the university students who participate in the sport after class are more motivated.

This might prove that this group of university students might affront normally social activities, requirement of healthy demand of themselves, professional function, love of table tennis, approval and behavior, grade of sport, sport's achievement in table tennis had a higher demand. From the past research in Taiwan showed that the students spent longer time after class in sports, they would have a stronger motive of participation (Chang, Su, & Leu, 1999). In addition, the students who participated in sports after school obtain a higher score of motive than the students who did not participate in PE course (Lee, Yang, & Qiu, 2003). According to Brown & Blanton (2002) research showed that college students who did not participate in sport are more likely to report suicidal behavior than those who were sports participants. Therefore, participation in sports after school had a stronger influence on the motivation of students' participation. How to improve sports facilities and infrastructure would be the most important task of enhancing students' participation in sports and their cultural life after school for schools.

Table 3 Summary of t-test on the motive of the university students that participated or not in the table tennis activities after class (N =208)

Motive factor	Participation after class	(M)	(SD)	t	P
Social demand	Participated	3.41	.568	3.50	. 001*
	Have not participated	3.14	.521		
Health and fitness	Participated	4.05	.476	4.14	. 000*
	Have not participated	3.77	.484		
Release of tension	Participated	3.71	.546	.83	.410
	Have not participated	3.64	.557		
Teacher's way of teaching	Participated	4.48	.433	2.52	. 013*
	Have not participated	4.33	.416		
Nature of sport	Participated	4.07	.556	2.96	. 003*
	Have not participated	3.83	.608		
Achievement and honor	Participated	3.57	.735	3.66	. 000*
	Have not participated	3.21	.672		
Grade consideration	Participated	3.85	.746	2.44	. 015*
	Have not participated	3.61	.615		

*p<.05

3.4 The impacts of the motivation factor on different skill levels of the university students

From table 4 we can understand the impacts of motivation on different skill levels of table tennis players at the university. Great differences can be detected in the factors of "social demand"(t =-2.953, p< .05),"health and fitness"(t =-2.742, p< .05),"nature of sport"(t =-3.742, p< .05), and "achievement and honor"(t =-3.192, p< .05). After further analyzing the average score of these four factors, we find that students who belong to the advanced level in table tennis skill tend to have higher scores than the basic level.

It showed that the university students who participated in advanced level of table tennis course had higher demand on social activity, health condition, achievement of sport and enthusiasm for table tennis than the basic level one. Evans & Robert (1987) research states that the students with more sports ability more popular they were, but the students with less ability were opposite. Tang's (1996) investigation also found that the university students thought that the most important acquirement after finishing their PE course was the improvement of the skill performance in that sport, and also most students thought that it's necessary to implement individual teaching during the physical education course. Guo & Shang's (2005) Research also showed that the university students who had the higher skill in sport (such as players), their sports motivation was higher than those ordinary one. Those students who had higher skill thought that they had more responsibility to participate sport activities. To obtain outstanding achievement in the sport performance was seen as their ambition, and this motivation would encourage them more to participate in sport activities.

This showed that the advanced level students were more popular than the basic level one in their course. Perhaps this will be one of the reasons to encourage advanced level students to improve their abilities. In addition, those advanced level students had higher demand on the table tennis course, thus how to design a course to fit their requirement would need us to think about it.

Table 4 Summary of t-test on the motive factor between different skill levels of the university students (N=208)

Motive factor	Level	M	SD	t	P
Social demand	Basic	3.20	.541	-2.953	.004*
	Advanced	3.43	.571		
Health and fitness	Basic	3.85	.480	-2.742	.007*
	Advanced	4.05	.504		
Release of tension	Basic	3.65	.541	-. 985	.326
	Advanced	3.73	.564		
Teacher's way of teaching	Basic	4.39	.423	-1.025	.307
	Advanced	4.45	.442		
Nature of sport	Basic	3.85	.591	-3.742	.000*
	Advanced	4.15	.543		
Achievement and honor	Basic	3.29	.730	-3.192	.002*
	Advanced	3.61	.685		
Grade consideration	Basic	3.72	.683	.106	.915
	Advanced	3.71	.728		

*p<.05

4 Conclusions and suggestions

4.1 Conclusions

4.1.1 The top three motives in order for taking table tennis were: teacher's way of teaching, nature of the sport, and health and fitness.

4.1.2 Those students had higher motivation who would play table tennis at their free time than those who would not.

4.1.3 Students of the advanced level in table tennis skill had higher motivation than students of the basic level.

4.2 Suggestions

4.2.1 The teacher should encourage students to join in the table tennis club in order to enrich their sports life. At the same time, we suggest that the school should hold more table tennis competitions after class in order to satisfy students' demand and increase the interaction among students and the participation of sports.

4.2.2 The teacher should not only make the teaching more interesting, but also incorporate a kind of curriculum design which improves students' sport skills.

4.2.3 The teacher may try to divide students in a class into different groups according to their levels of skills. In course planning, it is worth trying to divide students into different classes according to their levels of skills.

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AN EMPIRICAL STUDY FOR ATHLETIC PSYCHOLOGICAL SKILLS OF HANDICAPPED TABLE TENNIS PLAYERS IN TAIWAN

Abstract

The study was purported to examine the "athletic psychological skills" of handicapped table tennis players in Taiwan. The results might offer useful information for coaches, table tennis players, and promoting agents in terms of preparing training programs, consolidating players' confidence, promoting mental ability, improving performance and providing suggestions for competition strategies. A "Mental Skill Scale for Handicapped Table Tennis Players" was used in the research. Those subjects were handicapped table tennis players who randomly selected from various universities in Taiwan. The major findings from analyzing the answered questionnaire can be summarized as the followings:

1. *The dimensions of athletic psychological skills under the investigation were "Confidence", "Teachability", "Motivation", "Peak under pressure", and "Concentration". The results showed "Confidence" owned the highest scores, meanwhile, "Teachability", "Motivation" and "Peak under pressure" followed by order and "Concentration "got the lowest scores.*
2. *There were significant differences in "Peak under pressure" and "Teachability" between the subjects who have diverse accomplishment. Those non-national level players performed better in "Peak under pressure" than national level players, however, the performance on "Teachability" yielded the opposite results.*

Key Words: *Athletic Psychological Skills; Table Tennis; Collegiate Table Tennis Players*

Introduction

1.Motivation and the background

In 1991, the Science Committee of ITTF (International Table Tennis Federation) did a survey about psychological training to 75 participants in the 41st Table Tennis World Cup, 75.8% of players considered psychological training substantial; 74.1% of them agreed that the sport level would be raised if there are instructions given by psychologists (Chiu & Chang, 1994). Wu, Lin, and Liu (1998) found on many outstanding athletes that it is possible to be on the top of world table tennis only when an excellent athlete possesses extraordinary willpower, good thinking quality, and psychological outfit plus surpassing skills, tactics, physical strength, and accommodation. In the analysis done by An Ying and Kao Chi-ming (1998) about the world master, Waldner's key in his victory, the distinguishing characteristics of a deep technical & tactical foundations and good psychological quality of competition are the reasons why he has been a significant figure in the field of the world's table tennis for so many years.

Table tennis is a sport that requires excellent psychological control, agility, and delicate techniques. During an ever changing and extremely stressful game, what players need the most are the psychological skills such as managing stresses, lowering the anxiety, and elevating confidence. The training of table tennis also has to combine the practices of psychology, physicality, techniques, and tactics. During the game, when the skills and physical strengths of both parties are close, psychological skills will also become the key point. Besides, we notice that whether the players are of high level or not, during the important or formal games, their usual skill level is often reduced. This phenomenon is the so-called "shrinking," which means the lost of usual standard. To solve those problems, the means to efficiently utilizing psychological skills in games becomes crucial for athletes to accelerate their technical level.

Sport for the handicapped was the athletic activity for people with handicaps to improve their body functions by physical training. It was categorized into two aspects: activities for fitness and sports of athletics. On the perspective of activities for fitness, the sport for the handicapped integrates the functions of helping the defectives gain fitness and adjust their psychology; besides, it also includes the importance of sport-rights equality. The promotion of sport for the handicapped can be an evaluation of a nation's emphasis on the defectives' welfare. The perspective of athletic sports targets at discovering the defectives' physical potentials, presenting athletic talents, and achieving excellent accomplishments in sports. Getting good grades at international athletic competition for the handicapped shows how much attention a nation pays to the welfare of the defectives. (Chia, 1995)

Actually, the sports for the handicapped has already been promoted and developed for a century. And the wheelchair table tennis has formally become an event since it was introduced and practiced in the International Stoke Mandevill Wheelchair Games held in Stoke Mandevill, London in 1952. (Wu, 2000) The sports for the handicapped originally emphasized the rehabilitation, assistance for the defectives' recreational sports, and also development of their potentials. Until the establishments of medical grading, classification of sport functions, and the promotion of athletic competition according to physicality, the sport for the handicapped was gradually valued. (Lai, 1997) Compared to common athletic competition, the special feature of sport for the handicapped is that the participants must be qualified to the lowest standard of handicaps defined by the International Sports Organization for the Disabled. Meanwhile, for assuring the candor of the competition, the participants have to be graded according to the events they attend. In the inspection of the history and the status quo of sports for the handicapped, the event of the table tennis for disabled adopts the function classification which belongs to a more mature level. (Ting, 1996) In the equitable classification system, the table tennis sport for the handicapped includes obvious characteristics of athletic sports; therefore, table tennis for the handicapped is no more a passive activity for fitness in people's eyes.

So far, under the efforts of the players, coaches, and some related scholars in our nation, the wheelchair table tennis skill has achieved excellent successes many times and shown its glory to the sports world. But with the springing up of China, S. Korea, Japan, and European countries, the competition in table tennis will be keener and keener, and the issues of related researches and skill training will be more and more important. In recent years, our nation has paid much attention to the training of physical fitness and the promotion of the sport skills for the challenged, but the related studies about sports for the disabled are very lacking. Moreover, it is even insufficient in the cultivation of players' psychological quality and practice, so that there is still much space for handicapped table tennis players' psychological training to be actualized. Especially in the field of sports for the handicapped, experts and coaches are eagerly expected to do in-depth discovery and discuss. If our nation seeks to establish a new foothold, the sport for the disabled would be an issue worth developing and strengthening. Because the promotion of sports for the handicapped not only map out an integral plan for our nationals' physical education, but also elevate our nation's image of a welfare-oriented country at the same time. Thus, to efficiently improve the training level of table tennis for the defectives by the systematic scientific training would be a significant and imperative work.

This research only focuses on the psychological skills of players from different levels in order to discuss divergences of psychological skills between defective players and others. Also, we are able to know what psychological skills do the handicapped players need, and further practice the training of psychological skills for the handicapped table tennis players. By engaging in promoting the sports for the handicapped, I thoroughly understand its specialization. In my idea, besides enhancing the popularization of sport for the challenged, we should even probe into the related academic researches, to construct a theoretical basis, so that we can objectively and scientifically evaluate the shortcomings in the practice of the sport for the handicapped, lead the related studies in our nation to specialization and internationalization, further attract more experts to participate in the research and study of sports for the challenged.

2. Purpose

a. To study the characteristics in psychological skills of handicapped table tennis players.

b. To compare the psychological skills of handicapped players for different sexes, training years, game levels, and achievements.

3. Research area

This research adopted the questionnaire approach to collect related data. In order to achieve the study purpose, we designed the "Questionnaire of handicapped table tennis players' psychological skills." After testing the distinguish ability, reliability, and feasibility, deleting improper questions and changing question numbers by factors of experience, the questionnaire was completed. This questionnaire is divided into two parts: a. the assessment form of psychological skills for handicapped table tennis players; b. basic data.

Study Approaches and Procedures

1. Subjects

This study focuses on understanding the psychological skills of handicapped table tennis players, and the targets are the handicapped players in Taiwan, 64 in total. Before the test, the tester explained to the students in order to make them understand. There were 70 questionnaires in total given out, and 68 returned. 4 problematic questionnaires were taken off, and the rest were 64 valid questionnaires in total. The rate of valid return is 91%.

2. The design of questionnaire

The assessment form used in the study was mainly adopted from the form modified by Chiu (2001) based on the Athletic Coping Skills Inventory-28 ("ACSI-28" for short) of Smith el al. (1995) and adapted it for our research by applying related internal and external studies as references, and then revised improper questions by the pre-exam procedure. The design lists five elements as psychological skills: "Peak under Pressure", "Motivation", "Teachability", "Concentration", and "Confidence."

a. Item analysis

There were 31 questions in the assessment form. After the samples returned, items were analyzed by the data, the questions with a critical ratio lower than 3 were deleted. By the tests of the two approaches above, the pre-exam assessment form was verified with high distinguish ability. In the 31 questions, all were valid except question 7, 8, 12, 13, 15, 16, and 27.

b. Analysis of exploratory factors

There were 5 perspectives in all; the first one, "Peak under Pressure", included 9 questions, the factor loading was 0.496-0.790, the explainable measure of variance was 45.443%; the second was "motivation," 5 questions were included, the factor loading ranged 0.543-0.773, and the explainable measure of variance was 8.131%; the third was "Concentration", 5 questions, factor loading ranged 0.572-0.769, the explainable measure of variance was 5.378%; the forth was "Teachability," 2 questions, the factor loading was 0.584-0.8134, the explainable measure of variance was 4.798%; the fifth was "Confidence," 3 questions, factor loading was 0.525-0.724, explainable measure of variance was 4.516. All the items on the assessment form fall into each factor as expected.

c. Analysis of reliability

Cronbach's α was used to exam the coherence of whole content. The α coefficient above 0.7 represented the reliability, which was acceptable, but it must be rejected if α was under 0.35 (Nunnally, 1978). Thus, this assessment form showed high internal consistency, which mean it was high reliability. The total Cronbach's α of the assessment form for the psychological skills of handicapped table tennis players was 0.9438, and α coefficients of other aspects were 0.9122, 0.8449, 0.7996, 0.7346, and 0.6749.

d. Data management

After the questionnaires returned, we encoded all the data, abandoned incomplete ones and reorganize the valid ones. We used the software for statistics, SPSS for Window 10.0, to manage the information, and used α=0.05 as the significant standard.

Results and Discussion

1. Characteristics in the psychological skills of handicapped table tennis players

a. Descriptions of features in the samples

Table 1. Features of The Samples

Variables	Category	The amount of people	Percentage (%)
Sexes	Male	45	70.3
	Female	19	29.7
Training years	1-5 years	38	59.4
	6-10 years	8	12.5
	More than 10 years	18	28.1
Days of practice	1-2 days	38	59.4
	3-4 days	8	12.5
	More than 5 days	18	28.1
Level of game	Wheelchair	41	64.1
	Stand	23	35.9
Best achievement	National champion level	24	37.5
	Non-national	40	62.5
Total	champion level	64	100.0

b. Characteristics of the players' psychological skills

The aspects listed in the assessment were shown in table 2. "Confidence" got the highest scores, "Teachability" was the second, "Motivation" and "Peak under Pressure" followed in order. On the other hand, "Concentration" received the least points. The result was different from the research of Chuang (2004). Chuang checked normal table tennis players of different skill levels. The result showed the "Confidence" aspect got the lowest scores. Subjects were the possible cause to lead such unlikeness. The difference might indicate the diverse competition environment between handicapped and normal table tennis game. The handicapped table tennis players were not as many as normal players. Therefore, they had more opportunities to win the medal than those normal players. They owned much more confidence to play table tennis.

Table 2. Reflection of Aspects in Psychological Skills

Factors	Question number	Average	Standard Deviation
Confidence	4，6，21	4.11	.62
Teachability	17，19	3.72	.68
Motivation	2，5，14，18，30	3.58	.77
Peak Under Pressure	3，10，11，19，20，23，26，28，31	3.48	.70
Concentration	1，9，22，24，25	3.40	.69

Table3. Related Matrix of Handicapped Table Tennis Players' Psychological Skills

	Peak Under Pressure	Motivation	Concentration	Teachability	Confidence
Peak Under Pressure	1.00	.73**	.63 **	.77**	.61**
Motivation	.73**	1.00	.55**	.63**	.61**
Concentration	.63**	.55 **	1.00	.46**	.54**
Teachability	.77**	.63**	.46**	1.00	.54**
Confidence	.61**	.61**	.54**	.54**	1.00

2. Psychological skills in different aspects

a. Psychological skills of different sexes

After testing the scores of male/female players on the assessment form by the independent t test, the result showed that the players of different sexes do not diverse significantly on the five aspects of "Confidence", "Teachability", "Motivation", "Peak under pressure", and "Concentration" as shown in table 4. It meant that the handicapped players of table tennis do not vary in psychological skills due to sexes. The result does not cohere with Wei's research. Wei studied many kinds of school teams for national college of physical education & sports. He found the sex would affect the subject's level of Psychological skills. The unlikeness possibly was caused by events. Different events need diverse psychological skills and cause unlike impacts between both sexes. On the other hand, the handicapped people who step out and play tennis must have stronger willpower than others in spite of sexes. Regardless of the sexes, males and females put aside the preconceived ideas and the frame given by other people. So basically they had prepared well enough in psychological states to engage in sports like this, the divergence does not appear on the five aspects of psychological skills in both sexes.

Table 4. The t Test in Psychological Skills of Both Sexes

Aspects	Sexes	Average	Standard deviation	t	p
Peak Under Pressure	Male	32.56	5.29	2.18	.16
	Female	28.89	7.82		
Motivation	male	18.44	3.52	1.86	.45
	Female	16.53	4.31		
Concentration	male	17.38	3.32	1.31	.97
	Female	16.16	3.63		
Teachability	male	7.58	1.27	1.13	.82
	Female	7.16	1.54		
Confidence	male	12.64	1.77	2.05	.77
	Female	11.63	1.89		

b. Players' psychological skills of different game levels

After testing the scores on the assessment form by the independent t test, the result showed that the players of different levels did not diverse significantly on the five aspects, as shown in table 5. Actually, the handicapped events were divided by injury, all participants had similar situation. Therefore, their recognition about psychological skills won't be affected by injuries. They didn't show variables on the five aspects of "Confidence", "Teachability", "Motivation", "Peak under pressure" and "Concentration" because of the different game levels of wheelchair and standers.

Table 5. The t Test in Psychological Skills of Players in Different Game Levels

Aspects	**Game Levels**	**Average**	**Standard Deviation**	**t**	**p**
Peak under Pressure	wheelchair	30.37	6.37	-1.89	.86
	standers	33.44	5.86		
Motivation	wheelchair	17.61	3.66	-.74	.12
	standers	18.35	4.18		
Concentration	wheelchair	16.46	3.36	-1.75	.53
	standers	18.00	3.41		
Teachability	wheelchair	7.27	1.42	-1.47	.49
	standers	7.78	1.20		
Confidence	wheelchair	12.07	1.72	-1.58	.29
	standers	12.83	2.02		

c. Players' psychological skills of different achievements

After testing the scores on the assessment form by the independent t test, the result showed that the tests of different achievements show apparent divergence on "Stress management" and "Teachability," as shown in table 6. We could tell from the table that those non-national performed better than national champions in "Stress management," while the performance on "Teachability" yielded the opposite result. The possible explanation was that national champions bear more pressure in usual days. Too much stress from coaches and related organizations during usual training or games caused the players' lord. Roobbin (1985) indicated stress was dynamic. It often happened when important result was uncertainty or limitedly. The possible reasons for national level players to perform better than non-national level in "Teachability" were as the following: 1.The players of national level were more aggressive to seek breakthrough than non-national level. Thus, adopting others' suggestion was a good way to try. 2. They have more opportunity to represent the nation to attend games overseas, so the acceptance of revision in actions or skills is relatively higher. Non-national champions almost have no chance to join oversea games or expose to the stimulus from other good players of other countries, so they comparatively cannot accept others' advice.

Table 6. The t Test in The Psychological Skills of Different Player Achievements

Aspects	Achievement	Average	Standard Deviation	t	p
Peak under Pressure	National	31.47	4.46	-0.03	.04*
	Non-national	31.48	7.26		
Motivation	National	18.79	3.34	1.49	.75
	Non-national	17.33	4.05		
Concentration	National	17.21	2.86	.35	.31
	Non-national	16.90	3.76		
Teachability	National	7.83	1.01	1.94	.03*
	Non-national	7.23	1.49		
Confidence	National	12.58	1.67	.80	.55
	Non-national	12.20	1.96		

*p<.05

d. Players' psychological skills of different years of training

After examining the scores by one-way ANOVA on the psychological assessment, the result showed that players of different training length of years diverse on the "Motivation" aspect, as shown in table 7. Through the comparison by the Scheffe's Method, we could see that players trained for more than 10 years score higher in "Motivation" than those trained for only 1~5 years. It was probably because players with more than 10 years of training were all national level with better achievements; they have more chances to meet other good players, and have higher self-expectation, so they have more motive than those trained for fewer years. This result cohered with Mahoney's in 1989 that excellent players had higher motive than common players. Besides, players trained only for 1~5 years were mostly novices, they were still wait-and-see with no long-term goal, so they had different self-expectation. Since table tennis had different features from other ball games that it was opposability, required more techniques, and needed longer training years. It was not easy to be proficient and outstanding in the games, so players trained only for 1~5 years are still waiting and learning, and those had been trained for more than 10 years were already proficient in skills and tactics. Excellent players would set clear goals, maintain high motive (Orlick, Partington, 1989) and then kept revising when facing challenges during games. They wanted more training on techniques, tactic using, and better grades in games, so they have higher motive.

Table 7. One-way ANOVA in the Psychological Skill Related to Years of Training

Aspects	Variables	Average	Standard Deviation	Source of Variance	Total Sum of Squares	Degrees of Freedom	Mean Square	F	P	Scheffe's
Peak Under Pressure	1-5 years	30.01	6.74	Class interval	218.68	2	109.34	2.91	.06	
	6-10 years	32.38	3.38	In class	2296.26	61	37.64			
	More than 10 years	34.17	5.62	Sum	2514.95	63				
Motivation	1-5 years	16.95	4.11	Class interval	91.61	2	45.80	3.34	.04*	3>1
	6-10 years	18.25	2.71	In class	837.40	61	13.73			
	More than 10 years	19.67	3.09	Sum	929.00	63				
Concentration	1-5 years	16.47	3.88	Class interval	37.53	2	18.76	1.63	.21	
	6-10 years	16.88	1.96	In class	703.46	61	11.53			
	More than 10 years	18.22	2.65	Sum	740.98	63				
Teachability	1-5 years	7.18	1.50	Class interval	8.15	2	4.07	2.31	.11	
	6-10 years	7.50	.93	In class	107.71	61	1.77			
	More than 10 years	8.00	1.03	Sum	115.86	63				
Confidence	1-5 years	12.24	2.02	Class interval	1.25	2	.63	.18	.84	
	6-10 years	12.38	2.07	In class	215.19	61	3.53			
	More than 10 years	12.56	1.42	Sum	216.44	63				

*$p<.05$

e. Players' psychological skills of different days of training

After examining the scores by one-way ANOVA on the psychological assessment, the result showed that players of different training days diverse on the “Motivation” and “Concentration” aspects, as shown in table 8. Through the Scheffe's Method, we could see players with 3-4 training days have higher motive than those with 1-2 training days. The reason could be that the former are more eager to perform well in table tennis and willing to devote more time for advanced practices since motive is the origin of improvement. Liao indicated in 1993 that higher motive means the players are willing to devote more time on their special skills.

Table 8. One-way ANOVA in the Psychological Skill Related to Training Days

Aspect	Variables	Average	Standard Deviation	Source of Variance	Total Sum of Squares	ANOVA Degrees of freedom	Mean Square	F	P	Scheffe's
Peak Under Pressure	1-2 days	30.76	7.19	Class interval	61.41	2	30.71	.76	.47	
	3-4 days	32.59	4.42	In class	2453.53	61	40.22			
	More than 5 days	33.50	3.42	Sum	2514.95	63				
Motivation	1-2 days	16.68	3.68	Class interval	164.85	2	82.42	6.58	.00*	2>1
	3-4 days	19.84	3.30	In class	764.15	61	12.53			
	More than 5 days	20.75	2.99	Sum	929.00	63				
Concentration	1-2 days	16.63	3.08	Class interval	82.74	2	41.37	3.83	.03*	
	3-4 days	18.47	3.06	In class	658.25	61	10.79			
	More than 5 days	14.00	6.06	Sum	740.98	63				
Teachability	1-2 days	7.20	1.42	Class interval	8.14	2	4.07	2.31	.11	
	3-4 days	7.84	1.12	In class	107.72	61	1.77			
	More than 5 days	8.25	1.26	Sum	115.86	63				
Confidence	1-2 days	12.07	1.92	Class interval	11.66	2	5.83	1.74	.19	
	3-4 days	13.00	1.70	In class	204.78	61	3.36			
	More than 5 days	12.00	1.41	Sum	216.44	63				

*p<.05

Conclusion

1. Analysis of features in psychological skills of handicapped table tennis players

There were five aspects in the psychological skills of handicapped table tennis players: "Confidence", "Teachability", "Motivation", "Peak under Pressure", and "Concentration". Above all, "Confidence" received the highest score, it showed that most handicapped players are able to take challenges on the basis of confidence and give themselves positive feedbacks.

2. Comparisons among variables in different psychological skills of handicapped table tennis players

Among the variables in different psychological skills of handicapped table tennis players, "achievement" showed divergence in "Peak under pressure" and "Teachability", and players of different training length of year diverse in "Motivation" while players of different training days showed apparent variances in "Motivation".

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A COMPARISON OF SPORT ATTITUDE BETWEEN FEMALE TABLE TENNIS STUDENT ATHLETES TOWARD COMPETITIVE MOTIVE IN INDIVIDUAL AND TEAM SPORTS

Abstract

The findings of several studies that compare the attitudes of female athletes toward competitive motive in individual and team sports indicated that their competitive motives are quite different. Bowman et al (2001); McDonough and Crocker (2005); Sit and Linder (2006) found that female student athletes in team sports were more motivated in competition than those in individual sports. The purpose of this study was to compare the attitude of female university table tennis student athletes toward their competitive motives in individual and team sports. These athletes participated in the Seventh University Olympiad Games which was held in summer 2005. A total of 360 female students both from individual and team sports served as two samples in this study. Each sample consisted of 180 players. The Sport Attitude Inventory Questionnaire's (SAI) constructed by Willis (1986) was used as an instrument for this study. This instrument consisted of 3 dimensions: power motive (PM), motive to achieve success (MAS), motive to avoid failure (MAF), all of which together measure the student athletes' motives toward individual and team sports. The validity and reliability of this instrument were reported to be satisfactory. The results of MANOVA showed that there were significant differences between student athletes' attitudes toward individual(Table Tennis, Badminton , Track and Field) and team sports(volleyball, Basketball, futsal) in all three dimensions of competitive motive (PM, MAS, MAF). Then, in order to find out which group is different in dependent variables, one-way analysis variance was conducted. The results of the calculated F for all dependent variables were significant. When the mean scores difference of the sport attitude in individual and team sport athletes were compared, the post hoc test(LSD) showed that: 1) the mean scores differences of the attitude toward power motive between badminton athletes and futsal athletes was significant., 2) A same comparison between the attitudes of badminton ,track and field and futsal athletes in motive to achieve success showed no significant differences., 3) the mean difference between track and field with basketball athletes in motive to achieve success were reported significant., 4) the mean differences between basketball and futsal athletes in motive to achieve success were also significant., 5) the mean difference between table tennis and track and field athletes In motive to avoid failure was significant.,6) the mean difference between the attitude of track and field , volleyball and basketball athletes in motive to avoid failure were significant. However, when the mean scores of table tennis athletes were compared with athletes in other sports, no differences were reported to be significant. Since all student athletes in individual and team sports need to improve their competitive motives to advance their performances, it is, therefore, recommended that the coaches and team psychologists provide rich environment for athletes in different sports to help them identify and improve these competitive motives. This probably may help the athletes to maximize their potential and transcend the negative effects while maximizing the positive benefits of the intended traits such as power motive, motive to achieve success, and motive to avoid failure. Considering these traits may help them to improve their high anxiety, low stimulation and high competitive drive.

Key words: *Sport Attitude, Individual games, Team games, Olympiad, Table Tennis*

Introduction

Sport psychology is considered as a sub-domain of psychology which directs its activities to study strategies that can be related to the learning of general motor abilities, motor performance, and basic physical fitness movement patterns including kinesthetic perception. Sport psychologists also attempt to study the behavior, characteristics of individuals and the results of their findings provided services to both coaches and athletes to prepare and remain enthusiasm to their team and fans.

Those athletes who participate in the national, international and Olympic Games need to be emotionally comb to overcome their anxiety, worries against their opponent, referees and positive and negative reactions expected by the spectators. It is too easy for one to see different forms of mental stress and anxiety in the face of coaches and athletes for winning or losing the games on his or her TV monitor which are being broadcast by the media through out the world.

The role of participating and winning these games are so important that often leads coaches, athletes and fans not to be able to control their emotions and anxieties. Therefore, understanding competitive behaviors and determining what makes a winner or drives a successful athlete could assist in planning, promoting, and maintaining athlete's participation in sports.

There are different theories with regards to how a person will behave in different situations. The "Risk Taking Theory(RTT) is derivative of the achievement motivation theory and attempts to account for the risk preference of the individuals in situations in which the individual believes his behavior will be evaluated against some criterion of excellence and where the net results is clearly one of success or failure"(Atkinson as cited in Roberts, 1974). The presumption is that any situation that may result in an individual being able to achieve success also poses the possibility of failure. As success is accompanied by pride, so failure accompanied by humiliations. Roberts(1974) states that achievement-oriented behavior is thus "determined by the resultant of a conflict between two opposed tendencies-the tendency to achieve success and the tendency to avoid failure". The RTT focuses on the resolution of the conflict between these two opposed tendencies. There are believed to be common traits among successful athletes, which cause them to react to different situations in either positive or negative ways. Athletes either favor competitive situations and react so that they have superior performance, or they crumble under the pressure and their performance decreases.

Willis (1982) measured competitive motives (CM) in three dimensions. The power motive sub-scale (POW) was designed to measure the effect that one athletic has on another's feelings or behavior. This may be consciously or unconsciously, however, the person with the high need for power concerns themselves with their ability to influence others. Athletic is identified as a form of social power and hypothesized a link between sport participation and need for power. Some sports are seen to have more power-seeking athletes than others. The motive to achieve success (MAS) and motive to avoid failure (MAF) sub-scales were developed as achievement motivation was seen to consist of two parts, achieving success while avoiding failure. MAS was designed to focus a person desire to win and to beat others, the competitors main aim is to win the competition, personal best times and mastery goals take a back seat to his focus.

It has been identified that individuals are inclined to approach success and areas where they are likely to succeed and avoid failure or areas where they are at high risk of being defeated. Individuals high in achievement motivation (MAS&MAF) are characterized by willingness to work hard under longer objective odds, belief that personal effort makes a difference in the outcome, an interest in pursuits yielding achievement satisfaction, optimism, conscientiousness, ambition, patterns of delayed gratification and long term involvement. MAF is conceived as a capacity for reacting with shame and embarrassment when the outcome of the performance is poor. Athletes high in MAF tend to have higher anxiety and withdraw from situations where performance may be evaluated, or where risk of failure is high.

White (2003) found that the reason of participating the youth athletes in competition are sport-related motives. Reiss et al (2001) found that the reason of student's participation in physical activity and sports are competitiveness and winning.

In summary, the specific objective of this study was to study competitive motives between table tennis female university athlete students and student athletes in individual and team sports in seven Universal Olympic which was held in Isfahan, Iran in 2004.

Methodology

Population*. All female athletes who participated in Seventh Universal Olympiad Games which was held in Isfahan, Iran at the year of 2005, served as population of this study(N=965).*

*Sample .*A total of 360 female athletes from team sports (futsal, volleyball, basketball) and individual sports(table tennis, track and field, badminton), 60 of each, who participated in this games, were randomly selected as two samples for the intended purposes of this study.

Instrument

Sport Attitude Inventory (SAI) constructed by Willis (1982) was used to survey the attitudes toward the competitive motives. SAI was consisted of three sub-scales as follows: power motive, motive to achieve success, motive to avoid failure, and has 40 items which measures possible motives of athletes in above three dimensions. The scale is scored on the basis of 5 point Likert and states from strongly agree through strongly disagree. The reliability and validity of this instrument was reported to be significant.

Results

Descriptive data. Table 1 shows the mean and standard deviation of competitive motive and its three sub-scales in different sports. As the table 1 shows table tennis athletes have high mean in motive to achieve success and low mean in motive to avoid failure.

Table 1. Descriptive statistics (Mean, Standard Deviation).

sport / scale	Individual							
	Table Tennis		Badminton		Track & field		Total	
variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CM	3.63	0.42	3.56	0.33	3.8	0.4	3.59	0.38
PM	3.65	0.57	3.5	0.57	3.65	0.51	3.6	0.55
MAS	4.04	0.47	3.89	0.41	4.18	0.48	4.03	0.45
MAF	2.98	0.77	3.11	0.7	3.38	0.8	3.15	0.75
Sport / Scale variable	Team							
	Volleyball		Basketball		Futsal		total	
variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CM	3.64	0.43	3.52	0.34	3.8	0.34	3.57	0.37
PM	3.69	0.56	3.52	0.53	3.8	0.47	3.67	0.52
MAS	4.1	0.49	3.9	0.46	4.2	0.39	4.06	0.44
MAF	2.86	0.82	2.94	0.64	3.18	0.74	3	0.73

Testing hypotheses

In order to test the hypotheses that there may be a difference between the attitudes of athletes in different sports toward competitive motives, the multivariate analysis of variance (MANOVA) was used. Table 2 shows the results of multivariate analysis of variance for testing comparison of competitive motives for individual and team sports. The results of MANOVA showed that there were significant differences between student athletes' attitude toward individual and team sports in all three dimensions of competitive motive (power motive, motive to achieve success and motive to avoid failure)

Table 2. Mutivariate Analysis of Variance (MANOVA).

Variable	Source of variable	Value	F	df	df error	P
sports	Pillais Trace	0.121	2.984	15.000	1062.000	0.001
	Wilk's Lambada	0.882	3.013	15.000	972.118	0.001
	Hotelling's Trace	0.130	3.033	15.000	1052.000	0.001
	Roy's Largest Root	0.087	6.135	5.000	354.000	0.001

Therefore to find out which group is different in independent variable, a one- way analysis variance was conducted. Table 3 shows the results of ANOVA between means of independent variables with dependent variables. The results of the calculated F for all dependent variables are significant. When the mean differences of sport attitude between individual sport athletes (Table Tennis, badminton, Track and field) and team sport athletes(volleyball, Basketball, Futsal) were compared, the post hoc- test showed that the differences were significant (table 4, 5). In PM there is significant difference between badminton athletes with futsal players. In MAS there were significant differences among badminton athletes with track and field and futsal athletes; track and field athletes with basketball athletes; and basketball athletes with futsal athletes. In MAF there were significant differences between table tennis athletes and track and field players; track and field athletes with volleyball and basketball athletes. However, when the mean scores of sport attitude of table tennis athletes were compared with athletes in other sports, no differences were reported to be significant.

Table 3. The results of ANOVA of independent variables (individual and team Sports) with dependent variables (PM, SM, FM).

Scale / Source	variable	SS	df	MS	F	sig
Sports	PM	3.793	5	0.759	2.573	0.026
	MAS	5.526	5	1.105	5.267	0.001
	MAF	10.519	5	2.104	3.729	0.003

Table 4. Comparison of means between different sports in PM by post-hoc test.

Variable	Sports	mean	Table tennis	Badminton	Track & field	Volley-ball	Basket-ball	Futsal
			3.652	3.502	3.656	3.698	3.523	3.804
Power motive	Table tennis	3.652	-	-0.004	-0.042	-0.045	-0.129	-0.151
	Badminton	3.502	-	-	-0.154	-0.195	0.020	0.301*
	Track and field	3.656	-	-	-	-0.041	0.133	-0.147
	Volleyball	3.698	-	-	-	-	0.175	-0.105
	Basketball	3.523	-	-	-	-	-	-0.280
	futsal	3.804	-	-	-	-	-	-

* significant at p<.05

Table 5. Comparison of means between different sports in MAS by post-hoc test.

Variable	Sports	mean	Table tennis	Badminton	Track & field	Volleyball	Basketball	Futsal
			4.049	3.890	4.188	4.104	3.909	4.208
motive to achieve success	Table tennis	4.049	-	0.158	-0.1392	-0.0559	0.1392	-0.1598
	Badminton	3.890	-	-	-0.2980**	-0.2147	-0.0196	-0.318**
	Track and field	4.188	-	-	-	-0.083	278*	-0.020
	Volleyball	4.104	-	-	-	-	0.1951	-0.103
	Basketball	3.909	-	-	-	-	-	-0.299**
	futsal	4.208	-	-	-	-	-	-

* significant at p<.05 ** significant at p<.001

Table 6. Comparison of means between different sports in MAF by post-hoc test.

Variable	Sports	mean	Table tennis	Badminton	Track & field	Volleyball	Basketball	Futsal
			2.981	3.112	3.381	2.868	2.947	3.184
motive to avoid failure	Table tennis	2.981	-	0.130	-0.40*	0.113	0.034	-0.20
	Badminton	3.112	-	-	-0.269	-0.243	0.165	-0.07
	Track and field	3.381	-	-	-	0.513**	0.434*	0.197
	Volleyball	2.868	-	-	-	-	-0.078	-0.31
	Basketball	2.947	-	-	-	-	-	-0.23
	futsal	3.184	-	-	-	-	-	-

* significant at p<.05 ** significant at p<.001

Discussion and conclusion

Based on the findings of this study, it was found that there were significant differences in competitive motive of table tennis student athletes and other student athletes in intended sports. In other words, sports activities were influential factors to improve competitive motives.

These results are compatible with the findings of White(2003), Reiss et al(2001), Jones et al(2001), Gill and Deeter (1988). The results of these researchers suggest that an athletes attitude and beliefs consider as two important factor when they trying to achieve success.

The results of this study showed that the mean of sub-scales of competitive motives of the table tennis students were not in optimal level. In motive to avoid failure this mean is lower than the two other dimensions (power motive, motive to achieve success). The risk of doing poorly in a situation has tremendous effects on many athletes participation in sporting events. Individuals may be so high in MAF that they ultimately end up stopping their sports and leading a sedentary lifestyle. Identifying a strong MAF in athletes at any level can alert coaches and trainers to the areas that need to be focused on. Perhaps relaxation techniques that the athlete could use, or reducing the emphasis on winning to personal goals and achievements could help maintain high levels of participation.

Since all student athletes in individual and team sports must improve their competitive motives to advance their performances, it is, therefore, recommended that the coaches and team psychologists provide rich environment for athletes in different sports to help them identify and improve these competitive motives. This probably may help the athletes to maximize their potential and transcend the negative effects while maximizing the positive benefits of the intended traits such as power motive, motive to achieve success, and motive to avoid failure. Considering these traits may help them to improve their high anxiety, low stimulation and high competitive drive.

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INQUIRY INTO THE COLLEGE TABLE TENNIS ATHLETES' COMPETITIVE BURNOUT AND CONFIDENCE

Abstract

What I wish to show in this paper were: 1. to compare the differences of competitive burnout and confidence of college table tennis athletes with different demographic variables, and 2. to explore the relationship of college table tennis athletes' competitive burnout and confidence. One hundred and fourteen college table tennis athletes (male 63, female 51) were recruited and administered the Competitive Burnout Inventory and the Inventory of Confidence. The material in this paper was analyzed by independent t-test, independent one-way ANOVA, and Pearson product-moment correlation. The following results were obtained: 1. Male athletes had higher scores of "devaluation by coach and teammates", and "confidence" than those of female athletes. 2. National level athletes had higher scores of "psychological withdrawal" than those of national-game level athletes. 3. The athletes who practiced 6-7 days a week had higher scores of "devaluation by coach and teammates" than those of the athletes who practiced 4-5 days a week. 4. There were positive correlations between "confidence" and "the perception of personal sport performance" of competitive burnout, while there were negative correlations between "self-confidence" with "emotional and physical exhaustion" and "negative self concept of sport ability".

Key words: *college table tennis athletes, competitive burnout, confidence*

Introduction

University/ college athletes are the top sports players in our country. As regards, creating a team which represent by a nation, the university or college athletes possess most important status. Therefore, whether sports players continue to join the sports practices will influence the national sports by enhancing the sports status. Gould et al. (1996, 1997) found that the interaction of personal factors and environment will cause burnout. Besides, other study found losing interest in sport and the stress from coaches, parents or teammates are the main factors associated with burnout (Cohn, 1990; Silva, 1990; Weinberg & Gould, 1995). Coping with competitive stress or adjusting emotionally in competitive situations is important for athletes. Smith (1986) considered that burnout and stress were closely related. Since colleges are the foundation training center of great athletes, understanding the psychological experience and development of coping strategies will be important issues for physical education development. Raglin and Morgan (1989) demonstrated that 47% of athletes had the experience of competitive burnout. Athletes express that the reasons for burnout include exacting training, exhaustion, analeptic time is not enough and no responsibility. The development situation of the domestic athlete of college at present, influence it to participate in the main reason why the movement trains continuously, relate to psychological factor mostly (Raedeke, 1998; Raglin & Morgan, 1989). And participate in a great deal of influence athletes in the psychological factor of training or competition continuously, self-confidence is it influence important psychological characteristic that sport display, lack self-confidence is it can cause negative influence to display to sport to consider. Display to successful sports but the speech, and technology is very important at the speed, strength, but lack self-confidence in the contest, will make these relevant factors damaged (Mahoney et al., 1987). Self-confidence is unstable and transient for athlete, but it may influence the athlete's behavior, so before improving the athlete's self-confidence, at first should find out about the intension of its movement self-confidence and mechanism of operation, the coach or the sport psychologist can offer the tactics to these directions after understanding.

Other factors such as training from an early age, overtraining and cognitive appraisal may also contribute to burnout in sport.

Some scholars (Liao, 2003; Shane, 2000; Vealey, 1988) indicated that age, sex, sports type will affect athletes' confidence. Shia and Lu (2002) discussed the burnout of college tennis players by sex, training time and age. They found that age and training time will influence mood and staleness.

Definition of Terms

1 Negative self-concept of sport ability: Frustration that may occur from participating in sport activities.
2 Devaluation by coach and teammates: Negative feedback or evaluation from coach and teammates.
3 Psychological withdrawals: No response to problems due to stress.
4 Perception of personal sport performance: The expected sports achievements and satisfaction from coach.
5 Emotional and physical exhaustion: The emotion and exhaustion cause by sports participating.
6 Self-confidence: Referring to the athlete can reach the ability to succeed, the faith or degree that is sure of generally held to them in sports.

Methods

Description of Subjects

The subjects in this research consisted of two major groups from universities in Taiwan. The groups included top ten national (international) level collegiate athletes and national game athletes from Physical Education departments of universities. The players range from novice to intermediate and from advanced to elite athletes. Additionally, there were 82 males and 70 females (N=152) in this study (see Table 1).

Table 1 Sample distribution

Background	Classification	N	Percentage
sex	Male	82	53.9%
	Female	70	46.1%
Competition level	National level	33	21.7%
	National game	119	78.3%
Days of practice per week	Less than 3 days	15	9.9%
	4-5 days	101	66.4%
	6-7 days	36	23.7%

Research Instruments

The research instruments were Competitive Burnout Inventory and the Inventory of Self-Confidence. A pretest of these inventories was answered by coaches and athletes. By using the pretest, we can confirm the content's validity. When executing the inventory test, the authors explained test procedures to control for consistency.

The Competitive Burnout Inventory of this research was developed by Lu et al (2001). The main purpose of this inventory is to measure the degree of competitive burnout. There are 25 criteria to measure competitive burnout. The criteria include five factors: Negative self concept of sport ability, Devaluation by coach and teammates, Psychological withdrawal, Perception of personal sport performance and Emotional and physical exhaustion. Attitudes to each of the service attributes used in the inventory were assessed using a seven-point Likert scale anchored by the level of

"1 = never" to "7 = always". The total reliability of this inventory is 66.73%. The consistency of each factor is presented by Cronbach α, with values ranging from 0.68 to 0.92.

This scale is using the confidence scale in the development of athletic cognitive pattern scale which (1993) establishes by Liao, Z. M. (9 topics) carries on executes measured. Foundations of the people Mahoney that Liao, Z. M. is main (1988) Sport psychological for technical staff for five editions of questionnaires (Psychological Skills Inventory for Sport, whether R-5; PSIS-5) Revise but become "The scale of confidence meter of 36 question editions of the development of athletic cognitive pattern scale. This quantity scale adopts the model of seven-point scale anchored by the level of "1 = disagree extremely" to "7 = highly agree". In the confidence level test aspect of, by Cronbach is using α to test an internal uniformity of this scale, the confidence level is 0.78. In the validity level test aspect, this scale distinguishes validity level analysis discrimination outstanding group 35 by the area with common group 28, and the result two groups of differences reach the remarkable standard, indicated has the good validity. (Liao Zhumin, 1993).

Results and Discussion

The purposes of this study were: 1. to compare the differences of competitive burnout and confidence of college table tennis athletes with different demographic variables, and 2. to explore the relationship of college table tennis athletes' competitive burnout and confidence.

1. The difference between male and female athletes' competitive burnout and confidence

Table 2 shows the difference between male and female athletes' burnout and confidence. "Devaluation by coach and teammates" and "Perception of personal sport performance" showed males scored significantly higher than females. This result agrees with Gill (2000) and Shia and Lu (2002). Males believe their ability is better than females, but the evaluation estimated by coaches and teammates is negative.

Table 2 The difference between male and female athletes for competitive burnout and confidence

Variable	Sex	N	Mean	SD	t-value	p-value
Emotional and physical exhaustion	Male	82	26.63	7.00	-0.66	.512
	Female	70	27.37	6.78		
Perception of personal sport performance	Male	82	36.68	8.74	2.28*	.024
	Female	70	33.86	6.52		
Psychological withdrawal	Male	82	14.17	3.41	0.95	.342
	Female	70	13.67	2.98		
Devaluation by coach and teammates	Male	82	13.87	5.39	3.36*	.001
	Female	70	10.90	5.47		
Negative self concept of sport ability	Male	82	39.82	3.58	-0.99	.323
	Female	70	39.03	3.33		
Confidence	Male	82	28.17	6.37	0.79	.431
	Female	70	28.83	5.85		

*p < .05

2. The analysis of competitive burnout and confidence for different competitive levels

Table 3 shows that "Psychological withdrawal," "is significantly different between the levels of competition. The national level athletes' scored higher than the other competition level. The result shows the national-level athlete in the face of more taking the responsibility of arranging, relatively shrink back psychologically.

Table 3 The competitive burnout and confidence of comparison by athletes' level

Variable	level	N	Mean	SD	t-value	p-value
Emotional and physical exhaustion	National level	20	27.65	9.06	0.78	.435
	National game	94	26.36	6.08		
Perception of personal sport performance	National level	20	38.00	10.62	1.81	.072
	National game	94	34.61	6.81		
Psychological withdrawal	National level	20	15.70	3.15	2.73*	.007
	National game	94	13.55	3.20		
Devaluation by coach and teammates	National level	20	13.05	6.56	0.67	.503
Confidence	National level	20	38.50	11.38	1.78	.078
	National game	94	34.66	8.14		

*p < .05

Considering training time, Table 4 demonstrates that "Devaluation by coach and teammates" is a significant variable related to competitive burnout and confidence. Because athletes often train together with coaches and teammates at practice, the negative evaluation of athletes may occur more easily and frequently. The results also shows that the emotion expressiveness of athletes who training 6-7 days per week are better than 4-5days per week. From the research, athletes spend more time on the practices; they will have more confidence to win the game. As a result, the practices help athletes to build their confidence. Comparing to the athletes who spend less time on practices, athletes' confidence is different than sportsman who spend more time on their practices. For the teamwork, it has some problems to communicate with couches and team-members. From the research, athletes spend more time on the practices; they will have more confidence to win the game. As a result, the practices help athletes to build their confidence. Comparing to the athletes who spend less time on practices, athletes' confidence is different than sportsman who spend more time on their practices. For the teamwork, it has some problems to communicate with couches and team-members.

Table 4 The competitive burnout and confidence comparison by training time

Variable	Days	N	Mean	SD	F-value	p-value	post hoc
Emotional and physical exhaustion	Less than 3 days	15	25.27	5.30	5.47*	.005	6-7＞4-5
	4-5 days	101	26.09	6.55			
	6-7 days	36	30.17	7.52			
Perception of personal sport performance	Less than 3 days	15	36.80	9.45	0.40	.673	
	4-5 days	101	35.02	7.74			
	6-7 days	36	35.81	7.81			
Psychological withdrawal	Less than 3 days	15	15.07	4.06	1.31	.272	
	4-5 days	101	13.69	3.15			
	6-7 days	36	14.17	3.00			
Devaluation by coach and teammates	Less than 3 days	15	10.53	4.75	7.38*	.001	6-7＞4-5＞3
	4-5 days	101	11.74	5.39			
	6-7 days	36	15.44	5.61			
Negative self concept of sport ability	Less than 3 days	15	10.33	2.58	0.81	.445	
	4-5 days	101	10.23	3.38			
	6-7 days	36	11.08	4.01			
Confidence	Less than 3 days	15	38.27	4.77	3.47*	.034	6-7＞4-5
	4-5 days	101	38.81	6.20			
	6-7 days	36	41.75	5.98			

*p < .05

3. The correlation between table tennis athletes' competitive burnout and confidence

Table 5, shows the relation between "Confidence" and "Emotional and physical exhaustion" with "the movement ability negative self-concept" have the inverse correlation existence, "Individual movement performance consciousness presents" is being connected. Show the higher athlete's confidence of table tennis is, can relatively feel satisfied with one's own sport achievement, have spirit relatively, can raise the self-image and is it succeed in to feel in sport; and will not feel tired, depressed and mood is abominable, do not deny one's own concept to emerge even more.

Table 5 The correlation matrix between competitive burnout and confidence

variable	Emotional and physical exhaustion	Perception of personal sport performance	Psychological withdrawal	Devaluation by coach and teammates	Negative self concept of sport ability
Confidence	-0.24*	0.38*	-0.12	-0.08*	-0.44*

*p<.05

Conclusions and Suggestions

Conclusions

The purposes of this study were: 1. to compare the differences of competitive burnout and confidence of college table tennis athletes with different demographic variables, and 2. to explore the relationship of college table tennis athletes' competitive burnout and confidence. The findings were as follows:

1. Male athletes had higher scores of "devaluation by coach and teammates", and "Perception of personal sport performance" than those of female athletes.
2. National level athletes had higher scores of "psychological withdrawal" than those of national-game level athletes.

3. The athletes who practiced 6-7 days a week had higher scores of "devaluation by coach and teammates" than those of the athletes who practiced 4-5 days a week. Also the athletes who practiced 6-7 days a week had higher scores of "devaluation by coach and teammates" than those of the athletes who practiced less than 3 days a week.
4. There were positive correlations between "confidence" and "the perception of personal sport performance" of competitive burnout, while there were negative correlations between "self-confidence" with "emotional and physical exhaustion" and "negative self concept of sport ability".

Suggestions

1. The coaches should counsel athletes based on their background for reducing their sports burnout.

The results of this research suggest that the degree of athletic burnout occurring by male athletes is higher than female athletes. This may be due in part to the intensity of competitiveness. The more competition the more pressure the athlete feels. Therefore, the competitive burnout for sportsmen will occur. Coaches should offer male athletes counseling for avoiding pressure when training. Secondly, the athletes who have more time to train will respond with higher scores in the criteria Emotional and physical exhaustion and Devaluation by coach and teammates. Heavy training will make athletes feel exhausted and could attract coaches or teammates negative evaluations. Therefore, planned training will enhance the performance of athletes.

2. The coaches should counsel athletes on dealing with pressure.

To be successful, the athlete needs to know how to deal with pressure. The pressure is not only from themselves, but also from coaches, teammates or parents. In a violent competitive environment, athletes must be flexible to handle pressure. Letting go of issues will help the athlete avoid burnout.

3. Coach should assist the athlete to establish the self-confidence and the guidance in accordance to the competition pressure strategy

This research most important discovery nothing better than discovery self-confidence and the competition pressure may effective forecast athlete's athletics be tired in accordance to the strategy, this findings will be worth in the future all levels of training attention, i.e. no matter what kind of level's contestants need to teach the effective psychological skill each skill, by the effective skill, may depressurize produces to the movement tired influence, not only will have positive being of help to the result promotion, simultaneously can also lengthen athlete's movement life.

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MODEL OF SPORT MOTIVATION

Abstract

Motivation for sport activities has become very popular area in the field of sport psychology. Researchers are trying to find the basic determinants of motivation for physical activities. Some very interesting problems have occurred since they did not separate the phenomena of level of involvement in sport quite exactly. Some of the researchers have researched top sports, others college sports or other forms of fitness and recreation activities. Their approaches are mostly also very partial and just directed in investigating localised problems. But the motivation is very wide. We are trying to see motivation as very complex phenomena, which must be researched freely with all its correlating variables.

Motivation variables of elite Slovenian athletes and young Slovenian athletes (age 12-14) in 9 different sport disciplines have been obtained, among them also table tennis. Motivation included achievement motivation, incentive motivation, participation motivation, goal orientations, satisfaction and enjoyment in sport, self-efficacy, effort and ability attributions etc. The most popular framework for motivation in sport at the moment is social cognitive perspective. The aim of this study was to form a dynamic interactive model of sport motivation. We tried to upgrade different models of motivation to one unique model, which would explain all possible behaviours and motivation in sport situation.

Success in competitive sports depends mostly on athlete's skills, personality and motivation. Motivation became very popular lately in the last two decades and many of researches were conducted to investigate determinants of motivation. The presence of "zeitgeist" social cognitive perspective in psychology has changed the view on motivation for sport. On the base of these results we established the model of motivation, which helped us to improve motivation.

Key words: *table tennis, motivation*

INTRODUCTION

Success in competitive sports depends mostly on athlete's skills, personality and motivation. Motivation became very popular lately in the last two decades and many of researches were conducted to investigate determinants of motivation. The presence of "zeitgeist" social cognitive perspective in psychology has changed the view on motivation for sport. Social cognitive approaches became the main framework for investigation of sport motivation. Social cognitive prospective started with the work of Weiner (1971) and is built around expectancies and values, that individuals attach to different goals and achievement activities. Today, we can divide the social cognitive approach to three mini theories:

- the theory of self-efficacy (Bandura, 1977, 1986)
- the theory of perceived competence (Harter, 1980) and
- the theory of goal perspectives (Nicholls, 1981, 1989; Dweck, 1986; Maehr & Braskamp, 1986).

The motivation is very wide. We are trying to see motivation as very complex phenomena, which must be researched freely with all its correlating variables. Self-efficacy (Bandura, 1977, 1986) is a common cognitive mechanism for mediating athlete's motivation, thought patterns and behavior. Self-efficacy construct has been used to explain achievement behavior in sport. Self-efficacy beliefs and expectations are defined as *athlete's judgments of their capability to perform at certain levels. It is a conviction that an athlete needs to successfully execute the behavior necessary to produce a certain outcome. It is athlete's assessment what he/she can do with his/her ability*. Different studies indicate that self-efficacy has a positive effect on performance in individual sports (Feltz, 1982; Lee, 1988), in muscular endurance tasks (Weinberg and coll., 1981), but it is a question of relation between self-efficacy and collective efficacy and collective performance in group sports.

Harter (1981) tries to explain why people want to participate in achievement situation. A prediction of Harter's model is that children who perceive themselves competent in sport should be likely to participate in sport. Roberts and coll. (1981) and Feltz & Brown (1984) found this relationship very weak, so Roberts (1992) suggests that there are many different reasons for children's participation in sport.

Participation and persistence in sport, the choice and intensity of training and participating are goal directed (Duda, 1992). The goal is subjective and the effect of multiplicity of different goals is presented in the process of motivation. The success and failure in the performance are not always defined according to wining or losing in the competition (Maehr and Nicholls, 1980). There are two major goal perspectives or ways of defining success:

- task involvement or goal orientation (the focus is on learning, improvement and meeting the demands of the activity: "trying to do athlete's best", "to perform perfect" etc. to reach personal goals, where perceived competence is self-referenced and the subjective experience of personal improvement and task mastery defines success),
- ego involvement or win orientation (the focus is on wining, "being the best" and showing the superiority over others is the primary goal; perceived competence is normatively-referenced and depends on comparison of one's ability to others).

According to Nicholls (1989), the major goal of achievement behavior is to demonstrate ability and avoid the demonstration of low ability. The development of task and ego goals is a direct result of an emerging capacity to differentiate ability from effort as causal attribution of success and failure. *Task goals* are related to mastery, co-operation, sportsmanlike behavior, enjoyment and the belief that *effort* lead to success in sport (Duda & Nicholls, 1992). Ego goals are related to unsportsmanlike behavior, aggression and the belief that high ability leads to success (Duda and White, 1992).

Socialization appears to be the most determining factor of athletes' ego and task involvement. The parents and coaches become very important in building motivational climate (Roberts, 1984, 1992), which directs athlete's goal perspectives. The sport setting is characterized by an increasing emphasis on competitive outcomes and normative ability as the athlete moves through the sport system (from junior to top athlete). Achievement orientation is a function of both development differences and situational constraints (Duda, 1992).

The participation motivation approach is focused on the reasons why people engage in sport and continue in their athletic participation (Gill, Gross & Huddleston, 1980; Gould, Feltz & Weiss, 1985). Different researchers have found mainly 5 to 8 primary goals or incentives for participating in sport. These are: achievement, team, friendship, fitness, energy release, skill development and fun. Nicholls theoretical work (1989) suggests that there is a link between goal orientations and participation motives. Dispositional goal perspective that an athlete brings to a particular situation will impact on athlete's motivation. Susan Butt (1979, 1985 and 1987) constructed a similar measurement to assess various motivational and personality dispositions in sport. It associates scales for aggression, conflict, competence, competition and co-operation as the important reasons of motivation in sport.

In this study we tried to form a dynamic interactive model of sport motivation. We tried to upgrade different models of motivation to one unique model, which would explain all possible behaviors and motivation in sport situation.

METHOD

Sample:

The sample included all together 360 Slovene athletes. 170 athletes were between 17 and 30 years old (representatives of Slovenian national teams in basketball, football, handball, ice hockey, water polo, table tennis, ski jumping, alpine skiing, sport climbing, judo) and 190 boys between 12 and 14 years, young perspective athletes, who practice and train their sport in sport clubs at least three years. Four main sub samples have been made: top athletes in individual sports (TI) (N=80), top athletes in group sports (TG) (N=90), young athletes in individual sports (YI) (N=70) and young athletes in group sports (YG) (N=120).

Instruments*:*

Many different motivational variables have been measured such as:

- Perceptions of demonstrated ability, effort and self-efficacy. (Tušak, 1997) All those constructs were measured on 5-point Lickert scale. There was one question regarding ability: *"What part of your accomplishment on the competition is the consequence of your ability?"* and two questions for measuring effort: *"How strong do you try on the competition?" and "How much effort do you put into the competition?" .* There were also two items for measuring self-efficacy*: "How good do you think you compete in your sport?" and "How good are you in your sport discipline?" .*
- Sport satisfaction and enjoyment (Tušak, 1997) was obtained. Subjects had to evaluate their satisfaction with training, satisfaction with results, with participation and performance and with possibilities for training on a 5 point Lickert scale.
- Expectations of results and success (Tušak, 1997) (now, in the future and in the whole carrier) was measured with a 5 point Lickert scale.
- Sport Attitudes Inventory (Willis, 1982) has been used to asses constructs related to sport behavior and competitiveness on the competition. The first scale POWER motive stands for desire to have an impact on other people's behavior or feelings. Achievement motivation on the competition is represented by individual's inclination to achieve success (MAS scale-motive to achieve success-positive competitive motivation) and to avoid failure (MAF scale-motive to avoid failure-negative competitive motivation).
- Costello (1967) nAch questionnaire, which measures 2 achievement orientations: the need to achieve success with your own work and the need to achieve success regardless of your work.
- Sport Orientation Questionnaire (Gill, Deeter, 1988) was developed to asses the disposition to strive for success in competitive sport activities. The SOQ contains 25 items incorporating three subscales:
    1. competitiveness (tendency to seek out or avoid the competitive situation)
    2. win orientation (the desire to win in interpersonal competition in sport)
    3. goal orientation (the desire to reach personal goals in sport).
- Sport Motivation Scales (Butt, 1979) contains 50 items and was developed to asses various motivational and personality dispositions in sport. It measures total score and 5 different sources and incentives of motivation for sport activities: aggression, conflict, competence, competition and co-operation.
- Self Motivation Inventory (Dishman, Ickes & Morgan; 1980)
- Task end Ego Orientation Sport Questionnaire (Duda, 1989) with measures *ego and task orientation*
- Scale of motives for competition (Youngblood in Suinn,1980) with total score and 19 different subscales of incentives
- Participation Motivation Questionnaire (Gill, Gross & Huddleston, 1983) with the list of 30 motives for participation in sport and 6-factors latent structure:

fitness and recreation motive, development of abilities, success and achievement, health, progression motive and challenge, experience of arousal and individuality, team atmosphere and friendship.

On the base of these 6 factors, two new ones (of second order) were extracted: general participation motivation and specific participation motivation.

Procedures:

Subjects were requested to complete questionnaire items after the investigator had read the instructions. Analysis of variance were used for investigating differences between groups, discriminant analysis were used to establish differentiation model of motivation and factor analysis were used to set the model of motivation in sport.

RESULTS

Discriminant analyses were made. Reduced set of following variables were put into the analysis:
ability and effort attribution of success (**ABILITY**), goal orientations (ego and task orientation, win and goal orientation) (**EGO ORIENT., TASK ORIENT, WIN ORIENT., GOAL ORIENT**.), competitiveness (**COMPETITIV**), nAch motivation (need to achieve success with work or no matter of work) (**+nAch, -nAch**), achievement motivation for competition **(MAS, MAF, POWER** motive), self-motivation (**SELF-MOTIV**), self-efficacy expectations (**SELF-EFFICACY**), success and result expectations (**EXPECT.SUCCESS**), general and specific participation motivation (**GENERAL I., SPECIFI I.),** total score of motivation for competition (**TSMC**), total score of motivation from 5 different sources on Sport Motivation Scales (**TSSMS**), sport satisfaction and enjoyment (**ENJOYMENT, SAT**).

Table 1: Canonical discriminant functions

Fkc	Eigen value	Pct. Var.	Cum Pct	Canon. korr.	Fkc	Wilks' Lambda	hi-sq.	dF	sig.
					: 0	.166964	553.10	162	.000*
1*	1.5214	57.69	57.69	.7768	: 1	.420976	267.34	106	.000*
2*	.7842	29.74	87.43	.6630	: 2	.751124	88.43	52	.001*
3*	.3313	12.57	100.00	.4989	:				

Table 2: Structure matrix

	Function 1	Function 2	Function 3
ENJOYMENT,SATISF.	.48677*	-.10544	.38422
TSSPS	.39672*	-.19330	-.36987
TSMC	.39014*	.07771	-.02267
MAF	.21718*	-.09374	-.15156
SELF-MOTIV.	-.20962*	-.17793	.05677
TASK ORIENT.	.11085*	.03913	.05779
MAS	.09082*	.01218	.08044
WIN ORIENT.	-.01330	-.46297*	-.24388
EGO ORIENT.	.07343	.43211*	-.03300
GENERAL I.	-.24869	.31456*	-.01018
COMPETITIV.	.02047	-.23558*	-.10091
+nAch	-.02167	.11644*	-.00808
POWER	-.07769	-.11193*	-.03731
ABILITY	.03800	.09608*	-.04903
SELF-EFFICACY	.14825	-.18373	.47440*
GOAL ORIENT.	-.02043	.09010	-.32096*
SPECIFIC I.	-.07897	-.01931	.30481*
-nAch	.11212	-.01492	.26141*
EFFORT	-.08817	-.04528	.13845*
EXPECT.SUCCESS	.06401	.04887	.09845*

Table 3: Group centroids and canonical discriminant functions

Group	Function 1	Function 2	Function 3
YG	1.09825	-.26010	-.22630
YI	.35040	.71670	.58227
TG	-.92509	-.77231	.24975
TI	-.97494	.57201	-.44771

Table 4: FA of reduced set of motivation variables (PC analysis, varimax rotation)

Factor	Eigen Value	% of Var.	Cum. % of Var.
Intrinsic achievement motivation	5.48	27.4	27.4
Self-regulatory mechanism, cognitive mediators of motivation	2.15	10.7	38.2
Achiev. orientation, personal characteristics of Ach. behavior	1.42	7.1	45.2
Extrinsic achievement motivation	1.27	6.3	51.6
Incentive system of general motivation	1.08	5.4	57.0
Incentive system of specific motivation (ind.m. and thrill exp.)	1.01	5.1	62.0

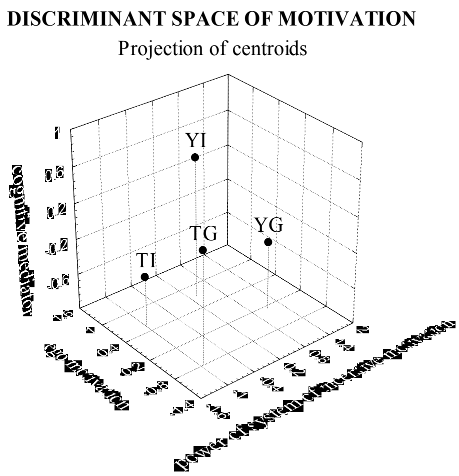
Table 5: Saturation of factors with manifest motivation variables (only correlation coefficients > 0,40)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
SELF-MOTIV.	0.77					
+nAch	0.73					
POWER	0.61					
MAS	0.59					
EFFORT	0.55	0.42				
TASK ORIENT.	0.49				0.43	
SELF-EFFICACY		0.81				
ENJOYM.,SATIS.		0.79				
EXP.SUCCESS		0.67				
ABILITY		0.58				
WIN ORIENT.			0.80			
COMPETITIV.			0.79			
GOAL ORIENT.			0.77			
TSSMS				0.68		
MAF				0.68		
-nAch				0.66		
EGO ORIENT.				0.52		
TSMC				0.38		
GENERAL I					0.83	
SPECIFIC I.						0.85

DISCUSSION

Analysis of univariate differences showed the existence of important differences among all four groups of athletes in self-efficacy, win orientation, ego orientation, negative nAch motivation, self-motivation, enjoyment, and specific factor of participation motivation, total scores of motivation for competition and in 5 subscales.
Discriminant function 1 includes motivation, which originates from incentive systems that are very attractive, important and useful for athletes. It is their intensity and their power, which is important for an athlete. These attractive motives stimulate athlete's activities. Discriminant function 1 includes also negative nAch motivation and enjoyment in sport, but on the other side it indicates the absence of self-motivation and inherent control in motivation process. First discriminant function indicates on the

"pull motivation", like attractive incentive systems, the usefulness of motives for competition, feeling of some emotions and expressing some personal dispositions. We could name the first function **the power of incentive motivation**. The second discriminant function includes general participation motivation (fitness and recreation motives, development of abilities, success and achievement, health, progression motives and challenge, team atmosphere and friendship), ego orientation and positive nAch motivation, but on the other side the absence of win orientation (which is related to group tasks and group directed goals and activities, such as co-operation) and competition. We can name this function **Ego motivation.** We found the most important correlations of third function with self-efficacy, total score of enjoyment in sport and specific motives for participation (motives to experience thrill, arousal and individuality) and expectancies of success (in present and in the future). On the other hand, the function is negatively correlated with goal orientation and motives for power. The function could be named **Cognitive mediators** of motivation.



Picture 1: Projection of centroids for groups in 3 dimensional discriminant space of motivation

Function *the power of incentive motivation* discriminates the most between young athletes in group (YG) and individual sports (YI) on one side (highly expressed) and top athletes in individual (TI) and group sports (TG) on the other side (less expressed). Function *ego motivation* discriminates between athletes in individual sports (TI and YI with high scores) and athletes in group sports (TG and YG with low score). It is quite hard to find an explanation for discrimination of function 3 *(cognitive mediators).* TI and YG reach higher results than YI and TG.

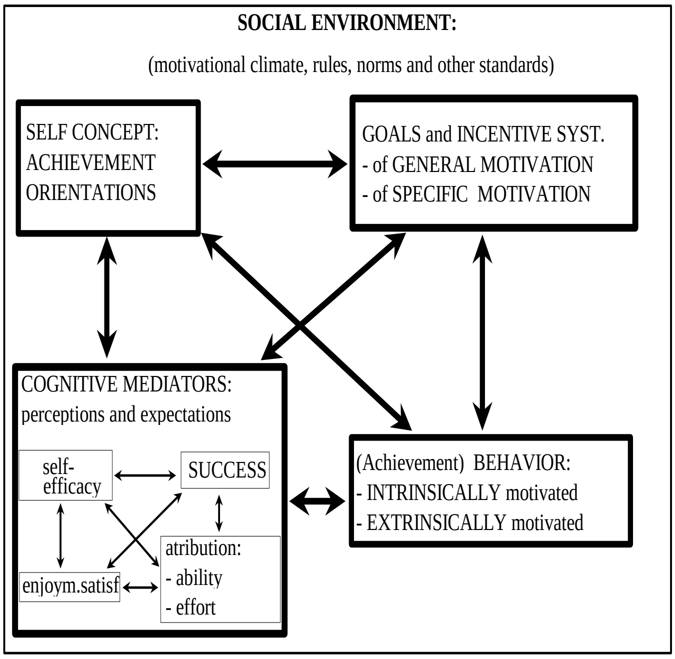
Analysis of motivational structure gave us quite clear model. The first factor represents the most positive component of motivation in sport. The aim of such motivation is to achieve success. An athlete is aware that sport results depend on athlete's hard work and effort. Such an athlete is motivated by hard work (which he/she invests into the practice and competition), by progress, learning and development of abilities. Such an athlete has a strong intrinsic control and is self-motivated and goal oriented, he is also motivated by the possibility to influence other participants in sport. This factor could be named **intrinsic (positive) achievement motivation** (Atkinson, 1964; Weiner, 1972). Results showed that this factor is the most important factor of motivation in sport as it explains almost 30 % variance. This intrinsic achievement motivation is also the most self-determined (Deci and Ryan, 1991).

Second factor includes variables related to mediators of motivation. The role of self-efficacy as the mediator in the process of motivation was mentioned by many researchers (Locke, Motowidlo and Bobko, 1986; etc.). Higher degree of self-efficacy leads to stronger goal setting and searching for more challenging goals which dictate stronger motivation. Even Bandura (1986) inside his concept of cognitive motivation, which is goal oriented, located self-efficacy in the sphere of mediator. Very similar approach was used for explaining motivation in sport by Dzewaltowski (1994) with his concept of sport enjoyment and satisfaction in sport as one of the cognitive mediators of motivation. Satisfaction and enjoyment represent the emotional self-evaluation which is one component of self-regulatory influences (Bandura, 1989). Self-regulatory influences and experienced satisfaction in sport are important motivators in sport (Scanlan, 1989; Wankel, 1993). Especially Bandura (1989) and Dzewaltowski (1994) suggest that anticipating sport satisfaction and enjoyment (which go together with reaching athlete's goals) have a strong impact on athlete's self-regulation. Inside the concept of self-regulation constructs we can find also the attributes of success (ability and effort perceptions). Nicholls (1984) emphasizes self-concept of ability, Harter (1981), Maehr & Braskamp (1986) about perceived competence, Bandura (1977, 1989) about self-efficacy. Attributes of success represent the central mediator process in motivational situation. Cognitive representations of all those mentioned concepts of the second factor participate in athlete's self-regulation process of motivation. This second factor represents Bandura's (1989) construct of self-efficacy expectations and cognitions related to self-reactive influences in the context of process of self-regulation. We should not forget the expectancies of success, which represent one of the three basic cognitive processes related to sport activities (Bandura, 1992), and impacts athlete's perceptions of self-efficacy and competence (Tušak, 1997). This factor could be understood as **self-regulatory skills, self-reactive influences or cognitive mediators of motivation.** Higher values on the second factor (Bandura, 1986) result in higher motivation behavior. High self-efficacy, clear expectations of results and defined attributes of success lead to optimal cognitive motivation, which dictate endurance in training and sport behavior (Weinberg, Gould & Jackson, 1980).

The third factor includes variables related to personal dispositions of achieving success. It represents athlete's achievement orientations in sport and training activities. We named the factor **achievement orientations** or **personal characteristics of achievement behavior**. It includes competitiveness, which discriminated between athletes and non-athletes (Gill & Dzewaltowski, 1988), win orientation (includes tendency to win in interpersonal competition) and tendency to reach important personal goals through participation in sport (goal orientation). Inside the concept of social-cognitive prospective (Bandura, 1986 and Dzewaltowski, 1994) we can find achievement orientations as personal determinants of sport activity, which were researched also by Dishman (1980) concept of self-motivation. Achievement orientations are personal characteristics, but they are also affected by motivational climate, which represents athlete's social environment and the influences of athlete's process of socialization.

The structure of fourth factor is quite unclear. It includes negative achievement motivation, ego orientation and total scores of incentive systems. It suggests a kind of **external and extrinsic achievement motivation**. Externally motivated athletes are motivated with the fear of failure, they are ego oriented and they do not take care much about their own improvement and hard work. In the context of self-determined continuum (Deci in Ryan, 1991) such motivation lies somewhere on the lower level (Vallerand and others, 1993).

The fifth and the sixth factor represent the attractiveness of incentive systems in sport. Fifth factor is called **incentive systems of general motivation** and includes attractiveness of all basic participation motives (achievement, recreation, skill development, group atmosphere etc.), which motivate most of the athletes. Sixth factor is named incentive **systems of specific motivation** and include motive to experience thrill and excitement. Inside Bandura's interactive model (1986) both factors represent the incentive systems of social environment, which could be understood as athlete's "pull" motivation (Tušak, 1997).



The analysis of scree test suggests two or three factors solution. But 6-factor solution was really interesting and it would be very interesting to think about a suggestion offered by this model, that intrinsic and extrinsic motivation should be understood as two different dimensions of motivation and not just two ends of the same dimension. Results confirm that there is a possibility that an athlete expresses high or low scores on both dimensions at the same time. Very important in the present model is the dimension of cognitive process mediators, which touches personal inclinations to different evaluation of success on the competition and different evaluation of relation result-goal-success. The attractiveness of incentive systems of environment is suggested with 5.th and 6.th factor and include general participation motives and specific motives which are very characteristic for extreme and high taking risk's sports (mountain climbing, ski-jumping, alpine skiing etc.).

On the base of present results we made a contemporary model of motivation in sport. The structure of the model should also be interpreted with the help of results from discriminant analysis, which confirm some of the differences between top and young athletes. The reasons for the differences could be found in different sport climate inside top and inside young sport, so there is a question if we can talk about top and youth sport together. On the other side, we should try to find a way to upgrade different models of motivation to one unique model, which would explain all possible behaviors and motivation in sport situation. The present model should be researched inside social-cognitive perspective, inside achievement motivation approach and inside interactive dynamic process of all motivational determinants in future.

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The 10th Anniversary ITTF Sports Science Congress

Part eight:

Sociology of table tennis

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DETERMINANT FACTORS OF SPECTATOR ATTENDANCE AT THE NATIONAL TABLE TENNIS CONTEST IN TAIWAN

Abstract

In today's society, sport spectating represents a predominant form of leisure behavior. Spectator attendance was related with on-field success of players. Chinese Taipei National table tennis team's performance has been very well in international competition recently. It should attract spectators to participate the game but it was only a few audience attending table tennis tournaments in stadium. Therefore, the table tennis association has been faced with the challenge of attraction of spectator attendance. The purpose of this study was to investigate determinant factors of spectator attendance.

Participants were 120 spectators who were attending in 2006 national table tennis tournament. Table Tennis Spectator Attendance Scale (TTSAS) was used in this study. Descriptive statistic and one-way analysis of variance were chosen in the data analysis. There were 30 questions in the questionnaire which was divided into 5 factors: Performance (5 items), Facilities and environment (3 items), Finance (2 items), Promotion (6 items), and Personal factors (14 items).

The results indicated that players' performance was the top rated factor followed by personal factors, facilities and environment, and promotion. Finance was the lowest rated factor. Suggestions of this study were as follow: (1) player's performance, personal factors, facility and environment, promotion were important determinant factors of spectator attendance; (2) determinant factors were significant related with demographic factors, such as gender, age, occupation, educational levels, and salary; (3) the findings of this study should be taken into consideration in developing strategies for National Table Tennis Association in Taiwan; and (4) there is a need for further study on table tennis spectators.

Key words: *determinant factors, spectator, attendance*

Introduction

Sport participation has become a major attraction activity in leisure (Nixon & Frey, 2000). Cohen and Avrahami (2005) mentioned that sport participation can take two forms: (1) direct participation, and (2) watching sport as spectator, such as watching games at the stadium or on television. However, sport spectating represents a predominant form of leisure behaviour in today's society (Robinson & Trail, 2005; Cohen & Avrahami, 2005; Kao, 2002). Spectators often attribute to the player's performance. Like Kelly (1996) said "The players, then, may come to find their motivation in the size and enthusiasm of the watchers…" (p. 215). Hence, spectators were a very important element to fulfill a successful competition in sports.

However, to understand the factors that motive people to watch sport is a challenge for researchers and practitioners (Armstrong, 2002). McDonald, Milne, and Hong (2002) indicated that much of empirical research in sport marketing does not address many critical questions of interesting sport organization, such as what factors can be used to explain and predict spectator participation. Most of research today emphasized on psychological needs and motivations to drive spectators watch a particular sport. The four factors of spectatorship were addressed as personal needs, mental, social, and basic sport. Some studies have focused on the behavior or the factors of sport spectators relative to their identification with a particular team (Wann & Branscombe, 1993; Wann, Brewer, & Royalty, 1999; Wann & Grieve, 2005).

This study focused on variable factors that influence decisions to attend sport events. In a literature review, a few articles were found related to the determinants of spectator attendance. Hansen and Gauthier (1989) addressed that four factors affecting attendance at professional sport event were finance, promotion, demographic factors (such as age, gender, educational levels), and player's performance. Huang and Liu (2006) proposed that facility and environment, player's performance, and personal experience were important determinant factors for spectators attending games. Some studies have examined determinant variables such as finance, promotions, and personal factors on attendance at sporting events, and have studied the relationship between demographic variables and watching sports (Zhang, Hui, & Michaud, 1995; Zhang, Smith, Pease, & Jambor, 1997; Baade & Tiehen, 1990). From the previous studies, player's performance, personal factors, facility and environment, promotion, and finance were the factor to influence spectators' decisions to attend sport events. Therefore, this study examined those factors in order to understand determinant factors of spectator attendance.

In addition, Sloan (1985) noted that "motivations differ from situation to situation and from sport to sport" (McDonald, Milne, & Hong, 2002, p. 101). Thus, this study was concentrated on one particular sport—table tennis rather than to sport in general. The reason to choose table tennis was because the author was the former table tennis player and concerning the table tennis development. Moreover, Chinese Taipei National table tennis team's performance has been very well in international competition recently. It should attract spectators to participate the game but it was only a few audiences attending table tennis tournaments in stadium. The table tennis association has been faced with the challenge of attraction of spectator attendance. Nixon & Frey (2000) proposed that understanding spectator is fundamental to promote spectating rates. Unfortunately, there was very little information on the determinants factors of spectator attendance at table tennis contests. Hence, the purpose of this study was to identify the determinant factors of spectator attendance at the National Table Tennis Tournament. Furthermore, the demographic characteristics of spectators were in an effort to know reasons for attendance (James & Ridinger, 2002). Therefore, demographic variables were also to examine in relation to determinant factors of spectator attendance. Results were hoping to provide information to National Table Tennis Association and providers of table tennis events for developing strategies and increasing spectator attendance.

Method

Sample

The subjects of this study were 120 spectators, who attended the National Table Tennis Tournament from November 16 to 19, 2006. Male participants comprised 44.2 (N = 53) and females 53.3 (N =64). The participants' age was below 20 years old (38.3%), 21-30 years old (29.2%), and above 40 years old (30%). The participants' marital status was married 46.7% and single 48.3 %. The educational level of subjects had obtained 40% of college degree, 20% had obtained a high school degree, and 37.5% had obtained a junior-high degree. The income of participant was reported as 58% of the sample income below $350, 22% of the sample income from $351 to $1,000, and 30% of sample income above 1,001. The participants' occupations were: student (36.7%), public official (15.8%), businessman (14.2%), worker (5.8%), agriculturist (13.3%), and artist (11.7%).

Instrument

Table Tennis Spectator Attendance Scale (TTSAS) was developed in this study. The instrument was developed with procedure: (a) a study of related literature, (b) a list of questions, (c) three experts reviewed the instrument, (d) the pilot study.

The initial instrument contained 30 questions from related studies (Shin, 2001; Wang, 2005; Hansen and Gauthier, 1989; Zhang, Hui, & Michaud, 1995; Zhang, Smith, Pease, & Jambor, 1997; Baade & Tiehen, 1990). Three experts who represented academy in sport management and research methods from Taiwan were asked to rate each question according to a five-point Likert scale. A criterion score of 3.0 was needed in the final instrument. They were also asked to group questions into composite subscales. There were no delete questions from the instrument.

The final questionnaire was consisted 30 questions which were divided into 5 factors: player's performance (5 items), facilities and environment (3 items), finance (2 items), promotion (6 items), and personal factors (14 items). A 5-point Likert scale was used as the rating scale. The internal consistency of the scale was calculated using Cronbach coefficients: player's performance α=.91, facility and environment α=.71, finance α=.83, promotion α=.92, personal factor α=.92.

Procedure

1. Pilot Study

The pilot study was conducted on October 22, 2006. Sixty of the spectators, who were watching the National Table Tennis Chairman Cup competition, were participated in the pilot study. These participants were excluded from the formal research project. The Cronbach coefficients α was used to test the internal consistency: Performance α=.87, Facility and environment α=.68, Finance α=.81, Promotion α=.91, Personal factor α=.89.

2. Formal Study

The questionnaire method was utilized in this study to identify determinant factors of spectator attendance. Students assisted with the distribution and collection of the questionnaire at the contest. Students were trained to explain and collection data before the competition. Students were placed at alternating entrances to seating areas in the stadium. The purpose of this study and the instruction for the completion of the survey were included with the questionnaire. One hundred and twenty participants completed the Table Tennis Spectator Attendance Scale (TTSAS) and the demographic information sheet. The survey took approximately 10 minutes to complete. The participants completed the questionnaire immediately and return it to students. All of the participants were informed of their right to confidentiality and anonymity.

Data Analyses

Descriptive statistics were used to report determinant factors of spectators' attendance at the game. The demographic factors, such as the participants' (1) gender, (2) age, (3) occupation, (4) education level, (5) marital status, (6) income were subjected to a one-way ANOVA to test the mean difference on each factor. For post hoc comparison, Tukey tests were applied to determine the multiple comparisons among groups.

Results

Results of the research questions were indicated as following:

Determinant factors of spectator attendance

Descriptive statistics were used to examine determinant factors of spectator attendance (see Table 1). The factors were indicated from the highest to the lowest mean ranked. The findings indicated that player's performance (M = 3.94, *SD* = .85) was the top rated factors followed by personal factors (M = 3.80, *SD* = .63), facility and environment (M = 3.68, *SD* = .85), and promotion (M = 3.51, *SD* = .96). Finance was the lowest rated factor (M = 2.70, *SD* = 1.05).

Table 1
Descriptive Statistics of Determinant Factors

Determinant factors	*N*	*M*	*SD*
Player's Performance	120	3.94	.85
Personal factors	120	3.80	.63
Facility & environment	120	3.68	.85
Promotion	120	3.51	.96
Finance	120	2.70	1.05

The Relationship between Demographic Variables and Determinant Factors

Demographic variables and their influence on determinant factors were examined by asking research question 2. A one-way ANOVA was used to examine the relationship between determinant factors and demographic variables. Demographic factors were: (1) gender, (2) age, (3) occupation, (4) education level, (5) marital status, (6) income. Each ANOVA was tested at a significance level of .05.

There was no significant relationship between gender and the variables of player's performance, facility and environment, personal factors and finance. However, there was significant relationship between gender and promotion (see Table 2).

Table 2
Summary of ANOVA for Relationship Between Gender and Determinant Factors

	N	***M***	***SD***	***F***	***p***
Facility and Environment					
Male	53	3.80	.61	2.45	.12
Female	64	3.55	1.01		
Player's Performance					
Male	53	4.06	.83	1.67	.19
Female	64	3.85	.87		
Promotion					
Male	53	3.79	.86	7.34*	.00
Female	64	3.32	.99		
Personal Factors					
Male	53	3.79	.58	.024	.87
Female	64	3.81	.68		
Finance					
Male	53	2.88	1.12	2.71	.10
Female	64	2.55	1.00		

$^*p<.05$

An ANOVA test was conducted to compare age and determinant factors of spectator attendance. There was significant relationship between age groups in player's performance, personal factors, facility and environment, promotion, and finance. Tukey test indicated that there was significant difference between the age group of below 20 years old and 21-25, 26-30, and 31-35 in player's performance. The results indicated that age 21-25, 26-30, and 31-35 spectators decided to participate the game were more influence on player's performance than age below 20 years old. Age below 20 years old was difference with age 31-35 in facility and environment and personal factors. In other words, age of 31-35 was more consider facility and environment and personal factors than age of below 20 when they were participated the game. Moreover, finance factor was difference between age group of below 20 and 21-25. The result also indicated that age of below 20 was more consider finance than age of 21-25 (see Table 3).

Table 3
Summary of ANOVA and Tukey Post Hoc Test for Relationship Between Age and Determinant Factors

	N	***M***	***SD***	***F***	***p***	***Post Hoc***
Facility and Environment					.	below 20＜above 41
Below 20	46	3.04	1.01	5.16*	.00	
21-30	12	3.97	.61			
31-40	23	3.84	.58			
Above 41	36	3.92	.69			
Player's Performance						below
Below 20	46	3.55	1.04	6.22*	.00	20＜21-30,
21-30	12	4.35	.43			31-40, and
31-40	23	4.25	.62			above 41
Above 41	36	4.11	.63			
Promotion						
Below 20	46	3.34	3.34	2.75*	.04	
21-30	12	3.79	3.79			
31-40	23	3.29	3.29			
Above 41	36	3.84	3.84			
Personal Factors						below
Below 20	46	3.56	3.56	3.85*	.01	20＜above 41
21-30	12	3.94	3.94			
31-40	23	3.90	3.90			
Above 41	36	3.98	3.98			
Finance						below
Below 20	46	3.02	3.02	3.89*	.01	20＞21-30
21-30	12	1.95	1.95			
31-40	23	2.69	2.69			
Above 41	36	2.54	2.54			

*p<.05

The ANOVA test indicated that occupation were significant related with facility and environment, player's performance, promotion, personal factors, and finance. Tukey test showed significant different between public official and student, public official and artist, agriculturist and artist in promotion. Occupation group of labour was significant difference with public official and agriculturist regarding personal factors. The results also displayed that artist was significant difference with students, public official in finance. Hence, it indicated that public official was more emphasis on promotion than student-artist and agriculturist placed more on promotion than artist. Agriculturist and public official displayed more on personal factors than labour. Moreover, student and public official were addressed more on finance than artist (see Table 4).

Table 4
Summary of ANOVA and Tukey Post Hoc Test for Relationship Between Occupation and Determinant Factors

	N	***M***	***SD***	***F***	***p***	***Post Hoc***
Facility and Environment						
Student	44	3.40	.91	3.06*	.01	
Public official	19	4.03	.59			
Businessman	17	3.70	.76			
Labour	7	3.09	1.43			
Agriculturist	16	3.97	.61			
Artist	14	3.90	.64			
Player's						
Performance	44	3.70	.92	2.81*	.02	
Student	19	4.25	.50			
Public official	17	3.94	.63			
Businessman	7	3.37	1.65			
Labor	16	4.36	.65			
Agriculturist	14	4.08	.68			
Artist						
Promotion						public official >
Student	44	3.43	.92	4.70*	.00	student, artist.
Public official	19	4.21	.88			Agriculturist>artist
Businessman	17	3.37	.76			
Labor	7	3.21	1.59			
Agriculturist	16	3.87	.78			
Artist	14	2.85	.56			
Personal Factors						Agriculturist,
Student	44	3.66	.55	3.41*	.00	public
Public official	19	4.02	.57			official>labor
Businessman	17	3.89	.46			
Labor	7	3.10	1.45			
Agriculturist	16	4.03	.46			
Artist	14	3.89	.44			
Finance						Student, public
Student	44	3.09	.99	4.52*	.00	official>artist
Public official	19	2.92	1.09			
Businessman	17	2.58	.77			
Labor	7	2.14	.89			
Agriculturist	16	2.53	1.28			
Artist	14	1.78	.64			

$^{*}p<.05$

By ANOVA test, there was significant relationship between education levels and family and environment, player's performance, promotion, personal factors, and finance (see Table 5). A post hoc comparison-Tukey test was used to determine difference among five levels of education. The results did not show significant difference between those groups with elementary, junior-high, high school, college, and above master degree.

Table 5
Summary of ANOVA for Relationship Between Education Levels and Determinant Factors

	N	***M***	***SD***	***F***	***p***
Facility and Environment					
Elementary	4	2.33	1.63	5.40*	.00
Junior-high	41	3.40	.93		
High school	24	3.88	.66		
College	47	3.88	.63		
Above master degree	1	4.33			
Player's Performance					
Elementary	4	2.75	2.06	5.62*	.00
Junior-high	41	3.64	.93		
High school	24	4.31	.62		
College	47	4.12	.57		
Above master degree	1	3.40			
Promotion					
Elementary	4	1.95	.86	4.28*	.00
Junior-high	41	3.44	1.15		
High school	24	3.87	.95		
College	47	3.58	1.00		
Above master degree	1	2.50	.80		
Personal Factors					
Elementary	4	2.46	.96	8.46*	.00
Junior-high	41	3.67	1.70		
High school	24	4.13	.57		
College	47	3.85	.53		
Above master degree	1	3.21	.41		
Finance					
Elementary	4	1.50	.57	4.93*	.00
Junior-high	41	3.18	.95		
High school	24	2.58	1.14		
College	47	2.46	.97		
Above master degree	1	1.50			

*p<.05

Marital status was not significant related with five factors which were facility and environment, player's performance, promotion, personal factors and finance (see Table 6). In other word, marital status was not correlated with determinant factors.

Table 6
Summary of ANOVA for Relationship Between Martial Status and Determinant Factors

	N	***M***	***SD***	***F***	***p***
Facility and Environment					
Married	56	3.75	.82	.94	.33
Single	61	3.59	.88		
Player's Performance					
Married	56	4.03	.86	1.13	.28
Single	61	3.86	.85		
Promotion					
Married	56	3.61	1.06	.71	.39
Single	61	3.45	.86		
Personal Factors					
Married	56	3.87	.73	1.71	.19
Single	61	3.72	.53		
Finance					
Married	56	2.55	1.07	2.08	.15
Single	61	2.83	1.03		

*p<.05

Income was not significant related with facility and environment, promotion, while it was significant related with player's performance, personal factors, finance. Tukey's post hoc analysis showed that there was significant different between income group of below $150 and $1001-$1350 in player's performance and income group of $351-$650 and $651-$1000 in finance. In other word, income of $1001-$1350 was greater in player's performance than income of below $150 and income of $651-$1000 placed more emphasis on finance than income of $351-$650 (see Table 7).

Table 7
Summary of ANOVA and Tukey Post Hoc Test for Relationship Between Income and Determinant Factors

	N	*M*	*SD*	*F*	*p*	*Post Hoc*
Facility and Environment						
Below $150	48	3.43	.89	1.79	.12	
$151-$350	10	4.13	.57			
$351-$650	11	3.72	.55			
$651-$1000	11	4.03	.87			
$1001-$1350	13	3.66	.60			
Above $1351	17	3.80	1.11			
Player's Performance						
Below $150	48	3.70	.92	2.80*	.02	Below $150<$1001-$1350
$151-$350	10	4.14	.59			
$351-$650	11	4.18	.49			
$651-$1000	11	4.32	.51			
$1001-$1350	13	4.47	.43			
Above $1351	17	3.72	1.15			
Promotion						
Below $150	48	3.40	.93	.57	.71	
$151-$350	10	3.60	.77			
$351-$650	11	3.65	1.01			
$651-$1000	11	3.89	.95			
$1001-$1350	13	3.70	.95			
Above $1351	17	3.50	1.22			
Personal Factors						
Below $150	48	3.67	.55	2.35*	.04	
$151-$350	10	3.97	.41			
$351-$650	11	3.89	.42			
$651-$1000	11	4.16	.62			
$1001-$1350	13	4.05	.55			
Above $1351	17	3.54	1.00			
Finance						
Below $150	48	2.99	1.02	3.41*	.00	$351-$650<$651-$1000
$151-$350	10	2.20	.63			
$351-$650	11	2.09	.88			
$651-$1000	11	3.40	1.06			
$1001-$1350	13	2.34	.77			
Above $1351	17	2.61	1.34			

*p<.05

Hence, it was concluded that determinant factors were significant relationship with age, occupation, education levels. Gender only associated with promotion. Income was related with player's performance, personal factors, and finance. Marital status was not correlated with determinant factors (see Table 8).

Table 8
Summary of the Significant Relationship Between Determinant Factors and Demographic Variables

	Determinant Factors				
Demographic Variables	**Facility and Environment**	**Player's Performance**	**Promotion**	**Personal Factors**	**Finance**
Gender			×		
Age	×	×	×	×	×
Occupation	×	×	×	×	×
Education Levels	×	×	×	×	×
Marital Status					
Salary		×		×	×

Discussion

Determinant factors of spectator attendance

The result of present article indicated that the player's performance was the top determinant factor of spectator attendance. It corresponded with prior research that stated that player's performance was an extremely important factor for spectators (Wang, 2005; Shih, 2001). Researches stated that player's performance can reinforce pleasures and enjoyment which can attract individuals to attending sport events (Huang & Liu, 2006; Robinson & Trail, 2005). Madrigal (2003) also noted that high quality of the athletes' actions would bring spectators to experience entertainment value. He further revealed that performance satisfaction could predict the decision to attend the event because spectators would look forward to see a skill performance. Consequently, player's performance was an important determinant factor associated with spectator attendance.

Personal factors were the second high score of determinant factor displayed in this study. This supports Carter and Rovells' (2004) statement which were watching sport activities were a way to feel relax and can escape from routine work. Sport is a special kind of experience which produces the drama of structure and uncertainty which fuller meaning to the contest of watchers. Kelly (1996) noted that the intrinsic pleasure or happiness, a quality of experience, and the meaning of activity were very important reasons for people to spend their time attending the game. Madrigal (2003) also pointed out that some spectators watched contests because they tended to favor on particular team or player have a strong desire to see the preferred team or player win games. Therefore, onlookers participated the game would consider their own experience, especially pleasure and enjoyment experience, or favor on a team/player.

The finding was not surprising that promotion was significant related to attending the contest. This supports Parkhouse (1996) stated that promotion is an important skill to attract people's attention, increase interest in the contest, arouse a desire, and ultimately motivate the spectators to participate the contest. Hence, promotion is very important way to attract spectator to attending games.

One additional determinant factor was finance which was the lowest score of determinant factor. The reason for this result could be because "appreciation of the aesthetic quality of the event loaded highly from the motive set" (Robinson & Trail, 2005, p. 76) so spectators seem concern more on aesthetic quality of the contest and the experience of drama in the game than the finance such as the ticket price.

The Relationship between Demographic Variables and Determinant Factors

The result indicated that gender was significant related with promotion of determinant factors. This finding is an important resource because it suggests the table tennis association and providers of table tennis events themes upon which to develop promotion strategies to attract both female and male spectators. This supports Robinson and Trails' (2005) statement which were "either males and females have innately different motives or that society implicitly or explicitly teaches male and females to have different motives" (p. 59). Wann, Brewer, and Royalty (1999) also showed that motivation was significant differences by gender. Research revealed that most people believe male spectators were predominant in sports (Gantz & Wenner, 1995). However, female spectators were as likely as male spectators (Dietz-Uhler, Harrick, End, & Jacquemotte, 1999). Therefore, in order to attract males and females equally to attending games, the National Table Tennis Association and providers of table tennis contests need to consider different promotion strategies to motive different gender to participate games.

Age, education levels, and occupation were significant relationship with determinant factors of spectator attendance. It corresponded with Carter and Rovells' (2004) suggestions: age, education levels, and occupation were important resources to understand background of target market and to design appropriating promotion program in order to attract people attending games. Thus, age, education levels, and occupation were important elements for understanding spectator attendance.

The surprising of the study was the factor of income. Income was not significant related with promotion. It did not corresponded with Parkhouse (1996) mention: investigating income of target people can aid providers of sport events to map out the level of individual spectator in order to attract spectator watching sport contests. The reason for this result could be because the competition did not need to buy ticket to watch games so promotion strategies did not need to consider spectators' income as a major element for attracting spectators' participated games. Another reason could be because "sport is quite important to many adults and even more to youths and children" (Kelly, 1996, p. 210). It seems indicated that sport is becoming a central element of people's life so no matter how much they made they still particpated games.

The interesting finding in this study was the factor of marital status. This finding indicated that marital status was not related with determinant factors of spectator attendance. The reason for this result could be because spectators were more concern on pleasure, enjoyment and experience of psychological feeling in the game than spectators who were married or not. Kelly (1996) addressed spectator enjoyed the intrinsic and social experience in games. He pointed out that "…the spectators—sitting, complaining, and eating as well as leaping, yelling, and letting themselves go" (p. 207). Madrigal (2003) also noted that "a sport event, like many types of performance, is consumed primarily for enjoyment" (p. 43). Hence, married status would not influence onlookers' participating games.

Conclusions and Suggestions for Future Research

Conclusions

The purpose of this study was to examine the determinant factors of spectator attendance. The findings indicated that player's performance was the top rated factors followed by personal factors, facility and environment, and promotion. Finance was the lowest rated factor.

The demographics were useful for predicting spectating rates (Nixon & Frey, 2000). The second research question was to find out the relationship between demographic variables and determinant factors of spectator attendance. It included gender, age, occupation, education levels, marital status, and income. The results displayed that age, occupation, and education levels were associated with determinant factors. Gender only related with promotion. Player's performance, personal factors, and finance were correlated with income. Marital status was not significant relationship with determinant factors.

Suggestions for Future Research

Understanding spectator is fundamental to promote spectating rates (Nixon & Frey, 2000). Thus, the results of this study can be a useful resource to the table tennis association and the provider of table tennis contests to understand the spectator in order to attract people attending table tennis games. However, this study only used the national table tennis tournament spectators as sample so future research should continue to duplicate the study within different contests, different levels of competition and different culture. Furthermore, spectators who were not attended games also need to be surveyed in order to gain a better understanding of the underlying determinant factors of those who might not attend games. In addition, Participation and spectating are often intertwined. Future research is needed to better understand the connection between participation and spectating in order to predict or attract people to involve in sports.

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TABLE TENNIS AS SELECTED SPORT IN SLOVENIAN PRIMARY SCHOOLS

Abstract

The electives represent an interesting variegation of the physical education process in Slovene schools. Children massively select elective subjects of sport activities which help to increase the variety of variegated and interesting sport activities in schools. Sports teachers thus have the possibility to offer extra activities in addition to the compulsory program.

The aim of this research was to acquire opinion of pupils from selected primary schools on the elective school subjects (electives) and position of table tennis in pupil's selection. The sample includes 245 male and female pupils form 11 Slovenian primary schools. Pupils have been given a questionnaire of 22 questions, targeted to establish the opinion of pupils on the subjects from various perspectives.

Based on the analysis of the questionnaire answers, the following conclusions can be drawn:

- *Pupils like to attend Sports as elective subject, while there is slightly lower interest in Dance.*
- *Within Sports as elective subject, pupils would most want to attend the following sports: swimming, handball, football, roller skating, volleyball, badminton, skiing. Table tennis is in the middle of pupils choices.*

The results indicate that teachers make good use of this fact for the benefit of children's harmonious physical and motor development.

Key words: *elective subjects (electives), table tennis, nine-year primary school, analysis, pupils*

INTRODUCTION

Sports education has a very significant role, not only as a positive compensation for the lack of children's natural need for movement but also as an effective means of education. The duty of each school is to provide its students with sports education according to the needs of a cultural human being and thus contribute to permanent acquisition of a healthy life style. Sports education is an important component of the integral conception of culture.

By using appropriate programs, forms and methods, aimed at individuals, we can influence the development and correlation among motor, cognitive, affective and social components of a child's personality.

As the society continuously changes, so is the education system subject to adequate changes. Novelties in the treasury of global knowledge, variations of earlier theories, different points of view, different requirements of society etc., are thus sooner or later reflected in the education system, requiring curriculum, organizational, methodological changes etc. The last major school system change in Slovenia was the implementation of a nine-year primary school (eight-year primary school before that).

The education system reform in Slovenia has introduced elective subjects to a nine-year primary school in the 1999/2000 school year. To enrich the compulsory program and to enable pupils extend their knowledge in the areas they are more interested and feel more successful in, the curriculum of the last three-year cycle includes a choice of elective subjects, which are approved by the RS Council of Experts for General Education. Among the elective subjects offered by the school each year, pupils select two or three subjects of their choice (Markun Puhan & Kovač, 2003).

Electives can be of one, two, or three-year duration. According to the primary school law, the school is obliged to offer the following subjects: second foreign language, rhetoric, religions and ethics. All other electives are offered according to schools human and financial resources, local tradition, pupils' choice and according to orientation and specialization of teachers teaching at the school.

There are two groups of electives: natural and technical science group and sociologic and humanities group.

Electives are primarily designed as a one-year program, and are usually not upgraded. The school is obliged to offer at least three electives for each group.

Pupils can therefore select among over 50 electives, two of them are the sports electives Sports and Dance.

Sports as an elective subject includes the following three one-year programs: Sport for a healthy lifestyle, Sport for relaxation and Selected sport. Dance as an elective subject includes the following three one-year programs: Dance, Folk dance, Old fashioned and social dance.

Within these sports and dance activities, pupils can get to know new sports, improve in the sports they already know and thus gain more theoretical information and practical knowledge. These subjects offer such sports activities that cannot be implemented in the compulsory program. Because these contents have sports-recreational effects, such subjects are significant for adopting sports as a qualitative way of spending free time in all periods of their life. The focus is on the correlation between sports contents and other school subjects (cross-curriculum integration). The schools attempt to take account of the specific local community characteristics and to integrate with the local cultural community.

Electives can be performed also as out-of-school classes taking place after regular school periods. In these cases, special norms for forming groups should be observed (Kovač & Novak, 1999).

Electives are executed according to officially approved curricula. The curricula define the goals, levels of knowledge, the number of hours and place electives within the regular schedule. Pupils attend the subjects throughout the school year and are graded at the end of the year. A decree determines also who can be an appointed teacher for a selected subject. The electives thus complement regular physical education classes. Together they represent a well-rounded sports content offered to pupils in school.

The implementation of electives in our schools has been executed a while ago. Quite a few analyses of their implementation have been carried out. The aim of this research is to analyze the implementation of Sports and Dance as electives, and to acquire opinion of pupils from selected primary schools in Slovenia.

We wanted to find out:

- why do pupils decide to sign up for these electives,
- which contents are most interesting,
- position of table tennis in electives.

METHODS

PARTICIPANTS

The sample included 245 male and female pupils from 11 Slovene primary schools who attended electives Sports in the 2005/2006 school year. The electives are performed in the last three-year cycle; therefore, we have questioned pupils attending 7th, 8th and 9th grade (aged 12-15).

INSTRUMENTS

For the purpose of this research, we have used an anonymous questionnaire (Ismajlovič, 2005), including 22 closed type questions targeted to establish the opinion of pupils on the subjects from various perspectives. At each question pupils can select only one answer.

PROCEDURE

Data were collected during regular physical education hour of selected classes. Obtained data has been processed by the SPSS statistical software package and the Frequencies sub-program at the Faculty of Sports computer centre. Basic statistical parameters have been calculated (average values, standard deviation and frequencies of individual answers).

RESULTS

QUESTION: WHICH ELECTIVES DO YOU ATTEND TO THIS YEAR?

Most pupils attend sport for relaxation, then sport for a healthy lifestyle, selected sport, dance, old-fashioned and social dance, and folk dance. The results are presented in Figure no. 1.

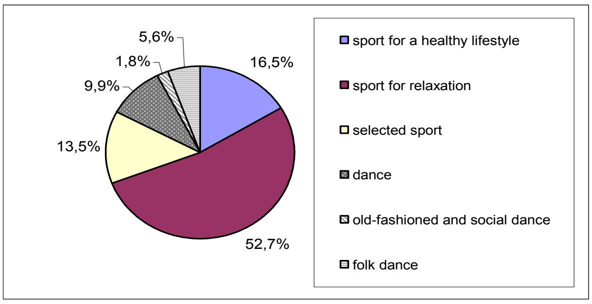
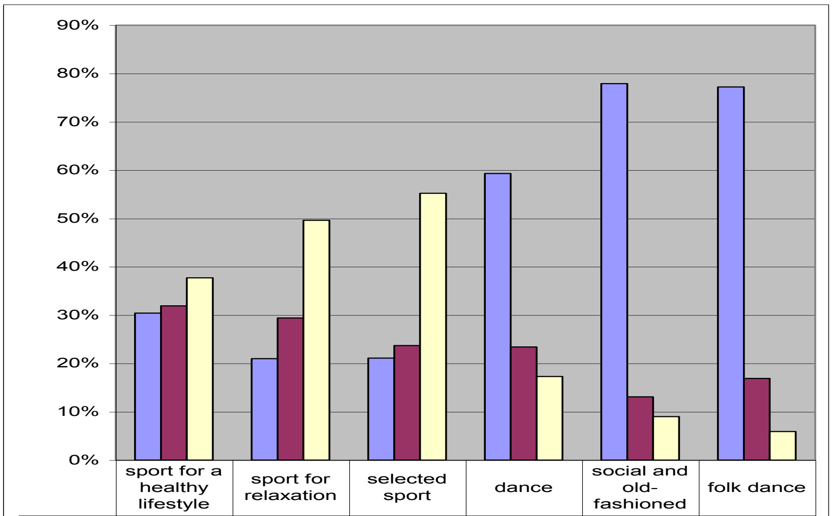


Figure no. 1

There are pupils who attended two electives given by sports teachers. Compared to the results of a similar research by Markun Puhan (2001), the number of such cases has now almost doubled.

Only a few percentage of pupils selected dance as elective subject (dance, old-fashioned and social dance, and folk dance). The main reason is that these contents have been offered by the least number of sports teachers.

QUESTION: WOULD YOU LIKE TO SELECT THE ELECTIVES SPORTS IN THE FOLLOWING YEAR TOO?



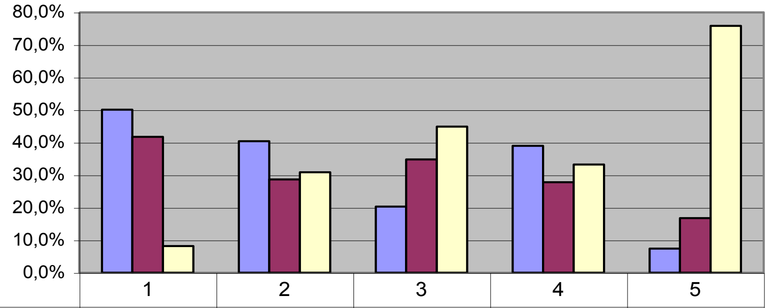
	sport for a healthy lifestyle	sport for relaxation	selected sport	dance	social and old-fashioned	folk dance
no	30,40%	21,00%	21,10%	59,30%	77,90%	77,20%
maybe	31,90%	29,40%	23,70%	23,40%	13,10%	16,90%
yes	37,70%	49,60%	55,20%	17,30%	9%	5,90%

Figure no. 2

The results in Figure no. 2 indicate that in the year to follow, the largest number of pupils would select Selected sport as an elective. Selected sport is followed by Sport for relaxation, Sport for a healthy lifestyle, Dance, Social and old-fashioned dance, and Folk dance.

The majority of pupils gave a NO answer to all three programs of Dance elective, which indicates that dance is not among the most attractive activities. The reason for such a situation could be that many of the selected schools do not offer Dance as an elective as they do Sports, therefore pupils are not familiar with such contents. The other reason could also be that these contents are (non)interesting and (in)attractive. Pupils are more likely to be interested in modern dance, rather than old-fashioned and folk dance.

QUESTION: WHY DID YOU DECIDE TO SELECT THE ELECTIVES SPORTS?



	1	2	3	4	5
not true	50,1%	40,4%	20,3%	39,0%	7,4%
partially true	41,7%	28,7%	34,8%	27,8%	16,8%
true	8,2%	30,9%	44,9%	33,2%	75,8%

Figure no. 3

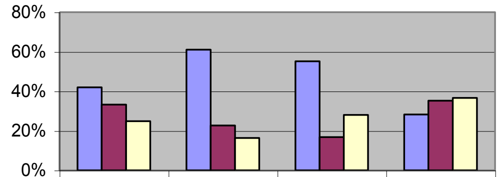
In this question, pupils rated the following five options:

1 – because of friends
2 – because there is no homework and afternoon studying
3 – because of a good grade
4 – because of the last year's good experience
5 – because the content is interesting and applicable

Figure no. 3 shows that the largest number of pupils selected the elective because they are of the opinion the content are interesting and applicable (75.8%). 44.9% of all pupils questioned stated their decision was driven by the fact they could get good grades. A little over 30% decided to select the electives because there is no homework and afternoon studying and because they have a good last year's experience. The least important in decision making was the choice of their friends (8.2% of all pupils questioned).

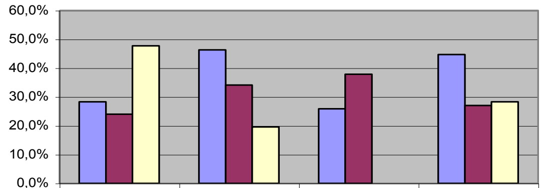
By introducing Sports as elective subject, children are offered a possibility to get to know new sport contents – the contents that are exempt form the curriculum or cannot be implemented at regular physical education classes. It is therefore not surprising that pupils rated the option »because is interesting and applicable« so high.

QUESTION: WHICH SPORT WOULD YOU SELECT AS AN ELECTIVE SUBJECT?



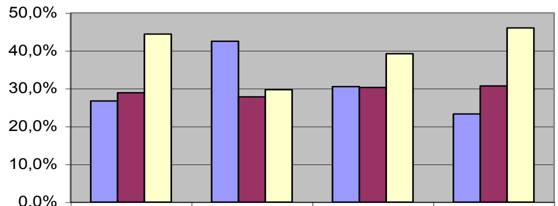
	track and filed	gymnastics	dance	basketball
would not select	42,00%	61,00%	55,20%	28,20%
may select	33,20%	22,70%	16,80%	35,20%
would select	24,80%	16,30%	28,00%	36,60%

Figure no. 4



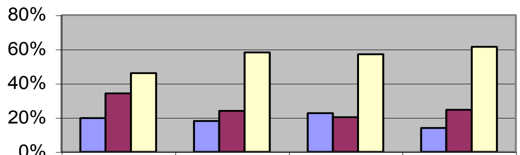
	roller skating	hiking	cycling	rowing
would not select	28,3%	46,3%	25,9%	44,7%
may select	24,0%	34,1%	37,9%	27,0%
would select	47,7%	19,6%	0,0%	28,3%

Figure no. 5



	skiing	marshall art	table tennis	badminton
would not select	26,7%	42,5%	30,5%	23,3%
may select	28,9%	27,8%	30,3%	30,7%
would select	44,4%	29,7%	39,2%	46,0%

Figure no. 6



	volleybal	handball	football	swimming
would not select	19,80%	18,00%	22,60%	13,90%
may select	34,20%	23,90%	20,30%	24,60%
would select	46,00%	58,10%	57,10%	61,50%

Figure no. 7

Pupils were offered the following 16 sports: track and field, gymnastics with aesthetic gymnastics, dance, basketball, volleyball, handball, football, swimming, roller sating, hiking, cycling, rowing, skiing, marshal arts (karate, judo...), table tennis and badminton. In this question, pupils had to mark each sport with one of the following options: would not select, may select, would select as elective subject Sports.

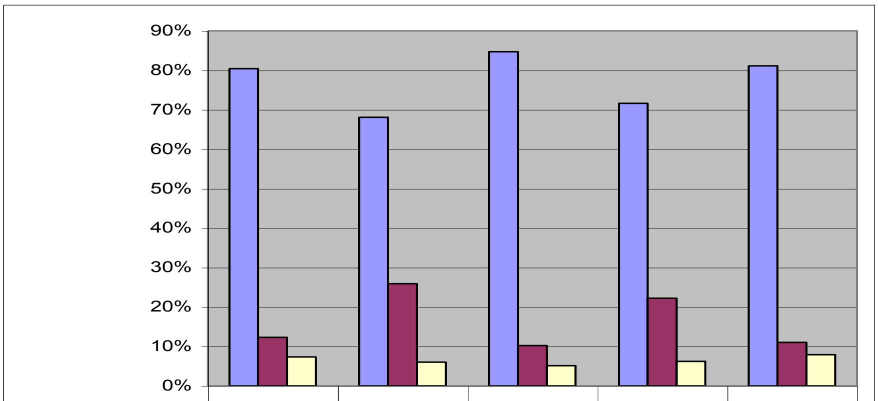
The results are presented in Figures 4 through 7. The majority of pupils questioned would select swimming (61.5%). Sports that follow are: handball (58.8%), football (57.1%), roller skating (47%), badminton and volleyball (46%), skiing (44.4%), table tennis (39.2%), basketball (36.6%), cycling (36.2%), marshal arts (29.7%), rowing (28.3%), dance (28%), track and field (24.8%), hiking (19.6%) and gymnastics (16.3%).

The majority of pupils would *not* select gymnastics (61%) and dance (55.2%).

It is surprising that swimming is the most favourable sport – it would sooner be expected it would be one of the group, ball games. We anticipated a lower percentage in hiking (19.6%) since children of this age are not particularly keen on long-lasting and monotonous activities.

Table tennis as elective sport is somewhere in the middle of pupils preferences. Table tennis is often played in small rooms in breaks between scheduled curriculum hours. Many schools doesn't have all equipment or suitable place to offer table tennis as a conducted teaching process as a selected sport.

QUESTION: WHICH ARE THE REASONS ONE WOULD NOT SELECT SPORTS AS ELECTIVE SPORT?



	teacher	pupils from other classes	not happy with grade	inappropriate schedule	level to advanced
disagree	80,40%	68,10%	84,70%	71,60%	81,10%
partially agree	12,30%	25,90%	10,20%	22,20%	11,00%
absolutely agree	7,30%	6,00%	5,10%	6,20%	7,90%

Figure no. 8

We have included a hypothetical question, asking pupils why they would not select the electives Sports or Dance in the following year. They were given five possible things we thought could bother them or would be the reason for not selecting the electives. The reasons given in this question were: teacher, pupils from other classes, not happy with the grade, inappropriate schedule, too advanced level. Figure no. 8 shows that the majority of pupils questioned do not agree with the offered reasons, and that these reasons are not so disturbing as to make them not select the desired elective.

DISCUSSION

Based on the analysis of questionnaire answers related to the organization of Sports electives, it can be ascertained that there have been no major difficulties, despite the fact that electives are a novelty in our education system and that schools have not had lot of experience in their design, organization and implementation.

A large percentage of the pupils questioned were of the opinion that the pedagogical process at Sports and Dance electives was very well organized. The majority of pupils would select these electives again in the following school year.

The electives which include sport activities are very popular among pupils and the highest number of pupils decides to select these subjects. Some pupils even decide to attend two such subjects. The majority of pupils select Sport for relaxation, Sport for a healthy lifestyle and Selected sport, while the least number of pupils select Old-fashioned, social and Folk dance.

This research gives very similar results to other researches: Markun Puhan (2000), Markun Puhan (2001) and Ačimovič Svenšek (2002), Ismajlovič (2005). All previous researches indicate that electives, particularly those that include sports contents, are very well accepted in schools and that these subjects are in fact among the most popular ones. They represent a very good variegation in the school curriculum and offer pupils a wide range of activities to satisfy individual desires. There are a large number of areas and contents to select from, so each individual can find something that he/she will enjoy doing, satisfy the creativity needs and develop his/her own potential.

Subjects like Sport for a healthy lifestyle offer a number of opportunities to make pupils keen on sport, to introduce the benefits of sports activity, to make pupils accept sport as the element of a quality way of life, to accept sport as an activity, which can help an individual avert the harmful consequences of modern life and bad habits like smoking, drinking, drugs, etc. (Videmšek et al.,, 2003).

The experiences in elective subjects in the field of sports have so far been very positive. We must therefore strive to preserve these subjects as a very significant part of the school curriculum.

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The 10th Anniversary ITTF Sports Science Congress

Part nine:

Talent identification in table tennis

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A SELECTION AND FORMATION MODEL FOR SPANISH YOUNG TABLE TENNIS TALENTS

Abstract

Detection, selection and technification process for sport talents represent one of the most important research area in Sport Sciences. Actually, Spanish Table Tennis Federation, throughout Sport Technification National Program (PNTD), is developing a detection, selection and technification process for young players with the aim to develop a sport specialization in a correct form.

Different players are selected after the application of valid criteria in sport talent identification. In this sense, table tennis players selected must to present a specific profile, take into account physical, technical, tactical, psychological, anthropological and social characteristics, although adaptation capacity to table tennis training of these players is the main factor to take into account.

Table tennis training concentrations in high performance centers have duration between four and ten days in which it follows a structured program. Also, multidisciplinary team composed by coaches, sport psychologists, ophthalmologists, sparrings (top-level table tennis players out of competition), and sport physicians evaluates to the players applying systematic and active methods.

With this work we want to give to know the features of a pioneer experience for young table tennis players in Spain, describing general and specific aims of the program and the main guidelines that are followed by the national coaches that are responsible of the PNTD.

Key words: *table tennis, talents, training, young players*

1. INTRODUCTION

The process of development of the career of an elite sportsman (sportswoman), it is difficult and laboriously and unfortunately put of the scope of any sportsman (sportswoman) who does not assemble the innate and acquired capacities necessary for a sports high yield. In the last decades, the selection and training of the sportsmen in early ages has suffered decisive quantitative and qualitative changes, passing from slightly demanding and punctual trainings, to daily and highly specializing trainings, producing an important advance of the yield to him, increasingly early, especially in those sports that need a high technical specialization, as the gymnastics, swimming or the table tennis, going forward this way, the ages of initiation (Lopez, 2000).

From this moment, a real revolution has been produced, especially in table tennis, where the learning of the different skills they suppose an adjustment and particular adjustment to a not habitual way and to the utilization of an implement, which must strike the mobile one that moves for the space to high speeds and with a quantity of certain rotation. This early specialization, it has changed notably the parameters of the elite sport and the methods of training, must adapt to early ages and to evolutionary periods and of psychobiologic determined ripeness. This way, from the point of view of the sports yield, a parallel increase has taken place in the investigation applied to the table tennis, orientated fundamentally towards (Baur, 1993):

- The precocious selection of sports talents trying to establish the scientific bases of a sports exploration, based on the precocious identification of the future champions.
- The optimization of the yields by means of the analysis of the biological, technical, methodological and psychological factors that determine the sports yields.
- The promotion of the talent by means of the promotion of the curriculum.

These processes of detection, selection and technification of talents are probably one of the big areas of investigation of the sport (Solanellas et al., 1996), and they us would justify that the differences between a champion and the others, they might assume, to a great extent, to the way of selecting the sportsmen from the base.

The detection and selection of talents in table tennis is not an easy task. From the Royal Spanish Federation of Table Tennis, concretely across the direction of the National Program of Sports Technification (PNTD), it removes working a decade, purifying a specific model of detection - selection, constructed attending to diverse variables as the age of the sportsmen, the degree of acquisition of specific skills, etc., in order to realize a suitable process of selection, orientated towards a sports early specialization (Blázquez, 1990).

In short, about what it treats itself it is of constructing a systematical process, across which there are identified the capacities, skills, psychological disposition(regulation) and social factors that constitute necessary conditions to assimilate the charges of training, related to the aims (lenses) corresponding to the stage of formation in which there is the sportsman (Leyva, 2003).

2. METHODS

The fundamental aim of the PNTD is the detection - selection of those subjects that stand out, already be for a better assimilation and / or yield, and that consequently present a major sports talent. The determination of this level of capacities, it is based on different evaluations, which if they are adapted, can allow us a prediction of what might be expected from a player depending on his initial situation of game, without forgetting in no moment of, besides his individual capacity (genetics or acquired), the motivations of the sportsman, of the social environment and of the interaction of these conditions.

To take to end this program, they have been selected in the first phase of intervention, to those individuals who show interest for his practice. In the second phase, diverse interventions are realized by these sportsmen, already be training camp and / or competitions, being selected again, to those that close to presenting a specific profile for the practice of this sport, besides were possessing a potential determined as for physical, psychological, biomedical and social characteristics. Definitively, it is tried to predict in what environment and which are the ideal characteristics, to be able to develop to the maximum the qualities and specific capacities of the Table Tennis.

The principal aim of the PNTD is of initially identifying (to detect), to choose (to select) and later to train, to those sportsmen who could develop a potential of adjustment to the training and a high capacity of technical - tactical learning, to tackle in ideal conditions, the later stages of training (Léger, 1986).

In our case, the detection begins in the first phases of the process of sports development of base (categories youngest children and fries), process during which the adjustment and general initiation will take place to the physical - sports concrete activity, trying to take advantage of the potential of the subject and trying to create a feeling attraction on the part of the child towards the Table Tennis (Lopez, 2000).

The later process is the selection of the sports talent, process of evaluation for which the sportsmen who show major specific potential for the table tennis (infantile and juvenile categories), are chosen and directed to a specializing training which prior aim is the search of the maximum sports yield.

Definitively, the intention is it of consolidating from the basic foundations of the sports training, to those individuals who present a set of powers and / or attitudes, or a natural aptitude (Aguila et al., 2000), in order to reach a precocious ideal specialization in this sport. We are speaking about detection, identification, selection and technification of sports talents (Lopez, 2000).

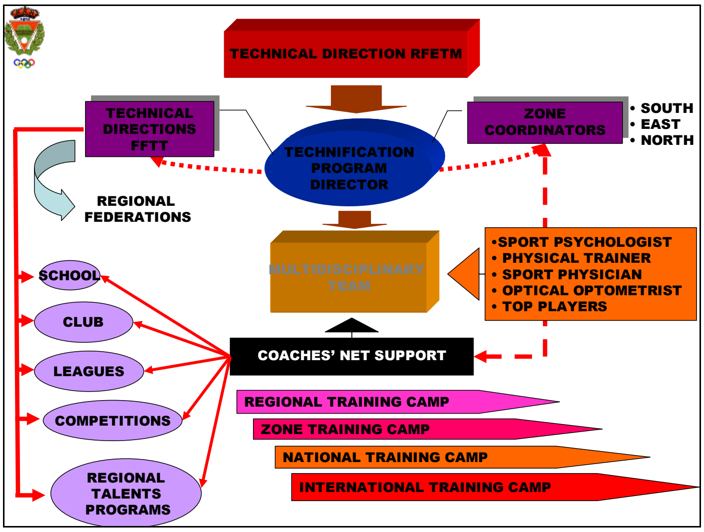

Figure 1 *Structure of the model.*

The PNTD or Spanish model (figure 1), depends on the Technical Direction of the Royal Spanish Federation of Table Tennis and is financed jointly in 70 % by public (funds) across the Top Council of Sports (C.S.D.), competent organ in sports matter, and in 30% for the private capital and / or own resources.

The organizational structure of the PNTD is shaped by the Director (national trainer and specialist in Sciences of the Physical Activity and the Sport), in coordination with three Codirectors or zonal persons in charge (trainers of the maximum national category and expert in the area of the Sciences of the Physical Activity and the Sport), located in the national geography of a strategic way in Zaragoza, Valladolid and Murcia (figure 2).

Figure 2 *Distribution of the zonal people in charge*

The program is designed to be employed at total coordination with the Technical National Direction, the Young men's (women's) National Team's Director and with the Technical Directions of the different Territorial Federations, extending this way to the maximum the spectrum of the intervention.

To take to end the sportsmen's (sportswomen's) selection, Spain is divided in three big zones of performance (figure 3):

- South Zone, composed by 7 regions: (Andalucía, Islas Canarias, Castilla La Mancha, Extremadura, Murcia, Ceuta and Melilla).
- East Zone, composed by 4 regions: (Cataluña, Aragón, Valencia and Islas Baleares).
- North Zone, composed by 8 regions: (Castilla y León, Galicia, Asturias, Cantabria, País Vasco, La Rioja, Navarra y Madrid).

Figure 3 *Performance zones*

The different performances (training camp, evaluations, ...) they are carried out in High Yield Centers and / or in Technification and Sports Specialization Centers, located in three zones of intervention: north zone (Valladolid), south zone (Granada, Córdoba and Murcia) and east zone (Barcelona). These activities, they are directed by the responsible zonal codirectors of the National Program of Sports Technification, in collaboration with a multidisciplinary team composed by a trainer, a sports psychologist, an optical optometrist, different players of high level and a doctor specialist in sport's medicine.

The initial methodology used for the captation of talents, it is the natural selection, the individuals choose this sport, already be for family tradition, random, or for other motives, in this moment the detection will begin and the different interventions will begin on the sports participants.

From here, there begins the second stage, the selection, as process in which they are individualized to those sportsmen provided with talent and with favorable attitudes for the table tennis, with the help of methods and of test scientific valid (Nadori, 1983), close to the development of others tests more specifics for our sport.

In this phase, there is applied an active and systematical methodology. All the players pass to be evaluated by means of a battery of proofs, of medical, physical, optical, psychological nature and technician - tactics, to verify if really these young players, possess these capacities and natural attributes necessary to be able to reach, to posteriori, high yield in this sport (Salmela et al.. 1983), though the discovery of the talent does not constitute in the same rapid and fast progress (Kondric, 1996), but only a hypothetical potential dimension.

Once detected the possible subjects it is still the model of Kunst and Florescu (1971), mentioned by Bompa (1987) and modified for our sport, on the principal elements to bearing in mind to select a sportsman. The realized valuations are in two places at the same time in four areas:

- The motive capacities.
- The psychological capacities.
- The visual skills.
- The biometric qualities.

Definitively, which is looked is the biophysic study of the selected individuals, by means of a series of evaluations, of the motive, psychological, optical and biomedical profile, to be able this way to determine, to short or half term, which is the most specific for this sport.

On all these aspects previously mentioned the PNTD is based. The theoretical raised model consists of 6 different interventions to detect and to select the sportsmen who present a major authority of the specific skills of our sport. These evaluations are gathered in the following areas:

A. Control of the specific skills

For its valuation there were designed a series of *technical - tactical exercises* of low complexity and adapted to every age, where it is evaluated, not the most correct technical execution, but the innate skill or the know-how, to be developed opposite to the own skills of this sport. The technical - tactical elements that are valued are mentioned later:

- Execution of services.
- Execution of the forehand stroke and of reverse.
- Return of services (the rest).
- Execution of blows of assault.
- Execution of the cut of right and of reverse.
- Displacements.
- Basic tactical thought.

B. Battery of physical tests

The equipment of specialists in the area of the physical activity chose for this evaluation, a series of physical tests but without an exclusive purpose, but as a possible determinant that might affect positively on the future performance of the chosen players. The tests that were selected were:

- Flexibility of the trunk in sat position.
- Explosive force of the low train (CMJ and SJ).
- Simple reaction speed before a visual stimulus (figure 4).
- Displacement speed in 20 meters.
- Specific speed.
- Course navette.
- Cyclical speed of top members.
- Manual Dinamometry.

Figure 4 *Reaction time and specific displacement test*.

The election of these tests and not of others, it has been for its easy aplicabilidad and its confirmed reliability. Having into counts the predominance of genetic factors in the manifestation of rapid and coordinated movements (Porta et al., 1996), in the technical basic actions of this sports discipline, the selection of the above mentioned testshey will be able to predict to us the potential performance of the sports young men, in order to realize an ideal early detection.

C. Psychological valuation

From the psychological perspective one tries to know some characteristics of the individuals that form a part of the project, considering, from the familiar and social environment, up to details and own features of the personality of every subject. For it they are realized:

- Personal interviews.
- Emotional state's studies.
- Study of sports habits.
- Study of the ratio concentration / easing.

D. Social determinants

In this point, the interest was centring on knowing the social reality of every individual, that is to say, the real conditions in which the sportsman is, from the club to which it belongs, up to the sports facilities and its degree of availability (Campos et al., 2000).

As determinant factor, there is analyzed the possible availability of different specialists, as sports doctors, level players, psychologists or graduated technical personnel, close to the level of knowledge's of the trainer with regard to the specific sport, the physical general activity and the health, as variables that determine the later process towards the high yield.

E. Study of the visual skills

Among all the factors that influence in the sports yield table tennis, one of the most important is the vision. This aspect allows us a sports practice without limitations, looking for the specialization of certain visual determinant skills in this sports modality. In our case the following visual parameters are studied:

- Visual keenness that values the aptitude of the visual system to differentiate objects to certain distance.
- Function of sensibility to the contrast.
- Binocular distantly behaviour.
- Close point of convergence on the object of interest.
- Accommodating flexibility or control of the approach.
- Extent of merger related to the spatial location and the depth.
- Estereopsis or quality of binocular vision.
- Ocular Motility: stability of fixation, ocular follow-ups and fixation changes without loss of brightness.
- Visualization.

Its importance takes root, in the context of the sports training, in providing the sportsman orders on where, when and how looking (Bard et al., 1975, 1976; Ripoll, 1987).

F. Medical evaluation

Continuing part of the model mentioned by Bompa (1987), the criteria that bear sound in mind in the biomedical paragraph:

- *The health*, medical evaluations are realized during the training camp. They consist of carrying out a clinical history, an electrocardiogram and espirometría of rest, a biochemical analysis and haematologyc, a study of the locomotive device and a effort test in rolling tapestry with electrocardiographic monitoring and gas analysis (just to the subjects of major age), realized by specialists in sports medicine, where one tries to detect possible physical or organic problems.
- *The morphologic study* of every individual, having in consideration the values of the height, weight, perimeters, diameters, plaits and length of the extremities.

Besides, for the attainment of the aims raised in the National Program of Sports Modernization, it becomes necessary to consider other more general, but not less important aspects for it, of organizational and methodological type, considered necessary for the correct functioning and ideal utilization of the programmed activities. As more prominent aspects, later we relate some of them that we consider to be relevant:

1. Training place selection

The High Performance Centers (CAR), Sport Technification Centers (CTD) and/or Sport Specialization Centers (CETD), where every last-generation technical means are available, just as the ideal infrastructures for training, have been selected for that purpose, because:

- All necessary facilities are located inside a single sport complex, absolutely separated from outside and surveillance and security is assured 24 hours a day.
- Bedrooms, dining-room, training room, gymnasium, relaxation rooms (sauna, Jacuzzi), library, cafeteria, computer room, medical assistance, TV-room, etc, are available.

2. The players selection

We will consider different basic criteria just as: the national ranking, the evolution of national and international results, the skills acquisition, the capacity to learn, the attitude in competition, the physical and psychological abilities, and the educative behaviour.

3. Main objectives of the meeting

To carry out a technical-tactical work (stressing the importance of the basic blows of right/back), with intensive exercises with sparrings, multi-balls, and with videos. The following selection of the players who will assist to the meetings and/or international competitions will be done from the results of these activities.

4. The quality training

A special interest will be taken on this section from the first meetings that the players take (the youngest and the beginners), keeping in mind essential aspects just as the evolution of the sportsmen, personal features, training level, learning skills, etc. A number of different exercises will be taken under the supervision of the trainers and with the help of sparrings (high-level players), working intensively with groups from two to four children.

5. The multilateral team

In spite of trainers are in charge of the organization the structure and development of the meetings, we count on a very professional human team composed of: trainers, sparrings, fitness coaches, psychologist, doctors (experts in sport-medicine and ophthalmologists), masseur and spare time leader.

6. Timetables and norms.

For the good functioning of the training camp there will be indispensable the fulfillment of a few schedules and procedure, established by the trainers, and that from the moment of the revenue to the activity the sportsmen will know. The training camps are in the habit of ranging between four and ten days.

7. Feed-back with the trainers.

Before and after the training camp there are established contacts (meetings, conversations or reports) by the trainers of the clubs of the players selected in order to inform him about the sportsman, to unify the process and the direction of the training. Besides, from the PNTD, there are programmed formative activities directed by trainers who work with young men (women).

3. CONCLUSIONS

The PNTD is a show experience, pioneering in table tennis, very positive from the methodological point of view, bearing in mind the rigor that has followed and the confirmed experience of the multidisciplinary team that takes part.

One could have stated an improvement in the yield of the sportsmen included in the worldwide PNTD, supported on an integral selection, based on changeable technical - tactics, physical, psychological, biomedical and social.

All these elements that have been scientifically analyzed in the sportsmen seem to be an important fact to approach the high sports yield in table tennis, dividing from a global perspective and not being studied from an isolated comprehension.

At present, scientific methodologies are applied to investigate more in depth this sport. They are designed and applying more specific tests, increasing this way in major measurement the scientific rigor. Also the quality of the sample is trying to increase object of study, in order to be able to seat the bases and the necessary means, to realize a good detection and an excellent evolution, as for planned and methodical trainings.

On the basis of the exposed thing, we must emphasize that there exist multiple factors that delimit the human yield. Every individual has a few particular and innate characteristics of biological and psychological type framed and submitted to the environmental influence, factors that from the PNTD have tried to be controlled.

Finally, we think succeeded the design of the PNTD to predict the future yield of the sports young men who take part, studying it entirely, the maximum of factors involved in the above mentioned yield, though there is imposed the need to realize a longitudinal study to repeat the obtained results.

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The 10th Anniversary ITTF Sports Science Congress

Part ten:

Training of table tennis

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THE USE OF SPLIT-STEP BY TABLE TENNIS PLAYERS IN TURKEY

Abstract

Footwork plays a very important role in table tennis. As the level of players increases it becomes more critical. Split step is an action that players' hops off the ground and land on the balls of the feet at the moment the opponent makes contact with the ball. Split step makes the player get ready to react and move quickly according to the direction, speed and spin of the ball in table tennis. It has always said to be an important action for tennis players. However it has not been investigated or taken into consideration in table tennis. Therefore the aim of this study was to investigate the use of split step by table tennis players from Turkish Super League. The sample of 40 male and 40 female players was video recorded and their use of split step while returning serve was investigated. Results demonstrated that there was no gender difference in the use of split step. It was found that players do perform split step.

Key words: *table tennis, split-step, serve return*

INTRODUCTION

Footwork plays a very important role in table tennis. As the level of the play increases, the importance of footwork becomes more critical. Since table tennis is being played in a narrow distance and the velocity of the ball is very high, the players should be ready for all types of shots coming from the opponent. The most important part of a table tennis play is the serve return. An effective serve return has an important role to win the point. In order to receive the ball in the right place and return it effectively, players should have a perfect footwork.

The split step is a moment that when a player lands with both feet parallel with the body. It happens right after the opponent makes contact with the ball. The player hops slightly off the ground so as the landing is on the balls of the feet. This gets the heels off the ground because the initial step towards the ball happens on the toes. This forward motion will help the receiver move into the return as well as be prepared to move laterally. The split step has the added benefit of having the legs ready to spring into action.

The split step has said to be a very important technique in tennis. However it is not stated to be performed in table tennis literature. Although, tennis and table tennis are two similar sports, they have some important differences. Tennis is being played in a very wide distance approximately 20 meters, while the distance between two table tennis players is about 3 meters. So it can be said that tennis players have much more time to get ready for the shots. Tennis players have enough time to understand the direction, speed and the spin of the ball. Table tennis players, however, have very limited time to understand the direction, speed and the spin of the ball. If split step is believed to be a very important action when receiving the ball, it should also be executed by the table tennis players.

When we observe top table tennis players, we can see that most of them tend to perform split step while receiving the serve. However, it is not stated in the literature and most of the trainers and players probably do not practice on this important action.

There is no study conducted about the split step in table tennis. The effect of split step on the serve return performance also not investigated. This study is important in terms of understanding the use of split step by high level table tennis players. The problem of the study was to determine the use of split step by table tennis players in Turkey.

If split step in an important technique for the players while receiving the serve, players and coaches should devote time and effort to develop this technique to improve their performance. The purpose of this study was to determine the usage percentage of split step in Turkey. It was believed that the information provided in this study would assist in understanding the importance of split step and its use by table tennis players in Turkey.

METHOD

Forty male and forty female Turkish super league table tennis players participated in this study. All players were still active players and training at least three times a week. The mean age of male players were 29.2 (± 8.6) and the mean age of female players were 24.7 (± 6.3). Male players had been playing table tennis for 19.7 (± 7.5) years and female players had been playing for 15.9 (± 6.1) years.

Players were video recorded during one round of the league using Sony HC-32E and Sony DCR-DVD105E camcorders. Every player was recorded at least during two full games.

Video recordings were analyzed and the use of split step was compared according to the gender, nationality, age, playing duration and game type (attack or defense) by using SPSS 11.5.

RESULTS

Descriptive statistics for the players is shown in table 1 and 2. According to the results, the average age of the female players was 24.7 (± 6.3), the average age of the male players was 29.2 (± 8.6) and the average age of the all players participated in this study was 26.9 (± 7.8). The results demonstrated that the average playing duration of the female players was 15.9 (± 6.1), the average playing duration of the male players was 19.7 (± 7.5) and the average playing duration of all players participated in this study was 17.8 (± 7.0) (Table 1).

Table 1. Descriptive Statistics of Players According to Age and Playing Duration

	Female n=40 *M (SD)*	Male n=40 *M (SD)*	Total n=80 *M (SD)*
Age	24.7 (6.3)	29.2 (8.6)	26.9 (7.8)
Playing Duration	15.9 (6.1)	19.7 (7.5)	17.8 (7.0)

The results showed that among forty female players, 37 (92.5 %) of them were Turkish and 3 (7.5 %) of them were from other countries (China, Romania). There were 38 (95.0 %) attack players and 2 (5.0 %) defense players (Table 2).

Table 2. Frequencies and Percentages of Variables

		Female		**Male**		**Total**	
		f	%	*f*	%	*f*	%
Nationality	Turkish	37	92.5 %	33	82.5 %	70	87.5 %
	Foreign	3	7.5 %	7	17.5 %	10	12.5 %
Game Type	Attack	38	95.0 %	37	92.5 %	75	93.75 %
	Defense	2	5.0 %	3	7.5 %	5	6.25 %

Among forty male players 33(82.5 %) of them were Turkish and 7 (17.5 %) of them were from other countries (China, Bulgaria, Egypt). There were 37 (92.5 %) attack players and 3 (7.5 %) defense players (Table 2).

Among eighty players 70 (87.5 %) of them were Turkish and 10 (12.5 %) of them were from other countries. There were 75 (93.75 %) attack players and 5 (6.25 %) defense players (Table 2).

According to the results of descriptive statistics, 35 (87.5 %) of the male players were performing split step and 5 (12.5 %) of the male players were not performing split step while receiving serve. When female players were analyzed, it was found that 30 (75.0 %) of the players were performing split step and 10 (25.0 %) of the players were not performing split step while receiving serve (Table 3).

Table 3. Frequencies and Percentages of variables according to the use of slit step

		split step *f (%)*	non split step *f (%)*	Total *f (%)*
Gender	male	35 (87.5)	5 (12.5)	40 (100)
	female	30 (75.0)	10 (25.0)	40 (100)
Game Style	attack	64 (85.3)	11 (14.7)	75 (100)
	defense	1 (20.0)	4 (80.0)	5 (100)
Nationality	Turkish	55 (78.6)	15 (21.4)	70 (100)
	Non Turkish	10 (100)	0 (0.0)	10 (100)
Total		65 (81.25)	15 (18.75)	80 (100)

The results also demonstrated that 64 (85.3 %) of the attack players were performing split step, however 11 (14.7 %) of the attack players were not performing split step while receiving serve. When defensive players were analyzed, 1 (25.0 %) of the players was performing split step, however 4 (75.0 %) of the defensive players were not performing split step while receiving serve (Table 3).

When the players were analyzed according to their nationality, it was found that 55 (78.6 %) of the Turkish players were performing split step and 15 (21.4 %) of the Turkish players were not performing split step while receiving serve. All 10 (100.0 %) non-Turkish players, however, perform split step while receiving serve (Table 3).

The results demonstrated that among 80 players 65 (81.25 %) of them were performing split step and 15 (18.75 %) of them were not performing split step while receiving serve (Table 3).

DISCUSSION

The purpose of this study was to determine the use of split step by Turkish super league table tennis players. Since there is no study conducted on split step for table tennis players, it is not possible to compare our result with others. Even though, there is no study conducted about the effectiveness of split step on performance or movement time.

It can be seen from our results that most of the table tennis players do perform split step while receiving the serve. We don’t know whether this action is consciously or unconsciously performed. When we asked to some of the Turkish trainers about the split step, we realized that the effectiveness of this action is not known. Moreover, they don’t know whether there is such an action while receiving the serve. Since this is a preliminary study about the split step, one of the limitations of this study is the lack of information about the player and trainer knowledge about the split step. We don’t know if they really know the importance of this action. Do they perform consciously or unconsciously?

Our result showed that the split step usage percentage of male players is higher than female players. The results also showed that the percentage of attack players performing split step is higher than the defense players. 4 of the 5 defense players do not perform split step. The only player that perform split step is a Non-Turkish player.

When we compare Turkish and Non-Turkish players, it can be seen that all of the Non-Turkish players do perform split step. From Turkish players, however, 21.4 percent of the players do not perform split step while receiving serve. The low percentage of Turkish players' split step use may be because the effectiveness of this action is not known by the coaches and players. It may also not be included in the training programs.

When we analyzed 35 matches and 62 male and female players from European and world championships, we found that nearly all of the players do perform split step. From 62 players 10 of them were defense players and all were performing split step.

If split step is an action that must be performed before returning serve and increases the performance of the player, it should be included in the training plans by the trainers and players should try to work on the timing of split step.

Further studies should be conducted for better understanding of this action. The next step of this study would be to increase the number of players and make surveys questioning the knowledge and consciousness of players and trainers.

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TWO SYSTEMS FOR PROVIDING KR FEEDBACK IN TABLE TENNIS TRAINING

Abstract

In table tennis, performance parameters describing the outcome of one stroke are the spin, the position, where the ball hits the table, and the ball velocity. Systems that give immediate feedback on the quality of the ball just played are applicable in training. Besides of directing and conditioning the technique some motivational effects can be expected. The application of two types of KR (knowledge of results)-feedback systems shall illustrate the concept. The first type is based on detecting impact positions of the ball on the table in almost real time, the second on the acquisition of ball impact intervals. The impact point detecting system is capable to give feedback on the accuracy of the placement when performing certain tasks and to give feedback on impact positions during service. The system neither disturbs the players nor does environmental noise influence the system. Four accelerometers are fixed onto the underside of one half of the table. A triangulation method is applied to calculate the impact position from the vibration signal registered by the accelerometers. In a typical application of the system in training, a table tennis robot serves the ball in short intervals. The player has to return each ball into a marked area. After each series of trials, the player gets visual feedback on the ball impact positions. To give feedback on the quality of service techniques, a low cost device was developed. Ball impacts on the table cause typical acoustic signals. Two microphones are used for recording these signals. A microcontroller based system allows determining and displaying the time interval between first and second impact of the ball on the table immediately after service execution. In the case of short services, it also determines and displays the time interval between the second and the third impact. Obviously, the time intervals are strongly affected by the degree of spin of the serviced ball.

Key words: *table tennis, knowledge of results, impact position*

Introduction

According to Farfel's principle (Farfel, 1977) effective feedback systems applied in training should provide feedback information rapidly and objectively. Powerful information and communication technology simplify the development of sports specific feedback systems of that kind. Special focus may be put on the acquisition and presentation of performance relevant parameters.

In the case of table tennis factors affecting the quality of the ball played are the spin, the position, where the ball hits the table, and the time left for the opponent to react properly (Baca, Baron, Leser & Kain, 2004; Hohmann, Zhang & Koth, 2004). Systems that give immediate feedback on certain performance parameters have been developed to assist training. Applying these systems in training, the technique shall be directed and conditioned. Moreover, some motivational effects are expected.

Two types of feedback systems have been built. The first variant is based on the detection of impact positions of the ball on the table, the second on the acquisition of ball impact intervals (cf. Baca & Kornfeind, 2006).

Methods

Impact position detection

A schematic of the setup is presented in Figure 1. A detailed description can be found in Baca & Kornfeind (2004). Four accelerometers (Kistler 8632C10; four-channel amplifier 5134A1; Kistler, Winterthur, Switzerland) are fixed on the underside of one half of the table and connected to an amplifier, which itself is connected to a DAQ-system consisting of a notebook computer and a data acquisition card (NI-6062E, National Instruments, Austin, USA). Vibration signals produced by the ball hitting the table are registered by the four sensors. A trigger impulse, generated from an electronic circuit, starts the recording of a specified number of samples repeatedly after every ball impact (1000 Samples@125 kHz). A threshold algorithm determines the four instants of time, when the vibration signal arrives at the sensors. Software (LabVIEW®, National Instruments, Austin, USA) has been programmed for this purpose.

A triangulation algorithm, which is also implemented in the software developed, calculates the impact position from the four instants of time. To determine the coordinates of the impact position, x_T and y_T, only three instants of time, and, consequently, three sensors would be required. The fourth, redundant sensor is used to increase accuracy. A least square method has been selected to determine the impact point coordinates. x_T and y_T are calculated, which minimize

$$\sum_{i,j}\left(\sqrt{(x_i-x_T)^2-(y_i-y_T)^2+z_i^2}-\sqrt{(x_j-x_T)^2-(y_j-y_T)^2+z_j^2}-(t_i-t_j)v\right)^2$$

$$(i=1...4;\ j=1...4;\ i\neq j)$$

where x_i, y_i and z_i are the coordinates of the i-th sensor with regard to the table coordinate system, t_i, the instants of times, the vibration signal arrives at sensor i (i=1,…,4), and v is the velocity of signal propagation (534 m/s for the table used), which depends on material properties of the table. Since the right-handed coordinate system xyz originates in the left upper corner of the table (Figure 1) z_i is identical for all sensors.

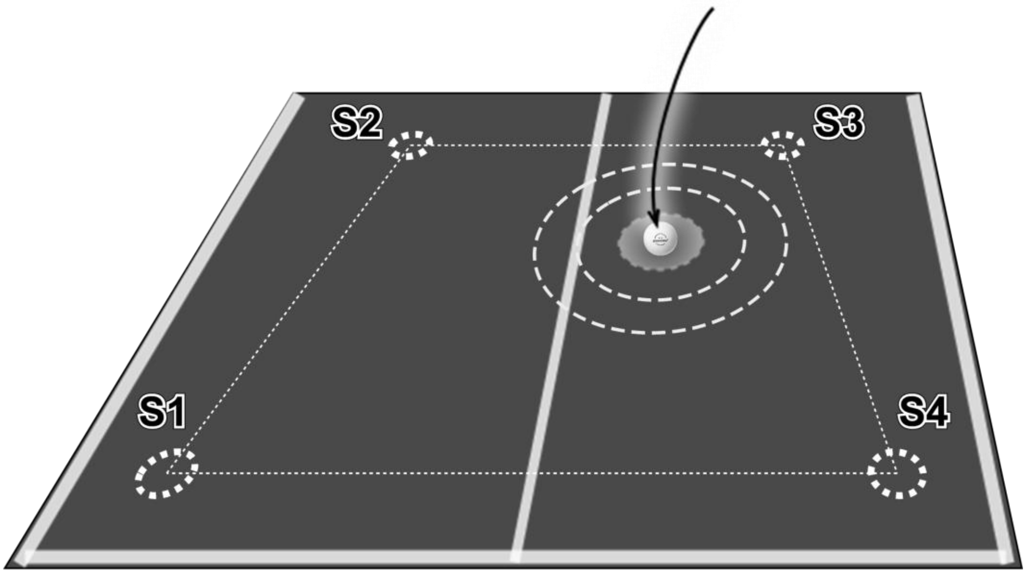

Figure 1 *Setup for detection of ball impact positions. S1 – S4 denote the positions of the accelerometers fixed on the underside of one half of the table*

If metallic parts are coupled to the table top, as is the case for the type of tables used by Baca and Kornfeind (2004), vibration damping material has to be used for a mechanical decoupling of the table top and the metallic parts. Thus, faster signal propagation towards the sensors through the metal resulting in noise signals can be prevented.

The program developed displays the reconstructed impact points immediately after the impact. A circle representing the ball is drawn onto the calculated position into a graphic presentation of the table half. In addition, the numerical values of the coordinates are shown (Figure 2).

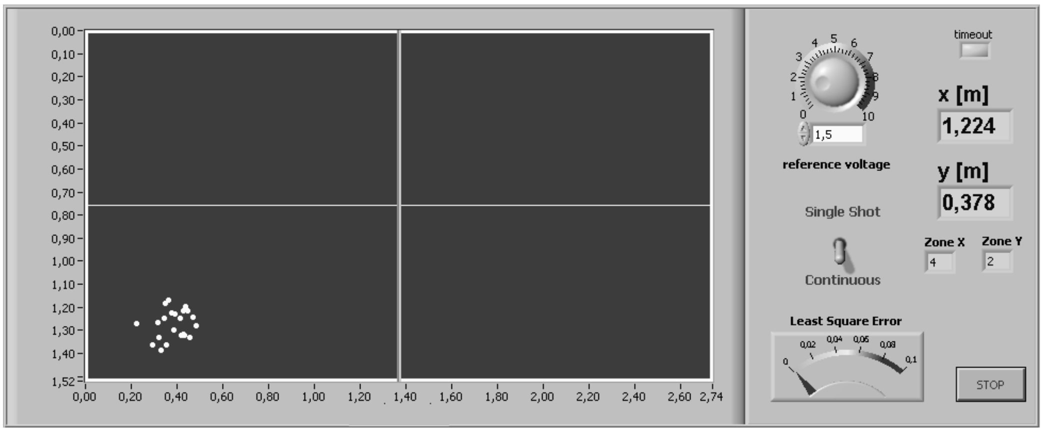

Figure 2 *Computer screen presenting a series of ball impact positions*

An average accuracy of 0.020± 0.011 m was obtained by Baca and Kornfeind (2004) within the area of the table at least 0.25 m away from the net.

Impact time interval detection

A low cost system has been developed to determine time intervals between ball impacts after the serve in table tennis. In the case of long serves the time interval between first (own side) and second (opponent's side) impact is determined. In the case of short serves, the ball bounces on the opponent's side twice resulting in a second time interval to be calculated.

Two microphones are used for recording the acoustic signals caused by the ball impact on the table. Both are fixed in metallic boxes. The boxes are put onto both halves of the table. The signals from the microphones are preprocessed electronically and then fed to a microcontroller (PIC16F628; Microchip, USA), which is also connected to the serial port of a PC, notebook or PDA (Figure 3).

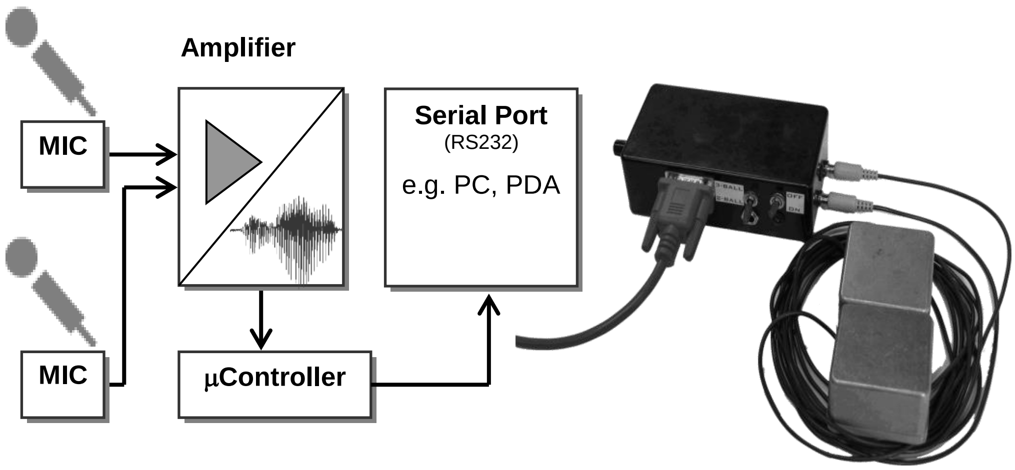

Figure 3 *Left: Schematic presentation of the system for calculating impact time intervals. Right: Complete system without PC/PDA*

A LabVIEW® application program acquires the data from the serial port and displays the results on the computer screen. In addition to a numerical presentation of the time intervals a speedometer informs on the player's performance graphically (Right: Green area – good; Left: Red area – bad; Figure 4).

The overall system is not bound to a specific table tennis table and can easily be transported to the environment (table, hall, etc.), where it is used.

The system operates self-controlled. Because of an automated system reset into a "wait state" after a short period without acoustic impact signal, no user intervention is required between successive serves. If connected to two monitors, the system may be used by two players standing on both sides of the table, who serve alternately.

Results

Both types of systems have successfully been applied to give feedback in youth training. Usability and system stability were considered satisfactory by the users.

Feedback based on impact position detection

The feedback system does not disturb the players in any way. Environmental noise does not bias the system's results. Feedback on the accuracy of the placement when performing certain tasks may be given. In addition, a series of trials may be evaluated and summary feedback may be given.

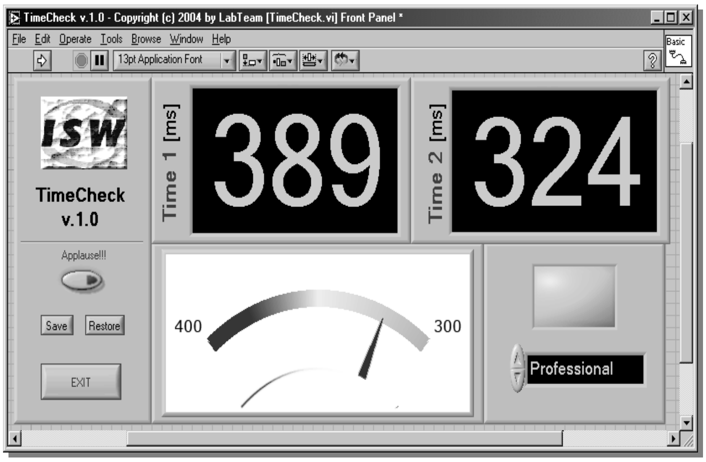

Figure 4 *Presentation of impact time intervals. Time 1: First to second impact, Time 2: Second to third impact (short serves only)*

When applying the system in training, manifold scenarios may be realized. The player has, for example, to return balls which are served by a table tennis robot into a marked area, or to return one ball cross and the following into the marked area alternately. After each series of trials the player gets visual feedback on the ball impact positions (Figure 2, Figure 5).

The system may also be used to give feedback on impact positions and impact time intervals in serve training. Players are thereby able to study the variability of different serve techniques.

Feedback based on impact interval detection

Typical exercises performed by the players include the task to minimize the impact intervals in order to decrease the time of the opponent to react properly. Obviously the time interval is strongly affected by the degree of spin of the serviced ball. Youth players utilizing the system in serve training enjoyed this kind of aid and were highly motivated. A kind of competition situation can be observed. We found some indications that training with the system might be useful in shortening the impact time intervals of short services (i. e. Time 2 in Figure 4).

Discussion

Rapid feedback systems utilizing powerful sensor and information technology provide innovative and effective support to coaches and athletes. Mighty IT-tools facilitate the development of user-friendly systems, which are specifically oriented towards their needs.

Figure 5 *Feedback training using impact position detecting system*

In the development of the systems used to give feedback in table tennis special care has been taken to measure and/or calculate the characteristics of interest accurately and to present the results to the users (coaches and athletes) fast and comprehensive. Graphic visualisation forms have therefore been implemented in both cases in addition to the presentation of the numerical values (Figure 2 and Figure 4).

It is expected that novel and rapid performance measurement and feedback tools based on modern information technology will become more and more pervasive in daily table tennis training.

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THE EFFECTS OF DIVERSE LEARNING METHODS ON TABLE TENNIS BACKHAND PUSH

Abstract

The main purpose of this study is to explore the effects of diverse learning methods on table tennis backhand push. Eighty students (average height 165.3±8.37cm , weight 58.8±9.79kg , age 20.3±1.37 years) with no previous experience in table tennis from a local college were recruited and randomly assigned to four groups, namely control group, mental practice group, physical practice group, and mental-physical practice group. The experiment had lasted four weeks and three times per week; each session is 60 minutes. Results showed that 1. the mental-physical practice group has the best score on backhand push among the four groups, physical practice group ranked second and mental practice group ranked third. 2. The mental-physical practice and physical practice groups performed better than the other two groups in retention test. 3. Although less effective, the mental practice is beneficial to the beginners for learning table tennis backhand push.

Key words: *mental practice, physical practice, table tennis backhand push*

I INTRODUCTION

1. Background and motive of this research

Practice is a key factor in the sports skill learning. It is the most cost-saving and precise learning procedure and it facilitates the interaction between the faculty and students in sports skill learning process. Physical practice is one of the critical factors in increasing sports skill learning and performance (Chen, 1993). There are many sorts of practice methods. It is an important issue for the faculty to select appropriate practice methods to instruct students, improve students' sports skill learning and enhance performance.

The effect of the mental practice in sports skill learning is supportive by the scientific evidence. Because mental practice can perceive the acknowledgement of correct actions and ascertain correct actions, it truly can enhance students' learning ability during real competitions or simulation games of learning situations. The literature related to the mental practice is ample, such as the free throws in basketball (Buckles, 1984; Hall & Erffmeyer, 1983), serve the ball in tennis (Noel, 1980), jumping water (Badri, 1986; Grouios, 1992b). Moritz, Hall & Martin (1999) stated that delicate actions of the muscular application of (such as discus throwing) and the rough actions of the whole body muscle application are also related to the sports skill learning and performance. However, some researcher pointed out that there is no direct connection between mental practice and sports learning behaviours (Cho 1984 & Pai 1987). According to the aforementioned, there are positive and negative arguments with respect to the effect of mental practice toward sports learning behaviours. Generally speaking, researchers usually use "examination" to test the effect of sports skill learning, but it is not objective at some point. Therefore, in this study, the researchers will use "expert validity" to evaluate learners' outside actions to distinguish the learning effect. The researchers will focus on the effect of mental practice toward continuous attacking with forehand balls and testify by the outside actions.

Table tennis is a high skill difficulty sports which emphasizes the whole body coordinate and it was composed mainly of forehand attacking, backhand attacking and serving attacking. Generally speaking, it is easier for students to learn sports skill by his/her accustomed hand than the other hand. Backhand push has some certain difficulty and adaptability. It is the physical educators' responsibility to find a solution to improve learning effect. Therefore, the purpose of this study is to explore the effects of the table tennis backhand push toward the diverse learning methods and offer a recommendation for the future teaching curriculums.

2. Purpose of this study

According to the aforementioned, there are two main purposes in this study:

(1). To explore the effects of the table tennis backhand push toward the diverse learning methods.

(2). To explore the effect of the skill of the table tennis backhand push toward the diverse learning methods.

II METHODOLOGY

1. Subjects are 80 students from the Tainan Woman's College of Arts and Technology (average height 165.3±8.37cm, weight 58.8±9.79kg, age 20.3±1.37 years) and they never experienced any training programs of table tennis skill before.
2. Time and location of this research: This survey was between April 5, 2006~April 30, 2006; the survey had lasted four weeks and three times per week; each session is 60 minutes. The location of this survey was in the table tennis arena of the Tainan University of Technology.
3. Survey Process:

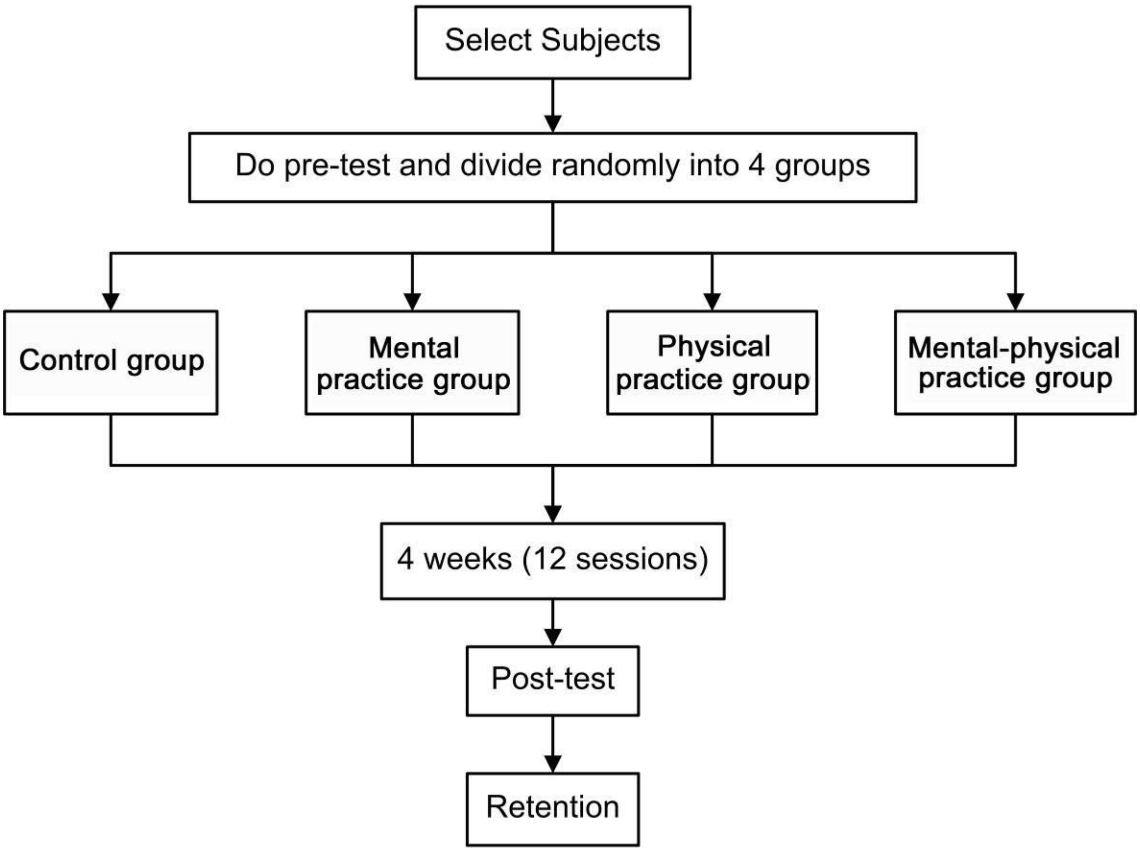

Chart 1 experiment flow chart

4. Research Tools and Instruments:
   (1). Ball: The brand is made from XUSHOOFA practice ball.
   (2). Table: The brand is made from butterfly (95080).
   (3). Serving Machine: The brand is made from XUSHOOFA (v988).
   (4). Recorder: The brand is made from SANYO (MCD-RX10RC).
   (5). Television: The brand is made from Panasonic (29TZF).
   (6). VCD player: The brand is made from PIONEER (890007).
   (7). Digital Recorder: The brand is made from SONY (TRV-33).
   (8). VCD: it was published by "Key Point" Corporation (3F., No.395, Sec. 1, Neihu Rd., Neihu District, Taipei City 114, Taiwan (R.O.C.)
   (9). Contents of the mental practice group and pre-recording cassette: This research adopts the edition of Martin (1995) and re-designs one module after referring to the study of Chen (2002) and Wang (2001). The contents include muscular relax training, image practice, perceptive behaviour correction and watching VCD of serving attacking.
5. Key skills to serve the Top Spin
   Key skills:
   (1). Standing position: The leaner stands besides the left side of the table and both foots stand the same width as the learner's shoulder. The right foot is slightly ahead of the left foot (approximately 3 inches). The learner's knees must bend slightly and the abdomen must draw back. Two elbows bend 90 degrees and is higher than the table surface. The upper body faces the straight forward and the racket is above the end line.
   (2). Ways of gripping racket: Competitive table tennis players grip their rackets in a variety of ways. The manner in which competitive players grip their rackets can be classified into two major styles. One is described as *shakehand*, and the other *penhold*. (a) Shakehand is so-named because one grips the racket similarly to the way one performs a handshake. The grip is referred to as a "Western grip" which is popular among players in Western countries. (b) Penhold is so-named because one grips the racket similarly to the way one holds a writing instrument. The thumb and index finder puts aside of the racket. This style is usually referred to as the Chinese penhold style, involves curling the middle, ring, and fourth finger back.
   (3). Keep Strategies in Stroke (a) transition of the center of the body: When the opponent hit the ball, the center of the body is rapidly located in left foot. However, when the ball bounces up, the center of the body moves from the left foot to the right foot. (b) Stroke sequences: when the center of the body moves to the left foot, the racket hand slightly draw backs. When the center of the body moves to the right foot, the racket push forward and the elbow must extend straightforward simultaneously. (c) The Hitting moment: the period between the ball bounce up and the highest point. (d) The transition of the center of the body and the stroke sequences are consistent and all of the actions must return to the original standby position after each stroke.
6. Process of the survey:
   At the beginning, all of the 80 students trained the skill of backhand push. The subjects were divided randomly into four groups, namely control group, mental practice group, physical practice group, and mental-physical practice group. The experiment had lasted four weeks and three times per week; each session is 60 minutes. During the experimental stage, each group will experience different methods of experimental operation (see the Table 1). A post-test will follow as soon as the experiment is ended and a retention test will execute in 7 days after the experiment is ended.

Table 1 Experiment Control Table

Group / Week	control group	mental practice group	physical practice group	mental-physical practice group
1st 2nd 3rd 4th	Subjects are only reading unrelated magazines or articles. They don't involve in any sports skill training programs.	Subjects are viewing the teaching VCD, backhand push, action practice, muscular relax training and mental practice	Teaching and practice of the backhand push.	Teaching and practice of the backhand push, muscular relax training and mental practice

7. Methods of test

The tests of this research include pre-test, post-test and retention test. The methods and contents of the experiment are identical and each student must accept 10-ball test. VCR will be utilized to record all of the actions during the test and the results will be assessed by the evaluators. There are 4 parts in sports skill evaluations: (1). standby action: standby actions before the forehand attacking, steps of standing position and allocation of the center of the body. (2). actions of racket drawing back: location of the racket, turning of the wrist, transition of the center of the body; (3). location of attacking ball and action of racket drawing back: to identify the location of attacking ball, to identify the transition of center of the body. (4). fluent action and coordination. Each section occupies 25 points and the total points are 100. In umpire selection, the standard is to pick up umpire with abundant teaching experience. Through the average score of 3 judges, we can get the actual points of the examinee. In order to achieve fair reliability among judges, three scores will be examined by Pearson product moment correlations.

Table 2 Relative Correlations among Judges

	Judge A	B	C
Judge A	--	.90*	.89*
B		--	.92*
C			--

*p<.01

According to the results, the correlation is .90 .89 .92 respectively and it is positively related. Those figures demonstrate that umpire evaluates scores with a same standard.

8. Limitation of this research

The subjects are the 80 students from the Tainan Woman's College of Arts and Technology and they never experience any training programs of table tennis skill before. The hypothesis is that all subjects can concentrate to learn table tennis and follow the directions which are regulated by the coach. All of the subjects are not allowed to do an additional practice. The subjects of this research are focused only on the college students, and it cannot be applied to other races, groups or other sports skills.

9. Data analysis

This research uses analysis of covariance to analyze learning effects of each experimental group. If the result shows a significant difference, the main learning effects can compare with LSD. The obvious standard of this research is set up to α=.05.

III Results of this Research

According to the pre-test, post-test and retention test, we can get the following results.

Table 3 Mean and SD of Each Group

	Number	pre-test	post-test	retention
Control group M	20	22.3	22.7	22.7
SD		2.05	2.39	2.09
Mental practice group M	20	21.7	32.9	23.8
SD		2.56	3.83	2.71
physical practice group M	20	22.8	68.4	62.8
SD		1.88	3.88	3.94
mental-physical practice group M	20	22.3	73.4	70.9
SD		1.78	3.94	2.98

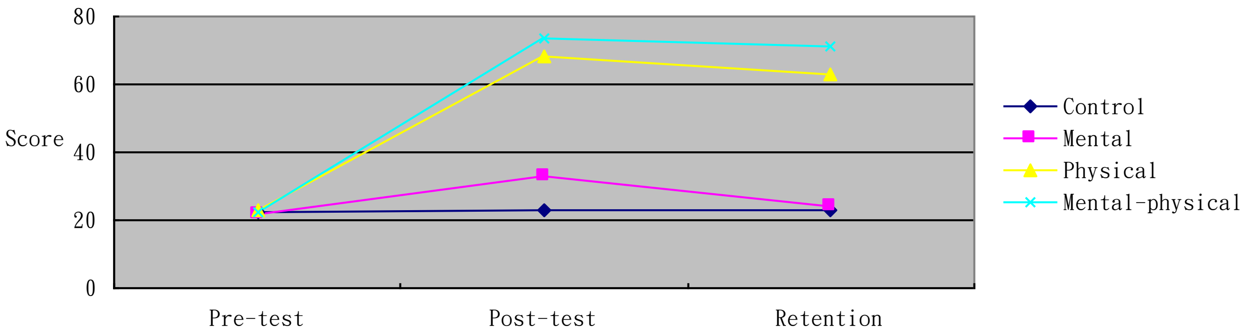

Chart 2 Line chart of each group' score

According to the above chart, we can get the following conclusion by utilizing two-factor mixed variance analysis.

Table 4 Two-factor Mixed Variance Analysis

Source of variance	SS	DF	MS	Value F	sig
Diverse tests	33851.20	2	16925.60	2275.09	.00*
Diverse groups	51661.75	3	17220.58	1501.68	.00*
Correlation	25537.21	6	4256.20	572.10	.00*

*p<.05

According to the Table 4, there is a significant difference among the diverse tests (pre-test, post-test and retention test), diverse groups (control group, mental practice group, physical practice group and mental-physical practice group) and correlation. Therefore, we need to further examine it by means of pure validity.

Table 5 Pure Validity to Examine Variance Analysis

Source of variance	SS	DF	MS	F	sig
Diverse groups					
Pre-test	11.62	3	3.87	.88	.45
Post-test	38453.82	3	12817.94	1004.09	.00*
Retention	38733.52	3	12911.17	1403.83	.00*
Diverse tests					
Control group	1.73	2	.86	.17	.83
Mental practice group	1425.55	2	712.77	73.65	.00*
Physical practice group	24715.37	2	12357.68	1085.01	.00*
Mental-physical practice group	33245.75	2	16622.87	1806.49	.00*

*p<.05

According to the Table 5, Value F of Pre-test is .88 (p>.05), there is no significant difference among the four groups of pre-test and it confirms that all of the subjects in this experiment has the same qualification. The value of F in post-test and retention is 1004.09 and 1403.83 (p<.05) respectively and it shows a significant difference. Therefore, we have to further examine them.

There is no significant difference in control group in diverse experiments (F=.17, p>.05); it shows a significant difference in mental practice group, physical practice group and mental-physical practice group. Therefore, those three groups have to further examine.

Table 6 Post-test Comparison of Each Group

	Control	Mental	Physical	Mental-physical
Control	—	10.26*	45.69*	50.76*
Mental		—	35.43*	40.49*
Physical			—	05.06*
Mental-physical				—

	Control	Mental	Physical	Mental-physical
Control	—	10.26*	45.69*	50.76*
Mental		—	35.43*	40.49*
Physical			—	05.06*
Mental-physical				—

*p<.05

According to the Table 6, there is a significant difference among the four groups in post-test experiment.

Table 7 Retention Comparison of Each Group

	Control	**Mental**	**Physical**	**Mental-physical**
Control	—	1.08	40.09∗	48.23∗
Mental		—	39.01∗	47.58∗
Physical			—	08.14∗
Mental-physical				—

*p<.05

According to the Table 7, there is a significant difference among the four groups.

Table 8 Comparison of Mental Practice Group

	Pre-test	Post-test	Retention
Pre-test	—	11.21*	2.06*
Post-test		—	9.15*
Retention			—

*p<.05

There is a significant difference in mental practice group.

Table 9 Comparison of Physical Practice Group

	Pre-test	**Post-test**	**Retention**
Pre-test	—	45.57*	39.99*
Post-test		—	5.57*
Retention			—

*p<.05

There is a significant difference in physical practice group.

Table 10 Comparison of Mental-physical Practice Group

	Pre-test	**Post-test**	**Retention**
Pre-test	—	51.13*	48.64*
Post-test		—	2.49*
Retention			—

*p<.05

There is a significant difference in mental-physical practice group.

IV Conclusions and Recommendations

According to the aforementioned, we can discuss and divide the results into three parts, namely post-test, pre-test and retention.

2. Post-test

According to the above results, mental practice is beneficial to the table tennis backhand push. This result is matched with the viewpoint of Weinberg & Gould (1999). Mental practice can clarify the acknowledgement of correct actions and accomplish correct actions. Mental practice can also enhance learning ability by the simulation of real games or learning situations. It is undoubted that physical practice is also beneficial to the table tennis backhand push; by means of repeated practices, it is really beneficial to learn correct actions and modify wrong actions. Mental-physical practice is more beneficial and effective than single mental practice or physical practice. Mental-physical practice utilizes internal feeling rehearsal and learning actions and copes with external physical practical rehearsal; it is recognized as the best effective sports skill learning methods. This result is also identical with the study of Chen (2002) and Wang (2001). During the process of learning, not only physical practice but mental practice are emphasized; mental-physical practice can enhance student's learning effectiveness and facilitate student to further understand table tennis afterwards.

3. Retention

From the Table 5, we can find out one phenomenon, i.e. there is no significant difference between control group and mental practice group. Singer (1980) points out, factors that will influence retention effectiveness include: (1) the essence of sports skill actions; (2) the learning meaning of sports actions; (3) interval time; (4) medium activity of interval time; (5) situational condition of practice. According to the above results, because those subjects are the first time to touch table tennis and the interval lasts 7 days between post-test and retention test, the feeling toward table tennis sports skill will lessen. In physical practice group and mental-physical practice group, the former emphasizes external physical practice to recognize sports skill, the later incorporates internal and external feeling to enhance learning skills, so the retention effectiveness is better than the mental practice group.

4. Conclusions

From the results and discussions, we can conclude the following:

(1). The mental-physical practice group has the best score on backhand push among the four groups.

(2). Physical practice group ranked second and mental practice group ranked third.

(3). The mental-physical practice and physical practice groups performed better than the other two groups in retention test.

(4). Although less effective, the mental practice is beneficial to the beginners for learning table tennis backhand push.

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GRF OF TABLE TENNIS PLAYERS WHEN USING LOOP DRIVE TECHNIQUE

Abstract

In order to discover the characteristics of the GRF (Ground Reaction Force) during the loop drive techniques of table tennis, and to find the difference between two types of force to drive (medium strength and the maximal strength), the GRF of table tennis player was tested. The subjects were 10 excellent ping-pong players in China (20±2 years old, the training years were 11±2). Two groups of loop drive techniques were tested, using the measurement methods of the KISTLER force-plate system (two force-plates were used). The two groups of GRF data (peak and valley value of the vertical direction, left-right direction and the front-back direction) were analyzed and compared. The table tennis player's drive technique characteristic in three dimensions was described by the obtained dynamic data.

When compared the peak of left foot between two types of forcing method, the difference was evident. When the player drive loop with the maximal strength, it paid more attention to increase the GRF of left-right direction and front-back direction, which mean that the moving of gravity in left- right direction and front-back direction should be increased.

Key words: *GRF, loop drive, strength, difference*

1 Introduction

In order to discover the characteristics of the GRF (Ground Reaction Force) during the loop drive techniques of table tennis, and to find the difference between two types of force to drive (medium strength and the maximal strength) the GRF of table tennis player was tested. Furthermore, the authors hoped to give some suggestions for players and coaches on how to loop drive ping pong with the maximal strength.

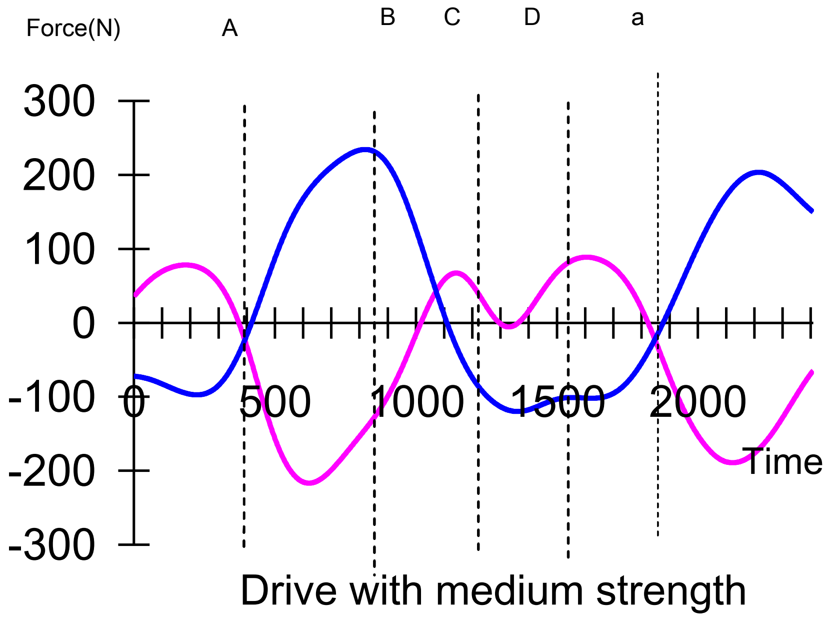
2 Material and Methods

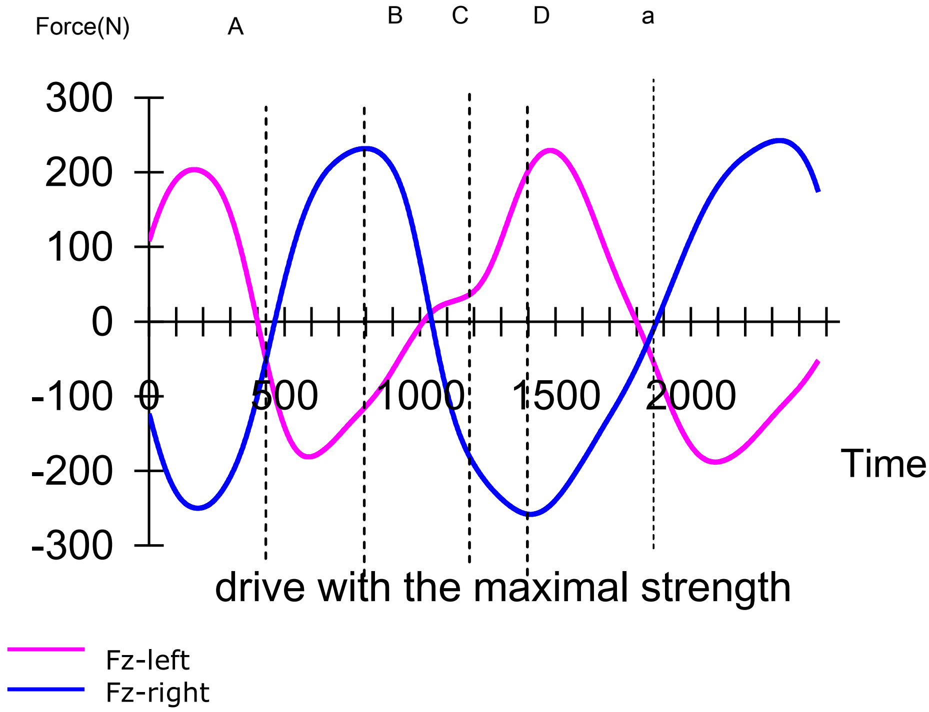
The participants were 10 excellent ping-pong players in China (20±2 years old, the training years were 11±2). Two groups of loop drive techniques were tested, using the measurement methods of the KISTLER force-plate system (two force-plates were used). One group of loop drive technique used medium strength, and the other used the maximal strength. The two groups of GRF data (peak and valley value of the vertical direction, left-right direction and the front-back direction) were analyzed and compared. The data of GRF subtracted the body weight.

3 Results and Discussion

3.1 The analysis on the GRF in the vertical direction

Figure 1 GRF in the vertical direction





Note:

(1) Fz-left is the GRF of left foot, Fz-right is the GRF of the right foot.

(2) The definition of the character moment. The point of A is the beginning moment of the driving. The point of B is the ending moment of shaking racket backward. The point of C is the moment of batting the ball. The point of D is the ending moment of shaking racket frontward. The point of a is the next beginning moment of the driving.

(3) The definition about the above in the other figures are same as thee picture 1.

Table 1: The comparison of the GRF in the vertical direction between left foot and right foot (n=10) unit:N

The peak value	Driving with the medium strength (M±SD)	Driving with the maximal strength (M±SD)
Right foot	220.57±14.78	226.67±19.55
Left foot	103.39±18.30*	207.97±27.20

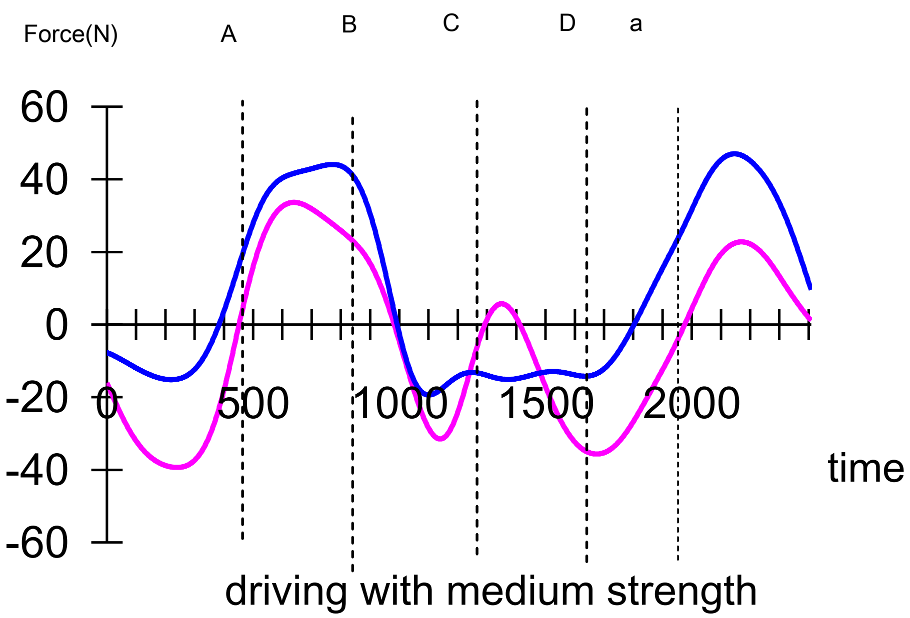
Note: *, which represents the difference is significant between the driving with medium strength and maximal strength.

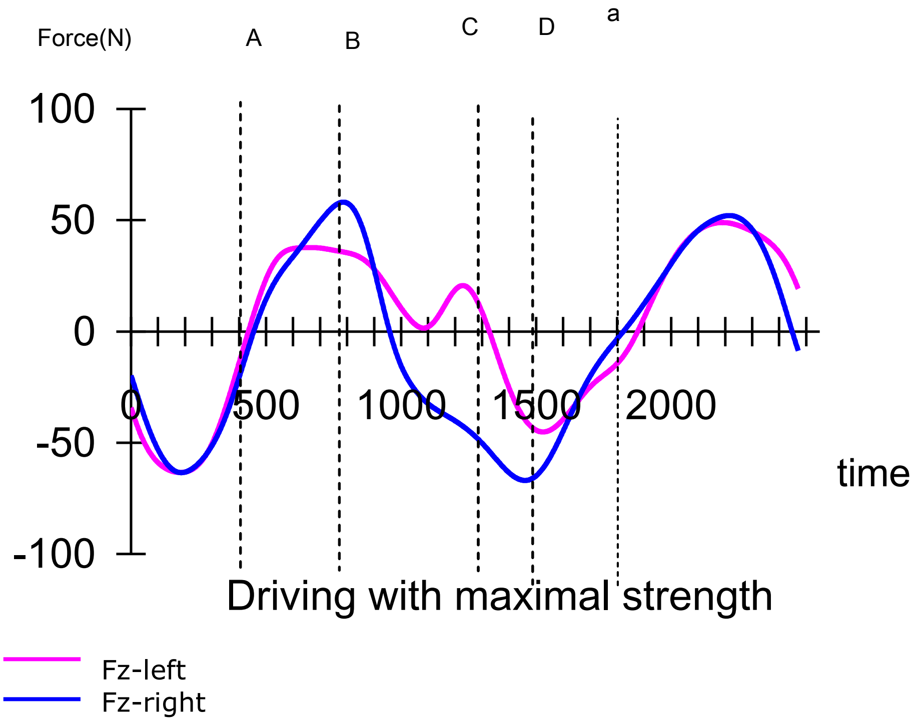
In the vertical direction of GRF, the maximal value of right foot when player used medium strength to drive loop was 220.57±14.78N, and the peak of using the maximal strength was 226.67±19.55N, which showed that the difference was no evident.

When compared the peak of left foot between two types of forcing method, the difference was evident. The peak value of the maximal strength (207.97±27.20N) was higher than the medium strength (103.39±18.30 N). The point of peak value of left was appeared at the end of the player's driving when the gravity of player was moved from right foot to left foot fully. It can be explained that driving loop technique with maximal strength moved more.

3.2 The analysis on the GRF in the right-left direction

Figure 2 GRF in the left-right direction





Note: the positive direction is the right one

Table 2: The comparison of the GRF in the left-right direction between left foot and right foot (n=10) unit:N

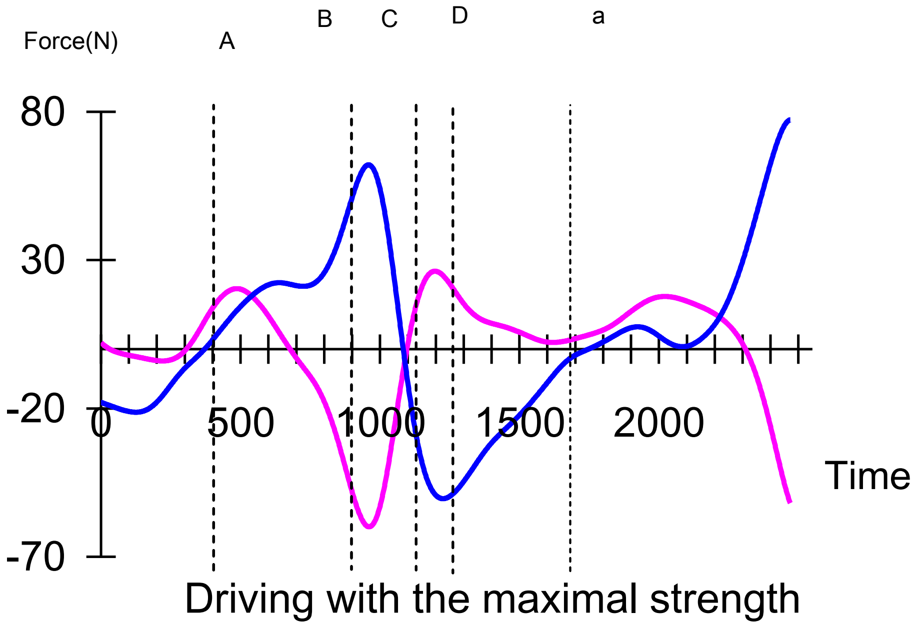
value	foot	Driving with the medium strength (M±SD)	Driving with the maximal strength (M±SD)
The peak value	Right	42.77±6.11*	63.78±7.56
	Left	36.76±3.32*	41.54±5.70
The valley value	Right	- 15.12±3.54*	- 41.77±3.56
	Left	- 38.35±4.19*	- 63.59±7.23

Note: *, which represents the difference is significant between the driving with medium strength and maximal strength.

In the left-right direction of GRF, both the peak and valley values of right foot and left foot were compared, there was evident difference between two types of force, and the driving with maximal strength was higher. The peak values of right foot of two type of force were 63.78±7.56 N and 42.77±6.11 N. The peak values of left foot of two type of force were 41.54±5.70 N and 36.76±3.32 N. The valley values of right foot of two type of force were -41.77±3.56 N and -15.12±3.54 N. The valley values of left foot of two type of force were -63.59±7.23 N and -38.35±4.19 N.

3.3 The analysis on the GRF in the front-back direction

Figure 3 GRF in the front-back direction



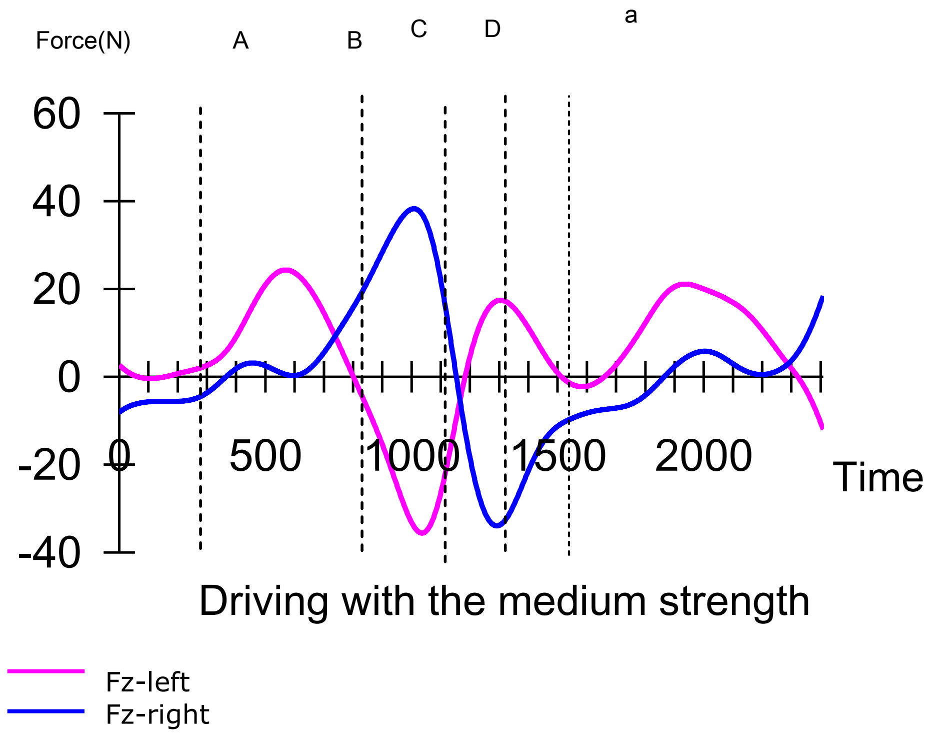


Table 3 the comparison the GRF in the front-back direction between left foot and right foot (n=10) unit:N

value	Driving with the medium strength (M±SD)	Driving with the maximal strength (M±SD)
The peak value of right foot	32.38±3.49*	59.89±7.05
The valley value of right foot	- 38.13±5.87*	- 63.54±7.90
The peak value of left foot	12.89±2.08*	23.11±2.46
The valley value of left foot	- 38.56±4.02*	- 61.09±4.76

Note: *, which represents the difference is significant between the driving with medium strength and maximal strength.

In front-back direction, the peak and valley values of right foot and left foot were compared, there was evident difference between two types of force, and the driving with maximal strength was higher.

4 Conclusions

The table tennis player's drive technique characteristic in three dimensions was described by the obtained dynamic data.

When the player drive loop with the maximal strength, it paid more attention to increase the GRF of left-right direction and front-back direction, which mean that the moving of gravity in left- right direction and front-back direction should be increased.

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ITTF SCORED A GOAL (changes of rules in table tennis during 2000-2003)

Abstract

In late nineties the ITTF estimated that table tennis has no bright future without changes of the rules. The need for changes was inevitable. Though the order of changes was adjusted nobody could predict how those changes would affect table tennis.

The system which would analyze the structure of the competitive activity of table tennis players was required in order to find out the consequences caused by the change of rules. Activities had to be representative and objective in order to perceive possible variations within them (related to the change of rules) and related to the logical group of the activities to which they belong. Competitors' activities were analyzed in 61 activities (variables), grouping in 3 systems of activities (variables):

1. *System of variables for evaluation of frequency, way of realization and effective of technical and tactical elements (30 variables)*
   - *frequency of technical and tactical elements, effect of these elements, stroke placement zone, stroke realization zone.*
2. *System of variables for evaluation of realization service stroke (and returning of service) and effective after service stroke (and returning service) (23 variables)*
   - *realization of service stroke (type of service and service placement zone), effect of service stroke and activity after the service, realization (type) of returning service, effect of returning stroke*
3. *System of variables for evaluation of movement activities (8 variables)*
   - *side and deep movements, change of forehand and backhand position, stroke in forehand/backhand position and arm swinging for forehand/backhand strokes*

The analyses were done in the following competitive periods:

- *Competitive season 2000/2001 - 40mm ball play*
- *Competitive season 2001/2002 - 11-2 system of play*
- *Competitive season 2002/2003 - new service rule*

For every analyzed period the most important changes were defined and described.

The comparative analysis of the final matches at the Olympic Games in Atlanta (1996), Sidney (2000) and Athens (2004) was made.

The influence on the ranking in European and World table tennis (trend) was observed – analysis of the first 50 players at the European and World rank lists, and the changes in rank regarding the changes of rules)

A special attention was given to comparison of the Asian and European players (both before changes and after).

Key words: *table tennis, game rules*

1 Introduction

In late nineties the ITTF estimated that table tennis has no bright future without changes of the rules. The need for changes was inevitable. Though the order of changes was adjusted nobody could predict how those changes would affect table tennis.

Toward the end of 2000, the ITTF started with rules changes aimed at making table tennis more viable as a televised spectator sport. First, the older 38 mm balls were officially replaced by 40 mm balls. This increased the ball's air resistance and slowed down the game. By that time, players had begun increasing the thickness of the fast sponge layer on their bats, which made the game excessively fast, and difficult to watch on television. Secondly, the ITTF changed from a 21 to an 11 point scoring system. This was intended to make games more fast-paced and exciting. The ITTF also changed the rules on service to prevent a player from hiding the ball during service, in order to increase the average length of rallies and to reduce the server's advantage.

This was a sign for the experts, coaches and players to adopt themselves to these changes the fastest and best they could, in order to retain their positions or achieve better results. There were no great changes in the world's top table tennis, but the ability to easily adapt is what makes the great players "great". This research on exact way show - what really happened in structure of game through this period of changes.

The basic aim of this research is rationalization and to improve the efficiency of training in table tennis. Considering these results of research, which are explaining change and model of modern concept of table tennis game, also, can be and sign for further ideas for changing the rules in this game.

2 Methods

The system which analyzes the structure of the competitive activity of table tennis players was used in order to find out the consequences caused by the change of rules. Activities had to be representative and objective in order to perceive possible variations within them (related to the change of rules) and related to the logical group of the activities to which they belong. Competitors' activities were analyzed in 61 activities (variables), grouping in 3 systems of activities (variables):

1. System of variables for evaluation of frequency, way of realization and effective of technical and tactical elements (30 variables)
2. System of variables for evaluation of realization service stroke (and returning of service) and effective after service stroke (and returning service) (23 variables)
3. System of variables for evaluation of movement activities (8 variables)

2.1 Participants

Subject of this research were 240 top table tennis players. 4 groups of 60 players were made (Group 1 – from season 1994/95 till 2000, Group 2 – season 2000/2001, Group 3 – season 2001/2002 and Group 4 – season 2002/2003 - 2004/2005.) (mostly leading World players - rank in the first 100 at ITTF Rank list) Data were collected by video recordings of matches.

2.2 Procedure

2.2.1 Statistical analyses

For all analyzed activities following statistical parameters are done:
Descriptive statistics:

- Arithmetic Middle
- Standard Deviation
- Variation (Maximum and Minimum results)
- Simple and relative Frequency

Percentage in complete activity and group of activity are done. Discriminative analyses and Multivariate Analysis of Variance (MANOVA) was used (and FOLLOW UP - ANOVA) were used for the defining of existing differences between analyzed groups of players (group of players with 38 mm ball - 40 mm ball - system of play until 11 points - new service rule play) and other groups (winner/loser – top ranked/lower ranked players).

3 Results

In the game with 38 mm ball the conception of the aggressive forehand game was clearly recognizable and the great influence of the service and its effect on the ultimate result.

Competitive season 2000/2001 - 40mm ball play

Introducing the 40mm ball caused confusion in the game, so the ratio of forehand strokes decreased and become more equal with backhand play. The influence of the service considerably increased, return of the service became more aggressive and the ball was more "active".

Table 1 *Comparation analyses of 38mm ball play and 40mm ball play*

	38mm ball till 21pt	**40mm ball till 21pt**
Rally per point (without service)	3.52	3.81
Forehand/Backhand play	57/43%	54/46%
Efficacy of strokes	23.47%	24.63%
Errors	23.75%	25.07%
Service efficacy	43.61%	51.23%
Playing near the table	88.69%	85.51%

- The number of strokes in the rally per point increased for 0.29 strokes, after the enlargement of ball (21 points game).
- Errors slightly increased for about 1.32%, as a consequence of players' adaptation to new ball. This result also, and an increase of the stroke efficacy for 1.16%.
- Points won directly with the service and in action after service increased about 7.62%. But when we look in this group of activities carefully we can make some conclusions. SERACE (ace service) - increased from 12.02% (in all service activities) to 17.81%. SERWFS (point won with first stroke after service) - decrease from 27.36% to 26.39%. SERACT (point won with action after service (more than one stroke)) - increase from 4.23% to 7.03%. SERLOS (point lost after service) - increase from 40.67% to 42.13%. SERERR (service error) - stayed in nearly the same relation.

Larger ball make players during return of services much more confident, and because adaptation to the rotation and bounce of new ball wasn't on adequate level, they made much more mistake in return of service. On the other hand, open play after service with more rallies is notable, which is very important for next stage of play.

Expecting that new ball is slower, players accept to play much more near the table, which cause more errors during play. These is also, and cause of much more equalizing of the forehand and backhand play in game.

Competitive season 2001/2002 - 11-2 system of play

With the new system of game to 11 points with 2 services each, every point became precious. The players adapted to the bigger ball, the service and the return of it became more secure, the game became more open with lot of spin strokes, concept of the game started to look more like that of the game with 38 mm ball, the strong forehand game and secure backhand game with few errors near the table, after which the initiative was taken and the point won.

Table 2 *Comparation analyses of 40mm ball play and play till 11 points*

	40mm ball till 21pt	**till 11pt/2 service**
Rally per point (without service)	3.81	3.97
Forehand/Backhand play	54/46%	60/40%
Efficacy of strokes	24.63%	21.54%
Errors	25.07%	23.34%
Service efficacy	51.23%	44.86%
Playing near the table	85.51%	87.52%

- After the change of system of play from 21 to 11 points, the number of strokes in the rally increased for 0.16 strokes. Efficacy of strokes decreased for 3.09%. Errors in the play during the match decreased for 1.73%.
- Points won directly with the service and in action after service decreased for 6.37%. This is the activities where the changes are the most notable. SERACE (ace service) - decreased from 17.81% to 13.60%. SERWFS (point won with first stroke after service) - decrease from 26.39% to 24.88%. SERACT (point won with action after service (more than one stroke)) – slightly decrease from 7.03% to 6.38%. SERLOS (point lost after service) - increase from 42.13% to 45.77%. Players adapt to larger ball during return of services, because errors during return decrease from 19.34% to 13.38%.

Forehand play again is dominant. Also, because importance of every point players changes playing more rallies in zone far from table.

Competitive season 2002/2003 - new service rule

With the introducing of new service rule no important differences in the game concept were noticed, probably because of the judging criteria, and not the players themselves.

In stead of previous change rule period, number of strokes in point increases for 0.05 strokes, forehand play become more dominant in stead of backhand play. Service efficacies decrease further more for 2.85%. The other parameters stayed nearly at the same level like before. Probably caused of better concentration of players on return of the opponents service, because more importance for every stroke and point in game.

The comparative analysis of the final matches at the Olympic Games in Atlanta (1996), Sidney (2000) and Athens (2004)

The object of analyzes were only the final games of Olympic tournament in men category. Because, it is only one game, these results can be right measure of the changes in structure of the game, but, they can show to us some details. Analyzed games were following:

- 1996 - Atlanta LIU Guoliang (CHN) vs. WANG Tao (CHN)
- 2000 - Sydney KONG Ling Hui (CHN) vs. WALDNER Jan Ove (SWE)
- 2004 - Athens RYU Seung Min (KOR) vs. WANG Hao (CHN)

Games from 1996. and 2000. Olympiad were analyzed together (because they were played under the same rules), in stead of the game from 2004. Number of strokes is increased for about 0.53 per point. Efficacy of service is decreased for about 8%. Unfortunately, changes of rules happened in period from 2000/2001 to 2002/2003, so in four year period was impossible to see what happened with game during these changes individually.

The influence on the ranking in European and World table tennis (trend) was observed – analysis of the first 50 players at the World rank lists, and the changes in rank regarding the changes of rules)

ITTF World Rank lists were analyzed on every 2 month from the beginning of changing rules in table tennis.

Only in season 2002/2003, exactly in 2003. there was a change in top of the World table tennis. After domination of Chinese players, there was significant development in ranking of European players (Timo Boll and Werner Schlager and at position no 3 was also and Vladimir Samsonov). First half of 2003. mark Boll, and after Schlager (winning a World Championship in Paris).

We can get conclusion that service was key element in domination of Chinese players in stead of others. By decreasing of number from five to two services in game, and with changing rule of service visibility, in period of adaptation to these rules, difference between European players and Chinese players was reduced. With less point in game, larger ball, game become more uncertainly, and the best European players (Boll, Schlager, Samsonov, Kreanga) find their change and take advantage.

After that, again come period of adaptation of Chinese players to these changes and they gain again top position in World table tennis.

4 Discussion/Conclusion

For modern table tennis we can say that it is "born again" after these changes. Today it represents a new, dynamic, attractive and exciting game, which draws the attention the audience again. From the data in Table 3 we see, that game become attractive and dynamic with less points and time of playing. That service is not dominant so much as before, and that game gives equal chances to players (if they are on nearly same level).

Table 3 *Comparation analyses of 38mm ball play and actual system of play*

	38mm ball till 21pt	**actual system**
Rally per point (without service)	3.52	4.02
Forehand/Backhand play	57/43%	61/39%
Efficacy of strokes	23.47%	21.78%
Errors	23.75%	23.45%
Service efficacy	43.61%	42.01%
Playing near the table	88.69%	86.79%

Ability of quick adaptation in game is one of the most important abilities in modern table tennis which cause the results efficacy. Adaptation to changes of rules is in correlation with training technology.

From the following, we can see that Chinese approach to training technology, in stead of the others (no mater in individual cases), is more serious and efficacy in long term. The reasons are in high education of their coaches, and also, with the serious attention in analyzes of trends in game and thinking how to leave it behind in most efficacious ways. European table tennis, if think to "stay in game" must to give more attention in education of coaches, change in way of thinking, development of training technology to higher level.

Generally, training technology in some sports as football, basketball and volleyball are in top level, and they represent leaders in innovations in this field, while table tennis stay behind them. If Europe thinks to become serious threat to China, needs it need awaking, and serious efforts in next four year period.

It means, that it is not necessary organizing camps for the best players for training, this camps should be and some kind of "surround tables" of leading table tennis experts and coaches with new ideas in innovation of training. Because, competitive European players in stead of Chinese, are one of the reason for more attractiveness in this game at the Championships and TV broadcasts.

If International Table Tennis Federation have interest to continue with changes in way of equalizing of players, these changes should be pointed in area of decreasing of influence of service, which is still dominant element in result efficacy, and the one of the main cause of efficacy of the European and Asian players.

So, these ideas, maybe, should be next step in thinking of some future change:

1. Enlargement of ball diameter to 44mm (it should slow down game and decrease efficacy of strokes and service with increase of rally in point).
2. Increasing of net high (which should have directly influence in service efficacy and service performance).
3. Alternate performance of service (it should have influence in increase of dynamic in game, and eventually in some way neutralize advantage of excellent service performers).
4. Alternate service – one forehand service – one backhand service.
5. Introduction of strict zone place of service (for example, one service should be placed in forehand and the other in backhand zone, this way return of service would be relieved).
6. Perform of one long and one short service (player on service, can choose which kind of service will be first (if the first one is long, another should be short (it means that the other bounce of ball should be on table in stead of long service). If short service in second bounce is going out of table and the receiver notice that, he should let ball to drop out, player on service lose point)).
7. Prohibition of gluing.

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THE EFFECTIVENESS OF SHADOW PRACTICE IN LEARNING THE TABLE TENNIS STANDARD FOREHAND DRIVE

Abstract

The study was conducted in response to the problem on how to develop a practice structure that will promote learning in Table Tennis Physical Education classes even with limited time and inadequate facilities which is a common fixture in Philippine setting. In the present study, the participants (n= 32) were randomly assigned to either one of two subject groups. The experimental group (n= 16) performed the shadow practice while waiting for their turn to practice with multi-balls. The control group (n= 16) practiced with a single ball for each pair of students while waiting for their turn to practice with multi-balls. The commonly used consistency and accuracy skills test was used to determine their pre-test, post-test and retention test scores. The level of significance was at P = .05. Using descriptive measures, the data revealed that both groups showed a significant change in the scores in the post-test phase of testing. The experimental group's mean = 83.5 while this group's pre and post test t = -14.3226. The control group's mean = 81.7 while this group's pre and post test t = -16.02311. However, only the experimental group was able to retain their scores in the retention test phase of testing. The experimental group's mean = 83.4 while this group's post and retention test t = 0.04897. The control group's mean = 78.3 while this group's post and retention test t = 4.6929529.

Key words: *table tennis, shadow practice, multi-ball practice, physical education, feedback.*

Teaching P.E. in Philippine Schools

Two of the most important objectives of P.E. 2 courses are for the students to have improved physical fitness and for them to perform the basic skills with an acceptable degree of proficiency. P.E. classes in many Philippine universities have a two hour session once a week schedule which is divided into two schedules: one hour session twice a week or a two hour session once a week. Most schools in the Philippines especially those in the provinces have limited facilities. Even major universities with a high student population use a maximum of four tables in their P.E. classes. Thus, it is common for classes to have students more than what could actually be accommodated. Ideally, a pair of students should play on a table at a given time. Nevertheless, it would be important to maximize whatever could be accomplished given this situation

Using guidance techniques

Teaching the skills in table tennis, basic as it may seem is not as simple as it is perceived to be. The standard forehand forehand drive for instance, requires the spatial and temporal coordination of sub-movements. Its' success depends on the timing and spatial characteristics of the back swing, the forward swing, ball contact and follow through. The teaching of motor skills involves the use of guidance techniques. According to Wulf, Shea and Witacre (1998), "guidance techniques guide the learner to the correct response" (p. 368). Lintern and Gopher (1978) also stated that, "guidance techniques provide the learner with a clearer image of the goal movement" (p. 192). The guidance technique used in table tennis is the shadow practice. The shadow practice is executed by simulating the stroke within the table tennis table, in front of a mirror or in any convenient space. The participants in the study performed the shadow practice within the table tennis table.

Using guidance techniques with feedback

The uses of guidance techniques include providing feedback. According to Lee, Keh and Magill (1993) "the feedback provided by teachers is typically in the form of positive, non specific evaluative statement." (p. 228). When feedback is used in experimental works it is termed knowledge of results. Schmidt and Wrisberg (2001) defined knowledge of results as the "extrinsic, usually verbal information that tells learners something about the success of their actions with respect to the intended environmental goal" (p. 279). The feedback provided in the study was both verbal as in instructing the subject to swing forward and backward as well as physical as in making the necessary corrections on the angle of the subject's racket and guiding the subject in the execution of the stroke.

The scheduling of feedback

There are contrasting views on when feedback should be provided in teacher-learning situations. The guidance hypothesis, Schmidt (1991) states that, "too much feedback enhances acquisition performance but degrades retention performance (as cited by Kohl and Guadagnoli, 1996, p. 233). Guadagnoli and Kohl (2001) likewise stated that "support for the guidance hypothesis has been plentiful but not universal" (p.218).

Studies supporting the guidance hypothesis point-of-view (Goode & Magill, 1986; Wrisberg & Liu, 1991) recommend that making feedback more difficult during skill acquisition can be detrimental in acquisition but beneficial in retention. However, studies of more complex task (Guadagnoli, Dornier & Tandy, 1996; Wulf, Shea & Matschiner, 1998; Lai & Shea, 1998) proved contrary to the guidance hypothesis point-of-view.

The present study tried both recommendations; the experimental group had an easier task of performing the shadow practice while waiting for their turn to practice with multi-balls whilst the control group had the more difficult task of trying to keep the ball in play while waiting for their turn to practice with multi-balls.

The purpose

The purpose of the study was to see the performance of college students in the commonly used consistency and accuracy skills test using shadow practice in learning the standard forehand drive. The study specifically aimed to see the performances among two different conditions; (a) the experimental group using shadow practice in combination with multi-ball practice (b) the control group using one ball per pair of students in combination with multi-ball practice. The other purpose was to compare the significant difference in the two group's pre and post-test and post and retention test scores.

Methods

Subjects

The subjects were female (n=32) volunteer U.P. Baguio female students from the different P.E. 1 Lecture Classes. Only female students were chosen as subjects because of the male and female ratio (1 male = 4 females) in all P.E. 1 classes. Also, many of UP Baguio would be male subjects play table tennis recreationally during their free time. All subjects were considered pure beginners in the sport of table tennis.

Those who ever held a table tennis racket were discouraged from volunteering during the dissemination of the study.

Instrument

The consistency and accuracy skills test was used to determine the scores of the subjects. A total of one hundred trainer balls were used for the test and two persons, the feeder and the counter administered the test. The test was conducted with one subject at a time. Each subject was instructed to hit as many balls as she could to the designated target area (crosscourt) at the opposite court. The number of balls that hit the specified target area was counted (e.g., 50/100, 70/100, 80/100).

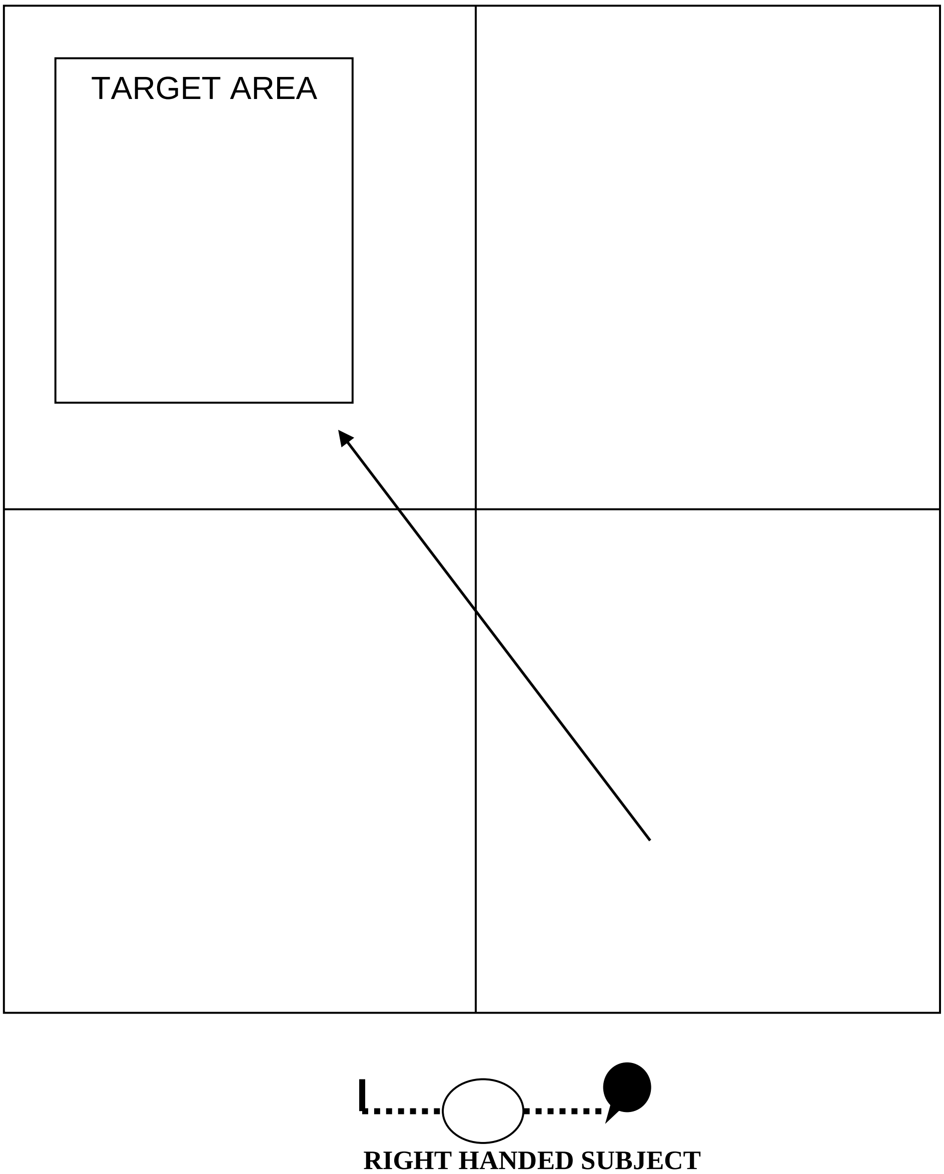

Figure 1. ***The research instrument***

Task

The standard forehand drive was selected as the experimental task. Since this open skill is foundational to the game of table tennis. It is also typically first in the learning sequence in many P.E. classes after the introduction of the basic mechanics such as the grip and the basic ready position.

Procedure

All subjects were briefed that the purpose of the study was to determine their performance in the consistency and accuracy skills test.

Pre-test. The subjects (n=32) were taught the basic ready position and the shakehand grip. The subjects were positioned half at arms length from the table's end line. Using the consistency and accuracy skills test, each participant was instructed to hit as many balls as she could to the designated area (crosscourt) at the opposite court.

Practice sessions. The participants were randomly assigned to two practice conditions after the pre-testing phase, the experimental group using shadow practice in combination with multi-ball practice and the control group using one ball per pair of participants in combination with multi-ball practice. Each group practiced for a period of one hour a day for five days.

The experimental group were instructed to follow the instructor perform the shadow practice for five minutes after which the instructor proceeded to feed multi-balls to each subject. The instructions were as follows: bend knees and slightly leaned forward for the right handed subject, right foot slightly forward for the left handed subjects, hold racket slightly higher than table height in front of the body, then backswing, then forward swing. One subject practiced with multi-balls at a time while her partner picked balls missed and placed them on a bucket so as not to delay time. Each pair alternated on this tasked until both finished practicing with multi-balls. The pair then resumed shadow practicing. The rest of the group shadow practiced as they waited for their turn to practice with multi-balls.

Each pair of the control group played with a single ball as they waited for their turn to practice with multi-balls. They were instructed to strike the ball crosscourt or diagonally and try to keep it in play with a controlled action. They were also not allowed to smash the ball even after they had gain some control over their strokes in the course of the five day treatment period.

Post-test. Upon completion of the five day treatment period, the participants were given a post-test using the same procedure as in the pre-test. The experimental group was the first to be given the post-test followed by the control group.

Retention test. After a period of three calendar days, a retention test was given using the same procedure as in the pre-test and post test.

Data Analysis

Data was analyzed using t-test to determine the significant changes in the two subject group's pre-test, post-test and retention test. Independent samples were use to determine the significant difference between the two subject group's post-test and retention test. The level of significance was at P = .05.

Results

Table 1. *The experimental group's scores*

	Mean Score	N	Standard Deviation	t
Pre-test	36.8	16	16.37	
Post test	83.5	16	8.52	-14.3226*
Retention test	83.4	16	10.40	0.04897*

Sig. at P = .05

Table 1 shows a significant difference in the mean scores between the pre-test and post-test of the experimental group. It also shows that there is no significant difference between the mean scores in their post and retention test. The findings suggest that the beneficial effect of using shadow practice is not temporary in nature but can positively affect the learning of the standard forehand drive. Shadow practicing enabled the participants to have a pattern of coordination and gave them an idea as to what the "goal movement pattern of striking the ball feel" (Lintern & Gopher, 1978). They had what Schmidt and Wrisberg stated as their own "proprioceptive or kinesthetic information" (p. 93). They may have consciously or unconsciously experienced the movement of their joints and thus develop their muscle memory that eventually became automatic as they shadow practiced (Packer, 2005). The findings also showed that the performers can use the experience of shadow practicing to shorten the learning process, which is to reach a higher level performance in less time.

Table 2. *The control group's scores*

	Mean Score	N	Standard Deviation	t
Pre-test	37.3	16	14.99	
Post test	81.7	16	10.92	-16.02311*
Retention test	78.3	16	12.42	4.625929*

Sig. at P = .05

Table 2 shows a significant difference between the mean scores of the pre-test and post-test of the control group. It also shows a significant difference between the mean scores of their post-test and retention test scores as the scores were lower in retention. The control group played with a single ball as they waited for their turn to practice with many balls. They were instructed to play the ball crosscourt or diagonally with a controlled action. They stopped to pick up the ball more often than trying to keep it in play. As studies that have found out that skill learning is positively related to successful practice trials and negatively related to unsuccessful practice, (Ashy, Lee & Landin, 1988; Silverman, 1985, 1990; Hebert, Landin & Solmon, 1996) stopping to pick balls missed reduced the amount of time of actual practice. They were not able to experience the goal movement pattern of striking the ball crosscourt since they had more time picking up the ball than putting it in play. The findings contradicted what could be expected from a guidance hypothesis point-of-view (Schmidt, 1991) that making the practice experience more difficult results in the attenuation of acquisition performance but enhances retention. The control group were able to achieve high scores as shown in their post-test but were not able to retain their scores as shown in their retention test.

Table 3. *Independent sample test*

	T	Sig. (2 tailed)
Pre-test	-0.09016	0.928802
Post-test	0.52639	0.60477
Retention test	1.265308	0.215501

Sig. at P = .05

Table 3 shows that there is no significant difference between the experimental group and control group in their post-test and retention test scores. Although the control group had a mean score of 78.3 (Table 2) as compared to the experimental group's mean score of 83.4 (Table 1) in the retention test, the control group's standard deviation of 12.42 (Table 2) is higher than the experimental group's standard deviation of 10.40 (Table 1). Both groups had subjects that achieved high scores in the retention test. Both the experimental and the control group were able to achieve high scores in their post-test. However, the experimental group retained their scores while the control group did not.

Discussion

The findings that studies on feedback have provided justified its being generalized to practical situations. However, majority of these studies had been conducted in laboratory settings which may have some disparity when compared to sports skills. Hebert, Landin and Solomon (1996) stated that "compared to typical laboratory tasks, sports skills are generally more complex movements, involve the control of a greater number of degrees of freedom, and require more practice to master"(p. 53). In line with Lee, Keh and Magill's (1993) recommendation that "these assertions be tested in Physical Education classrooms" (pp. 228 – 243), this study was conducted to observe the performance of college students using the guidance technique of shadow practice in learning the table tennis standard forehand drive.

Most schools in the Philippines do no have sufficient table tennis tables to address the ideal number of students which is a pair for each table. P.E. instructors experience difficulty facilitating learning in situations where there are more students than what could actually be accommodated and with a limited time. A typical example of this scenario is a major university north of Manila, the Philippine capital. The school has an average of twenty students enrolled in their one hour per meeting table tennis P.E. class. However, this school has only three tables. Even if the school could afford to purchase additional tables, there would still be complications on how these tables would be utilized. The class is conducted at the same time with other P.E. courses, thus they only have an allotted space in the school gymnasium. How learning can be more conducive in this school and in other schools with similar situations is also the concern why this study aimed to see if shadow practice is an effective mode for skill instruction.

A total of 32 female U.P. Baguio volunteer students with a mean age of 16 were used as subjects for this study. All were considered pure beginners in the sport of table tennis. Those who ever held a table tennis racket were discouraged from volunteering during the dissemination of the study to the different P.E. 1 Lecture classes. The subjects were pre-tested (experimental groups' mean = 36.8; control group's mean = 37.3.) and randomly assigned to either of the two subject groups. They were asked to report for five days for their treatment after which a post-test (experimental group's mean = 83.4; control group's mean = 78.3) was administered after three calendar days from the post-testing phase. Data was analyzed using descriptive measures, t-test (experimental group's t = -14.3226, post and retention test t = 0.04897; control group's pre and post test t= -16.02311, post and retention test t = 4.625929).

The study revealed that both the experimental group and control group had a significant change in their scores in the post-test phase of testing. However, only the experimental group was able to retain their score in the retention test phase of testing.

Conclusion

The findings of the study support studies (Wulf, Shea and Matschiner, 1998; Wulf, Shea and Witacre, 1998) which had similarities in the results. Specifically, the results contradicted what could be expected from a Guidance Hypothesis point-of-view (Schmidt, 1991). The results of the study led to the conclusion that both shadow practicing and using a single ball for each pair led to high scores in the post-test. Statistically treated data revealed that only those who performed shadow practice were able to retain their scores in the retention test while those who practiced with a single ball per pair had a significantly lower score in their retention test as compared to their post test. Thus, the study revealed that using shadow practice is a mode for effective skill instruction. The study concluded that there are no significant difference among the two subject group's pre-test and post-test. Both groups were able to achieve high scores in their post test.

The experimental group using shadow practice did not show any significant difference in their post and retention test. Thus, this group was able to retain their scores in the retention test. However, there was a significant change in the control group's post and retention test scores. The control group using one ball per pair was not able to retain their scores in the retention test.

Recommendation

Based on the results of the study, students who are waiting for their turn to play in schools which have limited facilities should perform shadow practice. As the findings revealed, even subjects who had the privilege of playing while waiting for their turn to practice with multi-balls were not able to retain their scores in the retention test. How much more for students who would spend considerable time waiting than actually playing?

It would also be recommended that future studies involve male subjects as what Wrisberg and Liu (1991) did in extending the learning of three badminton serves (pp. 406 -412). Their study involved male subjects since Goode and Magill's (1986) study had only females as subjects (pp. 308-314). Their findings showed that there were no disparity between the male and the female subjects' performance. Further studies should also see if it could derive the same results.

Other foundational skills such as the standard backhand drive and a combination of both strokes should also be included in future studies. Studies by Hebert, Landin and Solmon (1986) on "high and low skilled students using the tennis forehand and backhand ground strokes argued that these two skills required different motor responses yet had similar perceptual and timing characteristics" (pp. 52 - 58). Their findings concluded that random practice failed to facilitate learning even for the high skilled students. Further studies should determine if using block practice as what was used by the aforementioned study, still facilitate learning with the addition of the other foundational skills

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THE EFFECT OF A RECOMMENDED TRAINING PROGRAM FOR DEVELOPING THE MOTOR ANTICIPATION SPEED ON PERFORMING SOME ANTICIPATORY SITUATIONS AND OFFENSIVE SKILLS FOR TABLE TENNIS JUNIOR PLAYERS

Abstract

Table tennis balls are different in directions, places and speeds. He linked the ball speed with its direction and type of spine. There are spine-free balls that represent a problem for the junior player in anticipating the ball speed, place and trajectory. The current research is an attempt to increase the experiences of junior table tennis players under 15 years as long as the junior player at this stage lakes the necessary experience, When using a device for measuring the motor anticipation speed in the training hall, this will be considered as a valuable additive in the field of anticipation speed for table tennis juniors using the real playing tools that are the ball, the racquet and the table. Designing a training program for enhancing motor anticipation speed skills using different ball directions, places and speeds for junior table tennis players under 15 years ,Recognizing the effect of using the recommended training program on enhancing and developing motor anticipation speed for junior table tennis players under 15 years. The researcher used the experimental approach using one group with pre- and post- measurements, (15) Junior table tennis players under 15 years from Tanta Sports Club , The motor anticipation speed measuring tool (designed by the researcher), Anticipatory situations tests (designed by the researcher). Findings: The anticipatory situations tests (simple or complex) indicated a positive direction in increasing the improvement percentage after applying the recommended training program.

Key words: *table tennis, training program, anticipation, speed*

Introduction and Research Problem

Table Tennis is a dynamic sport in which training affects both the sensory and motor systems. It demands unlimited technical and tactical skills. It can, also, be classified as a fast-ball-sport, as it demands , in all levels, that the player should be able to use motor anticipation, speed, reaction speed, a powerful nervous system and intelligence in making decisions. (27:26).

The researcher thinks that sports evolution doesn't follow strict phases. Instead, it flows as an integrated process, as the player can spend as much time as he/she wants in any of its phases according to his/her needs. The evolution is not necessarily upwards-directed, as the player can return to any previous phase to correct a specific problem of any kind. Motor anticipation is a common feature for motor building. Formally, it is expressed as the readiness of the player for the next move before the start of the first one (3:104).

Janusze Lapszo (1999) divided anticipation in table tennis into two components that were place anticipation (trajectory) and ball anticipation (speed and spine). As for the first component, it consists of predicting the place to which the ball is moving and executing the approach movement to be as near as possible to that place. In the second component, anticipation is responsible for the spatial and temporal coordination for the hitting action of the ball or the opponent with the ball or opponent trajectory. He assured that motor anticipation includes the movement execution time, the movement beginning time and the response time.(20:144).

Dimosthenis E. Messinis (2000) mentioned that one of the most difficult features of table tennis is anticipation the coming ball and making the correct decision about the ball timing. This because table tennis is a fast-ball sport and the decision should be taken in less than a second. The player should anticipate the opponent's ball so that he/she can be ready to receive it in a manner that leads to gain the point. Anticipating the opponent's ball consists of two components; the first component refers to the surrounding circumstances, coordination with the ball and the opponent's behavior. The player's experience is critical in understanding the opponent's behavior. Basic experience in tactics, that can be developed by training, includes fast playing for unanticipated strokes. Thus, the player can develop self –confidence and the ability of controlling the game (11:96) (20:96).

Shereef Saleh (2004) designed and calibrated a device for measuring the motor anticipation speed for table tennis players. He used the concept of motor stimuli – the ball – (audio visual) on the basis of recognizing the opponent's movements and the first phase of the ball trajectory. The player can deal with this information as a stimulus that directly refers to the place where he/she should move to. The final phase of the ball trajectory or the opponent's trajectory is the base of motor anticipation and can be considered as target stimuli that refer directly and accurately to the place and timing of meeting and hitting the ball. The table tennis player should concentrate with his eyes on a 40mm-ball that weighs 2.7g, moving very fast in a free space. Besides he/she has to see, clearly, both the opponent and the table simultaneously. Expert players anticipate the ball trajectory and the opponent's stroke direction, stroke action and play pattern.

Anderson Mikeal (1998) stated that to win a point in a table tennis match, the player should have speed, spin and direction. Besides he/she should play fast and anticipates the ball spin in the first part , then anticipates the ball direction and its hitting point on the table on the second part (9:19). Technical and tactical aspects of table tennis are done as reactions according to the anticipation of the opponent's and the ball's movements. Except the serve, all other table tennis strokes depend, for their execution, on the opponent's position in addition to the place, speed, spine and flight trajectory of the ball. Tactical skills dominate modern table tennis and give the advantage of winning the first five balls with increasing the offensive nature of the game. This is concluded in the studies of Sherif Saleh (2002), Cai Xueling (2005), Cao Bing (2005), Wang Dazhung (2005) and Hazem M. Al-Shalakany (2006) (4), (12), (25), (31), (2).

The researcher assured that table tennis balls are different in directions, places and speeds. He linked the ball speed with its direction and type of spine. There are spine-free balls that represent a problem for the junior player in anticipating the ball speed, place and trajectory. The current research is an attempt to increase the experiences of junior table tennis players under 15 years as long as the junior player at this stage lakes the necessary experience. Tim Holder (1999) assured that, in any game situation that needs organized thinking, the available time for the player to prepare for the upcoming stroke of the opponent is very limited. This can never be done correctly unless the player reacts to the ball. Anticipating the direction and kind of the opponent's stroke may minimize the time needed for preparing the stroke to keep the ball running and not losing a valuable point in the match. When using a device for measuring the motor anticipation speed in the training hall, this will be considered as a valuable additive in the field of anticipation speed for table tennis juniors using the real playing tools that are the ball, the racquet and the table.(29:16)

Importance of This Study:

1- To try developing and enhancing the motor anticipation speed in junior table tennis players.

2- To make use of measurement as a training competitive tool among players, which in turn is considered one of the most important methods of developing skills and enhancing result levels.

Aims:

1- Designing anticipatory performance tests for anticipation speed skills in table tennis.
2- Designing a training program for enhancing motor anticipation speed skills using different ball directions, places and speeds for junior table tennis players under 15 years.
3- Recognizing the effect of using the recommended training program on enhancing and developing motor anticipation speed for junior table tennis players under 15 years.
4- Establishing the skills differences in motor anticipation speed performance using real-game tasks including real strokes.

Hypotheses:

1- There are statistically significant differences between the means of pre- and post- measurements of the research group in the studied simple anticipatory situations (using any kind of spine) for table tennis junior players in favor of the post-measurement.
2- There are statistically significant differences between the means of pre- and post- measurements of the research group in the studied complex anticipatory situations (using complex kinds of spine) for table tennis junior players in favor of the post-measurement.
3- There are statistically significant differences between the means of pre- and post- measurements of the research group in executing some of the studied offensive skills for table tennis junior players in favor of the post-measurement.

Research Terminology:

1- Motor Anticipation Speed: It is the ability of a player to move to the best place on the table to cover all possible lines of ball trajectory and stroke kind and to successfully hit the ball during the minimum time possible from the moment the ball comes out of the canon till it is hit by the racquet. (5:28)
2- Simple Anticipatory Situations: Balls of different directions that fall with the same speed on the table without any kind of spins.
3- Complex Anticipatory Situations: balls of different directions and places that fall inside/outside the table with different speeds and different kinds of spins.
4- Junior Player: According to ITTF, it is a player under 12, 18 or 20 years of age (18).

Literature Review:

1- Janusz Lapszo (2002) executed a study titled by "Simulation in Table Tennis" that aimed at measuring motor anticipation speed under false conditions in table tennis. The researcher used the experimental approach with a sample of (32) players (10 men and 22 junior males and females). The researcher used the sports table tennis simulator (a device with lights over the table and several sensors that the player hits instead of the ball). Results showed individual differences and group differences according to the chosen variables (21).
2- Mark A. Williams et al (2002) executed a study about anticipation skills in real tasks: measurement, training and transformation in table tennis. The study aimed at developing a laboratory real test for anticipation skill in real table tennis tasks using real-size images and motor response measurements. Besides, it aimed at exploring the use of a training program using video simulation and field training in enhancing the anticipation skill. The researcher

used the experimental and descriptive approaches. He also used a mobile eye movement recorder to identify the differences in the visual search behavior between elite and non-elite players. Results showed that anticipation skill in real tasks can be accurately measured in laboratory using simulated projections with real-size images and real response measurements. Video simulation and specific teaching of experts' strategies have an applied use as a way of enhancing anticipation skill in real tasks.

3- Sherif F. Saleh (2004) executed a study titled by "Designing and calibrating a device for measuring motor anticipation speed for table tennis players". The study aimed at designing and calibrating a device for measuring motor anticipation speed with balls of different directions and speeds for table tennis players inside the training hall using an electric digital watch (measuring 1/10000 sec). the researcher used the experimental approach. The device was designed and calibrated on a sample of (16) junior players of Gharbia table tennis team under 18. Results showed that the device has a high validity, referring to the ability to use it in measuring the anticipation speed for different ball directions for table tennis players. The device specifications (size – shape – structure – performance) enable using it both inside the training hall and during real performance. (5)

Procedures:

Methodology:

The researcher used the experimental approach using one group with pre- and post- measurements.

Sample:

(15) Junior table tennis players under 15 years from Tanta Sports Club, who are registered in the Egyptian Table Tennis Federation for 2006 season, were purposefully chosen as a sample for this study.

Sample was chosen for the following reasons:

1- The researcher is training and supervising the table tennis team of Tanta Sports Club.
2- The club's administration approved executing this research.

The researcher homogenized the sample according to age, height, weight and training chronology variables and some physical and technical skills under investigation. The following table summarizes these results:

Table (1): Homogenizing the sample on the basic under investigation variable (n=15)

s	Variables		unit	means	SD	Median	Regression
1	Growth variables	Age	Year	14.46	0.516	14.0	0.149
		Weight	Kg	36.66	0.723	37.0	0.628
		Height	Cm	134.06	0.798	134.0	0.128
2		Training age	Year	5.446	0.5164	5.0	0.149
3	physical variables	Passing in 10 sec test	Number of passes	6.600	0.507	7.0	0.455
		Fast numbered circles test	Time	8.66	0.488	9.0	0.788
		Trunk bend from standing	Cm	6.600	0.5071	7.0	0.455
		Machine-delivered ball test	Number of times	10.666	0.488	11.0	0.788
		Passing from movement accuracy test	Number of times	19.53	0.516	20.0	0.149
		Triangular jump test	Number of times	5.600	0.5071	0.600	0.0455
		1kg medical ball pushing test	m	187.8	1.146	188.0	0.118
4	Technical variables	Straight forehand strike	Degree	62.46	0.2416	62.0	0.205
		Straight back stroke	Degree	51.86	1.457	52.0	0.105
		Smash forehand stroke	Degree	10.464	0.516	10.0	0.149
		Foot work	Degree	54.13	0.9904	54.0	0.210
		Third ball attack	Degree	52.73	1.0486	0.53	0.075
		Forehand lope stroke	Degree	7.60	0.507	8.0	0.455
1	First situation	1st ball/p9	sec	0.7733	0.04577	0.80	1.176
2		2nd ball/p1	sec	1.0467	0.06399	1.00	1.085
3		3rdball /p3	sec	1.1540	0.05235	1.200	0.141
4		4th ball/p5	sec	0.894	0.008	0.90	0.094
5		5th ball/p7	sec	0.8173	0.03615	0.8000	1.736
6		6th ball/p6	sec	0.9060	0.00507	0.9100	0.455
7		7th ball/p3	sec	1.1737	0.04577	1.200	1.176
1	Second situation	1st ball/p9	sec	0.7733	0.4577	0.800	1.176
2		2nd ball/p3	sec	1.0600	0.5071	1.100	0.455
3		3rdball /p7	sec	0.8093	0.00838	0.8100	0.142
4		4th ball/p2	sec	1.160	0.05071	1.200	0.455
5		5th ball/p4	sec	0.8800	0.0414	0.900	1.672
6		6th ball/p6	sec	0.8667	0.04880	0.900	0.788
7		7th ball/p1	sec	1.0867	0.06399	1.100	0.103
1	3rd situation	1st ball/p2	sec	1.122	0.01014	1.130	0.929
2		2nd ball/p6	sec	0.7267	0.00488	0.730	0.788
3		3rdball /p4	sec	0.7373	0.011.	0.7200	0.237
4		4th ball/p7	sec	0.7773	0.04131	0.7600	0.495
5		5th ball/p3	sec	0.8773	0.04131	0.900	1.478
6		6th ball/p1	sec	0.8907	0.03990	0.900	1.488
7		7th ball/p9	sec	0.7867	0.5164	0.800	0.282
1	4th situation	1st ball/p1	sec	1.2513	0.009155	1.2500	0.938
2		2nd ball/p3	sec	1.2667	0.04880	1.300	0.788
3		3rdball /p1	sec	1.1693	0.00798	1.170	0.128
4		4th ball/p7	sec	0.8847	0.00639	0.890	0.802
5		5th ball/p6	sec	0.9840	0.00632	0.9800	0.547
6		6th ball/p5	sec	1.1242	0.00623	1.1230	0.661
7		7th ball/p4	sec	1.2347	0.00743	1.2300	0.130
1	5th situation	1st ball/p2	sec	1.2213	0.00743	1.220	0.227
2		2nd ball/p3	sec	1.1213	0.00743	1.1200	0.227
3		3rdball /p3	sec	1.1213	0.00743	1.120	0.227
4		4th ball/p6	sec	1.0193	0.00703	1.0200	0.092
5		5th ball/p5	sec	0.9787	0.00743	0.9800	0.237
6		6th ball/p5	sec	0.9573	0.00457	0.9600	1.176
7		7th ball/p1	sec	1.2533	0.05164	1.300	0.149
1	6th situation	1st ball/p3	sec	1.4247	0.00516	1.421	0.149
2		2nd ball/p3	sec	0.1187	0.00743	1.120	0.227
3		3rdball /p1	sec	1.0860	0.00507	1.090	0.455
4		4th ball/p1	sec	1.5253	0.00639	1.530	1.085
5		5th ball/p1	sec	1.1173	0.00798	1.120	0.555
6		6th ball/p2	sec	1.0233	0.00723	1.020	0.628
7		7th ball/p5	sec	1.7260	0.00507	1.730	0.455

From table (1) it is clear that regression values for the sample ranged from (0.705) to (0.788), that is between (+/-3). This means that it is inside the moderate curve as it near zero.

Designing the Recommended Training Program:

The recommended training program was designed as follows:

Aim of the program:

The aim of this program was to enhance and develop performance in some anticipatory situations and on some offensive skills of junior table tennis players under 15 years.

Content of the program:

The program contains a set of technical tests (appendix A). The program was divided into three main parts as follows:

1- Warm Up:

It aimed at preparing the player's body for the performed effort during a training session or a match. It is divided into:

- General warm up: that aims at elevating the readiness level of body parts, in general, for the activity.
- Special warm up: that aims at preparing the player physically, functionally, technically, tactically and mentally for the upcoming effort. This kind of warm up is preferred to be individual so that it suits each junior.

2- The main Part:

This part contains the drills that wok on achieving the training goal and contribute in developing the training status of a junior player. It takes nearly 75:80% of the training unit time. The researcher considered unifying the timing and content of the entire warm up, physical preparation, technical drills and final parts for the experimental group.

3- Drills:

The researcher reviewed the literature to build the drills for the under-investigation skills (Arno Stienen 2002, Boris Turina 2002, Butterfly 2003, Ertan Patir 2002,2003, Richard Macafee 2004, ITTF 2006) (10,11,14,17,16,26,19).

4- Final Part:

This part aims at returning the junior player back to his/her natural status.

The recommended training program elements were shown to table tennis experts. The agreement percentage was between 85:100% (appendix B).

Table (2): Results of Experts' Opinions on the Recommended Training Program.

	Element	Expert Opinion	Agreement (%)
1	Program Period	3months	100%
2	Number of weeks	12 weeks	90%
3	Number of units	36	90%
4	Unit Period	120 min	95%
5	Load Unit Format	1:1, 1:2, 1:3	85%
6	Training Loads	Below moderate – moderate – below maximum	90%
7	Training Method	High/Low intensity Intervals	100%
8	Used Tests	• ETTF Tests. • (6) Anticipatory Situations using motor anticipation speed measuring device (by the researcher)	100%

After getting the basic elements of the recommended training program, the researcher developed the training program, according to the opinions and modifications made by experts.

The researcher followed the following steps in his recommended training program:

1- Increasing the ball flight velocity by (5%) each training unit.
2- Playing a seven-round match (the player versus the ball canon without using the motor anticipation speed measuring tool.
3- Using the motor anticipation speed measuring tool as a training aid (one session every eight training units).
4- Identifying the duration and load intensities.

Relative rest periods for players were identified. Besides, time of pulse recovery for each player was calculated for below moderate, moderate and below maximum loads. Pulse rate was calculated every 6 seconds. Training was organized on that basis.
Distribution of time percentages for physical, technical and tactical preparations:

Table (3) percentages of preparation content:

	Physical	Technical and tactical	Cool down	Total
Percentage	20%	75%	5%	100%
Training units	864 min	3230 min	216 min	4320 min
Training unit	24 min	90 min	6 min	120 min

From table (3) it is clear that mental preparation times are not calculated inside the training units, as most of it is done outside the training units. In table tennis, technical and tactical preparations are mixed together in one unit, as tactical aspects are nothing but the correct application of the skills and all its physical, psychological and mental needs all around the table.

Data Collection Tools:

The researcher used the following tools to collect data:

1- Physical and Skills tests.
2- Personal data forms.
3- A medical balance for measuring weights.
4- Electronic ball canon.
5- Blue-color tables.
6- International legal table tennis net (approved by ITTF).
7- Legal table tennis balls (butterfly with three stars, 40mm in diameter and 2.7 gm in weight with yellow color).
8- The motor anticipation speed measuring tool (designed by the researcher).
9- Anticipatory situations tests (designed by the researcher) (appendix E)

Tests Used:

Physical Tests:

The researcher used a test battery for table tennis (designed by Magdy Ahmed Shawky 1996) (6).

Skills Tests:

The skills test battery used for The British Table Tennis Federation (1999) that counts on the coach who controls the balls and technical tests for offensive aspects of the game (15).

Anticipatory Situations Test: (by the researcher appendix E)

The researcher designed (6) anticipatory situations according to the following measures:

- The test should cover all the different points on the table from which most table tennis players hit the ball.

- Performance of each situation should simulate real performance in the game and the movement from one point to the other is logical and similar to the real performance and familiar to the players.
- The test should encourage good performance and show it well.
- The test should be exciting to motivate the players to perform.
- The used skills should vary.

Each situation should contain the following conditions:

1- seven balls at different places, directions and speeds on the table.
2- The final destination of each ball is random.
3- The situation should be multi-dimensional containing several skills.
4- There are several probabilities that distract the junior's mind and oblige him/her to choose the most valid one.
5- The test contains two simple situations (non-spin balls) and four complex situations (non-spin, top-spin or side spin then top-spin with side-spin).

The researcher designed these situations according to the studies of Sherif F. Saleh (2002), Cai Xueling (2005), Cao Bing (2005), Roger F;ynn (2005), Wang Dazhong (2005) and Hazem M. Al-Shalakany (2006) (4,12,24,27,30,2).

According to the concluded results, the researcher built the situations and showed them to the experts (appendix B). According to the experts' points of view, the researcher modified the specific part of performance characteristics and the test was on its final form. The researcher then tested the final form by measuring the time of test and the appropriate number of juniors taking the test per day.

The researcher canonized the test by calculating the validity of distinction (the test ability to distinct between different groups) and to take the first measure of validity. The researcher used test/retest format and calculates the correlation coefficient between the means of the two measures. This was done using two groups, one of them is distinct (Ghazl Al-Mahalla Sports Club, n=8 under 15 years), while the other is less distinct (the pilot study sampl). Results are shown in table (4).

Table (4): Difference Significance between the distinct and non-distinct groups on the anticipatory situations test. (n=16)

	Variable		measure	Distinct (n=8)		Non-distinct (n=8)		T
				means	SD +/-	means	SD +/-	
1	First situation	1st ball/p9	sec	0.6750	0.04652	0.8750	0.0463	8.64 *
2		2nd ball/p1	sec	1.0375	0.0517	1.2625	0.516	8.69 *
3		3rdball /p3	sec	0.8475	0.0198	1.050	0.0534	10.04*
4		4th ball/p5	sec	0.9600	0.0075	1.162	0.0517	10.95*
5		5th ball/p7	sec	0.7525	0.00707	0.8463	0.030	17.89*
6		6th ball/p6	sec	0.8451	0.00522	0.8850	0.00534	15.09*
7		7th ball/p3	sec	1.062	0.5175	1.2500	0.0535	7.12*
1	Second situation	1st ball/p9	sec	0.7500	0.0053	0.8588	0.0401	7.59*
2		2nd ball/p3	sec	0.9650	0.0054	1.162	0.0517	10.73*
3		3rdball /p7	sec	0.7650	0.0267	0.9250	0.00534	6.22*
4		4th ball/p2	sec	0.9963	0.0051	1.275	0.0462	16.92*
5		5th ball/p4	sec	0.8550	0.0053	0.9238	0.0051	26.13*
6		6th ball/p6	sec	0.8588	0.0064	0.9275	0.00707	20.07*
7		7th ball/p1	sec	0.9637	0.0051	1.162	0.0517	10.80*
1	3rd situation	1st ball/p2	sec	1.043	0.0051	1.250	0.0534	10.86*
2		2nd ball/p6	sec	0.6763	0.0052	0.7563	0.0074	24.96*
3		3rdball /p4	sec	0.6962	0.0051	0.7813	0.0083	24.48*
4		4th ball/p7	sec	0.7075	0.00707	0.7750	0.0053	21.53*
5		5th ball/p3	sec	0.8550	0.0053	0.9425	0.0337	7.25*
6		6th ball/p1	sec	0.8550	0.0053	0.9338	0.0342	6.43*
7		7th ball/p9	sec	0.7250	0.0054	0.8138	0.0341	7.25*
1	4th situation	1st ball/p1	sec	0.9125	0.0103	1.262	0.0517	18.75*
2		2nd ball/p3	sec	0.9613	0.0099	1.265	0.517	16.17*
3		3rdball /p1	sec	1.0500	0.0534	1.225	0.0462	7.0*
4		4th ball/p7	sec	0.8625	0.0517	0.9963	0.0051	7.27*
5		5th ball/p6	sec	0.8500	0.0534	0.9950	0.0053	7.63*
6		6th ball/p5	sec	0.9500	0.0544	1.162	0.0051	8.07*
7		7th ball/p4	sec	1.062	0.0517	1.275	0.0462	8.65*
1	5th situation	1st ball/p2	sec	1.0750	0.0462	1.275	0.0463	8.641*
2		2nd ball/p3	sec	1.0625	0.0517	1.237	0.0516	6.763*
3		3rdball /p3	sec	1.0500	0.0534	1.262	0.0517	8.078*
4		4th ball/p6	sec	0.9375	0.0517	1.0137	0.0744	6.242*
5		5th ball/p5	sec	0.8625	0.0518	1.025	0.0462	6.619*
6		6th ball/p5	sec	0.8500	0.0534	1.062	0.0517	8.07*
7		7th ball/p1	sec	1.137	0.0517	1.275	0.0462	5.60*
1	6th situation	1st ball/p3	sec	1.2750	0.0462	1.475	0.0463	8.64*
2		2nd ball/p3	sec	1.062	0.0517	1.226	0.0456	6.711*
3		3rdball /p1	sec	1.050	0.0534	1.212	0.0834	4.63*
4		4th ball/p1	sec	1.3500	0.0535	1.562	0.0517	8.07*
5		5th ball/p1	sec	1.050	0.0534	1.225	0.0463	7.00*
6		6th ball/p2	sec	0.9838	0.0051	1.137	0.0517	8.66*
7		7th ball/p5	sec	1.550	0.0535	1.763	0.0518	8.07*

T (at p=0.05) = 2.14

From table (4), there are statistically significant differences between distinct and non-distinct groups in all the tests in favor of the distinct group. This approves the validity of the tests.

To calculate the stability of the test, the researcher used the test/retest format on a sample of (8) players from the pilot study sample, outside the main sample. The time between the two tests was 10 days. Table (5) shows the results.

Table (5): Correlation coefficient (R) for the anticipatory situations test (n=8)

	Variable		Test		Retest		R
			means	SD +/-	means	SD +/-	
1	First situation	1st ball/p9	0.6750	0.0465	0.6588	0.0415	0.873*
2		2nd ball/p1	1.0375	0.0517	0.9775	0.0864	0.854*
3		3rdball /p3	0.8475	0.0198	0.8413	0.058	0.731*
4		4th ball/p5	0.9600	0.0075	0.9400	0.0333	0.793*
5		5th ball/p7	0.7525	0.0070	0.7375	0.032	0.769*
6		6th ball/p6	0.8451	0.0052	0.8426	0.0070	0.753*
7		7th ball/p3	1.062	0.5175	1.0700	0.0440	0.814*
1	Second situation	1st ball/p9	0.7500	0.0053	0.7425	0.0190	0.840*
2		2nd ball/p3	0.9650	0.0054	0.9587	0.0135	0.887*
3		3rdball /p7	0.7650	0.0267	0.7550	0.0277	0.847*
4		4th ball/p2	0.9963	0.0051	0.9950	0.0053	0.775*
5		5th ball/p4	0.8550	0.0053	0.8488	0.0155	0.765*
6		6th ball/p6	0.8588	0.0064	0.8525	0.0158	0.740*
7		7th ball/p1	0.9637	0.0051	0.938	0.0091	0.966*
1	3rd situation	1st ball/p2	1.043	0.0051	1.033	0.0176	0.761*
2		2nd ball/p6	0.6763	0.0052	0.6738	0.0074	0.788*
3		3rdball /p4	0.6962	0.0051	0.6925	0.0116	0.889*
4		4th ball/p7	0.7075	0.0070	0.7100	0.0075	0.802*
5		5th ball/p3	0.8550	0.0053	0.7575	0.0070	0.756*
6		6th ball/p1	0.8550	0.0053	0.7575	0.0070	0.754*
7		7th ball/p9	0.7250	0.0054	0.7275	0.0071	0.756*
1	4th situation	1st ball/p1	0.9125	0.0103	0.9063	0.0184	0.878*
2		2nd ball/p3	0.9613	0.0099	0.9525	0.0175	0.720*
3		3rdball /p1	1.0500	0.0534	1.0375	0.0517	0.755*
4		4th ball/p7	0.8625	0.0517	0.08463	0.0504	0.760*
5		5th ball/p6	0.8500	0.0534	0.8313	0.0530	0.882*
6		6th ball/p5	0.9500	0.0544	0.9325	0.0465	0.747*
7		7th ball/p4	1.062	0.0517	1.037	0.0694	0.845*
1	5th situation	1st ball/p2	1.0750	0.0462	1.0562	0.0517	0.745*
2		2nd ball/p3	1.0625	0.0517	1.0500	0.053	0.775*
3		3rdball /p3	1.0500	0.0534	1.037	0.051	0.765*
4		4th ball/p6	0.9375	0.0517	0.9250	0.0462	0.745*
5		5th ball/p5	0.8625	0.0518	0.8500	0.0534	0.775*
6		6th ball/p5	0.8500	0.0534	0.8375	0.0517	0.775*
7		7th ball/p1	1.137	0.0517	1.125	0.0461	0.745*
1	6th situation	1st ball/p3	1.2750	0.0462	1.262	0.0517	0.745*
2		2nd ball/p3	1.062	0.0517	1.050	0.053	0.775*
3		3rdball /p1	1.050	0.0534	1.036	0.044	0.880*
4		4th ball/p1	1.3500	0.0535	1.330	0.650	0.822*
5		5th ball/p1	1.050	0.0534	1.025	0.0707	0.756*
6		6th ball/p2	0.9838	0.0051	0.9825	0..0070	0.878*
7		7th ball/p5	1.550	0.0535	1.531	0.0458	0.729*

Significant at 0.05=0.707

From table (5), there is a statistically significant correlation between the first and second applications of the test. This proves the test stability.

Scientific factors for used physical and technical tests:

To calculate validity and stability of these tests, the researcher applied them on 22/6/2006 and 24/6/2006.

The researcher calculated the validity for the physical and technical tests using two groups, one of them is distinct (Ghazl Al-Mahalla Sports Club, n=8 under 15 years), while the other is less distinct (the pilot study sample). Table (6) shows the results

Table (6): Difference significance between the two groups on physical and technical tests (n=16)

	Variable		Element	Distinct (n=8)		Non-distinct (n=8)		T
				means	SD +/-	means	SD +/-	
1	physical	Passing in 10 sec	Speed	7.625	0.517	3.750	0.707	121.05*
2		Numbered circles	Coordination	6.375	0.518	8.50	0.534	8.07*
3		Trunk bend from standing	Flexibility	8.625	0.517	4.62	0.518	15.45*
4		Ball pushed from canon	Reaction	13.625	0.517	8.5	0.534	19.48*
5		Passing accuracy from movement	Accuracy	22.37	0.518	16.75	0.462	22.91*
6		Triangular jump	Agility	7.37	0.517	3.75	0.463	14.76*
7		Medical ball (1kg)push	force	165.37	0.516	160.3	0.517	19.32*
8	technical	Straight forehand stroke	Degree	72.50	0.534	57.62	0.517	56.54*
9		Straight back stroke	Degree	62.63	0.517	48.12	0.640	49.78*
10		Forehand smash stroke	degree	13.62	0.518	9.62	0.640	49.78*
11		Foot work	Degree	56.62	0.516	50.50	0.534	23.28*
12		Third ball attack	Degree	67.75	0.462	49.25	0.707	51.90*
13		Forehand lope stroke	degree	9.625	0.517	5.625	0.518	15.45*

T (at p=0.05) = 2.14

From table (6), there are statistically significant differences between the two groups on all physical and technical tests used in the study, in favor of the distinct group, signifying the validity of these tests.

To calculate the stability of the physical and technical tests used in the study, the researcher used test/retest format on a pilot sample of (8) player (Ghazl Al-Mahalla Sports Club) away from the main sample, with time intervals of (3) day’s between the two tests. Table (7) shows the results.

Table (7): Correlation Coefficients for physical and technical tests used in the study (n=8)

	Variable		Element	Test		Retest		R
				means	SD +/-	means	SD +/-	
1	physical	Passing in 10 sec	Speed	7.625	0.517	7.375	0.744	0.788*
2		Numbered circles	Coordination	6.375	0.518	36.68	0.703	0.760*
3		Trunk bend from standing	Flexibility	8.625	0.517	8.437	0.728	0.876*
4		Ball pushed from canon	Reaction	13.625	0.517	13.33	0.715	0.777*
5		Passing accuracy from movement	Accuracy	22.37	0.518	22.12	0.640	0.868*
6		Triangular jump	Agility	7.37	0.517	7.15	0.798	0.882*
7		Medical ball (1kg)push	force	165.37	0.516	165.1	0.834	0.868*
8	technical	Straight forehand stroke	Degree	72.50	0.534	72.75	0.707	0.756*
9		Straight back stroke	Degree	62.63	0.517	62.37	0.744	0.788*
10		Forehand smash stroke	degree	13.62	0.518	13.31	0.799	0.842*
11		Foot work	Degree	56.62	0.516	53.27	0.848	0.854*
12		Third ball attack	Degree	67.75	0.462	67.50	0.755	0.816*
13		Forehand lope stroke	degree	9.625	0.517	9.875	0.934	0.868*

Significant at 0.05 = 0.707

From table (7), there are statistically significant correlations between the results of test and retest on all physical and technical tests used.

The Experiment:

1- Pre-measurements:

After validating the tests used, the researcher applied them to conclude pre-measurements from 1/3/2006 to 3/3/2006.

2- Main experiment:

At the end of pre-measurements, the researcher initiated the main experiment from 5/8/2006 to 25/10/2006 at the table tennis hall, Faculty of Physical Education – Tanta University.

3- Post-measurements:

Post-measurements were taken from 28/10/2006 to 30/10/2006 after finishing the training program.

Statistical Treatment:

The researcher used means, standard deviation, median, (t) test and variance rate (improvement percentage).

Findings:

Table (8) Difference Significance Between Pre- and Post- Measurements for the Experimental Group (n=15) on The First Anticipatory Situation.

	Variable		Pre		Post		Difference	T	Variance Rate %
			means	SD	means	SD			
1	First situation	1st ball/p9	0.7733	0.0457	0.6667	0.0487	0.1067	6.959*	13.79
2		2nd ball/p1	1.046	0.0639	0.7867	0.0351	0.2600	13.66*	24.85
3		3rd ball/p3	1.155	0.0523	0.8767	0.0048	0.2773	20.27*	24.02
4		4th ball/p5	0.8940	0.0082	0.7267	0.0457	0.1673	13.25*	18.71
5		5th ball/p7	0.8733	0.0361	0.6127	0.0276	0.2047	15.72*	25.04
6		6th ball/p6	0.9060	0.0050	0.7767	0.0313	0.1293	14.96*	14.27
7		7th ball/p3	1.173	0.0457	0.8200	0.04140	0.3533	21.38*	30.11

T at 0.05 = 2.14

From table (8), there are statistically significant differences at (0.05) between pre- and post- measurement of the first situation in favor of post-measurement

Table (9) Difference Significance Between Pre- and Post- Measurements for the Experimental Group (n=15) on The Second Anticipatory Situation.

	Variable		Pre		Post		Difference	T	Variance Rate %
			means	SD	means	SD			
1	Second situation	1st ball/p9	0.7733	0.7733	0.5733	0.0457	0.200	10.24*	25.86
2		2nd ball/p3	1.060	0.0507	0.7860	0.0050	0.274	20.59*	25.84
3		3rd ball /p7	0.8093	0.0088	0.5800	0.0414	0.2293	20.04*	28.33
4		4th ball/p2	1.160	0.0507	0.8266	0.0048	0.3333	26.06*	28.73
5		5th ball/p4	0.8800	0.0414	0.7360	0.0479	0.1440	8.934*	16.36
6		6th ball/p6	0.8667	0.0487	0.7360	0.0440	0.1307	8.112*	15.08
7		7th ball/p1	1.086	0.0639	0.824	0.005	0.2627	16.67*	24.18

T at 0.05 = 2.14

From table (9), there are statistically significant differences at (0.05) between pre- and post- measurement of the second situation in favor of post-measurement.

Table (10) Difference Significance Between Pre- and Post- Measurements for the Experimental Group (n=15) on The Third Anticipatory Situation.

	Variable		Pre		Post		Difference	T	Variance Rate %
			means	SD	means	SD			
1	Third situation	1st ball/p2	1.121	0.0101	0.8267	0.0457	0.2953	26.35*	26.31
2		2nd ball/p6	0.7267	0.0048	0.5833	0.0231	0.1433	22.75*	19.71
3		3rd ball /p4	0.7373	0.0109	0.5867	0.0351	0.1507	18.39*	20.43
4		4th ball/p7	0.7773	0.0243	0.6533	0.0639	0.1240	7.37*	15.95
5		5th ball/p3	0.8773	0.0413	0.7393	0.0499	0.1380	8.766*	15.73
6		6th ball/p1	0.8907	0.0399	0.7800	0.0414	0.1107	7.65*	12.42
7		7th ball/p9	0.7867	0.0516	0.6667	0.617	0.1200	6.00*	15.25

T at 0.05 = 2.14

From table (10), there are statistically significant differences at (0.05) between pre- and post- measurement of the third situation in favor of post-measurement.

Table (11) Difference Significance Between Pre- and Post- Measurements for the Experimental Group (n=15) on The Fourth Anticipatory Situation.

	Variable		Pre		Post		Difference	T	Variance Rate %
			means	SD	means	SD			
1	Fourth situation	1st ball/p1	1.2513	0.0091	0.0863	0.0480	0.3880	28.45*	31.00
2		2nd ball/p3	1.266	0.0487	0.8533	0.0516	0.4133	25.01*	32.64
3		3rd ball /p1	1.169	0.0079	0.7860	0.0501	0.3833	30.79*	32.78
4		4th ball/p7	0.8847	0.0063	0.6800	0.0414	0.2047	19.23*	23.13
5		5th ball/p6	0.9840	0.0063	0.7887	0.0368	0.1953	19.93*	19.84
6		6th ball/p5	1.124	0.0062	0.8200	0.0414	0.3042	29.41*	27.06
7		7th ball/p4	1.234	0.0074	0.8800	0.0410	0.3547	30.73*	28.74

T at 0.05 = 2.14

From table (11), there are statistically significant differences at (0.05) between pre- and post- measurement of the fourth situation in favor of post-measurement.

Table (12) Difference Significance Between Pre- and Post- Measurements for the Experimental Group (n=15) on The Fifth Anticipatory Situation.

	Variable		Pre		Post		Difference	T	Variance Rate %
			means	SD	means	SD			
1	Fifth situation	1st ball/p2	1.221	0.0074	0.8733	0.0457	0.348	30.66*	28.50
2		2nd ball/p3	1.121	0.0073	0.8667	0.0487	0.2547	20.38*	22.72
3		3rd ball/p3	1.121	0.0074	0.8673	0.0493	0.2540	19.57*	22.65
4		4th ball/p6	1.019	0.0070	0.7733	0.0457	0.2460	20.39*	24.14
5		5th ball/p5	0.9787	0.0074	0.8467	0.0516	0.1320	9.53*	13.48
6		6th ball/p5	0.9573	0.0045	0.7800	0.0414	0.1773	16.62*	18.52
7		7th ball/p1	1.2530	0.0516	0.880	0.0410	0.3733	24.35*	29.79

T at 0.05 = 2.14

From table (12), there are statistically significant differences at (0.05) between pre- and post- measurement of the fifth situation in favor of post-measurement.

Table (13) Difference Significance Between Pre- and Post- Measurements for the Experimental Group (n=15) on The Sixth Anticipatory Situation.

	Variable		Pre		Post		Difference	T	Variance Rate %
			means	SD	means	SD			
1	Sixth situation	1st ball/p3	1.424	0.0051	1.128	0.0452	0.2967	27.22*	20.83
2		2nd ball/p3	1.118	0.0074	0.7800	0.0414	0.3387	30.68*	30.29
3		3rd ball /p1	1.086	0.0050	0.848	0.0313	0.2373	29.60*	21.85
4		4th ball/p1	1.525	0.0063	1.133	0.0487	0.3920	30.26*	25.70
5		5th ball/p1	1.117	0.0079	0.8400	0.0507	0.2773	21.89*	24.82
6		6th ball/p2	1.023	0.0072	0.8133	0.0351	0.2100	24.52*	20.52
7		7th ball/p5	1.726	0.0050	1.278	0.0531	0.4473	33.93*	25.91

T at 0.05 = 2.14

From table (13), there are statistically significant differences at (0.05) between pre- and post- measurement of the sixth situation in favor of post-measurement.

Table (14) Difference Significance Between Pre- and Post- Measurements for the Experimental Group (n=15) on The offensive skills.

	Variable	Pre		Post		Difference	T	Variance Rate %
		means	SD	means	SD			
1	Straight forehand	62.466	2.416	97.266	2.282	34.80	32.79*	55.71
2	Straight back	51.866	1.457	77.33	2.582	25.46	30.78*	49.08
3	Smash forehand	10.466	0.516	16.533	1.187	6.06	17.60*	57.90
4	Foot work	54.130	0.990	85.133	2.747	31.00	37.17*	57.26
5	3rd ball attack	52.73	1.486	87.93	3.61	35.20	32.49*	66.75
6	Forehand lope	7.600	0.507	11.73	0.457	4.133	25.01*	54.38

T at 0.05 = 2.14

From table (14), there are statistically significant differences at (0.05) between pre- and post- measurement of the offensive skills in favor of post-measurement.

Discussion:

Table (8) shows statistically significant differences between the pre- and post-measurements on the first situation, in favor of the post-measurement. The researcher thinks that is due to the significant differences resulting from the training program using electronically ball-canon, as the program considered the motor features of junior players and the variation principal in the training process. This leads juniors not to get bored and to training under game-like situations. Janusz Lapszo (2002) mentioned that motor anticipation of table tennis players is based on remembering the way of hitting the ball and its destination. Row & McKenna (2001) said that motor anticipation can be dealt with through learning how to read the ball and opponent motions, remembering previously used motions and recognizing the distinctive features of the opponent. (21:132) (28:64).

Also, table (8) shows that the experimental group has gained high and different variance rates. The researcher thinks that is due to real improvement on motor anticipation speed. Mark Williams' (2004), findings assures that this improvement is due to the improvement of the ability to catch simple information and to ignore unnecessary ones (7:111)

Table (9) shows that there are statistically significant differences between the pre- and post- measurements on the second situation, in favor of the post-measurement. The researcher thinks that is due to the fact that the ball-canon helps in making training situations similar to real situations. This leads the player to gain experience that may help him/her in performing well during games.

Table (9) also shows that the experimental group had high variance rate. This is due to the improvement of ball-racquet touching time and the correct touch of the ball inside the racquet. This is positively reflected on the correct skill execution. The program contains follow-up measurements as a result of the objective evaluation using the motor anticipation speed measuring device and the anticipatory situations tests that help the junior to know his/her progress. This is in consistence with Anderson Mikael (1998) that the major factor that a junior drops out is that he/she needs to feel his/her progress and can never actively participate in training program unless the program provides this condition. This is done using the device of this research (9:21)

Thus, the first hypothesis proves correct. It states that there are statistically significant differences between the means of pre- and post- measurements of the research group in the studied simple anticipatory situations (using any kind of spine) for table tennis junior players in favor of the post-measurement.

Table (10) shows that), there are statistically significant differences at (0.05) between pre- and post- measurement of the third situation in favor of post-measurement. The researcher thinks that is due to the training program contains drills that help regenerating the normal view of the player (serve return in table tennis). This leads the players to concentrate on more clear information, specifically from the ball-racquet contact points and to use search strategies that are more complex as they used the information to increase their previous experiences. Mark Williams (2004) said that increasing experience leads to clarify the relation between basic sources of information and the up-coming needs of action with providing necessary feedback. (7:122).

Table (10) also shows that the experimental group had high variance rate on the third situation (25, 15%). The researcher thinks that is due to traditional programs used by coaches give implicit information through exploration. For example, when teaching the player to anticipate counter forehand, we must not direct the player towards concentrating visually on specific information resources like ball direction, or ball racquet contact point. The researcher directed juniors towards contact points to discover natural states between the ball and racquet in all kinds of anticipatory situations. Thus we must make up different variations of ball and racquet directions so that juniors gradually know the fixed features regulating the whole matter.

From table (11), there are statistically significant differences at (0.05) between pre- and post- measurement of the fourth situation in favor of post-measurement. The researcher thinks that is due to the training program that contains methods of developing motor anticipation speed through training with many situations (simple and complex), executed by ball-canon. This is in consistence with what Bastawisy Mohamed (1999) and Richard Macafee (2000) mentioned. They said that the player who has correct motor anticipation is the one who takes the correct position to execute his/her motor program and whose anticipations of the ball and opponent moves are correct. (1:227), (25:17)

Also from table (11), the experimental group had high variance rate. This is due to the use of helping tools and equipments in table tennis training that contains several variables (speed, spin, altitude and ball follow). All these variables are integrated in the device enabling the coach to make a scientifically based training program. This leads juniors to actively participate in training and achieve higher levels.

Anderson Mikeal (1998) stated that to win a point in a table tennis match, the player should have speed, spin and direction. Besides he/she should play fast and anticipates the ball spin in the first part, then anticipates the ball direction and its hitting point on the table on the second part (9:19).

From table (12), there are statistically significant differences at (0.05) between pre- and post- measurement of the fifth situation in favor of post-measurement. These significant differences are due to the nature of the training program that contained drills that can be critically analyzed to find out how to execute the technical and tactical skills. This is in consistence with what the ITTF mentioned (2006) about the factors to be considered when choosing junior table tennis players, like having some mental abilities like intelligence and perception (8:18).

Also from table (12), the experimental group had high variance rate. This is due to the fact that junior players move the racquets immediately after the ball is out of the canon in a specific timing. This timing is linked with the junior's ability to perform in short durations and his/her ability to cut-off the preparation time for anticipating the up-coming ball, especially with short ball behind the net with all different spins.

These results are in consistence with what is mentioned by Michel Gadal (1997). That when building up drills for improving and developing skills in table tennis, it is necessary to link these drills with suitable training equipments (23:66).

From table (13), there are statistically significant differences at (0.05) between pre- and post- measurement of the sixth situation in favor of post-measurement. These significant differences are due to the fact that table tennis depends on the ability to respond to mixed stimuli during games. That is provided by the electronic ball-canon that in turn, leads to designing anticipatory situations using the probability theory. This is a one component of the recommended training program.

Table (13) also showed that the experimental group had high variance rate on the sixth situation. This is due to the fact that using the ball-canon plays a significant role in improving the improvement percentage in all anticipatory situations, in general, and the sixth one in specific, as it helps increasing the control over the racquet angles and directions during performance. This helps improving the motor anticipation skills for juniors and enhances the visual nerve so that juniors can notice the balls more clearly. The improvement of variance rate between pre- and post- measurements on anticipatory situations (simple and complex) is due to the fact that the individuals consisting the sample have gained some experiences that led them to have a style for dealing with different situations. Thus they gained the ability to anticipate the most probable variables. According to the researcher, this is due to the positive effect of instructions contained in the training program. These instructions integrated different directions, speeds, launch angles and various ball-table contact points, besides using complex forms of spins. L. Cognier et al (2003) noted that the player depends on his/her past knowledge and experiences (22:115).

This proves the second hypothesis that states that: There are statistically significant differences between the means of pre- and post- measurements of the research group in the studied complex anticipatory situations (using complex kinds of spine) for table tennis junior players in favor of the post-measurement.

From table (14), there are statistically significant differences at (0.05) between pre- and post- measurement of the offensive skills in favor of post-measurement. The researcher thinks that the period of three months is enough to show the enhancements in performance levels of technical skills. Zortan Bercezik (1999) said that the scientifically based training program should contribute in enhancing the performance level of table tennis skills as such programs are canonized and this is the only guarantee to make the necessary development for this sport, specially at the beginning of the second competition phase (31:8).

As shown from table (14), the experimental group achieved high variance rates with varied percentages. Lapszo (1999) said that, when using a new specific technique in offence or defense, a table tennis player should choose the best position to anticipate the motion trajectory of both the opponent and the ball. It is also obvious that the development of anticipation skill leads to the improvement of all studied skills.

The basis for motor anticipation is the player's experience, and all the players included in the sample have gained more experience through anticipatory situations using the ball canon. Marl Williams et al (2002) noticed that the elite players are faster than their less-skilled peers in anticipating the opponent's stroke direction, establishing their superior performance, at least partially, on the increased effectiveness of their visual search behavior. (8:2).

This is in consistence with Dimosthens E. Messinis (2000) who said that the duty of a table tennis coach is to give the junior the opportunity to train under game-like conditions, as offensive tactics dominate modern table tennis and provide a chance for gaining the first five points (20:147), (13:113)

This proves the third hypothesis that states that: There are statistically significant differences between the means of pre- and post- measurements of the research group in executing some of the studied offensive skills for table tennis junior players in favor of the post-measurement.

Conclusions:

According to the limits, sample and procedures of the current research, the researcher concluded the following:

1- Horizontally stoke balls from both the left and right sides can be anticipated more quickly than any other balls.

2- Longitudinally stoke balls to the middle of the table can be anticipated slower than any other balls.

3- The anticipatory situations tests (simple or complex) have higher rates of validity, indicating that they can be used for measuring the speed of ball anticipation in different directions for table tennis players.

4- The anticipatory situations tests (simple or complex) indicated a positive direction in increasing the improvement percentage after applying the recommended training program.

Recommendations:

According to the limits, sample and procedures of the current research, the researcher recommends the following:

1- Applying the recommended training program, using anticipatory situations (simple or complex) on training junior table tennis players under 15 years.
2- Using electronic ball canons for improving the performance level of junior table tennis players under 15 years.
3- Using the designed tool for choosing junior players and putting different criteria for junior table tennis players in the anticipation speed of different ball places and directions.

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THE ROLE OF SIGHT IN TABLE TENNIS (REMOTE MOVEMENT AND RETURN OF THE EYE)

Abstract

The purpose of our study was to investigate the role of practice in the ability to quickly move the eyes backwards and forward in order to follow the moving ball. 30 participants were used in the research, one half of participants were talented table tennis players (aged between 10 and 45, average age 19, 86) and the other half were non - athletes (also aged between 10 and 45, with the average of 33,60 years). The angle of observing the ball in each case was 28 degrees.

The results show that there are highly significant differences between the speed of moving one's eyes backward and forward in order to follow a moving object (in this case a ball) between table tennis players and non – athletes, the former being more successful in the task. These results enable us to improve our selection process for gifted young table tennis players and encourage us in further development of additional practices for improving eye – movement speed.

Key words: *table tennis, sight, speed*

Introduction

The design of the human eye was necessary to meet the competing evolutionary demands for high visual acuity and a large field of view. There is simply not enough neural real estate available in the brain to support a visual system that has high resolution over the required field of view. In table tennis we have best proof therefore with following a ball which is flying with the speed more than 160 km/h.

Eyes are the visual organs that have the retina, a specialized type of brain tissue containing photoreceptors and interneurons. These specialised cells convert light into electrochemical signals that travel along the optic nerve fibres to the brain.

The visual system in the brain is too slow to process information if the images are slipping across the retina at more than a few degrees per second second (Westheimer and McKee, 1975). Thus, to be able to see while we are moving, the brain must compensate for the motion of the head by turning the eyes. Another specialisation of visual system in human is the development of a small area of the retina with a very high visual acuity. This area is called the fovea, and covers about 2 degrees of visual angle in people. To get a clear view of the world, the brain must turn the eyes so that the image of the object of regard falls on the fovea. Eye movements are thus very important for visual perception, and any failure to make them correctly can lead to serious visual disabilities

Table tennis is the fastest ball game in the world. To react on time a player has too have among other motor abilities also best predispositions to catch a ball with his/her eyes. This is also one point which differentiates best players from other ones.

Providing research on 25 players of the German table tennis team who play on the national and worldwide level, Gendrusch (2006) found out that the strength of Timo Boll on the moving ball with 170 kilometres speed in an hour is 20 percent higher than the average sight of the above 25 players. This research has shown how well his eyes and movement have followed the ball, and how he has had control of his sight. The muscles of his eyes have strength of movement of 300 degrees in a second, which is even higher than the best goalkeeper in German Bundesliga - whose record is 297/5 degrees in second.

Because of that fact Timo’s national coach D. Schimelpfening says that because of the strong relationship between the strength of sight and his strokes, we can see that he has become one of the best players in the world.

The role of the eye is not only essential in hitting main strokes but at the same time the player must observe his opponent. The coach has to recognize the strength of sight and the anticipation of the movement of the opponent as the most important useful abilities in table tennis and has to place half of the strength of sight as the acceptance number in table tennis; of course the cost of the pre-experiment also should be allocated.

Research Goal

The goal of our research was the study and the comparison between the speed of forward – backward eye movement (voluntary nystagmus) of two groups of practiced and unpractised (table tennis) subjects.

Research methods

Was semi-experimental in which the ball was stable in one corner of the table and the subject was placed on the other side, while her head was also stable she was asked to move her gaze as faster as possible from the ball to the midline of the table.

The number of forward-backward movement of the eye in one minute was counted in each subject and two groups were compared.

Control Group: 15 persons of the players of the table tennis association of the province of Guilan in the age group range of adolescent, young and adult (10 to 45 years).

Experimental Group: 15 non – athletic persons (age range was 10- to 45 years)

Length time of Experiment: studding 1 minute of the forward and backward movement of the eye and itó s count.

Equipment: cameras, sensors and table tennis equipments.

Results and Discussion

The average cycle/minute of the unpractised (experimental group) was 47.2 while that of the control (practiced) group was 68.4 with a standard deviation of 21.2.

Using the T-table test, each time T 28 was calculated independently and a p-value of 3.87 was harvested.

Hence meaningful difference between the two groups has a certainty of 99 percent.

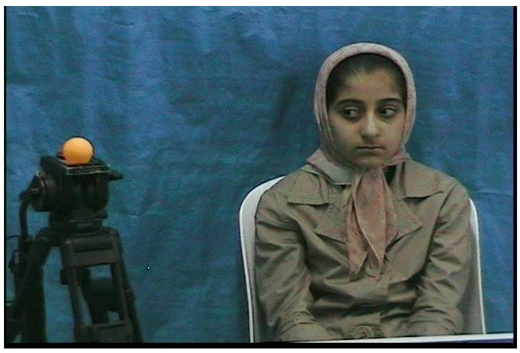
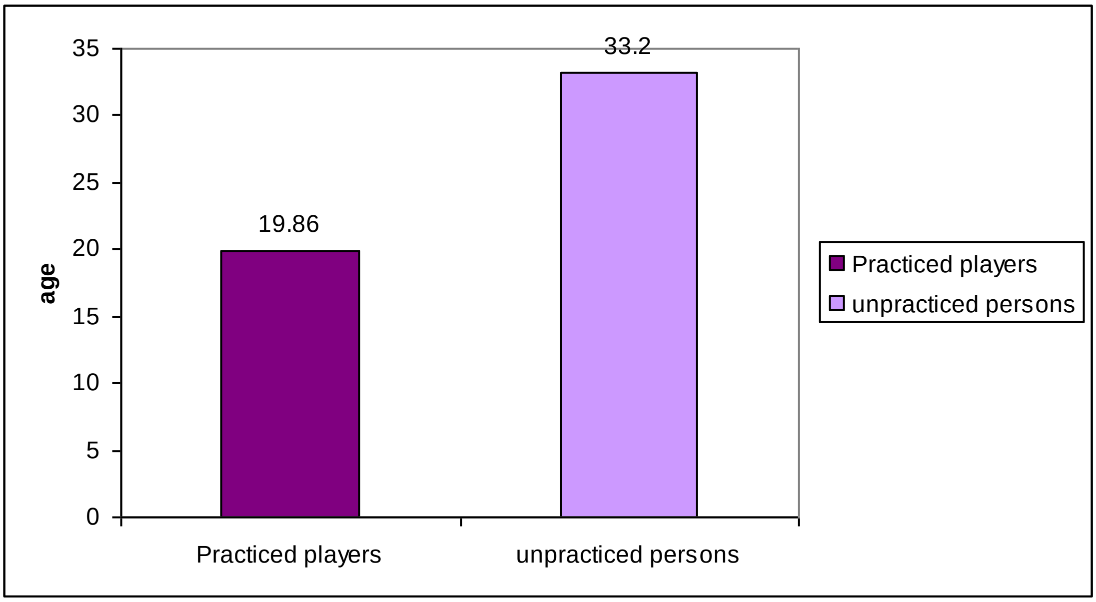
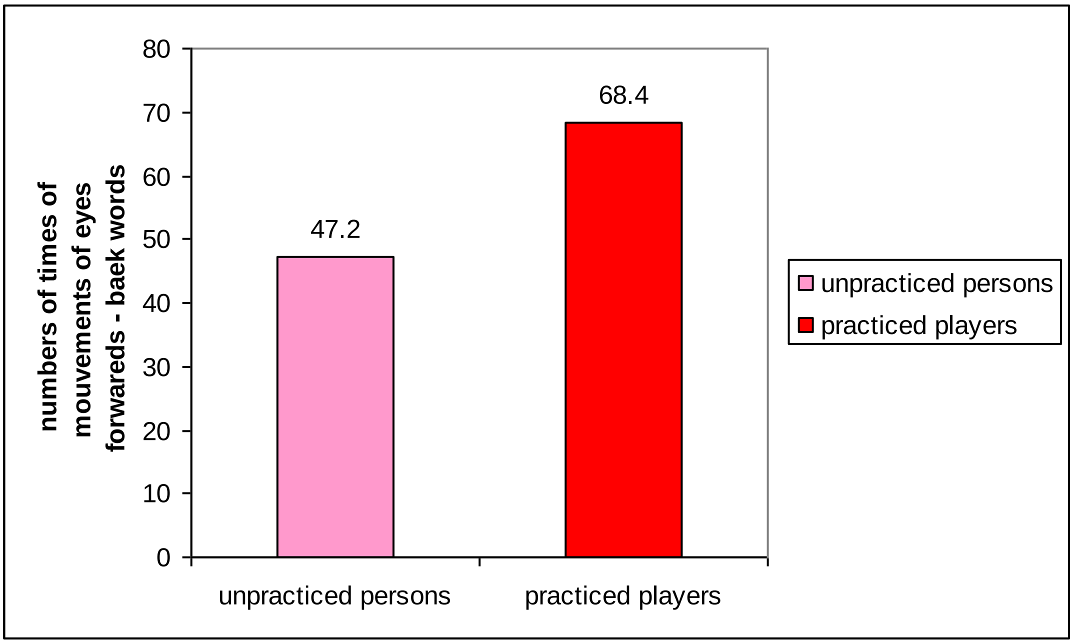


Figure 1: Age of participants



Average age of practiced players is 19.86 years and average age of the unpractised persons is 33.2 years.

Figure 2: Results of measurement



Statistical inferences
Average of practiced Group → 68/4
Average of Unpractised Group → 47/2
Difference of average → 21/2

30 participants have participated at our research; one half of participants were talented table tennis players (aged between 10 and 45, average age 19, 86) and the other half were non - athletes (also aged between 10 and 45, with the average of 33,60 years). The angle of observing the ball in each case was 28 degrees.

The results show that there are highly significant differences between the speed of moving one's eyes backward and forward in order to follow a moving object (in this case a ball) between table tennis players and non – athletes, the former being more successful in the task. These results enable us to improve our selection process for gifted young table tennis players and encourage us in further development of additional practices for improving eye – movement speed.

Conclusion and suggestion

The purpose of our study was to investigate the role of practice in the ability to quickly move the eyes backwards and forward in order to follow the moving ball.

With the accuracy of our table tennis test, we can see the sight factor for choosing potentially talented table tennis players and by designing exercises to strengthen the sight factor improve the performance of table tennis players.

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ANALYSIS ON TECHNIC AND TACTICS OF RYU SEUNG-MIN IN MAN'S SINGLES TABLE TENNIS FINAL AND SEMIFINAL OF THE 28TH OLYMPIC GAMES IN ATHENS

Abstract
To prove up characteristics of technique and tactics of Ryu Seung-Min in Man's table tennis singles final and semifinal of the 28th Olympic Games in Athens, in order to supply reference for there under in following training and matches. The paper have analyzed and researched on 11 games of Man's table tennis singles final and semifinal of the 28th Olympic Games in Athens, by means of literatures, Video observation, three-phase indexes method, mathematical statistics, single technique analysis. The results indicates that the score rate 68.4%, the applied rate 32.2% in phase of attack after service; the score rate 59.5%, the applied rate 35.6% in phase of attack after receiving; the score rate 34.2%, the applied rate 32.2% in phase of be locked in a stalemate in the final games. The score rate 81.5%, the applied rate 29.3% in phase of attack after service; the score rate 51.4%, the applied rate 38% in phase of attack after receiving; the score rate 43.3%, the applied rate 32.6% in phase of be locked in a stalemate in the semifinal games. The net score rate 7.6% of service, the net score rate 0.85% on location of forehand , the net score rate -2.5% on location of backhand, the net score rate 2.5% on middle location in final game. The net score rate 16.3% of service, the net score rate -3.3% on location of forehand, the net score rate 9.8% on location of backhand, the net score rate 1.1% on middle location in semifinal. The net score rate 11.4% of service, the net score rate -1% on location of forehand, the net score rate 2.9 % on location of backhand, the net score rate 1.9% on middle location in two games of final and semifinal. The data analysis indicates that service is the best technique of Ryu Seung-Min, the second was angled loop drive on location of backhand and forehand. In phase of be locked in a stalemate, defending on location of forehand and backhand was not good enough.

Key words: *the 28th Olympic Games, table tennis, Ryu Seung Min, characteristic of technique and tactics*

Introduction

The best of all attracting attention, Ryu Seung-Min won Men's table tennis singles golden medal of the 28th Olympic Games in Athens. He was promoted to final after defeating Sweden's famous Jan-Ove Waldner with score of 4:1 in Men's table tennis semifinal. He obtained the champion after defeating Chinese famous Wang Hao with score of 4:2 in Men's table tennis singles final. To investigate Ryu Seung-Min's technique and tactics characteristics of a series of winning in Man's table tennis singles final and semifinal of the 28th Olympic Games in Athens, to provide references for enriching and consummating table tennis scientific theory. 11 games of two matches of Men's table tennis singles final and semifinal of the 28th Olympic Games in Athens were systematically analyzed by methods of the data review, video observation, three-phase indexes, mathematical statistics, and single technique analysis. Now it's reported as follows:

Material and method

Subjects

11 games of the two matches in Men's table tennis singles final (Ryu Seung-Min vs Wang Hao) and semifinal (Ryu Seung-Min vs Jan-Ove Waldner) of the 28th Olympic Games in Athens were studied. Ryu Seung-Min, male, Korean famous table tennis player of pen-hold grip in right hand.

Data review

Searching and consult some papers in Journal of Beijing Sport University, Journal of Sport, Journal of Shanghai sport college, etc (Wei QZ,2004; Seve C ,2003,2004; Liu YT,1996; Dong Y,2003).

Three-phase indexes

11 games of two Men's table tennis singles final (Ryu Seung-Min vs Wang Hao) and semifinal (Ryu Seung-Min vs Jan-Ove Waldner) of the 28th Olympic Games in Athens were systematically analyzed by the method of three-phase indexes. The three-phase indexes meant that the subjects' features of techniques and tactics were analyzed by calculating the scoring rate and using rate in the phase of attack after service (PAS), the phase of attack after receiving (PAR) and the phase of be locked in a stalemate (PLS). The calculating formulas were as follows:

scoring rate of a phase = [scoring points of the phase÷(scoring points of the phase + losing points of the phase)]×100%

applied rate of a phase = [(scoring points of the phase +losing points of the phase)÷(total scoring points +total losing points)]×100%

Score rate was divided into 4 grades: excellent, good, pass and no pass. Applied rate was a reference standard in general. The evaluating criteria was in Table 1 (Li JL.2004)

Video observation

Ryu Seung-Min'S characteristics of technique and tactics was studied by video observation and statistics to Men's table tennis singles final (Ryu Seung-Min vs Wang Hao) and semifinal (Ryu Seung-Min vs Jan-Ove Waldner) of the 28th Olympic Games in Athens.

Table 1 Evaluating standard of three-phase indexes analysis method

PAS		PAR		PLS	
score rate(%)	applied rate(%)	score rate(%)	applied rate(%)	score rate(%)	applied rate(%)
excellent 70 good 65 pass 60 no pass ≤59	25-30	50 40 30 ≤29	15-25	55 50 45 ≤44	45-55

Notes: PAS= phase of attack after service; PAR =phase of attack after receiving; PLS= phase of be locked in a stalemate

Analysis method on single advantage and weakness technique

Single advantage technique was the highest score technique in the whole match. Score rate = (score of single technique÷total points of the whole match). Weakness technique was the highest losing points techniques. Losing point rate = (losing points of single technique÷total points of the whole match). Net score rate =[(the single technique's score - the single technique's losing score) ÷ total points of the whole match]. Thereinto, total points of the whole match = the whole match's total scoring points + the whole match's total losing points.

Integrating analysis method of advantage and weakness techniques

Score rate and losing rate and net score rate of service , forehand position, backhand position, middle court in final and semifinal were analyzed. And diagrams were made by Microsoft Excel 2000 software.

Results and analysis

Analysis on three-phase indexes of Ryu Seung-Min in final

Analysis results on three-phase indexes of Ryu Seung-Min in final was in table 2 .The 6 games of the final were analyzed by the three-phase indexes methods, it's results were in table 2. Ryu Seung-Min's score rate was 68.4% in phase of attack after service, it's almost excellent. Applied rate was 32.2%, it surpassed the maximum of applied rate in the phase of attack after service. This showed that Ryu Seung-Min was very actively to attack after service, and accuracy was higher. Ryu Seung-Min's services mainly relied on forehand low cast left side topspin and side backspin, sometimes served left side topspin straight short. The falling point of service was mainly at area of small triangle. Combine with chasing body angle long to destroy opponent's fast attack. Preemptive attack after service was mainly by backhand position sideways angle loop drive and forehand position angle loop drive, combine with backhand angle push, forehand straight push.

In phase of attack after receiving, Ryu Seung-Min's score rate was excellent (59.5%). Applied rate was 35.6%, it surpassed the maximum of applied rate in the phase of attack after receiving. This showed that Ryu Seung-Min was very actively to attack after receiving, accuracy rate was higher. Ryu Seung-Min's backhand position sideways angle loop drive and forehand push middle court was main scoring passport. All of backhand block, angle push, and forehand position loop straight drive could get points, but forehand position loop angle drive and defending lose more points.

In phase of be locked in a stalemate, Ryu Seung-Min′s score rate (34.2%), was not good enough. Applied rate (32.2%) was also far from lower bound of the phase of be locked in a stalemate. This showed Ryu Seung-Min′s Preemptive attack was not enough, and score was less. The techniques of phase of be locked in a stalemate was not good enough. Forehand position angle loop drive, backhand position sideways angle and straight loop drive were mainly applied in the phase of be locked in a stalemate, but accuracy was lower. Defending score of forehand and backhand was less.

Table 2 Three-phase indexes analysis results of Ryu Seung Min in final (Ryu Seung-Min vs Wang Hao)*

Games	PAS				PAR				PLS			
	SP	LP	SR(%)	AR(%)	SP	LP	SR(%)	AR(%)	SP	LP	SR(%)	AR(%)
1	3	0	100	21.4	6	2	75	57.1	2	1	66.7	21.4
2	4	4	50	40	4	2	66.7	30	1	5	16.7	30
3	5	3	62.5	40	3	5	37.5	40	3	1	75	20
4	4	4	50	40	3	2	60	25	4	3	57.1	35
5	6	0	100	25	4	5	44.4	37.5	1	8	11.1	37.5
6	4	1	80	25	5	1	83.3	30	2	7	22.2	45
Add up	26	12	68.4	32.2	25	17	59.5	35.6	13	25	34.2	32.2

*Men's table tennis singles final of the 28th Olympic Games in Athens

Notes: score point = SP; losing point = LP; score rate = SR; applied rate= AR

Analysis on the three-phase indexes of Ryu Seung-Min in semifinal

Analysis results on the three-phase indexes of Ryu Seung-Min in semifinal is in table 3. In phase of attack after service, Ryu Seung-Min′s score rate (81.5%) was excellent. Applied rate (29.3%) belonged to normal standard of the phase of attack after service. This meant that Ryu Seung-Min was very actively on preemptive attack in the phase of attack after service, firing accuracy was higher. Ryu Seung-Min mainly served left side backspin angle short, left side topspin angle short and chasing body angle long, to destroy opponent's preemptive attack. It was main to attack after service by forehand position angle loop drive, backhand position sideways angle loop drive, backhand position sideways straight loop drive. Defending of forehand position loses more points.

In phase of attack after receiving, Ryu Seung-Min's score rate (51.4%) was excellent. Applied rate was 38%, it was over the maximum of applied rate in the phase of attack after receiving. This shows that Ryu Seung-Min was very actively to attack after receiving, firing accuracy was higher. Ryu Seung-Min's backhand position sideways angle loop drive, sideways straight loop drive, forehand position angle loop drive were main scoring artifices. Combine with backhand block and angle push. Defending of forehand and backhand there were some faults.

In phase of be locked in a stalemate, Ryu Seung-Min's score rate (43.3%) was not good enough. Applied rate (32.6%) was lower than bound of the phase of be locked in a stalemate, also. This showed Ryu Seung-Min's preemptive attack was not enough, scoring is less. Techniques of phase of be locked in a stalemate were weakness. Forehand position angle loop drive were mainly applied in the phase of be locked in a stalemate, but accuracy was lower than half, defending of forehand and backhand there were some faults.

Table 3 three-phase indexes analysis results of Ryu Seung Min in semifinal (Ryu Seung-Min vs Jan-Ove Waldner)*

Games	PAS				PAR				PLS			
	SP	LP	SR(%)	AR(%)	SP	LP	SR(%)	AR(%)	SP	LP	SR(%)	AR(%)
1	6	1	85.7	35	4	3	57.1	35	1	5	16.7	30
2	3	1	75	20	3	6	33.3	45		4	42.9	35
3	4	2	66.7	30	4	5	44.4	45	3	2	60	25
4	3	1	75	25	4	1	80	31.3	4	3	57.1	43.8
5	6	0	100	37.5	3	2	60	31.3	2	3	40	31.3
Add up	22	5	81.5	29.3	18	17	51.4	38	13	17	43.3	32.6

*Men's table tennis singles semifinal of the 28th Olympic Games in Athens

Analysis on single advantaged and weak technique of Ryu Seung Min in final

Analysis results on single advantaged and weak technique of Ryu Seung Min in final is in table 4. In final, according to score rates from high to low, Ryu Seung-Min's the score rates of single technique respectively were backhand position sideways angle loop drive (10.2%), service (7.6%), forehand position angle loop drive (6.8%). According to losing rates from high to low, Ryu Seung-Min's the losing rates of single technique respectively were backhand position defending (9.3%), forehand position angle loop drive (8.5%) , backhand position sideways angle loop drive (8.5%).

To take statistics by grouping and work out net score rate. It showed Ryu Seung-Min's the net score rates of single technique respectively were service(7.6%), middle court (2.5%), forehand position (0.85%), backhand position (-2.5%). The data showed Ryu Seung-Min's score rate of backhand position sideways angle loop drive and forehand position angle loop drive were higher, but losing rate were higher especially in the phase of be locked in a stalemate, also. Indicating by the net score rate, service was Ryu Seung-Min's the best advantage technique. Defending of backhand position especially in the phase of be locked in a stalemate was his weakness.

Table 4 Analysis on single advantage and weakness technique of Ryu Seung Min in final*

No.	single technique	SP	LP	SR(%)	LR(%)	NSR(%)
1	forehand left side topspin angle short service	1	0	0.85	0	0.85
2	forehand left side topspin angle long service	2	0	1.7	0	1.7
3	forehand left side underspin angle short service	3	0	2.5	0	2.5
4	forehand left side underspin angle long service	1	0	0.85	0	0.85
5	forehand left side topspin straight short service	1	0	0.85	0	0.85
6	forehand left side underspin straight short service	1	0	0.85	0	0.85
	add up service	9	0	7.6	0	7.6
7	forehand position angle loop drive	8	10	6.8	8.5	-1.7
8	forehand position straight loop drive	3	0	2.5	0	2.5
9	forehand position straight push	5	0	4.2	0	4.2
10	forehand position defending	0	5	0	4.2	-4.2
	forehand add up	16	15	13.6	12.7	0.85
11	backhand position sideways angle loop drive	12	10	10.2	8.5	1.7
12	backhand position sideways straight loop drive	6	5	5.1	4.2	0.85
13	backhand position angle block	4	5	3.4	4.2	-0.85
14	backhand position straight block	2	2	1.7	1.7	0
15	backhand position angle push	5	2	4.2	1.7	2.5
16	backhand position straight push	3	1	2.5	0.85	1.7
17	backhand position defending	1	11	0.85	9.3	-8.5
	backhand add up	33	36	28	30.5	-2.5
18	forehand middle court push	4	2	3.4	1.7	1.7
19	forehand middle court smash or loop	2	1	1.7	0.85	0.85
	middle court add up	6	3	5.1	2.5	2.5

*Total points were 118 in this game. NSR = net score rate; LR(%)=losing rate;
SP=score points
LP=losing points

Analysis on single advantaged and weak technique of Ryu Seung-Min in semefinal

The results of analysis on single advantage and weakness technique of Ryu Seung-Min in semifinal (Ryu Seung-Min vs Jan-Ove Waldner) was in table 5.

In semifinal, According to score rates from high to low, Ryu Seung-Min's the score rates of single technique respectively were service (16.3%), backhand position sideways angle loop drive (7.6%), forehand position defending (6.5%). By losing rates from high to low, Ryu Seung-Min's losing rates of single technique respectively were forehand position defending (12%), backhand position defending (5.4%), forehand position angle loop drive (5.4%), backhand position sideways angle loop drive (5.4%). The statistics results of single technique indicated that Ryu Seung-Min's the net score rates of single technique respectively were service(16.3%) , backhand position (9.8%) , middle court (1.1%), forehand position (-3.3%) by from high to low of net score rate of single technique. The data showed Ryu Seung-Min's backhand position and forehand position there were higher score rate, but losing rate were higher, also. Indicating from the net score rate, service was Ryu Seung-Min's the best advantage technique, in the next place was backhand position. Destroy contender's attack by serving left side topspin and backspin angle short fall at net zone. Contender was misplaced because of response less on side topspin and side backspin angle long chasing body ball and action less enough. Defending of forehand position especially in the phase of be locked in a stalemate was his weakness.

Table 5 Analysis on single advantage and weakness technique of Ryu Seung Min in semifinal*

No.	single technique	SP	LP	SR(%)	LR(%)	NSR(%)
1	forehand left side topspin angle short service	4	0	4.3	0	4.3
2	forehand left side topspin angle long service	3	0	3.3	0	3.3
3	forehand left side underspin angle short service	2	0	2.2	0	2.2
4	forehand left side underspin angle long service	1	0	1.1	0	1.1
5	forehand left side topspin straight short service	2	0	2.2	0	2.2
6	forehand left side underspin straight short service	2	0	2.2	0	2.2
7	forehand left side underspin angle short service	1	0	1.1	0	1.1
	add up service	15	0	16.3	0	16.3
8	forehand position angle loop drive	5	5	5.4	5.4	0
9	forehand position straight loop drive	4	2	4.3	2.2	2.2
10	forehand position defending	6	11	6.5	12	-5.4
	forehand position add up	15	18	16.3	19.6	-3.3
12	backhand position sideways angle loop drive	7	5	7.6	5.4	2.2
13	backhand position sideways straight loop drive	5	2	5.4	2.2	3.3
14	backhand position angle block	4	2	4.3	2.2	2.2
15	backhand position straight block	3	1	3.3	1.1	2.2
16	backhand position angle push	4	0	4.3	0	4.3
17	backhand position straight push	1	0	1.1	0	1.1
18	backhand position defending	0	5	0	5.4	-5.4
	backhand add up	24	15	26.1	16.3	9.8
19	forehand middle court push	1	1	1.1	1.1	0
20	forehand middle court smash or loop	2	1	2.2	1.1	1.1
	middle court add up	3	2	3.3	2.2	1.1

*Total points was 92 in the games

Integrating analysis on advantage and weakness techniques

Integrating analysis results of advantage and weakness techniques of the two matches were in table 6, figure 1 and figure 2. According to score rates from high to low, Ryu Seung-Min's the score rates of single technique respectively were backhand position (27.1%), forehand position (14.8%), service (11.4%), middle court (4.3%). By from high to low of losing rates, Ryu Seung-Min's the losing rates of single technique respectively were backhand position (24.3%), forehand position (15.7%), middle court (2.4%).

Ryu Seung-Min's the net score rates of single technique turn and turn about service(11.4%), backhand position (2.9%), middle court (1.9%), forehand position (-1%). The data indicates Ryu Seung-Min's backhand position and forehand position there were higher score, strong attack, but losing score were higher especially in the phase of be locked in a stalemate, also. It furthermore intuitionistic showed by table 6 and figure 1-2, service technique was Ryu Seung-Min's the best advantage technique, was his main score method. Secondly, Ryu Seung-Min's backhand and forehand position loop drive attack. And yet defending in backhand and forehand position especially in the phase of be locked in a stalemate were his weakness.

Table 6 Analysis on advantage and weakness of Ryu Seung Min in final and semifinal

opponent	service		forehand position		backhand position		middle court	
	SP	LP	SP	LP	SP	LP	SP	LP
Wang Hao	9	0	16	15	33	36	6	3
Jan-Ove Waldner	15	0	15	18	24	15	3	2
add up	24	0	31	33	57	51	9	5
SR(%)	11.4		14.8		27.1		4.3	
LR(%)		0		15.7		24.3		2.4
NS	24		-2		6		4	
NSR(%)	11.4		-1		2.9		1.9	

*Total points of the two matches was 210. Note: NS=net score, NSR=net score rate.

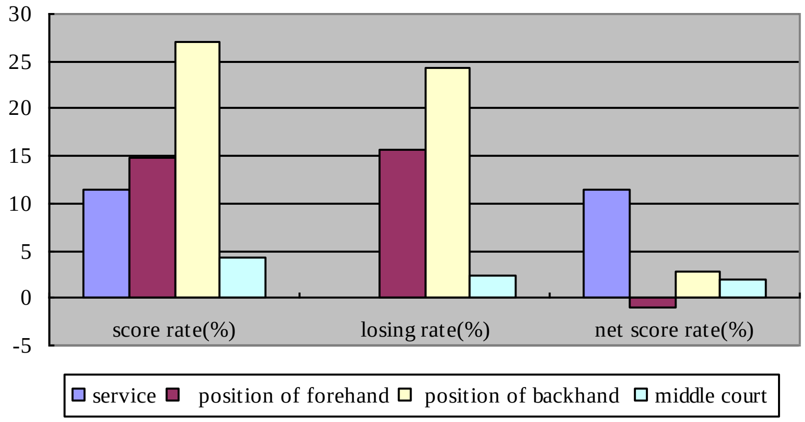

Figure 1 Analysis results of advantaged and weak techniques

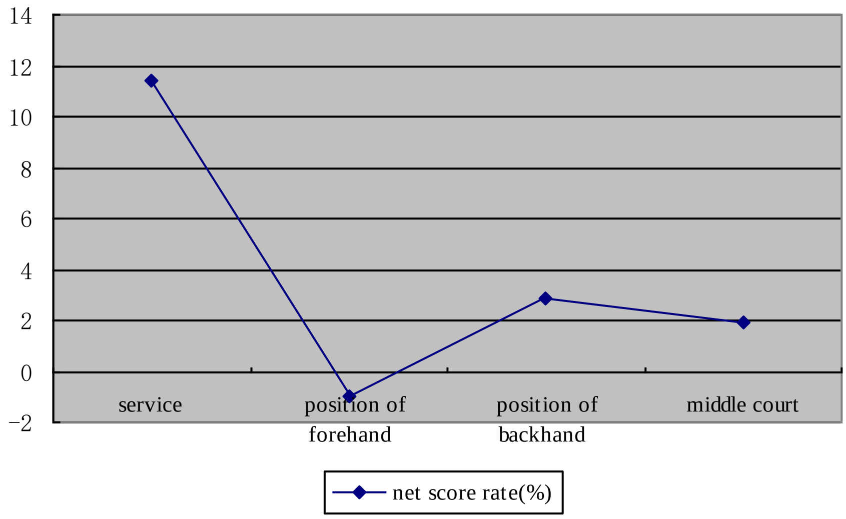

Figure 2 Net score rate of service, forehand, backhand, middle court

Discussion

Ryu Seung-Min's characteristics of techniques

Ryu Seung-Min suppressed or weakened opponent's attack by changes of spin, long or short, point of fall. Because of service levity, on the one hand, it can made score straight, on the other hand caused opponent passiveness in receiving and create a attack opportunities for himself. Ryu Seung-Min scored immediately 16.3% (score rate) only by service in semifinal (Ryu Seung-Min vs Jan-Ove Waldner). Ryu Seung-Min scored immediately 7.6% (score rate) by service in final (Ryu Seung-Min vs Wang Hao). It was apparently that Jan-Ove Waldner did not adapt Ryu Seung-Min's service. Ryu Seung-Min suppressed opponent's attack by left side topspin and left side backspin angle short line, and made the opponent responding without time enough, or made the opponent error because of action without plenitude enough. By combination with side topspin and side backspin short straight line, sneak attacked the opponent's forehand position.

In forehand position, it scored points by forehand angle loop, combining with loop straight line or push short straight line and pushes chasing body long line.

In backhand position, it was main by backhand position sideways loop drive angle line, combining with backhand position sideways straight loop drive, backhand position angle block, backhand position straight block, backhand position angle push, backhand position straight push.

In middle court, it was main by forehand shake, push, loop, smash, now and then using backhand smash. Although middle court's applied rate was low, net score rate (1.9%) higher than forehand position (-1%). It was reported that the middle court defensive ability of Ryu Seung-Min was weakness. But net score rate of middle court was higher than forehand's position in the two matches. Which showed Ryu Seung-Min's defensive ability in middle court had improved great.

In defensive ability, defensive ability of the phase of be locked in a stalemate was his weakness tache. In final, defensive net score rate of forehand position was -4.2%, defensive net score rate of backhand position was -8.5%. In semifinal, defensive net score rate of forehand position was -5.4%, defensive net score rate of backhand position was -5.4%.

In play long chasing body, when return, Ryu Seung-Min usually got success by backhand position adding force push or block long chasing body. The study results (Zhang, et al 2004) illuminated that it was the most efficiency about direction of driving table tennis from self backhand to opponent's backhand. The two findings were basic consistent.

Ryu Seung-Min's tactical consciousness and characteristics of utilizing tactics

Ryu Seung-Min, Wang Hao, Jan-Ove Waldner all were the most outstanding table tennis player in the world. Their techniques level was all square. Virtually, the competitions among them were stack up against in wisdom and tactics. The actions were controlled by brain consciousness. Only correct tactics consciousness can lead to correct tactic actions (UuJX, 1998; SuPR, 2001, 2003; QinH, 2004). Ryu Seung-Min had defeated Jan-Ove Waldner with score of 4:1 in semifinal which only costed 23 minutes. It showed that tactic consciousness of Ryu Seung-Min was correct and clear. The most time for the match was controlled under Ryu Seung-Min's tactic consciousness. He had held the initiative of match. And yet Jan-Ove Waldner did not change the passivity complexion. In before final, Ryu Seung-Min had already prepared sufficiently aiming at Wang Hao's characteristic of technique and tactics. In final, Ryu Seung-Min destroyed and weakened Wang Hao's the best of being adept at by-blow (drive horizontally) with pen-hold grip by serving net zone and chasing body goal zone. Wang Hao was gone into passivity, and yet Ryu Seung-Min held the initiative of match. Finally, Ryu Seung-Min obtained the champion by defeating Wang Hao with score of 4:2.

In the table tennis match, in order to defeat opponent, above all it was necessary to understand opponent's characteristics of using apiece techniques and tactics, and to find out opponent's advantage skills and weak skills in exact impersonality. At the same time it was necessary to understand own technique characteristics, advantage skills and weak skills correctly, also. Depending upon the facts mentioned above established concrete tactics of in the phase of attack after service, the phase of attack after receiving and the phase of be locked in a stalemate. In other words, in order to win, you had to avoid, destroy, control and weaken opponent's strong skills, and to attack opponent's weakness by using your strong skills. Ryu Seung-Min easily won again and again in the Man's table tennis singles final and semifinal of the 28th Olympic Games, explained or embodied that Ryu Seung-Min's tactics consciousness and utilization accord with internal rule of table tennis getting victory which destroy and weaken opponent's strong skills, and to attack opponent's weakness by using your strong skills.

Conclusion

Ryu Seung-Min's tactic consciousness and tactical utilization accorded with internal rule of table tennis getting victory, it was in deed reason that Ryu Seung-Min got victory easily from the two games.

Ryu Seung-Min belongs to excellent player with fast attack. Score rate and applied rate of phase of attack after service and phase of attack after receiving all were excellent, but techniques of phase of be locked in a stalemate was not good enough.

Service was his strongest skills, techniques of backhand position was secondly strongest skills. His defensive skill of forehand position and backhand position in the phase of be locked in a stalemate was not very well.

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APPROPRIATENESS OF SPECIAL TRAINING OF TABLE TENNIS

Abstract

To evaluate cardio-respiratory function of table tennis players, heart rates and oxygen intake quantities during training were measured by a telemetric method. The subjects of the test were top level student players. The measurements were made for the following 5 different stroke conditions.

Condition 1. long stroke at a fixed point,
Condition 2. drive stoke at a fixed point,
Condition 3. smash stroke at a fixed point,
Condition 4. drive stroke with right and left motion,
Condition 5. smash stroke with right and left motion

The measured data indicate that the oxygen intake quantity and heart rate increase in the order from Condition 1 to 5. It was also found that these quantities of a high level player are lower than those of a low level player.

Key words: *table tennis, cardio-respiratory system, heart rate, oxygen intake*

Purpose

This study has been made to examine the appropriateness of special training of table tennis. Measurement of heart rate and oxygen intake is important from the view of evaluation of cardio-respiratory function.

Method

The subjects of this study were selected from student players who are members of the Waseda University team and have experience in playing table tennis for more than 10 years. The total number of the subjects is 8 including the winners of all Japan Student Championship and the Kanto Student Championship. (Kanto is a name of area in Japan.)

The subjects got up in the morning 5 hours before the test. First, the subjects made a warming-up, and practiced light hitting training, and then had a 90 minutes rest. The test started after the rest.

Quantities of oxygen intake were measured by a telemetric method (Cosmed Inc., K4B2), where the sensor was attached to the subject's chest. The subject carried a battery on his back for providing electric power. A belt for measuring heart rate was wrapped around the subject's arm. The test was made under the following stroke conditions:

Condition 1. Fore hand long stroke without footwork,
Condition 2. Fore hand drive stoke without footwork,
Condition 3. Fore hand smash stroke without footwork,
Condition 4. Fore hand drive stroke with right and left footwork
Condition 5. Fore hand smash stroke with right and left footwork

The subject made 60 sequential strokes in 60 minutes, i.e., once in one second. The test was repeated for each subject in the above order 1 to 5. The subject was given 1 minutes rest between the conditions.

Results

The measured data of two players A and B are shown in figure 1 and figure 2 as examples, respectively. The Player A is better than Player B. The oxygen intake quantity and heart rate showed the maximum values in the case of condition 5. These quantities increased in the order from Condition 1 to 5. This result agrees with the previous ones. The measured data were scattered according to the subjects, but it was found that the scattering showed some tendency. The heart rate of Player A (better player) are low compared with those of Player B. This result means that the efficiency of motion is higher in the high level player than the low level one.

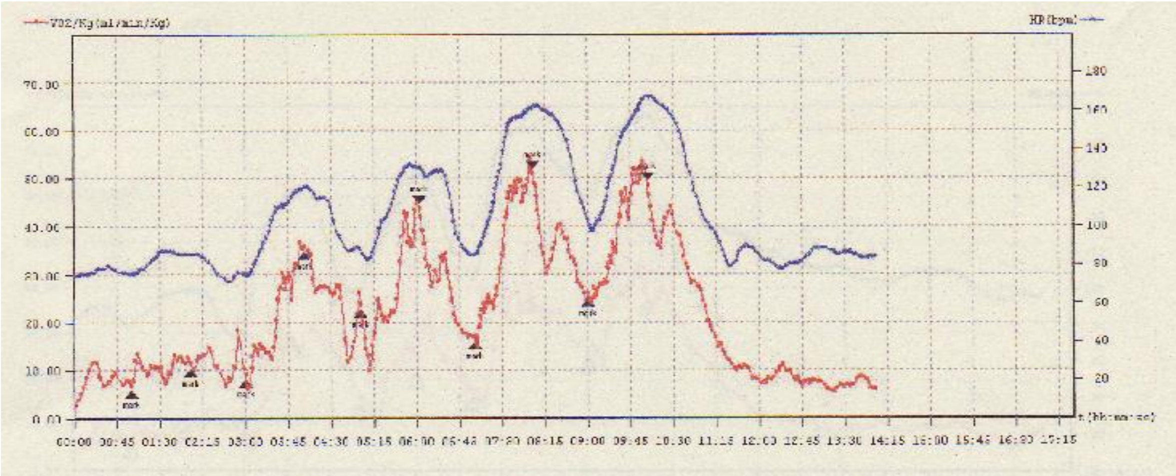

Fig.1 HR (b/min: blue) & oxygen intake (ml/min: red) during experiment of subject A. A is 3rd ranking player of all Japan intercollegiate championships.

Stroke	FH	DR	SM	DR+FW	SM+FW,
Vo2 (ml/min/kg)	10	20	26	34	38
HR (b/min)	83	100	108	127	132
Intensity (%)	19	38	48	63	70

Table 1

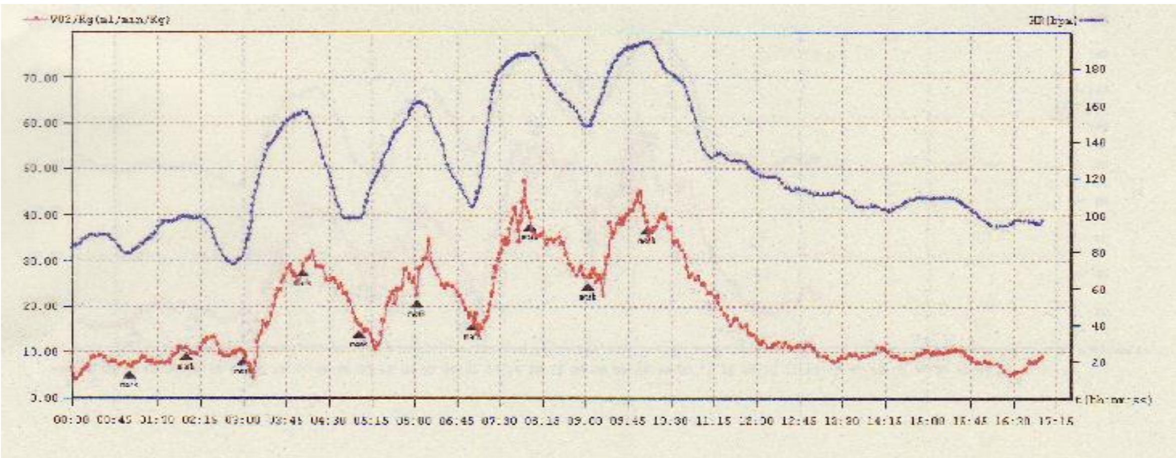

Fig.2. HR (b/min: blue) & oxygen intake (ml/min red) during experiment of subject B. B is participating of all Japan intercollegiate championships.

Stroke	FH	DR	SM	DR+FW	SM+FW,
Vo2 (ml/min/kg)	8	17	19	29	34
HR (b/min)	90	126	132	161	176
Intensity (%)	18	35	41	62	73

Table 2

Discussion

The strength of heart function becomes higher in the order of long, drive and smash strokes. If the right and lest motion is added to the stroke motion, heart function is further promoted. These results should be recognized in the training program. It has also been found that the higher the player's level, the lower the oxygen intake and heart rate. The date of these quantities can be used as indicators of level-up of play.

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DIFFERENCES IN GRF WHEN EXECUTING FOREHAND TOPSPIN WITH DIFFERENT BALLS

Abstract

In modern table tennis most international competitors favour the forehand top spin as most favourable attacking stroke. Technically correct performance of top spin strike and its power is, of course dependable on the player's knowledge, his motor abilities, his morphological characteristics and especially on his physical preparation. Perfectly performed top spin has to be initiated from the legs and an activation of a proper kinetic chain is therefore the most important part of this stroke.

The aim of this study was to find out if during the forehand top spin strokes with balls of different sizes there are differences in the ground reaction force (GRF). Lack of strength in player's legs can namely produce over time a wide range of injuries.

The comparison of selected parameters proved that the observed differences increase due to increased ball size. In order to hit the ball with more spin, the player must use wider movement path to position a ball on his racket. As bigger ball has at the same speed less spin, players need to execute top spin with more power.

The gathered data should facilitate planning of the physical preparation training process of table tennis players.

Key words: *table tennis, GRF, forehand top spin*

1 Introduction

Performance in table tennis and also in any sporting event is the result of a number of factors, which include the amount and structure of training performed, the body's predisposition and adaptation to the training, motivation level, facilities, socio-cultural background etc. Therefore, physiological parameters only account for a portion of any performance, and so the role of any exercise physiologist is also similarly limited. Through fitness testing, the factors involving physiological processes, over which there is some control, can be measured and ultimately improved upon. Competition is the ultimate test of performance capability, and is therefore the best indication of training success. Nevertheless, when trying to maximize performance, it is important to determine the player's ability in individual aspects of performance. Fitness testing attempts to measure individual components of performance, with the ultimate aim of studying and maximizing the player's ability in each component (Kondrič, & Furjan-Mandić, 2002).

The importance of strength in table tennis is not always obvious. However, the need to produce powerful strokes, the need for maximum power is apparent. From this point of view we can observe power as the result of two factors: strength to produce the force and speed to increase the rate at which the force can be applied (first of all by spin on spin game).

It was expected that the new, bigger ball will not only make it better visible for players and spectators but will as well to some extend reduce the speed in the game. At the beginning it was the case, not quite as much as expected, but due to development of equipment and playing techniques today the speed in the game is quite the same as before with the smaller ball and there is still the tendency to make the game even faster (Kondrič, Furjan-Mandić, Medved 2003; Furjan-Mandić, Kondrič, Kasović 2003). It seems necessary to run experiments to find out possibilities to reduce the speed of the ball without any drastic changes of equipment and rules, without making table tennis more expensive as it already is. On the other hand, even though that we always read how safe our sport is, we have to admit that there are some injuries which are caused due to improper movements regarding different strokes and footwork (Ogimura, 1973; Trupković, 1978; Hiruta et all, 1992) .

For every action, according to Newton's 3rd Law of Motion (Law of Action and Reaction), there is an equal and opposite reaction to every action. In other words, the action to the ground is always accompanied by a reaction from it. Due to the gravity, we constantly maintain contact with the ground, and in this process, there occur interactions between the body and the ground. The reaction force supplied by the ground is specifically called the **ground reaction force** (**GRF**), which is basically the reaction to the force the body exerts on the ground.

The ground reaction force is important external force acting upon the human body in motion. We use this force as propulsion to initiate and to control the movement.

The aim of our research is to find out if there are differences between forehand strokes performed with different balls. The gathered data should show us a difference in GRF providing of different strokes with different balls.

2 Methods

2.1 Design

To design an optimal movement for table tennis players executing top spin stroke, it is essential first to establish exactly how a player makes his movements regarding leg and centre of gravity. We measured the kinematic parameters of movements between the forehand top spin strokes executed with different balls. The greater turn (in stride) should ensure the greater ground reaction impact forces, which should also assist in generating unprecise strokes.

2.2 Participants

Ground reaction forces (GRF), as well as kinematic parameters were measured on a professional male table tennis player, a member of the Slovenian national team. The data were collected and analysed both visually and quantitatively.

2.3 Materials

"Kistler" force platform (model 9281 B11 – dimensions 60 x 40 cm) was used to collect the ground reaction force (GRF) data. There are four 3-axial force sensors embedded in the plate so that one can measure the ground reaction force in 3 axes: antero-posterior axis (*X* axis), transverse axis (*Y* axis), and vertical axis (*Z* axis) with the 1000 Hz sampling frequency. The force platform was installed in the middle of one side of the table tennis table in the Biomechanics Laboratory at the Faculty of Kinesiology in Zagreb, Croatia. The signal conditioner/amplifier was interfaced with a sampling system interfaced to a computer. The "Elite 2002" (BTS Bioengineering, Milan, Italy) biomechanical measurement system was used for kinematic data collection and analysis. During measurements 2 high speed video cameras interfaced to a real time automated video based tracking system were used. The cameras were positioned to obtain a side (sagittal – 2 cameras from left and from right) and rear (frontal – from back) view of the centre of gravity and legs.

2.4 Procedure

The measurements were conducted during forehand top spin strokes performed with the table tennis ball machine. The participant was filmed as he executed the strokes. To ensure the same conditions for all the performances (the same approaching ball trajectory), a table tennis machine was used. Prior to recording the movement, reflective markers were placed on the subject's left and right lower extremity and above the hips.

In this study we have used also a method of kinematic analysis, which enables the precise registration and evaluation of the most significant parameters of forehand top spin strokes. Those parameters will be described in other article.

2.5 Methods for measured signal processing

Averaged GRF signals were translated into numerical ASCI format and stored into the computer. SPSS statistical package was used for statistical signal processing.

The mean value of averaged kinematic data was calculated for each analyzed stroke. Descriptive statistical parameters (min, max, mean, SD) were calculated for these data. Analysis of variance (ANOVA) was used for calculating differences between measured parameters using two ball sizes.

3 Results

At first glance, it is obvious that there are certain differences in executing forehand topspin stroke with different balls.

The group means, standard deviations, and ranges for all GRF temporal and amplitude variables across trials are available by the authors. For all variables, at both 38mm and 40mm balls, the between-subject effect was significant ($P<.05$).

The Wilcoxon test is a nonparametric test that compares two paired groups. If the ***p*** value is small, we can reject the idea that the difference is due to chance, and conclude instead that the populations have different medians. If the ***p*** value is large, the data do not give us any reason to conclude that the overall medians differ.

Table 1: Wilcoxon matched pairs test results between variables Fz max 38 and Fz max 40.

		Wilcoxon Matched Pairs Test (Table tennis.sta)		
		Marked tests are significant at p <,05000		
Pair of Variables	Valid N	T	Z	p-level
Fz_max_38 & Fz_max_40	9	5,000000	2,073221	0,038153

Variables represent maximal GRF peak in vertical direction with two different sizes of ball, 38 and 40 millimeters.

Graphic 1: Graphic description median values of maximal GRF peak in vertical direction two sizes of ball, 38 and 40 millimeters.

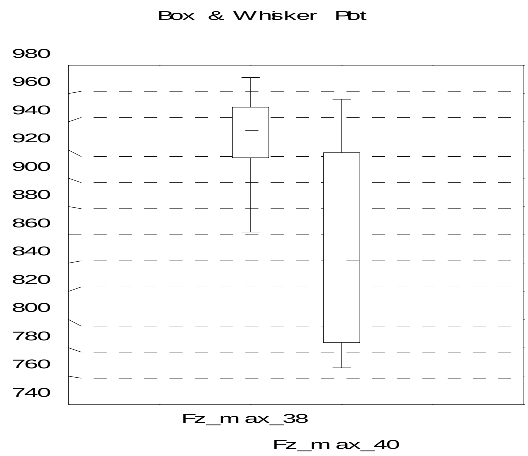


Table 2: Wilcoxon matched pairs test results between variables Fx max 38 and Fx max 40.

		Wilcoxon Matched Pairs Test (table tennis.sta) Marked tests are significant at p <,05000		
Pair of Variables	Valid N	T	Z	p-level
Fx_max_38 & Fx_max_40	9	3,000000	2,310161	**0,020880**

Variables represent maximal GRF peak in antero-posterior direction with two different sizes of ball, 38 and 40 millimeters.

Graphic 2: Graphic description median values of maximal GRF peak in antero-posterior direction two sizes of ball, 38 and 40 millimeters.

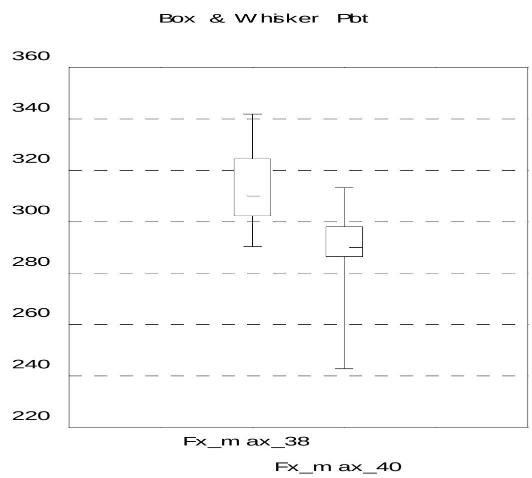
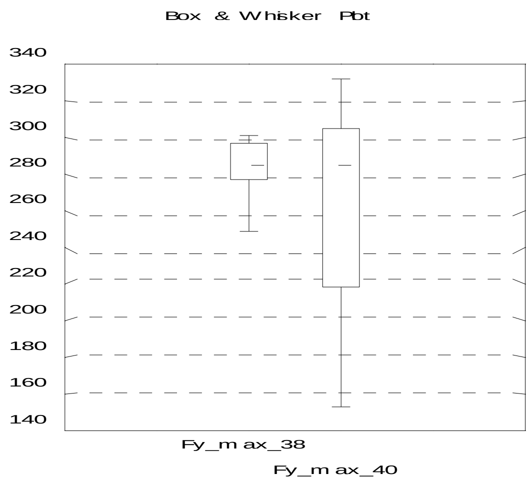


Table 3: Wilcoxon matched pairs test results between variables Fy max 38 and Fy max 40.

		Wilcoxon Matched Pairs Test (Table tennis.sta) Marked tests are significant at p <,05000		
Pair of Variables	Valid N	T	Z	p-level
Fy_max_38 & Fy_max_40	9	21,00000	0,177705	0,858955

Variables represent maximal GRF peak in transverse direction with two different sizes of ball, 38 and 40 millimeters.

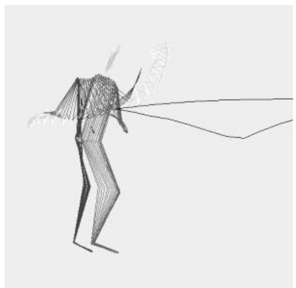
Graphic 3: Graphic description median values of maximal GRF peak in transverse direction two sizes of ball, 38 and 40 millimeters.



The loading rate is important since it reflects the force development rate during impact phase. Loading rate is closely related to the hardness of the shoe sole and the executing of the stroke.

4 Discussion

Although the value of strength in table tennis is no longer an issue of debate, we should be careful not to work on development of massive strength exclusively. Our first concern should be to ensure all-round strengthening of the body and herewith to avoid injuries. When selecting exercises for the strengthening programme, an analysis of movements involved in a particular stroke, in terms of type, speed, direction, etc., should be done in order to be sure which groups of muscles are involved in these movements.



Special exercises should be designed to approximate as closely as possible the pattern and rate of movements of an actual table tennis stroke execution. This will recruit (activate) and train stroke-related groups of muscles thus enhancing their specific neuro-muscular functions needed for a particular performance. Nevertheless, we must not forget that movement acceleration of a joint involved in a particular stroke will depend on the state of certain muscles, which can influence the joint's degree of flexibility. From this point of view, it is obvious that both the ligamentous structures and muscular ability to contract and relax are important (Nigg, 1985). Therefore, it is essential that table tennis players have good flexibility to assist movement and to control a particular stroke performance. It is also well established that muscle damage can be prevented by training, whether it involves concentric (Bosman et al., 1993) or eccentric exercise (Clarkson, & Tremblay, 1988; Balnave, & Thompson, 1993).

Ground reaction forces (GRF) play a major role in executing top spin. The greater the usable forces the greater the speed that one can attain. Thus how to generate effective GRF is the key how to give a ball more spin.

The practical problem of measuring characteristics of table tennis players during sportive activity has meant that the majority of assessments have been carried out in the laboratory and not in the practice hall at the table (Medved, 2001). However, many sports, including also table tennis, require intermittent exercise, and such tests therefore represent artificial situations.

Considerable confusion sometimes exists about the origin of the forces measured by a force platform. The best way to understand these is to think of the force platform as a whole-body accelerometer. Since Force = mass x acceleration (Newton's 2nd Law of Motion), any acceleration of the body will be reflected in a reaction when at least one foot is on the ground. An upwards acceleration (as occurs at performing top spin stroke) will be reflected in an increase in the vertical load (weight) recorded, while a downwards acceleration will reduce the effective body weight. We have to take into account that a downwards deceleration (such as occurs at initial contact) equals to upwards acceleration, and vice versa.

In our research we did not take into account the rubber gluing although it could have affected the measured parameters. Namely, several layers of glue can change the characteristic of rubber due to which velocity of the ball can be enhanced.

5 Conclusion

It is important to document the strength of forward flexion, abduction, external rotation, and internal rotation.

The desirability of a minimum quantity of strength in table tennis has been for long recognized. Unfortunately the advantages of maximum levels of strength in table tennis were not recognized by all physical educators, athletes and coaches. This neglect of the strength factor was the result of an unscientific acceptance by almost everyone concerned that the development of large amounts of strength in the musculature inevitably resulted in a condition known as muscle-bound. Being muscle-bound was supposed to limit both range and speed of table tennis strokes.

The aim of this study was to find out if during the forehand top spin strokes with balls of different sizes there are differences in the ground reaction force (GRF). Lack of strength in player’s legs can namely produce over time a wide range of injuries.

The comparison of selected parameters proved that the observed differences increase due to increased ball size. In order to hit the ball with more spin, the player must use wider movement path to position a ball on his racket. As bigger ball has at the same speed less spin, players need to execute top spin with more power.

The gathered data should facilitate planning of the physical preparation training process of table tennis players.

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POSSIBILITIES TO REDUCE SPEED AND SPIN BY CHANGING THE THICKNESS OF SPONGE, UPPER LAYER OR TOTAL THICKNESS OF SANDWICH RUBBER

Abstract

Table tennis is without no doubt the fastest game in the world. As table tennis has developed during last decade and player's techniques have improved, the ball's speed and spin have become too fast and that's why rallies are shorter. The aim of our research was to find out what are the differences in results when strokes are performed with rubbers of different thicknesses.

For this purpose the impact has been investigated, and a simple impact model has been proposed on the basis of the idea that the contact duration is determined by the natural period of a whole system composing the mass of ball, the nonlinear stiffness of ball and rubber.

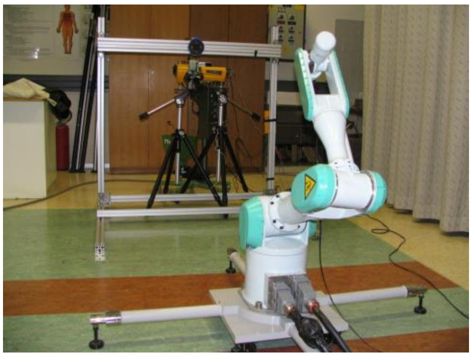
Different rebound angles from the racket on the robot arm determine different trajectories of parabolic shape. Therefore, at another angle where the parabolas are higher and the ball flight paths longer, the quartiles are wider since even a slight change in the rebound angle affects the duration of the ball flight more than when parabolas are lower, that is the flights of the ball are more direct.

These measurements and results of measurements show us that there is a big potential to regulate table tennis rules regarding to slow down a game and take into consideration health of table tennis players. We can do this with limitation of rubbers or with prohibition of speed gluing. Even though results show us differences in different kind of rubbers there is still a lot of work to be done.

Key words: *table tennis, rubber, speed, spin*

1 INTRODUCTION

Modern table tennis is a sport game that demands great speed, strength, power, endurance, flexibility, agility and good reflexes. The majority of top-level players prefer to concentrate on attacking or counter-attacking. Most international competitors favor the forehand spin stroke to produce high velocity and high rotation. However, a stroke angle has been changed since the circumference of the ball has been enlarged. The shoulder girdle muscles are today exposed to different loads than before because shoulder abduction should be performed more quickly now. As table tennis has developed during last decade and player's techniques have improved, the ball's speed and spin have become too fast and that's why rallies are shorter. In order to regain interest of spectator and make table tennis more attractive again, International Table Tennis Federation has made some rule changes in last few years, but it looks like that these measures have not been effective in improving the attractiveness for table tennis spectators.



After Olympic Games in Sidney, ITTF replaced 38mm ball with 40mm ball. It was expected that the new, bigger ball will not only make the ball better visible for the players and spectators but will as well to some extent reduce the speed in the game. At the beginning it was the case, not quite as much as expected, but due to development of equipment and playing techniques today the speed in the game is quite the same as before with the smaller ball and there is still the tendency to make the game even faster. It seems necessary to run experiments to find out possibilities to reduce the speed of the ball without any drastic changes of equipment and rules, without making table tennis more expensive as it already is. We have to take in consideration different materials we play with. Rubbers are probably most important part of modern table tennis equipment. We have a lot of different rubbers today that we can find in table tennis stores. The same stroke produced with different rubbers will result with different ball speed and rotation due to different characteristics of the rubber.

The aim of our research is to find out what are the differences in results when ball hits the bat with rubbers of different thicknesses.

2 GOAL OF THE EXPERIMENT

To test the possibility of reducing the speed and spin in the game by reducing the total thickness of the sandwich rubber and/or reducing the thickness of the sponge and/or reducing the thickness of the upper layer of the sandwich rubber.

For this purpose the impact has been investigated, and a simple impact model has been proposed on the basis of the idea that the contact duration is determined by the natural period of a whole system composing the mass of ball, the nonlinear stiffness of ball and rubber.

3 METHODS

3.1 Design

To design an optimal rubber which has positive influence on modern table tennis game, it is essential first to establish exactly how which thickness of rubbers affects speed and rotation of the ball. Therefore, we have measured the magnitude of the difference in speed of ball caused with rebound from different rubbers.

3.2 Materials

Physical parameters have been collected with measurement equipment located on the Faculty of Sport and Institute Jozef Stefan in Ljubljana. For this purpose we have used:

- »Microgate Polifemo Radio« photocell
- Two 6 dimensional sensors Jr3
- A 2D Motion Analysis System
- Mini DV camcorder
- TTmatic 500 (table tennis machine)
- MHI General Purpose Robot PA10 Series- 7-axis redundancy control robotic arm (Mitshubishi heavy industries)
- Rubbers of different thickness have been provided free of charge by ESN and TIBHAR, Germany.

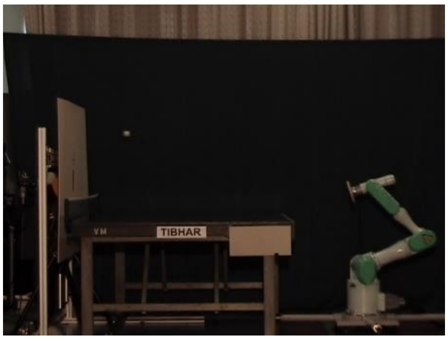
3.3 Procedure

Physical parameters of single rebounds and intensity have been measured on a professional engeneering system. The data has been collected and analysed both visually and quantitatively.

The measurements have been conducted during fifty rebounds (for each rubber) performed with the different rubbers on the same blade. The measurement has been filmed as table tennis machine launched the ball. To ensure the same condition for all the performances (the same approaching ball trajectory), a table tennis machine has been used.

The measurements have been taken at the Faculty of Sport and Institute Jozef Stefan in Ljubljana.

The measurement apparatus was put together as shown in following photo. The robot TTmatic 500 automatically launched balls with a frequency of approximately 10 min^{-1}. Immediately after being launched, the ball was intercepted by the »Microgate Polifemo Radio« photocell which triggered a specially designed program for capturing data from the computer AD card. Two 6-dimensional sensors Jr3 were plugged to the AD card for measuring force and torque in all three axes. The first, smaller sensor (maximum load 250 N) was plugged to the Mitshubishi Pa10 robot arm, which had a table tennis racket attached to it. The second, bigger sensor (maximum load 1 kN) was attached to a specially designed frame with a board. The ball bounced from the board after being returned from the racket. The board was placed 2 cm behind the edge of the middle of the table (see picture). The second computer controlled the Mitsubishi robot, and thus the appropriate racket settings – 2 positions wit corresponding orientations and angles. Data of all three force components of the smaller Jr3 sensor, and data of the main movement direction force component of the bigger Jr3 sensor was captured at a frequency of approximately 5.5 kHz.



The signals captured from the sensors show an impact force on the racket and an impact force on the rebound board. Using a specially developed program in the Matlab environment and a 1 N high trigger, we have determined the ball traveling times from the photocell to the racket and returning from the racket to the rebound board.

3.4 The task

- find out theoretically (computer calculations) the influence of different thickness of sandwich rubber, sponge, upper layer on speed and spin of the ball in the game,
- try in practice different total thickness of sandwich rubber, compare with the rubber in accordance with the present rule,
- try in practice different sponge thickness, compare with rubber in accordance with the present rule,
- try in practice different upper layer thickness, compare with rubber in accordance with the present rule,
- test the influence on the game, on the stroke technique,
- test the durability of such sandwich rubber when speed glued.

4 RESULTS

Table 1: *Differences between different rubbers (Bonferroni - Multiple Comparisons) – 1.8mm*

Dependent Variable	(I) RUBBER	(J) RUBBER	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
1.8 mm Angle 1	1	2	-32.70650(*)	7.63327	**.000**	-51.3283	-14.0847
		3	-18.82112	7.91094	.058	-38.1202	.4780
	2	1	32.70650(*)	7.63327	**.000**	14.0847	51.3283
		3	13.88538	7.49058	.201	-4.3883	32.1590
	3	1	18.82112	7.91094	.058	-.4780	38.1202
		2	-13.88538	7.49058	.201	-32.1590	4.3883
1.8 mm Angle 2	1	2	-24.92163	11.36688	.092	-52.6188	2.7755
		3	-13.44996	11.87509	.781	-42.3854	15.4855
	2	1	24.92163	11.36688	.092	-2.7755	52.6188
		3	11.47167	10.94554	.892	-15.1988	38.1422
	3	1	13.44996	11.87509	.781	-15.4855	42.3854
		2	-11.47167	10.94554	.892	-38.1422	15.1988

LEGEND:
Rubber 1 = Conventional 1.8
Rubber 2 = Tension 1.8
Rubber 3 = Test 1.8 (04/296)
Angle 1 = 112.8^o
Angle 2 = 107.9^o

Table 2: *Differences between different rubbers (Bonferroni - Multiple Comparisons) – 2.0mm*

Dependent Variable	(I) RUBBER	(J) RUBBER	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
2.0 mm Angle 1	4	5	-22.31870(*)	8.23259	**.023**	-42.3123	-2.3251
		6	-12.65694	8.08235	.360	-32.2856	6.9718
	5	4	22.31870(*)	8.23259	**.023**	2.3251	42.3123
		6	9.66176	8.13525	.712	-10.0954	29.4189
	6	4	12.65694	8.08235	.360	-6.9718	32.2856
		5	-9.66176	8.13525	.712	-29.4189	10.0954
2.0 mm Angle 2	4	5	-14.25836	9.17666	.370	-36.5846	8.0679
		6	-25.94011(*)	9.32379	**.019**	-48.6243	-3.2559
	5	4	14.25836	9.17666	.370	-8.0679	36.5846
		6	-11.68175	9.62014	.682	-35.0870	11.7235
	6	4	25.94011(*)	9.32379	**.019**	3.2559	48.6243
		5	11.68175	9.62014	.682	-11.7235	35.0870

LEGEND:
Rubber 4 = Conventional 2.0
Rubber 5 = Tension 2.0
Rubber 6 = Test 2.0 (04/297)
Angle 1 = 112.8^o
Angle 2 = 107.9^o

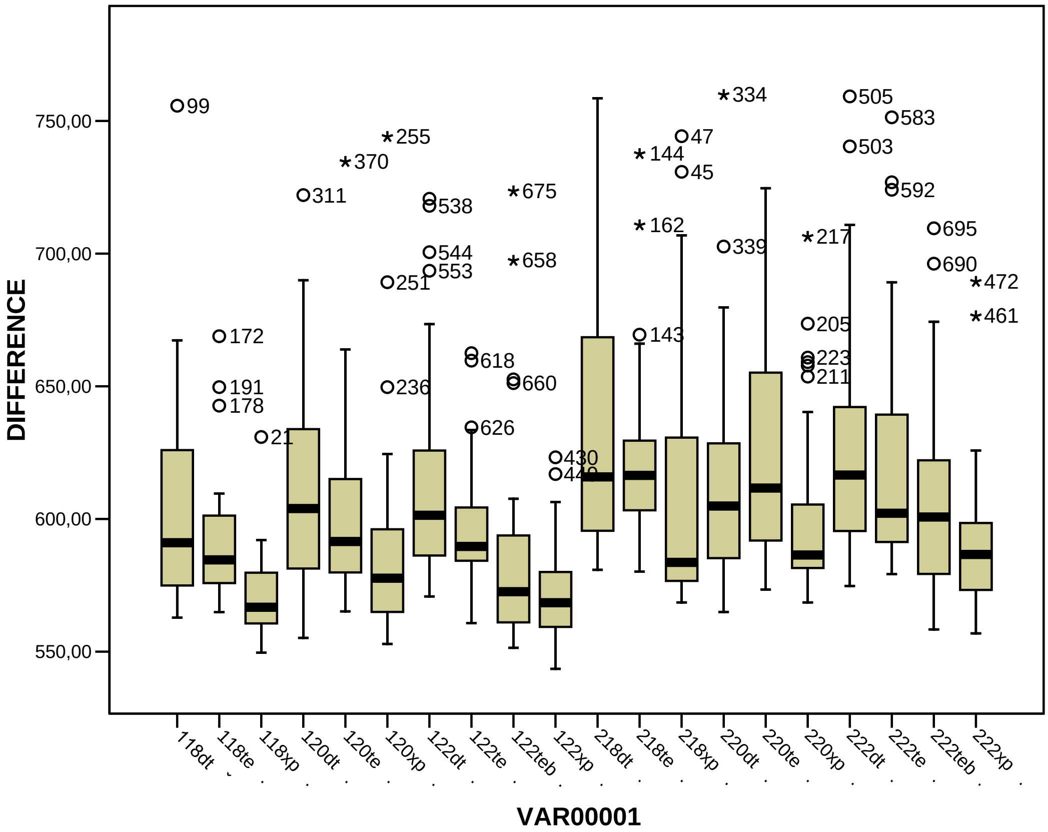
Table 3: *Differences between different rubbers (Bonferroni - Multiple Comparisons) – 2.2mm*

Dependent Variable	(I) RUBBER	(J) RUBBER	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
2.2 mm Angle 1	7	8	-39.00259(*)	7.58381	**.000**	-59.2831	-18.7221
		9	-24.72355(*)	7.88749	**.012**	-45.8161	-3.6310
		10	-11.21960	7.44791	.805	-31.1367	8.6975
	8	7	39.00259(*)	7.58381	**.000**	18.7221	59.2831
		9	14.27905	7.18900	.293	-4.9457	33.5038
		10	27.78299(*)	6.70378	**.000**	9.8559	45.7101
	9	7	24.72355(*)	7.88749	**.012**	3.6310	45.8161
		8	-14.27905	7.18900	.293	-33.5038	4.9457
		10	13.50394	7.04549	.343	-5.3370	32.3449
	10	7	11.21960	7.44791	.805	-8.6975	31.1367
		8	-27.78299(*)	6.70378	**.000**	-45.7101	-9.8559
		9	-13.50394	7.04549	.343	-32.3449	5.3370
2.2 mm Angle 2	7	8	-35.80558(*)	8.61573	**.000**	-58.8478	-12.7634
		9	-29.78131(*)	8.55593	**.004**	-52.6636	-6.8991
		10	-17.54027	8.74416	.280	-40.9259	5.8454
	8	7	35.80558(*)	8.61573	**.000**	12.7634	58.8478
		9	6.02427	8.77557	1.000	-17.4454	29.4939
		10	18.26531	8.95919	.260	-5.6954	42.2261
	9	7	29.78131(*)	8.55593	**.004**	6.8991	52.6636
		8	-6.02427	8.77557	1.000	-29.4939	17.4454
		10	12.24104	8.90170	1.000	-11.5660	36.0480
	10	7	17.54027	8.74416	.280	-5.8454	40.9259
		8	-18.26531	8.95919	.260	-42.2261	5.6954
		9	-12.24104	8.90170	1.000	-36.0480	11.5660

* The mean difference is significant at the .05 level.

LEGEND:
Rubber 7 = Conventional 2.2
Rubber 8 = Tension 2.2
Rubber 9 = Test 2.2 (04/298)
Rubber 10 = Test 2.2 (04/299)
Angle 1 = 112.8°
Angle 2 = 107.9°

Figure 1: *Difference between different rubbers – angle 1 and angle 2*



LEGEND:
Name convention: XYYAAA:
X=1 … angle 1 = 112.8°
X=2 … angle 2 = 112.8°
YY … rubber thickness [mm]
AAA … rubber type
- xp = Conventional 2.2
- dt = Tension 2.2
- te = Test 2.2 (04/298)
- teb = Test 2.2 (04/299)

Table 4: *Significant differences between different rubbers (One-way ANOVA)*

(I) Rubber	(J) Rubber	Sig	Angle
Conventional 1.8	Tension 1.8	.000	Angle 1
Conventional 2.0	Tension 2.0	.023	Angle 1
Conventional 2.0	Test 2.0 (04/297)	.019	Angle 2
Conventional 2.2	Tension 2.2	.000	Angle 1
Conventional 2.2	Test 2.2 (04/298)	.012	Angle 1
Test 2.2 (04/299)	Tension 2.2	.000	Angle 1
Conventional 2.2	Tension 2.2	.000	Angle 2
Conventional 2.2	Test 2.2 (04/298)	.004	Angle 2

4 DISCUSSION

The coefficient of restitution is closely related to the impact's energy losses. Racket vibration induced by impact seems to be one of the main sources of energy loss. The impact force and contact duration have strong influence on the racket vibrations. But there are still a number of unclarified points regarding impact phenomenon between a ball and a racket as well.

In this research rebound of a ball caused by different rubbers has been investigated.

The results (qualitative) demonstrate very well how a small modification (5 degrees) enormously affects the flight of the ball, which is extremely significant when performing spins.

Different rebound angles from the racket on the robot arm determine different trajectories of parabolic shape. Therefore, at another angle where the parabolas are higher and the ball flight paths longer, the quartiles are wider since even a slight change in the rebound angle affects the duration of the ball flight more than when parabolas are lower, that is the flights of the ball are more direct (as shown in Figure 1).

Different rebounds and the coefficient of quality impact depend not only on the rubber thickness, the type of rubber etc., but also on the point where the ball hits the racket (Tiefenbacher & Durey, 1994). Any deviation from the 'sweet point' on the racket results in a different or worse rebound. These are the very deviations in all directions (resulting from the dispersion of the robot induced ball flight trajectories), which cause the upper edge of the quartile width (longer times than the median) is further from the median than the lower edge of the quartile (shorter times than the median). The same behaviour can be observed with all rubbers and both rebound angles.

A similar effect of widening the area of the quartiles can be observed with rubbers, particularly at the first angle. Faster, conventional rubbers have a smaller dispersion of the ball flight trajectory and from the players point of view, this could mean these rubbers are more accurate, that is the good hit racket area (sweet area in terms of 'point') is wider – assumed that the effect of different parabolas is not the cause for differences in times. In the course of this project extension, we intend to further investigate the problem of trajectories with the help of mechanical modeling and the kinematic measurements that was taken at the same time.

It is necessary to consider the fact that at this time by the first method no ball rotation was measured (the racket was namely firmly fixed to the robot arm), since this research was focused solely on observing rubber at racket-ball impact. Spin measurement has been done by the second Wassing dom method by Tiefenbacher.

5 CONCLUSION

These measurements and results of measurements show us that there is a big potential to regulate table tennis rules regarding to slow down a game and take into consideration health of table tennis players. We can do this with limitation of rubbers or with prohibition of speed gluing. Even though results show us differences in different kind of rubbers there is still a lot of work to be done, but first we need to know in which direction we should take our researches. Namely, those researches are very expensive.

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FOOTWORK TECHNIQUES USED IN TABLE TENNIS: A QUALITATIVE ANALYSIS

Abstract

INTRODUCTION
Footwork and steps (one step, side to side, slide step, "turn" step, cross step, and combinations of these steps) are fundamental in table tennis. Players should use the best technique for guarantying the shortest time to arrive in the right position, that gives the possibility to play the best shot.
AIM OF THE STUDY
This study aims to define the different footwork techniques used by table tennis players. To compare different footwork techniques for giving useful suggestions to coaches and implementing better training for players, from a technical and physical point of view.
METHODS

1. *Analysis of 2 matches of 4 male players from 2006 World Team Table Tennis Championships (videos recorded from television). During that competition the players were the n° 1 (Wang Liqin), 2 (Timo Boll), 4 (Ma Lin) and 56 (Christian Suss) in the world ranking. Analysis of the matches: L. Ma vs T. Boll, and L.Q. Wang vs C. Suss.*
2. *To record the 5 different types of steps defined and the 16 types of shots (drive and back) was used a 16 x 5 table. To carry out this analysis it has always been taken into account the last step before the shot or before the attempt to hit the ball.*
3. *The analysis of the frequencies of the different types of steps were performed and percentages calculated.*
4. *The non-parametric Chi Square test were performed to identify significant differences ($\alpha=0.01$) in the use of footwork techniques by the 4 players considered.*

RESULTS
The results allow a qualitative description of the various step movements.
The most frequent step is the one step with a frequency of 37.3%; the second one is the turn step with a frequency of 21.1%; they are followed by the chassè 15.2%; the stroke without stop 11.5 %; the slide step 7.5% and the crossover 7.3%.
Chi Square analysis, by comparing the use of different types of steps by the players, shows significant differences between them (χ^2 (15) = 40.63, $p<0.01$). A single match analysis shows that between Boll and Lin there are not significant differences in the steps used (χ^2 (5) = 14.01, $p>0.01$); while between Wang and Suss the differences in steps movements are significant (χ^2 (5) = 26.62, $p<0.01$).
DISCUSSION
Analysis of the matches suggests inter individual differences in the characteristics of the steps movements. The "one step" is especially used to hit the ball in the forehand and backhand push to return the service. The "turn step" is used to prepare the forehand top spin. The Timo Boll vs Ma Lin match shows a similar use of steps by players whereas in the Wang Liqin vs Christian Suss match, the first player (the winner of the match) uses the "turn step" more frequently than the other player. Further studies on a larger number of matches, using the same methods, will permit a better understanding in the use of footwork techniques.

Key words: *table tennis, footwork technique*

1. Introduction

Table tennis is an extremely complex sport and its development never stops.

Analyzing table tennis is immediately possible to notice that it includes the most important characteristics of sports in general: techniques, game plan, physical and psychological skills.

These are fundamental skills and it should be underlined the importance of studying, developing and training them in order to reach high agonistic degrees.

This paper is based on already done studies [Leach J., 1971] [Trupkovic J., 1978], and aims to get deeper in technique's development.

A good technique, considered as carrying out in the best way a specific movement, is the main base for building up a good player. Moreover, its development is affected by lot of factors: scientific knowledge, rules, tools, experience. This is the reason why lot of studies aim to develop its teaching and learning.

The training aims to get closer to a pattern considering the player's personal skills, for building up a specific personal technique, or a personal style.

This process starts from a basic level technique, it goes through a standard pattern built up on the best player's analysis and finally it should fit on the player personal style and become as close as possible to a pattern.

The table tennis technique is based on different types of strokes and movements or steps.

Regarding the strokes' technique, different studies have been carried out: on the ITTF "Level 1 coaching manual" [2003] Tepper G. clearly defined a standard classification of the different types of strokes, describing the execution technique. Moreover, Ripoll H. [1989-1990] considered the strokes' psycho-motor aspects and Rodano R. [1991] the biomechanics ones.

The most important thing, considering the best players technique, is the best execution of movements and steps, for reaching in the shortest time the right position, and playing the best stroke.

This is the reason why movements and steps are considered the most important technical aspects for table tennis [Deniso P., 1992] and it is fundamental to get deeper in their analysis.

2. Aims of the study

This study has three main aims:

1. create a clear and overall standard definition of the different types of steps and movements used in table tennis
2. construct the best standard technique pattern of steps and movements, analysing some high level players' matches
3. suggest a good method for studying and analysing different players' techniques in order to improve training and obtain better high agonistic results

3. Methods

1. Analysis of two "2006 World Team Table tennis Championships" semifinal matches ,Bremen, Germany (videos recorded from television)
2. The players analysed were the n° 1 (Wang Liqin), n° 2 (Timo Boll), n°4 (Ma Lin) and n° 56 (Christian Suss) in the world ranking
3. The analysis is based on two matches: Ma Lin vs Timo Boll and Wang Liqin vs Christian Suss
4. Data have been recorded in a 16x5 table in which different types of steps and strokes have been taken into account

Footwork

One of the main characteristics of "modern" high level table tennis is high speed.
A good moving technique is the starting point for reaching in the shortest time the right position and playing the best stroke.
The different steps' classification below is based on a right hand player but it could be referred also to a left hand one in a perfectly symmetric way. This classification has been mainly based on the moving technique independently from the step's direction. Before going through the steps' description is necessary to give a definition of the ready position.

3.1.1. Ready position

The ready position is an important base stance as all possible strokes must be easily reached. The feet should be shoulder width apart or slightly wider, knees bent, body leaning slightly forward and the weight on the front part of the foot to provide balance and readiness for movement. Variations of the ready position exist according to the style of play of the player [Tepper G., 2003].
The four players considered are all forehand attackers, Ma Lin is the only one playing with the Chinese style pengrip.
So that their ready position can be described as follows: standing close to backhand corner with the left leg forward for right-handers, so that the majority of balls can be played with the forehand.

3.1.2. Steps' classification

1. One step
2. Short and medium steps
   a. side to side or "chassé"
   b. slide step
   c. turn step
3. Crossover

1. **One step** is a small step played starting from the ready position or during other game phases, keeping one foot still and moving the other one towards the ball. The foot that plays the movement should immediately come back into the ready position.
One step footwork is used when the ball is played very quickly by the opponent and there is insufficient time to get into the right position for playing the stroke. This type of step is mainly played to return short services or balls played very close to the net.

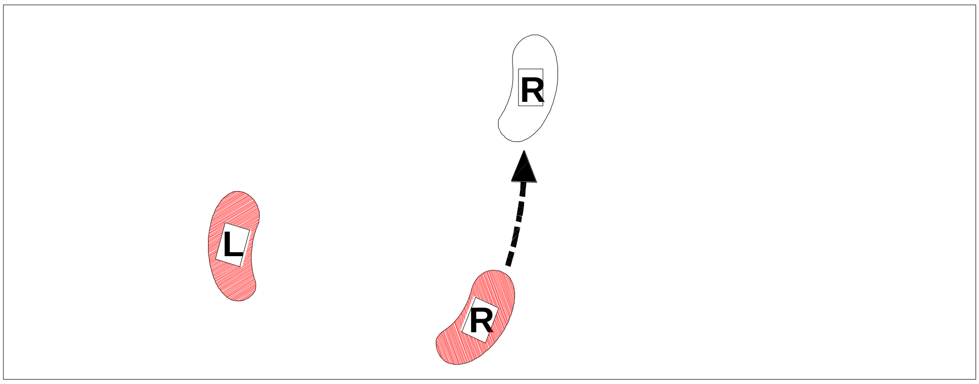

Figure 1 *One step*

2. **Short and medium steps**: all those movements played from the ready position or during other game phases and involving the movement of both feet. These steps

allow players to cover short or medium distances, towards the ball for playing the strokes, with very high speed

a. **Side to side or "chassé"**: if the movement is on the right side, the left foot moves first and has to get close to the right one, which will move on the right side. So that, at the end of the movement the player will get back on the ready position.

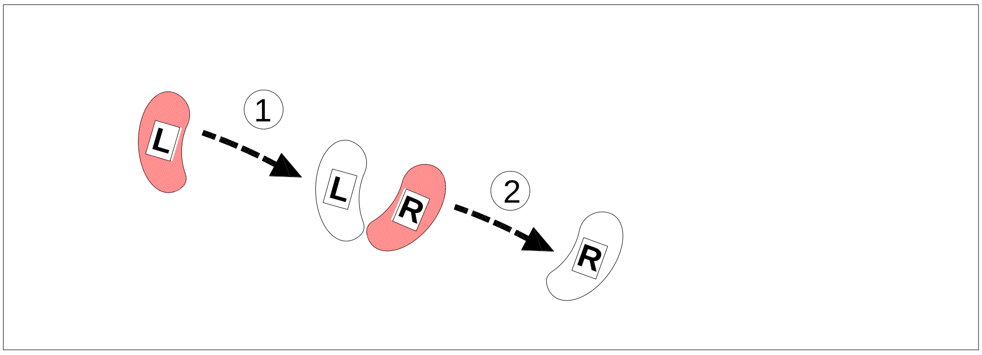

Figure 2 *Chassé*

b. **Slide step**: if the movement is on the right side the right foot moves first, followed by the left one which will slide in the same direction. So that, at the end of the movement the player will get back on the ready position.

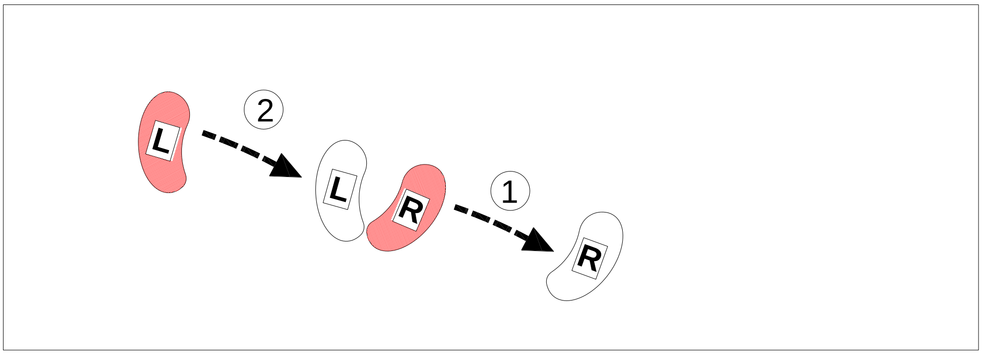

Figure 3 *Slide step*

c. **Turn step:** is the movement played by a player who wants to play a forehand stroke from the backhand corner. This step could be done following the chassé or slide step technique. It is especially useful for playing the forehand topspin from the backhand corner.

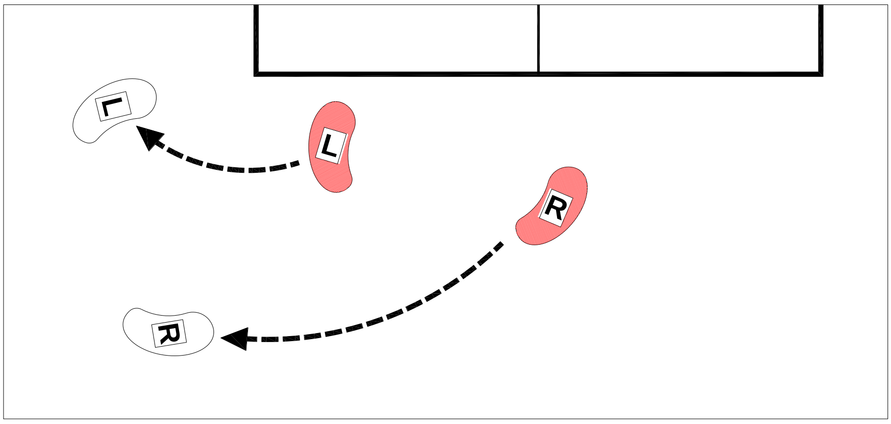

Figure 4 *Turn step*

3. **Crossover:** is used when the player has to cover a long distance in a short time. Crossover footwork should not be used for short distances. The player is in the backhand corner waiting to cover most of the table with the forehand. The player initiates movement to the right by tacking a step with the right leg into a wide stance. The left leg crosses over in front of the right leg as contact is made. As the follow-through is completed the right leg is brought forward. At the end the right leg finishes in a wide position ready to push back to the left [Tepper G., 2003].

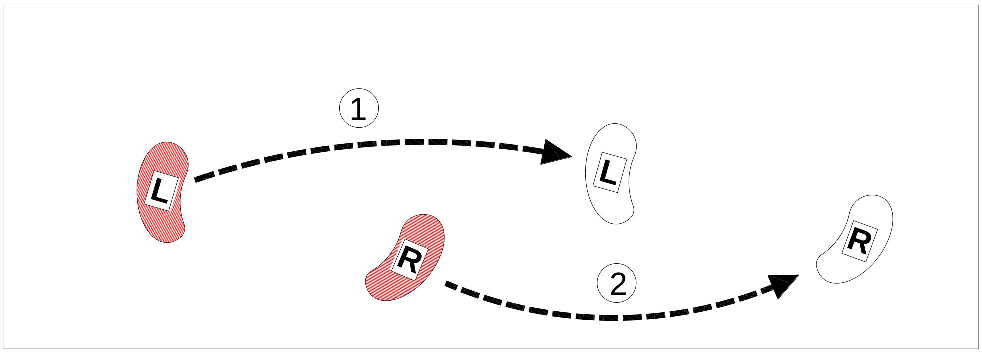

Figure 5 *Crossover*

3.2. Strokes

Regarding the strokes, it follows a list without description:

1. Forehand Topspin
2. Backhand Topspin
3. Forehand Push
4. Backhand Push
5. Forehand Block
6. Backhand Block
7. Forehand Topspin counter Topspin
8. Backhand Topspin counter Topspin
9. Forehand flick
10. Backhand flick
11. Forehand smash
12. Backhand smash
13. Forehand drive
14. Backhand drive
15. Forehand lob
16. Backhand lob

3.3. Methodological aspects

Into the following table have been also considered, together with steps, the services, distinguishing between the forehand ones and the backhand ones. Moreover have been collected data referred to “steps without stroke” and “strokes without step”.

Covering a long distance, more than one step could be involved into the movement, it is important to underlie that for carrying out this analysis it has always been taken into account the last step before the stroke, or before the attempt to hit the ball.

Data have been collected looking at matches with the slow motion and looking at one player each time.

4. Results

One table for each player has been created and then data have been collected all together in the following table.

Table 1 *Data collected for the four players considered*

Forehand service	144		**Short and medium step**						
Backhand service	0	**One step**	Chassé	Slide step	Turn step	**Crossover**	**Stroke without step**	**N row**	**Forehand plus Backhand**
Topspin	F	17	10	15	53	16	3	114	167
	B	20	8	10	-	0	15	53	
Push (back)	F	89	7	0	15	1	0	112	145
	B	32	0	0	-	0	1	33	
Block	F	0	1	0	1	1	1	4	72
	B	10	16	12	-	0	30	68	
Topspin counter Topspin	F	5	20	2	36	12	9	84	94
	B	1	5	0	-	1	3	10	
Flick	F	19	2	1	4	0	0	26	45
	B	18	1	0	-	0	0	19	
Smash	F	0	0	0	1	0	0	1	1
	B	0	0	0	-	0	0	0	
Drive	F	0	0	0	0	0	0	0	9
	B	1	4	0	-	0	4	9	
Lob	F	0	0	0	0	1	0	1	2
	B	0	1	0	-	0	0	1	
Step without stroke		2	12	3	11	10	0	38	38
N column		214	87	43	121	42	66	573	573

In the following figure different steps' frequencies have been calculated in percentages:

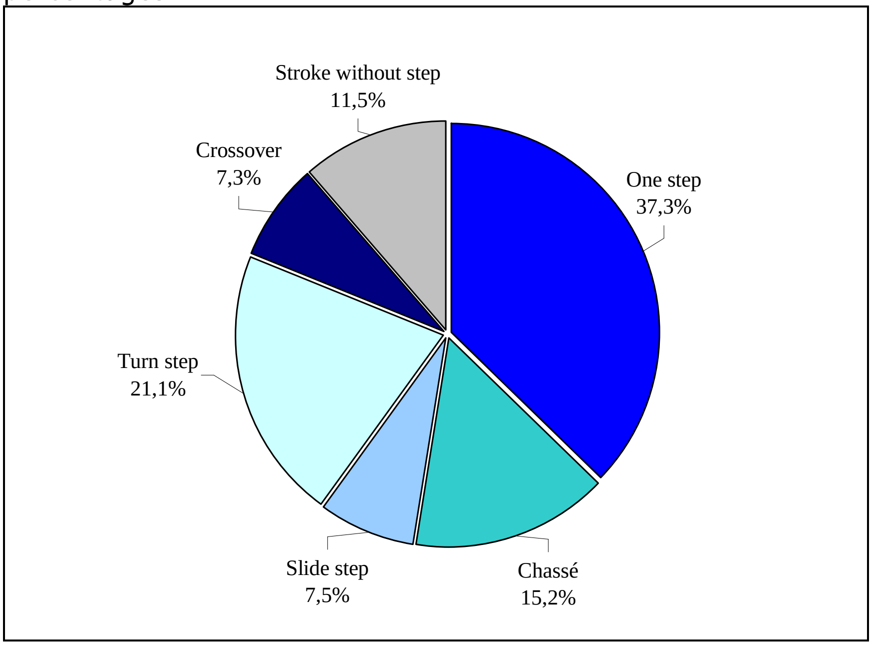

Figure 6 *Different steps' percentage frequencies*

The results allow a qualitative description of the various step movements.

The most frequent step is the one step with a frequency of 37.3%; the second one is the turn step with a frequency of 21.1%; they are followed by the chassè 15.2%; the stroke without step 11.5 %; the slide step 7.5% and the crossover 7.3%.

The following graph considers the analysis of the different steps used by the four players considered:

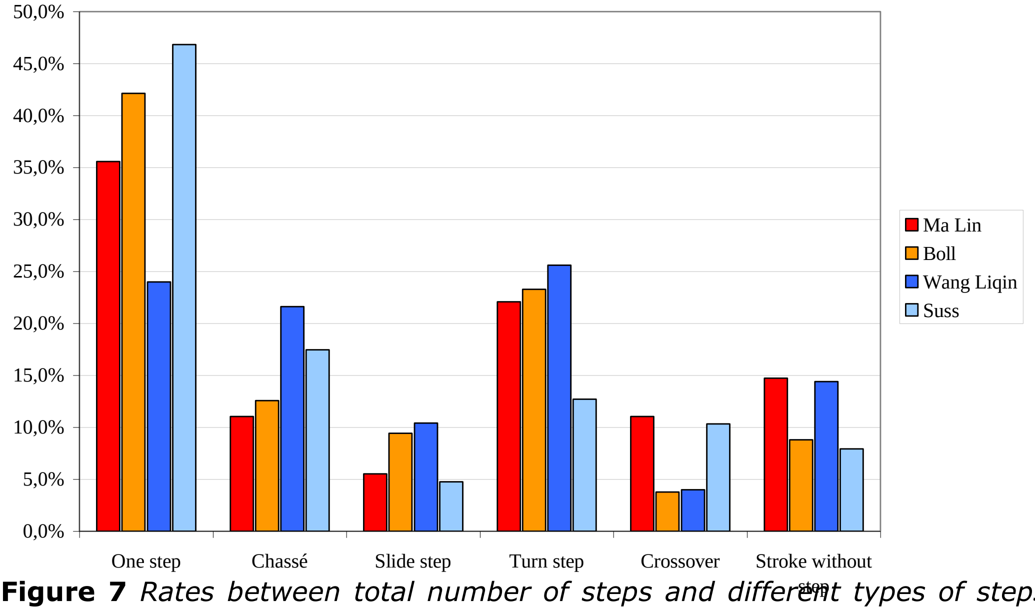

Figure 7 *Rates between total number of steps and different types of steps for each player*

5. Conclusions

In order to define all the technical features of table tennis it is necessary to develop a comprehensive and standard language at international level.

This enables setting and developing a method for studying and analysing the different movements. They are very important but they are not recognised as much as strokes.

To this purpose a best pattern should be taken as a reference, which is composed by the best players on the world ranking. The different players' games have been watched in slow motion in order to permit an accurate data collection.

The major problems emerged regard in particular the difficulty in recognising and discerning: "steps without stroke", "stroke without step", and "the last step before the attempt to hit the ball" especially if it is considered a situation in which lot of different quick steps' combinations are involved.

The statistical results, of the analysis carried out on the four world players, allow a quantitative description of the various step movements.

The most frequent step is the "one step" with a frequency of 37,3%; the second one is the "turn step" with a frequency of 21,1%; they are followed by the "chasse" 15,2%; the "stroke without step" 11,5 %; the "slide step" 7,5% and the "crossover" 7,3%.

Through these results it has been possible, for example, to deny the "chassè" as the most used step.

Moreover the analysis of the matches suggests inter individual differences in the characteristics of the steps movements. For example the "one step" is especially used to stroke the ball in the forehand and backhand push to return the service. The "turn step" is used to prepare the forehand top spin or to make a counter topspin.

While block often doesn't need any step.

Lot of similar conclusions can be drawn from this analysis and they permit to underline differences in the use of steps and to find out which are the most useful steps in order to improve the training and the basic technique.

Finally the non-parametric Chi Square test were performed to identify significant differences ($\alpha=0.01$) in the use of footwork techniques by the 4 players considered.

Chi Square analysis, by comparing the use of different types of steps by the players, shows significant differences between them (χ^2 (15) = 40.63, $p<0.01$). A single match analysis shows that between Boll and Lin there are not significant differences in the steps used (χ^2 (5) = 14.01, $p>0.01$); while between Wang and Suss the differences in steps movements are significant (χ^2 (5) = 26.62, $p<0.01$).The Timo Boll vs Ma Lin match shows a similar use of steps by players whereas in the Wang Liqin vs Christian Suss match, the first player (the winner of the match) uses the "turn step" more frequently than the other player.

Comparing different players' technique can also allow a deep analysis of the game plan and further studies on a larger number of matches, using the same methods, will permit a better understanding in the use of footwork techniques.

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ADJUSTING OF THE "BIOPAC" INVESTIGATION MINILAB FOR MEASURE THE REACTION SPEED TO THE VISUAL STIMULUS

Abstract

The appearance of Personal Computers and the computerized mini-labs marked a quality improvement in the technological development. By means of the new technology, a larger amount of information is being processed, information which is then stored for later use.

The concrete purpose of the scientific investigation was to determine how the BIOPAC investigation mini-lab can be used to measure the reaction speed to a visual stimulus, in order to use it for further as a tool for researchers, teachers of coaches who are in charge of identifying and measuring the ability.

As a conclusion to the study we can state that: The complex made up of the BIOPAC student investigation mini-lab and the notebook can be successfully used to measure the reaction speed to the visual stimulus. Moreover, the system offers mobility and multiple possibilities of analyzing the data, since it has a reduced weight, it is compact and easy to move and it has a large data storing capability

Key words: *test, reaction speed, visual stimulus, BIOPAC*

INTRODUCTION

At present, the performances achieved have reached high levels, thus leading to complex demands on the individual qualities. That is the reason why the process of discovery and selection must be continuously improved from the point of view of the somatic, motion, and functional structure of the individual.

In the case of the high level performance players, the demands imposed due to the technical and tactical value are extremely high, and the energy spent during the game is considerable, being characterized by a large number of high speed motion activities (especially implying the performance and reaction speed) movements.

Most of the great achievements made lately in the field of science and technology are also due to the science of computers, which has created new opportunities for making some complex calculations and for processing large amounts of information in a short time. The creation of personal computers and of the computerized minilabs is the great improvement realized by the technological evolution. By means of the new technologies, a large amount of information is being processed and then stored for later use. This development is the germ and the essence of the new technical and scientific revolution.

PURPOSE

The actual goal of the scientific investigation was to determine the possibility of using the BIOPAC student lab investigation minilab for measuring the reaction speed to the visual stimulus, in order to use it as a working tool for the researchers, teachers or coaches who are trying to identify and quantify this motion quality.

CONTENT

Modern technology, and especially future technology, with its amazing dynamic is certainly going to leave a mark on the specific equipment for high performance sports.

As a consequence of these aspects we have considered that the use of a complex technical device which would allow us to get some actual quantifiable information concerning the reaction speed to the visual stimulus could be an interesting subject. We have tried to find a practical, efficient method, which would save time and especially one which would be mobile, offering possibilities for investigation, storage and analysis of data for a greater number of subjects.

The BIOPAC student lab investigation minilab (photo 1,2) is a complex device of analysis and investigation for no less than 17 functional parameters. The device is made up of a series of sensors, a central unit for analysis which has an interface for transmitting the data in a graphical form to a P.C.

Foto 1

Foto 2

Foto 3

Photo 1, 2, 3 *The BIOPAC student lab investigation minilab*

The investigation device can be made in a standard form by following certain procedures which are presented in a user's manual. The system has the great advantage of being a mobile investigation lab, easy to use if the testing stages are respected, it can be efficiently used as a didactic material in the educational institutions, and an interactive communication system with the device makes the usage parameters to be clear, not allowing any possible usage error.

The BIOPAC can make measurements of the following indexes: electromyography (EMG); electroencephalography (EEG) the rhythm of the alpha, beta, delta end theta waves of the brains; electrocardiography (ECG) the mechanical actions of the heart, the peripheral pressure etc.; the breathing cycle, the breathing rate; the galvanic response time on the level of the epidermis; polygraph; electro-oculogram (EOG); the time of reaction to auditory stimuli; lung functions – volumes and capacities; cardiovascular and respiratory adjustments during the aerobe physical exercise, ECG during and after the performance of the exercises, heat exchanges etc.; the blood system - ventricular systoles diastoles, arterial pressure, etc.

For our research we have used the BIOPAC connected to a Toshiba Tecra A2 notebook (photo 4), and we have adjusted the test for measuring the reaction speed to auditory stimuli in order to measure the reaction speed to a visual stimulus following a pre-established standard protocol . The data has been gathered in a data base which has been used later.

Photo 4 *Progress of the test*

The investigation protocol supposes the presentation of the method of carrying out the test for the whole group of subjects, and then the test itself will take place with a single subject in the lab (gym, office etc.).

At irregular intervals, 10 signs will appear on the screen of the PC (photo 5), signs materialized into some triangles (A). Every time they appear, the subject will have to press the switch as quickly as possible (photo 3). In the end, the subject's results will be displayed and stored, results including the difference between the apparition of the stimulus and the moment when the switch was pressed, as well as the average per exercise.

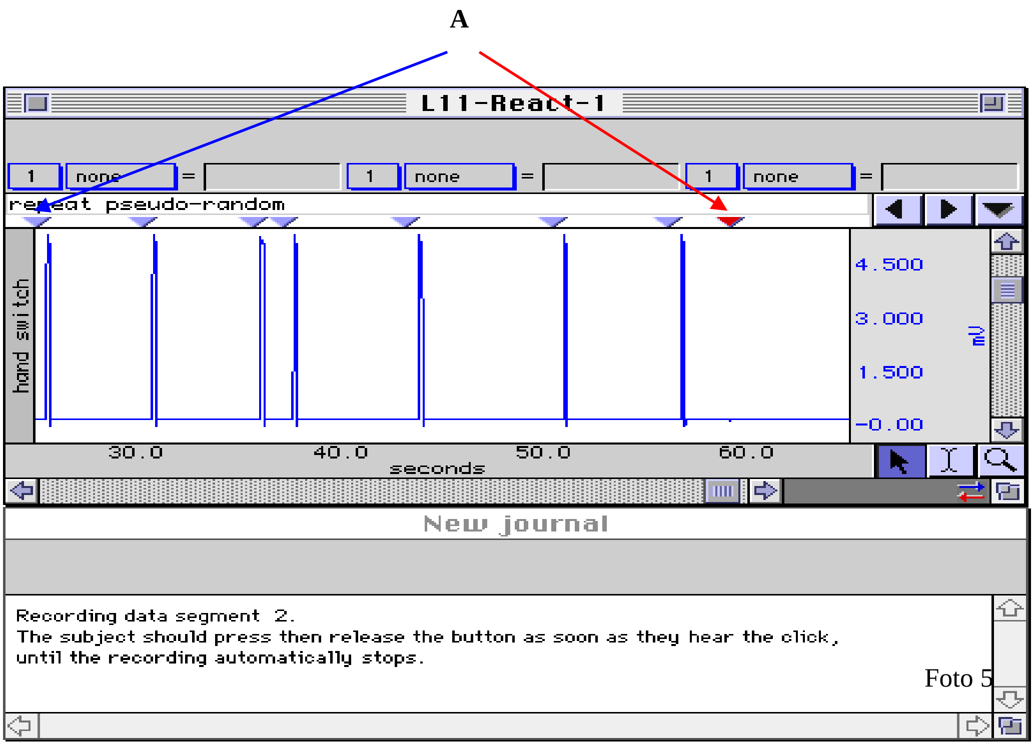

Photo 5 *Image with signs on the screen of the PC*

The study has been carried out on 90 subjects, pupils in the second form at Miron Costin School in Bacău (8 month). As a result of the measurements carried out, a data base has been made up (tab.1) which also included identification data, sex, values of the height, weight and span, by means of which a hierarchy could be drawn up to show the subjects' skills for practicing performance sports from the point of view of the values of the reaction speed to a visual stimulus.

nr	Indicator	sex	cl	DN	Î	G	A	Biopac V
	name/ first name			year	cm	kg	cm	sec
1	M.P.	b	2D	97	127	25,8	132	0,346
2	G.D.	b	2A	96	133	33,0	136	0,357
3	N.T.	f	2A	97	134	24,2	128	0,386
89	S.E.	f	2C	95	126	24,0	132	0,574
90	P.A.	f	2B	97	135	43,1	133	0,588

Table1. *Example of the data base by means of which the hierarchy of the subjects has been drawn up*

CONCLUSIONS

The technical device: BIOPAC student lab investigation minilab. + notebook has proved its usefulness. Small, compact, easy to move, having a great power of storing and analyzing the data, the complex technical device can be successfully used for measuring the reaction speed to visual stimulus.

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METHOD AND SYSTEM FOR CORRECTING AND PERFECTING THE PERFORMANCE TECHNIQUE IN TABLE TENNIS

Abstract

The concrete scientific goal of this study was to realize an electronic system meant to correct and improve the performance technique of the main technical elements in table tennis for beginner players.

1. The electronic device for correcting and perfecting the performance of the technique (DECT) has been born out of the necessity of making the coach's work easier, as well as for decreasing the period of time necessary for learning the basic technique in table tennis. An essential problem that comes up when the subject has the necessary skills for practicing the sport is learning the correct technique. The technical device has been made so as to be compact, to have a reduced size, to be easy to transport, efficient and to solve the matters he was designed for.

2. By linking together a notebook and a digital video camera, we managed to store a large amount of information which was later used for the analysis.

This method can be successfully used for learning, as well as for the correction and self-correction of the technique. Moreover, the self-control system, combined with the reduced weight and the large data storage capacity, offers the researchers, the teachers or the coaches in this field a high degree of mobility.

Key words: *electronic device, technique, table tennis*

INTRODUCTION

Most of the great achievements made lately in the field of science and technique are also due to the science of computers, which has created new opportunities for making some complex calculations and for processing large amounts of information in a short time. The creation of personal computers and of the computerized minilabs is the great improvement realized by the technological evolution. By means of the new technologies, a large amount of information is being processed and then stored for later use. This development is the germ and the essence of the new technical and scientific revolution.

At present, the performances achieved have reached high levels, thus leading to complex demands on the individual qualities. That is the reason why the process of discovery and selection must be continuously improved from the point of view of the somatic, motion and functional structure of the individual.

OBJECTIVES

The actual scientific objective was to achieve a method and a system for the correction and the improvement of the performance technique of the main technical elements (in table tennis) in the case of beginner players.

CONTENT

The correction method (fig.1) – the perfection of the performance technique in sports consists in the following succession of stages, having an automatic development:

- the stage of pre-establishing the field of movement A – is made up of a positioning phase a, when the limitation in height of the space in which the sportsman will move is defined, a phase b of the angular adjustment, when the angular opening of this space is defined on a vertical as well as on a horizontal plan, and a phase c of materialization of the limits established before for the field of movement;

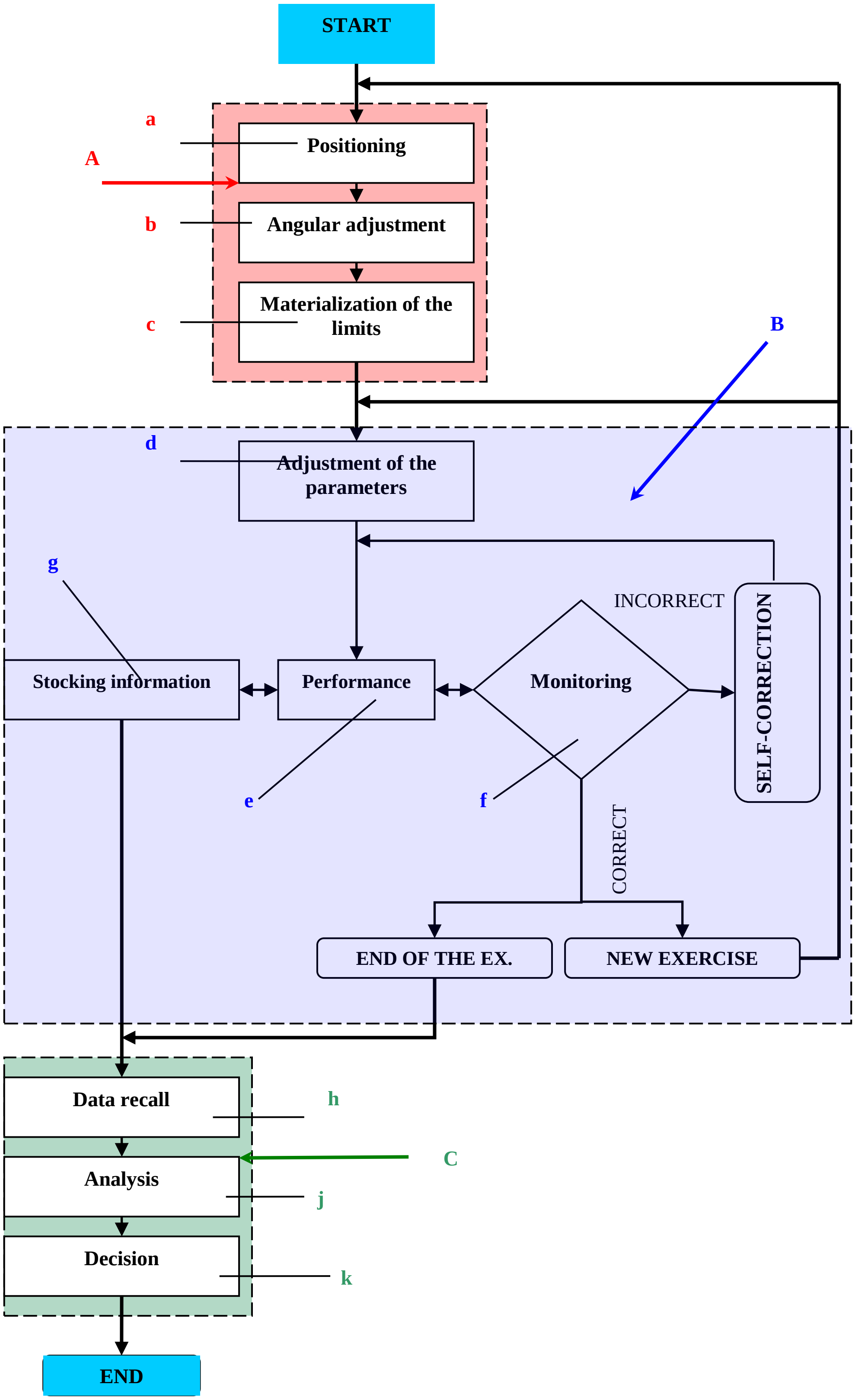

Figure 1 *Stages of the correction and perfection of the performance technique in sports*

- the stage of the exercise performance B – is made up of a phase d of adjustment of the parameters, when the technical characteristics of the exercise are adjusted – for example by replacing the training partner in the table tennis with a robot the trajectory, the rotation and the frequency of the balls are adjusted – and the performance phase e, when the player does the exercise. The performance phase e takes place at the same time as the monitoring phase f and a phase of stocking the information g. During the monitoring phase f, the movements of the player are continuously watched on, and the deviations from the limitations of the field of movement pre-established during the previous stage A are noticed. In the case when, during a determined period of time, no deviations are noticed, or the deviations are less than the acceptable number for a certain training stage of the sportsman – situation generally named "CORRECT" -, we either pass to the performance of a new exercise of the same type, but with different parameters or of an exercise of a different type, and repeat all the succession of stages starting, as the case may be, with the phase d of adjustment of the parameters or with the stage of pre-establishing the field of movement A (another field of movement), or we finish the training.

In case deviations are noticed, situation named "INCORRECT", the sportsman gets some warning signals and he can put into practice the necessary self-control and the self correction, continuing the performance and the repetition of the exercise until he reaches the "CORRECT" situation. After a certain number of repetitions of the exercise, the sportsman gets to form some conditioned reflexes. During the phase of stocking the information g, the recording and the memorization of the data concerning the sportsman's training takes place, so that they can be used later, every time this is necessary, to be interpreted, analyzed, processed, etc., during a later stage of the method, the assessment stage.

- the assessment stage C – is made up of a phase h of data recalling, an phase j for the analysis, during which the data is interpreted, processed, assembled and a phase k of making decisions concerning the sports career, during which the individuals assessed in this manner are selected into different groups according to their value, and their sports career can be administrated.

The stages of the method are almost entirely computerized. Thus, the human factor which led the activities – that is the coach – has a decisive intervention only during the assessment stage C, stage which cannot take place without the human thinking. The involvement of the coach is necessary, but it can be reduced to the minimum during the stage of pre-establishing the field of movement A and during the phase d of adjustment of the parameters, which is to say that, by using the computerized technique – for example a programmable electronic device -, the parameters of the different fields of movement and those of different types of exercises can be memorized and recalled by simply pressing a button on a remote control. All these phases which suppose the involvement of the coach have a small extent from the point of view of the time span of the method. The largest extent in time is that of the performance phase e, during which takes place the actual process of learning and perfection of the performance technique of the sportsman, phase which is completely automatic. This phase is the greatest consumer of the coach's resources in case of classical training. At the same time, due to the fact that the sportsman receives warning signals, he can put into practice the necessary self-correction in real time (at the right moment), fact which reduces considerably the time necessary for learning a technical element, an exercise, for the formation of a skill, etc.

The system of correction-perfection (fig.2) of the performance technique includes a correction device D, a data control and analysis block E and a simulation robot F. The correction device D performs the following functions:

- the pre-establishment of some movement fields, defined by the height from the ground and inclination angles on vertical and horizontal plans;
- materialization of the pre-established movement fields limitations;
- noticing the deviations from the limits of the pre-established movement fields and the warning in case the limits of the pre-established fields are surpassed;
- the command of stopping the exercise after a pre-established period of time or when a certain level of performance was reached, level defined, for example, by a minimum number of warming signals accepted in a certain period of time.

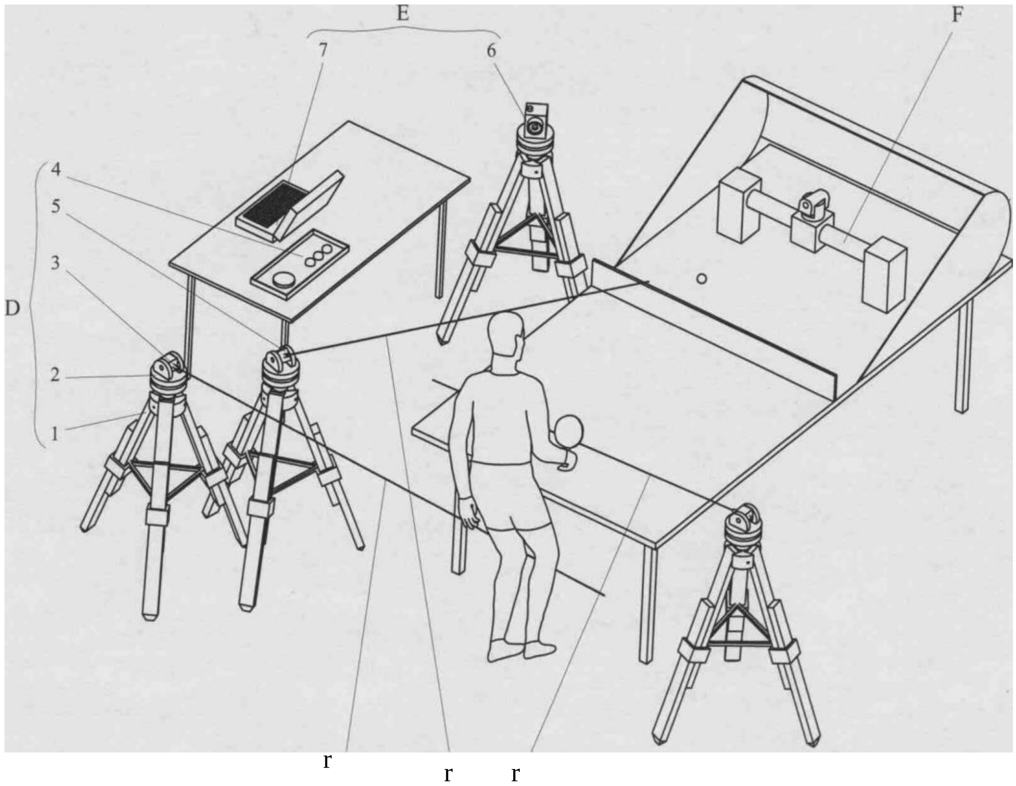

Figure 2 *The system of correction and perfection of the technique in table tennis*

According to these functions, the correction device D contains specific component parts. Thus, the device contains positioning components, each made up of mechanical support l which can be a tripod, with three segments of height, adjustable independently, which insures an adjustable height of the movement field, covering a range of about 1/3 of the height of the human body; it also has an angular adjustment component 2, which insures a degree of mobility of 0-180° on the vertical plan, and 360° on a horizontal plan. The device also includes some guiding components, each consisting of an optic emitter 3, able to materialize the pre-established limits of the field by means of a visible concentrated (non divergent) light radiation r. The positioning components and the guiding components can be activated manually or non-conventionally, by means of a programmable remote-controlled electronic device. This device will have the function of memorizing the parameters of different movement fields and of the different types of exercises, so that the activation of the positioning components and of the guiding components can be made by simply pushing the button of a remote control. The device also includes a sensorial component, consisting in a central unit 4 for monitoring, which takes over the information transmitted by the sensors through infrared cells included into the mobile capsules 5, which is capable of emitting visual and sound warning signals in case of some deviations from the pre-established limits of the movement field. The act of transmitting the information between the mobile capsules 5 and the monitoring central unit 4 is achieved without a wire. The monitoring central unit 4 can count the number of deviations from the pre-established limits of the movement field and can also order the end of the training. The mobile capsules 5 are each fixed on one of the ends of the angular adjustment component 2 and are also united with one of the optic emitters 3. Each of the mobile capsules 5 works autonomously, each including a source of electricity (storage battery). The central unit 4 also includes a source of electricity.

The control and data analysis block E, made up of a digital video camera 6 and a computer 7, does the recording and the memorization of the data during the sportsman's training, so that it can be used later, whenever it is necessary, in order to be interpreted, analyzed, processed, etc.

The simulation robot F attached to the tennis table replaces the training partner and simulates the exercises necessary for the training, offering the possibility of adjusting the trajectory on a vertical and on a horizontal plan, of adjusting the frequency and the rotation of the ball, of attaching some contact sensors and the visualization of the information they gather.

The functioning of the system for the correction and perfection of the performance technique is based on the interruption of the infrared signal emitted by the sensors included into the mobile capsules 5 by interposing a part of the sportsman's body, before the beginning of the training, the correction device D calibrates, that is the limits of the movement field are established. Thus, the height necessary for the exercise is established by activating the mechanical support 1 and the horizontal and vertical angles necessary for the exercise are established by activating the angular adjustment component 2. These limits of the movement field are defined by infrared signals emitted by the sensors included into the mobile capsules 5 and are materialized – that is they are made visible – through the optic emitter 3, united with the mobile capsules 5. Each optic emitter 3 is located so as the trajectory of the visible concentrated light radiation r emitted should coincide with the trajectory of the infrared signal emitted by the sensor of the mobile capsule 5 which is united with the optic emitter 3. Thus the movement fields become perfectly visible to the player (or for any other person situated in the area) and they also become present in the recordings of the digital video camera 6. One or more movement fields can be established, according to the way we work – with one or with more mobile capsules 5 - according to the stage of the player's training, and to the purpose of the training. We can thus define the basic position of the sportsman, as well as the way in which he performs of some technical elements. For example, we can establish limits for the correction of the vertical position – the "bent knees" position; any deviation caused by a higher position of the sportsman will be immediately announced by sounds made by the sensor – by announcing the sensor which has been activated – as well as visually – by a light on the monitoring central unit 4. As a consequence of the warning, the sportsman can self-correct his/her position immediately, especially since he/she can actually see the limit materialized by the optic emitter 3 and the effect is similar to the movement inside a "cage". In the same way we can limit the trajectory of the arm for the performance of different shots or we can limit very precisely the specific movements. The sportsman can repeat the exercise and do the self-correction every time he hears the sound warning, since he/she achieves the conditioned reflexes, his/her movements developing towards becoming automatic movements.

Since the transmission of the information between the sensors of the mobile capsules 5 and the monitoring central unit 4 is done without a wire, the possibilities of placing and calibrating the correction device D are practically unlimited inside the transmission area.

The practice of the method and the use of the system for the correction and perfection of the performance technique in sports offer the coach freedom of action and save his forces, sparing him useless and routine work during the phases of initiation of the sportsman as well as during the phases before achieving great performance. This routine work, which does not need thinking but only stereotype performance can be successfully taken over by machines and can easily be computerized. This is exactly what the system does, the coach gaining thus the physical and mental comfort necessary for the really important creative work, when he is asked to use his skills for the selection and shaping of the great champions.

CONCLUSIONS

By putting into practice the method and using the system for the correction and perfection of the performance technique in sports we can gain the following advantages:

- time is saved and the mental effort of the coach is reduced, due to the fact that he does no longer need to supervise continuously and closely the sportsman in order to notice his/her technical mistakes, function which is assumed by an electronic part of the system;

- the coach can simultaneously supervise a greater number of sportsmen, since their monitoring by means of electronic devices offers him a larger freedom of movement, the area in which he can move being considerably larger, without a negative influence on the quality of the teaching activity;
- the time of learning is reduced, since the whole learning process is computerized and the corrections of the wrong position is done in real time, the sportsman being able to impose the self-control and the self-correction immediately, due to the sound and visual warning transmitted automatically by some parts of the system;
- the human error in assessing an individual is considerably reduced due to the fact that the information gathered during the training of the sportsman is memorized by the digital parts of the system and it can be recalled later, whenever necessary, in order to be analyzed for the assessment of the sportsman's degree of training, as well as for drawing up game strategies and for the improvement of the sportsman's performance technique.

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REACTION CAPACITY, ACCELERATION AND VELOCITY IN A SPECIFIC DISPLACEMENT AFTER VISUAL STIMULUS IN YOUNG TABLE TENNIS PLAYERS

Abstract

Introduction. *Table tennis is a sport in which the players must to react quickly to a great number of visual stimulus in each rally of the match. Also, displacements and specific skills must be repetitively performed in tenths of seconds. For this reason it is important to develop the reaction capacity and the velocity since the initial stages in table tennis training. Thus, the aims of this study were: a) to quantify the reaction capacity in young table tennis players; b) to determine acceleration and velocity developed in a specific displacement, and c) to compare these values with those from age-matched sedentary group.* ***Method.*** *Twenty-five young table tennis players (14 boys and 11 girls; age between 9 and 11 years) and twenty-five age-matched sedentary children (15 boys and 10 girls) took part in this study. Subjects from the two groups carried out the Take-Off Reaction Test (Newtest®) and were tested in random order. From table tennis base position (on contact mat) subjects reacted to the red light (left or right) that electronic device emitted in random order. Next, subjects leaved the contact mat and performed a lateral run until left or right photocells (placed 5 m from the mat). Subjects completed 12 attempts (6 to the left and 6 to the right) and the best result was registered.* ***Results.*** *Table tennis players showed a better reaction capacity than the sedentary children. Also, acceleration and velocity developed in 5 m in table tennis players were significantly higher than the values found in sedentary group. No significant differences were found in reaction capacity, acceleration and velocity taken into account the left or the right side of displacements.* ***Conclusions****. The Take-Off Reaction Test is a simple but valid tool to test reaction capacity to visual stimulus in table tennis players. However, the test needs of certain adaptation (to reduce the lateral run distance) for to obtain higher levels of specifity. Table tennis practice generates neuromuscular adaptations of which effects have been demonstrated in this study.*

Key words: *table tennis, reaction capacity, velocity, acceleration*

Introduction.

Visual information is the dominant channel in sport performance optimization process (Magill, 1993). Visual system plays a double role in "open" sports: semantic and sensorimotor. Semantic function permits to identify and to interpret a determined sport situation. Thanks to this function players can to consider visual pre-indexes from opponents that are used for predict their motor behaviours and the type of shot that they will perform. By other side, sensorimotor function facilitates the coordination between visual and motor systems that are implicated in shot actions (Ripoll, 1991).

Reaction and movement times (RT and MT, respectively) are part of sensorimotor function and have been studied using a wide variety of tasks and sport skills. Indeed, it have been established that physical exercise generates a positive effect on RT and MT (McMorris & Graydon, 2000; Tomporowski, 2003). Thus, it is easy to think that regular exercise or sport training can to provoke RT and MT improvements. Anthony (2003) determined the effects of a plyometric strength training program on the starting (MT) and RT of college swimmers. The results of this study showed that RT of the strength-trained swimmers was significantly decreased; however starting time (MT) was not affected. Thomas & Harden (2005), compared RT values between cricketers and sedentary subjects. Taken into account the importance of the visual processing in cricket actions and the experience of cricket players, the authors found no significant differences in RT to a visual stimulus.

In table tennis, a sport in which the players must to react quickly to a great number of visual stimulus in each rally of the match, both semantic and sensorimotor functions must be well developed. However there is a lack of information about the effect of table tennis practice on RT and MT, particularly in young players. For this reason the aims of this study were: a) to quantify the reaction capacity in young table tennis players; b) to determine acceleration and velocity developed in a specific displacement, and c) to compare these values with those from age-matched sedentary group.

Methods.

Subjects.

Twenty-five young table tennis players (14 boys and 11 girls; mean ages ± SEM: 10.0 ± 0.2 and 9.6±0.2 years, respectively) and twenty-five age-matched sedentary children (15 boys and 10 girls; mean ages ± SEM: 10.1 ± 0.2 and 9.8 ± 0.3 years, respectively) took part in this study after inform consent was signed by the parents. Table tennis players were participating in National Sport Technification Program developed by the Spanish Table Tennis Federation while sedentary subjects were students in the last year of primary education. In any case, all of them were right handed.

Testing procedure.

Subjects from the two groups carried out the Take-Off Reaction Test (Newtest® - Finland) and were tested in random order. From table tennis base position (on contact mat) subjects reacted to the red light (left or right) that electronic device emitted in random order. Next, subjects leaved the contact mat and performed a lateral run (maximal sprint performance) until left or right photocells (placed 5 m from the mat). Subjects completed 12 attempts (6 to the left and 6 to the right) and the best result was registered (Figure 1). All attempts were carried out consecutively. At the end of each attempt subjects returned to the map starting the next one when table tennis base position was adopted.

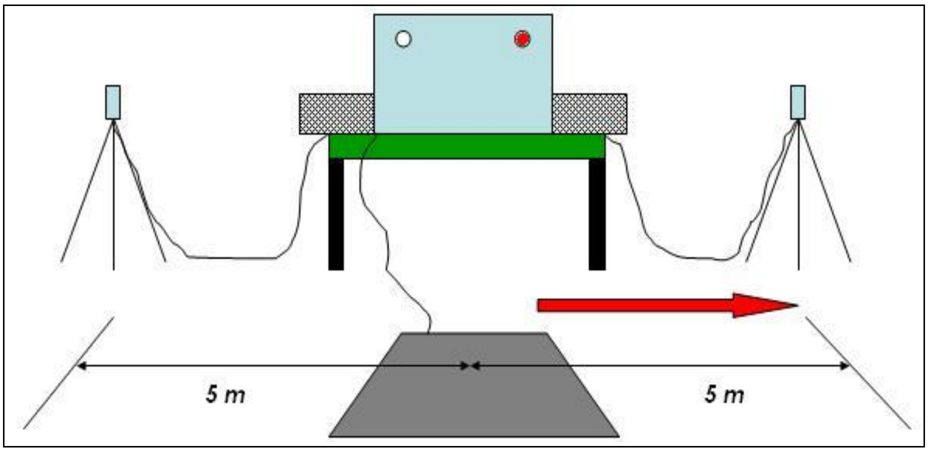


Figure 1. *Take-Off Reaction Test device emplacement.*

Parameters measured were: a) reaction capacity time (RCT): elapsed time between lights on (right or left) and the moment in which the subjects took – off from the mat (ms); b) movement time (MT): elapsed time between the take – off from the mat and the moment in which the subjects broke the photocells barrier (lateral displacement over 5 m) (ms); c) total time (TT): elapsed time between lights on (right or left) and the moment in which the subjects broke the photocells barrier (ms); d) mean velocity (V) in 5 m lateral displacement ($m \cdot s^{-1}$), and e) mean acceleration (A) in 5 m lateral displacement ($m \cdot s^{-2}$). It s important to indicate that we consider anticipation when the players reach a reaction capacity of <150 ms. Also, and for to prevent the incidence of upper limbs on automatic timing photocells were situated at the height of subjects' hips.

Statistical analysis.

A statistical analysis was carried out using SPSS v.12.0 for Windows. Statistical comparisons between groups (players and sedentary people; males and females) and between sides of the displacement (left and right) were made by using a multivariate analysis of variance (MANOVA) and t-test for paired samples (after Kolmogorov–Smirnov test). All data are expressed as mean ± SEM. A *p* value of less than 0.05 was considered statistically significant.

Results.

Taking into account only gender factor, we observed significant differences between males and females in RCT (left) and TT (right) parameters. In both cases, the values reached by females were higher than those reached by males (Table 1).

Table 1. *Temporal parameters by gender.*

	RCT (ms)		MT (ms)		TT (ms)	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**
Males	650.09 ± *127.85*	723.16 ± 148.99	1521.94 ± 198.33	442.31 ± 241.60	2172.03 ± 213.48	2165.47 ± *201.67*
Females	*768.30*** ± 123.74	778.10 ± 136.67	1445.05 ± 180.17	442.31 ± 241.60	2213.35 ± 150.54	*2318.90*** ± 195.44

Values are expressed as mean ± SEM. **p<0.01 compared with females' values.

Attending to the group criteria, there were significant differences between table tennis players and sedentary group in TT (right), V (left and right), and A (left and right). In all cases, values found in table tennis players were higher than those observed in sedentary group. Also, the results showed a sign of statistical signification (p=0.07) in MT (right), although the higher values were found in sedentary group (Table 2).

Table 2. *Temporal parameters by group.*

		Players	Sedentary group	Total
RCT (ms)	Left	697.15±132.29	693.96±145.87	*695.96±137.88*$^{++}$
	Right	726.54±134.32	762.04±156.55	744.29±145.53
MT (ms)	Left	1452.27±193.64	1532.46±188.45	1492.37±193.46
	Right	1423.96±218.51	1536.42±252.94	1480.19±240.81
TT (ms)	Left	2130.67±219.87	2208.53±207.31	2172.03±213.48
	Right	2150.50±186.19	2298.46±212.13	2224.48±211.26
V ($m\cdot s^{-1}$)	Left	*3.54±0.45**	3.29±0.39	3.42±0.44
	Right	*3.67±0.64***	3.32±0.55	3.50±0.61
A ($m\cdot s^{-2}$)	Left	*2.54±0.63****	2.20±0.51	2.37±0.59
	Right	*2.67±0.99****	2.27±0.75	2.52±0.91

Values are expressed as mean ± SEM. *$p<0.05$, **$p<0.01$, and ***$p<0.001$ compared with sedentary group, respectively; $^{++}p<0.01$ compared with right side.

Significant differences between left and right side of displacement in TR were observed for total group (Table 2). However, there were no statistical differences when gender and group factors were combined or mixed (Figures 2 – 7; Table 3).

Table 3. *Mean velocity and acceleration values.*

		Velocity ($m\cdot s^{-1}$)		Acceleration ($m\cdot s^{-2}$)	
		Left	Right	Left	Right
Males	Players	3.44±0.46	3.79±0.70	2.40±0.62	2.97±1.14
	Sedentary group	3.23±0.38	3.41±0.58	2.12±0.48	2.39±0.82
	Total	3.33±0.42	3.59±0.66	2.25±0.56	2.66±1.01
Females	Players	3.67±0.43	3.50±0.52	2.73±0.61	2.49±0.72
	Sedentary group	3.41±0.41	3.15±0.46	2.12±0.48	2.03±0.58
	Total	3.59±0.66	3.34±0.51	2.56±0.60	2.29±0.69

Values are expressed as mean ± SEM

Figure 2. *RCT to the left side.*

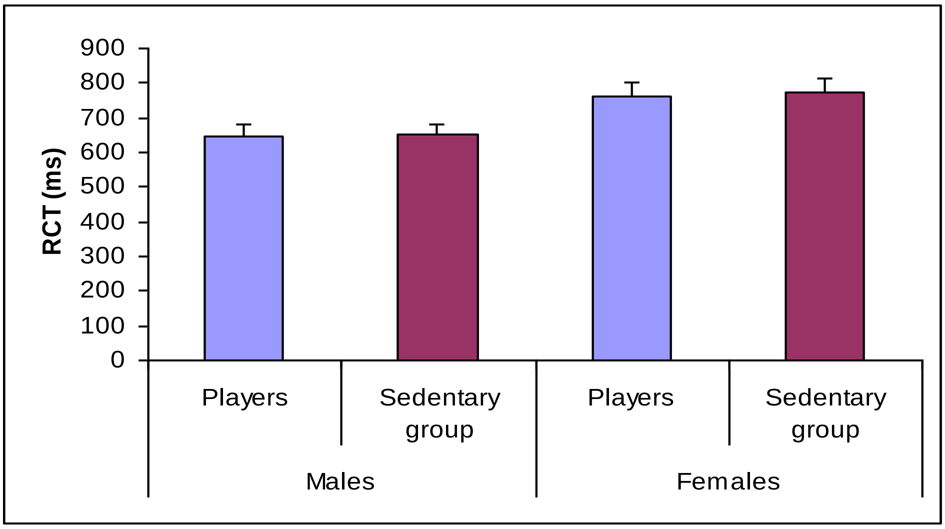


Figure 3. *RCT to the right side.*

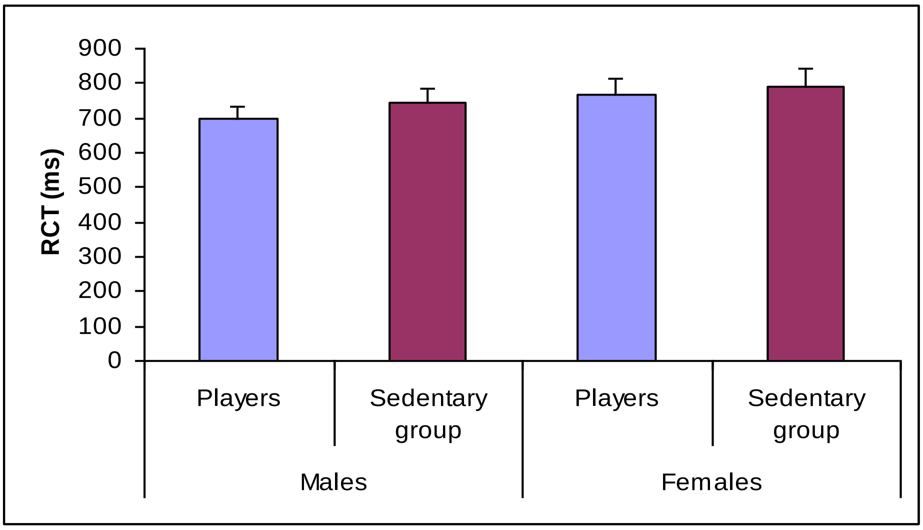


Figure 4. *MT to the left side.*

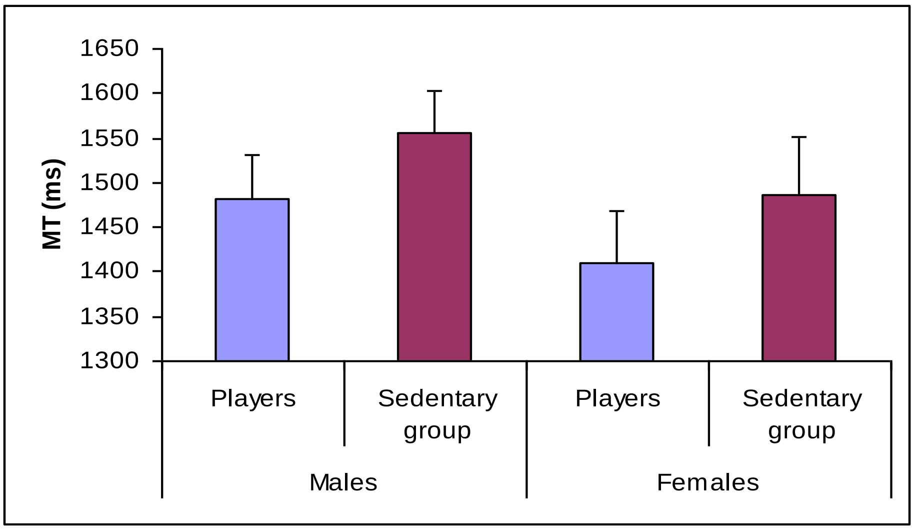


Figure 5. *MT to the right side.*

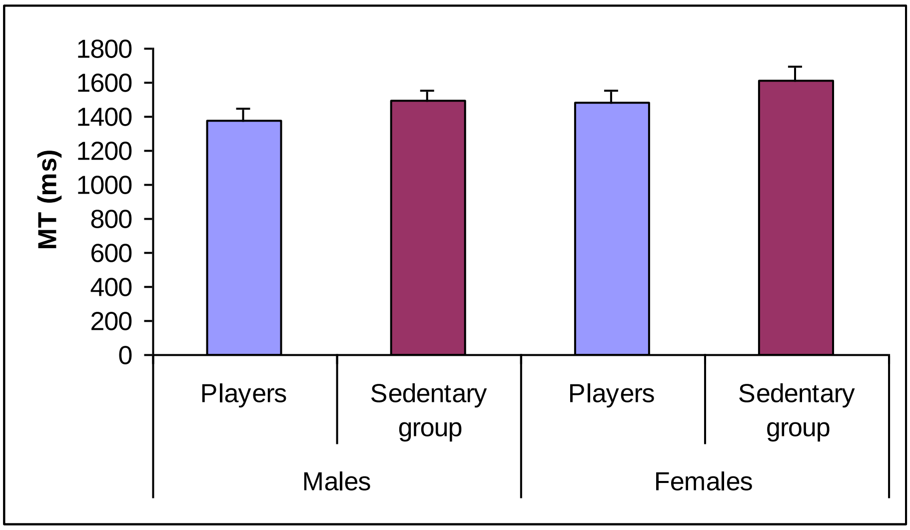


Figure 6. *TT to the left side.*

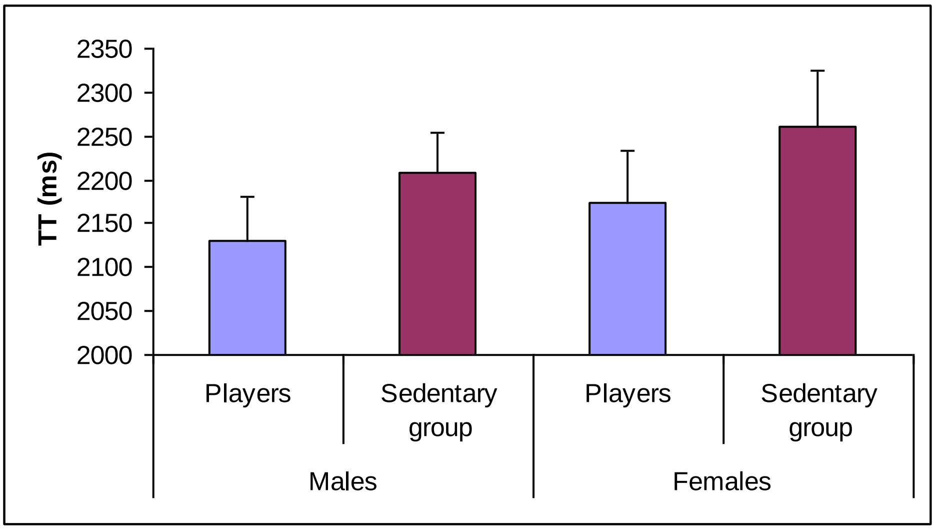
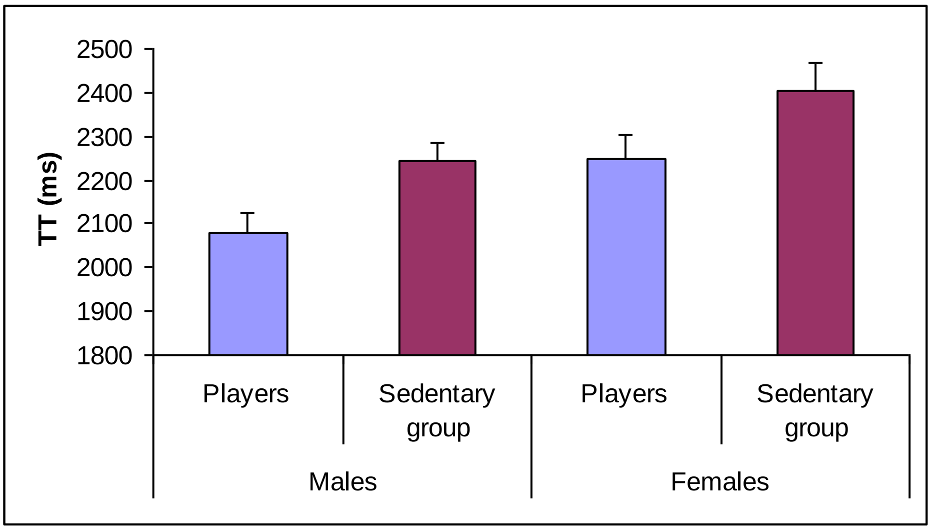


Figure 7. *TT to the right side.*



Discussion.

In many sports, the capacity to react to visual stimulus is a key factor to obtain a successful performance, acquiring a vital importance in those sports in which players must to shot or to receipt a ball that has been throwed previously by an opposite player. In racket sports, and specially in table tennis, is very important the reaction capacity to the opposite actions. Indeed, several authors have proposed the assessment of perceptual skills like a fundamental evaluation to identify young sport talents (Williams et al., 1999). Parameters such us reaction time and movement time must to be taking into account in table tennis training and testing in young players.

Reaction time is the elapsed time between the receiving of stimuli and the subsequent reaction. Reaction time can be classified in simple reaction time and complex reaction time. Simple reaction time is the time it takes to react to stimuli. The average human's reaction time falls somewhere between 200 and 270 ms, although athletes and others who train themselves can achieve reaction times approaching 150 ms. Complex reaction time is the latency between a variable stimulus and a respectively variable response. In this investigation we have tested the use of Take-Off Reaction Test (Newtest®) for to evaluate the reaction capacity and the specific displacement efficacy in a group of young table tennis players. It is important to note that reaction capacity time measured in this study is not equal to reaction time assessed in many of the investigations reviewed. In these studies reaction time is the elapsed time between the receiving of stimuli and the muscle activation (or beginning of the electromyographical –EMG– signal). When we defined reaction capacity time we included a part of movement time considered by others authors (elapsed time between the beginning of the EMG signal and the end of the movement). Therefore movement time (MT) registered here (elapsed time between the take – off from the mat and the moment in which the subjects broke the photocells barrier) is a part of the real movement time and it is related to the time invested to cover 5 m lateral run. In any case, subjects were tested under the concept of "complex reaction time" because they reacted to the lights on (right or left lamp) and ran over the corresponding side.

In general, the results show no differences between players group and sedentary group in many of the parameters evaluated, although velocity and acceleration values (in both sides) were higher in table tennis players reaching statistical significance. Lateral running over short distances is the most frequent displacement in table tennis and its specific training in players would to generate this differences. This is, in part, in accordance with previous studies (McMorris & Graydon, 2000; Tomporowski, 2003) in which it have been established that physical exercise generates a positive effect on reaction time and movement time. Curiously, reaction capacity times were similar in players and sedentary group, results that are in accordance with those obtained by Thomas et al. (2005) who reported similar reaction times in cricketers and sedentary people. Attending to the gender factor, we observed a quicker response to the visual stimulus in males so reaction capacity times (to the left side) were significantly higher in females. Also, total time values (reaction capacity time plus movement time) to the right side were significantly higher in females than in males. In this sense, it is important to note that the Newtest® device only report the best result in a set of twelve attempts (six to each side) and for this reason we can't to discriminate differences in movement time. Significant differences between left and right side of displacement in reaction capacity time were observed for total group obtaining lower values to the left side. All of participants in this study were right-handed and it is possible that they were likely to have crossed dominance (dominant eye contralateral to dominant hand) (Thomas et al. 2005). An analysis of ocular dominance is necessary to confirm this. Lastly, there were no statistical differences when gender and group factors were combined or mixed.

As a conclusion, we can to confirm that the Take-Off Reaction Test (Newtest®) is a simple but valid tool to test reaction capacity to visual stimulus in table tennis players. However, the test needs of certain adaptations (to reduce the lateral run distance and the use of an EMG device) for to obtain higher levels of specifity and precision. Table tennis practice generates neuromuscular adaptations of which effects have been demonstrated in this study.

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DEPENDENCE OF RESULTS IN TABLE TENNIS ON CERTAIN GAME EFFICIENCY INDEXES

Abstract

From sports aspect, the basic and most utilitarian indicator of game quality is exactly the achieved result on a particular sports competition. Amongst different manners of quality analysis of table tennis players' game, the basic idea of research was to seek to detect those indicators (data) for collection of which only the final result in particular competitions in larger number of events, in one table tennis match, certain sets in one table tennis match could be sufficient. Sindik (in year 1999) performed that by implementation of variables which could directly be derived from the results of competitions, however, those variables one could reduce to a smaller number of indexes. The basic aim of the research is to question to which extent the indexes directly derived from the results of individual table tennis matches could foresee indexes which are described by the final result of an individual in a larger number of individual table tennis matches. Research is comprised of analysis of appropriate sample of 39 entities – *total individual competition effect of sportsmen in 9 team championships,* for all the players of one table tennis team, in the period from 1990 till 1996, in the organization of TTOCAZ, in different competition ranks in which the named team has competed. 16 indexes – indicators of efficiency of an individual in table tennis competition have been defined, which can be derived directly from the competition results. The predictive value of used indicators has been determined, significant in statistical manner, for the prognosis of direct indicators of success on basis of other indexes. However, due to characteristics of the sample, the generalization of results is not possible.

Key words: *table tennis, game efficiency, correlation, basic hypotheses, data collection, entities, dependent variables, independent variables, collective indexes, multiple regression analysis*

INTRODUCTION, GOAL AND HYPOTHESIS

Except in technical field, table tennis is demanding, as well with regards to tactful knowledge and appropriate conative characteristics necessary for a successful competition achievement (Grujić, 1975, Hudetz, 1982).

The basic question which is set by the professionals aiming to improve result effect of sportsmen or teams in different sports is – how to assess the game quality (Brčić, Viskić-Štalec, Fressl, 1997). From sports aspect, the basic and most utilitarian indicator of game quality is exactly the achieved **result** on a particular sports competition. Amongst different manners of quality analysis of the table tennis players' game, the basic idea of research was to seek to detect those indicators (data) for collection of which only the final result in particular competitions in larger number of events, in one table tennis match, certain sets in one table tennis match could be sufficient. Sindik (in year 1999) performed that by implementation of variables which could directly be derived from the results of competitions, however, those variables one could reduce to a smaller number of indexes.

The **basic aim** of the research is to question to which extent the indexes directly derived from the results of individual table tennis matches could foresee indexes which are described by the final result of an individual in a larger number of individual table tennis matches. This kind of analysis could potentially be useful, as well for the needs of future programming of scholastic process for individual player. **Particular goals** are to determine:

1. basic descriptive characteristics and correlation between particular indexes – indicators of table tennis game efficiency;
2. ability of index prognosis: NUMBER OF MATCHES WON/LOST, NUMBER OF SETS WON/LOST – on basis of other indexes of table tennis game efficiency;
3. to determine correlation between so called ‘collective indexes’ of efficiency, derived by summarization of several particular indexes.

Past researches, which could directly be connected with the author’s ideas – in table tennis, have not been found in available literature. From the research goals, following **basic hypotheses** have been derived:

H1: Indicators (indexes) directly derived from the results are not correlated in statistically significant manner.

H2: Indicators (indexes) directly derived from the results do not predict in statistically significant manner the indexes – indicators of final competition success – indicator NUMBER OF MATCHES WON/LOST, NUMBER OF SETS WON/LOST.

H3: So called ‘collective indexes’ derived from particular indexes are not correlated in a statistically significant manner.

WORK METHODS, ENTITIES AND VARIABLES

Data collection has been performed by inspecting results of individuals – examinees of the given sample in the minutes of matches played. The total result of an individual in larger number of individual tennis table matches, sets, games has been registered.

Research is comprised of analysis of appropriate sample of 39 **entities** – *total individual competition effect of sportsmen in 9 team championships,* for all the players of one table tennis team ‘Patuljci pojma nemaju (*Dwarfs do not have a clue*)’, in the period from 1990 till 1996, in the organization of Table Tennis Organization of Clubs and Activities of Zagreb (TTOCAZ) - in different competition ranks in which the named team has competed. The team played all the games visiting, the role of judges and audience was reduced to a minimum, while matches were played in two sets won. Each individual whose result was collected played at least 10 individual matches within a particular competition, while the maximum number of individual matches which the individual could play during one competition was 33. Or in table:

CHAMPIONSHIP	1.	2.	3.	4.	5.	6.	7.	8.	9.	TOTAL
NUMBER OF MATCHES	99	99	99	99	99	99	99	99	99	891
NUMBER OF PLAYERS	4	5	4	4	5	4	5	4	4	39

SAMPLE OF ‘VARIABLES’[1]

16 indexes – indicators of efficiency of an individual in table tennis competition have been defined, which can be derived directly from the competition results. These indexes are theoretically organized as a ‘composition‘ of two or even three particular

[1] *(Note: quotations on the word 'variable' indicate to the specific quality of the research; i.e. to the fact that instead of variables indicators / parameters / respectively indexes were used in the analysis, as compositions of two or three variables.)*

variables, while their basic 'logic' is the calculation of ratio between effectively accomplished number of cases and the maximum possible number of cases, in relation to the hypothetic indicators of efficiency in competition situations. Following 'individual' indicators (indexes) have been determined: As **dependent 'variables'**, *indexes which are direct indicators of players' efficiency (ordinal number 1, 2), i.e. criteria have been determined*:

1. WIN/LOSEGAME – ratio between the number of matches won and lost – in individual matches: - number of matches won is divided with the total number of matches played; calculated for each entity by the ratio amount expressed in %;
2. WIN/LOSESET – ratio between the number of sets won and lost – in sets of played matches of an individual: - number of sets won is divided with the total number of sets played; entity is adjoined with the amount expressed in %;

Independent 'variables' *were predictors directly derived from the results (ordinal number 3-14):*

3. WIN/LOSEDIFF – ratio between the numbers of sets won and lost – in sets played on difference (21:19, 22:20 etc.): - number of sets won on difference is divided with the total number of sets played on difference; entity is adjoined the amount of ratio expressed in %;
4. WIN/LOSE3SET – ratio between the number of matches won and lost – in matches played in 3 sets (namely, when the result is 2:1 – if the matches are played on 2 sets won); number of matches won is divided with the total number of matches played, while the entity is adjoined with the amount of ratio expressed in %;
5. WINLESS11S – ratio between the number of sets won in which the opponent won less than 11 points per set: number of sets won in which the opponent won less than 11 points is divided with the total number of sets played (in championship or on a tournament), while the entity is adjoined the amount of ratio expressed in %;
6. WINLESS11BOTHS – ratio between the number of matches won in which the opponent won less than 11 points in both sets (when the match is won with the result 2:0) : number of sets won in which the opponent won less than 11 points is divided with the total number of matches played (in championship); entity is adjoined the amount of ratio expressed in % ;
7. LOSELESS11S – ratio between the number of sets lost in which the opponent won with the result of more than 11 points difference per set: number of sets lost in which the opponent won with more than 11 points difference is divided with the total number of sets played (in championship); entity is adjoined the amount of ratio expressed in % ;
8. LOSELESS11BOTHS – ratio between the number of matches lost in which the opponent won with the result of more than 11 points difference in both sets (namely, when the result is 0:2) to the benefit of the opponent : number of matches lost in which the opponent won with the result of more than 11 points difference in both sets is divided with the total number of matches played (in championship); entity is adjoined the amount of ratio expressed in % ;
9. WIN/LOSE1SLOST – ratio between the number of matches won and lost – in which an individual lost first set; number of matches won in which an individual lost first set (namely, when the result is 2:1 to the benefit of an individual) is divided with the total number of matches played in which an individual lost first set (in total, regardless of winning or losing); entity is adjoined the amount of ratio expressed in % ;
10. WIN/LOSE2SLOST - ratio between the number of matches won and lost – in which an individual lost second set; number of matches won in which an individual lost second set (namely, when the result is 2:1 to the benefit of an individual) is divided with the total number of matches played in which an individual lost second set (in total, regardless of winning or losing); entity is adjoined the amount of ratio expressed in %
11. WIN/LOSEW1L2S - ratio between the number of matches won and lost – in which an individual won the first and lost second set; number of matches won in which an

individual won the first and lost second set (namely, when the result is 2:1 to the benefit of an individual) is divided with the total number of matches played in which an individual won the first and lost second set (in total, regardless of winning or losing); entity is adjoined the amount of ratio expressed in %

12. WIN/LOSEW2L1S - ratio between the number of matches won and lost – in which an individual lost the first and won second set; number of matches won in which an individual lost the first and won second set (namely, when the result is 2:1 to the benefit of an individual) is divided with the total number of matches played in which an individual lost the first and won second set (in total, regardless of winning or losing); entity is adjoined the amount of ratio expressed in %

13. WIN/LOSE1SWON- ratio between the number of matches won and lost – in which an individual won the first set; number of matches won in which an individual won the first set (namely, when the result is 2:1 to the benefit of an individual) is divided with the total number of matches played in which an individual won the first set (in total, regardless of winning or losing); entity is adjoined the amount of ratio expressed in %

14. WIN/LOSE2SWON - ratio between the number of matches won and lost – in which an individual won the second set; number of matches won in which an individual won the second set (namely, when the result is 2:1 to the benefit of an individual) is divided with the total number of matches played in which an individual won the second set (in total, regardless of winning or losing); entity is adjoined the amount of ratio expressed in %

15. [2]NUMBERONDIFF - ratio between the number of played sets on difference – in relation to the total number of sets played on difference; number of sets played on difference is divided with the total number sets played; entity is adjoined the amount of ratio expressed in %

16. [2]NUMBERM3SETS –ratio between the number of matches played in 3 sets – in relation to the total number of matches played; number of matches played in 3 sets is divided with the total number of matches played; entity is adjoined the amount of ratio expressed in %.

So called **'collective indexes'** derived from individual indexes based on principle of 'logical connection':

I. DIRINDEFF – direct indicator of result efficiency in a competition – represents a sum of percentage values for indexes no. 1 and 2; it has been presumed that the 'collective index' is able to provide an insight to the general result effect of an individual during the competition in the given championship

II. EQUALIZATION– equalization (incertitude of matches of an individual in given championship competition) – represents a sum of percentage values for indexes no. 15 and 16; it has been presumed that the 'collective index' is able to provide an insight to the result equalization of an individual against sports opponents during the competition in given championship

III. SECURINCRYSIS – stability in critical situations (in conditions of increased tension, result incertitutude) - represents a sum of percentage values for indexes no. 3,4,11 and 12; it has been presumed that the 'collective index' is able to provide an insight to the result efficiency when high amount of result equalization is present with an individual and its sports opponents during the competition in given championship

IV. MEASURING UP - (to which extent the individual is able to measure up to competition rank in sense of its competition efficiency) - represents a sum of percentage values for indexes no. 5,6,7 and 8; it has been presumed that the 'collective index' is able to provide an insight to the result unequalization of an

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[2] *Indexes o. n. 15 and 16 are only used in descriptive statistics and in correlation analysis, while they are not used as predictors, or as criteria.*

individual and its sports opponents during the competition in given championship

V. GENERALSTABIL – general stability (competition efficiency of an individual in more and less result equalized competition situations) - represents a sum of percentage values for indexes no. 9,10,13 and 14; it has been presumed that the 'collective index' is able to provide an insight to the 'structure' of efficiency in a competition when reasonably high amount of result equalization is present with an individual and its sports opponents during the competition in given championship

VI. TOTAL - (total indicator of efficiency of an individual in championship competition) - represents a sum of percentage values for indexes no. 1-14; it has been presumed that the 'collective index' is able to provide an insight to the total efficiency of an individual in events with sports opponents during the competition in given championship.

METHODS OF RESULT ANALYSIS

Arithmetic mean and variants of samples of all 16 selected indexes have been determined, and correlation and graded multiple regression analysis with backward strategy has been performed (Krković, 1978). Criteria variables founded on the number of victories (no.1, 2) have been projected on the basis of predict-kind variables no. 3-14. All used methods of processing and result overview have been received within the *Microsoft Excel* computer support program. Research restrictions consisted of using the appropriate, not random entity sample (Nikolić, 1998), while the result distributions for all indexes have not been initially normally distributed. Viskić-Štalec (1998) describes a sequence of 'corrective' procedures in different experimental situations. In this research following 'corrective' procedures have been performed: standardization of results for all indexes, transformation into z-values. As well, poor possibility of result generalization is emphasized.

RESULTS, DISCUSSION, CONCLUSIONS

Relevant fault of the efficiency indicators directly derived from the competition results is the fact that the total result does not need to necessarily be the real 'measure' of players' competition efficiency. In practical situations in competition, it might come to players being 'laid-back' in situations of more significant result advantage or 'fall back' in relation to the opponent, 'predictions' of convincing victory or defeat, 'playing' with anticipatory inferior or 'superior' opponent during the entire event. However, in average and in 'result-wise more equalized' competitions, suggested efficiency indicators could be useful hypothetically. Furthermore, one did not consider: different quality levels of different players (in relation to competition effect), different levels of opponents' qualities (Brčić, Viskić-Štalec, Fressl, 1997) – especially considering different levels of competition (leagues).

On basis of analysis of degree of symmetry of the result distribution for particular indexes, in multiple regression analysis extremely aberrant indexes - no. 6, 7,8,14 and 15, are not included. In Table 1 average result values for individual indexes are determined, while the amounts of obtained result variants are direct consequence of potential and actual result range for given indexes (Minimum and Maximum). With regards to inter-correlation of efficiency indexes on the basis of competition results, strong correlation of so called direct indicators of efficiency (o.n. 1, 2) is noticeable. Namely, as a rule indexes are – direct indicators of efficiency NUMBER OF MATCHES/SETS WON (namely, o.n. 1, 2.) medium strongly or strongly connected with other indexes, except those under no. 15 and 16. Equalization' of sports opponents, manifested in index NUMBER OF MATCHES PLAYED ON DIFFERENCE, is poorly connected with the equalization of opponents under NUMBER OF MATCHES PLAYED IN 3 SETS.

In Tables 3 and 4 predictive values of predictive indexes is determined for the prognosis of direct efficiency indicators –o.n. 1. and 2. (NUMBER OF MATCHES/SETS WON/LOST). Both coefficients of multiple regression are significant statistically with p<0.01. For the index *NUMBER OF WON/LOST MATCHES* (Table 1) the most predictive individual index is NUMBER OF WON/LOST MATCHES WHEN SECOND SET WAS LOST, and NUMBER OF WON/LOST MATCHES WHEN FIRST SET WAS WON (p<0.01). For the index *NUMBER OF SETS WON* (Table 2) the most effective prognosis is given by the same indexes.

Table 1. Prognosis of NUMBERS OF WON/LOST MATCHES on basis of other particular variables (standardized results)

Regression Statistics	
Multiple R	0.98
R Square	0.95
Adjusted R Square	0.93
Standard Error	0.27
Examinees	39
Importance	**p<0.01**

VARIABLE	*Beta-coeff.*	*Standard Error*	*t Stat*	*Importance*
WIN/LOSEGAME	0.00	0.04	0.00	1.00
NUMBERM3SETS	**-0.20**	0.07	-2.98	**p<0.01**
NUMBERONDIFF	-0.03	0.06	-0.48	0.63
WIN/LOSE3SET	-0.16	0.18	-0.90	0.38
WIN/LOSEDIFF	0.20	0.06	3.57	**p<0.01**
WIN/LOSE1SWON	0.35	0.07	5.02	**p<0.01**
WIN/LOSE2SWON	0.10	0.09	1.03	0.31
LOSELESS11S	-0.20	0.09	-2.33	0.03
LOSELESS11BOTHS	-0.18	0.07	-2.52	0.02
WIN/LOSE1SLOST	0.13	0.10	1.30	0.21
WIN/LOSE2SLOST	0.55	0.10	5.62	**p<0.01**
WINLESS11S	0.13	0.08	1.70	0.10
WINLESS11BOTHS	0.11	0.07	1.66	0.11
WIN/LOSEW1L2S	-0.22	0.12	-1.86	0.08
WIN/LOSEW2L1S	0.16	0.11	1.46	0.16

Table 2 – Prognosis of NUMBERS OF WON/LOST SETS on basis of other particular variables (standardized results)

Regression Statistics	
Multiple R	0.97
R Square	0.94
Adjusted R Square	0.90
Standard Error	0.31
Examinees	39
Importance	**p<0.01**

VARIABLE	*Beta-coeff.*	*Standard Error*	*t Stat*	*Importance*
WIN/LOSESET	0.00	0.05	0.00	1.00
NUMBERM3SETS	-0.15	0.08	-1.90	0.07
NUMBERONDIFF	-0.05	0.07	-0.70	0.49
WIN/LOSE3SET	-0.33	0.21	-1.61	0.12
WIN/LOSEDIFF	0.32	0.07	4.89	**p<0.01**
WIN/LOSE1SWON	0.45	0.08	5.50	**p<0.01**
WIN/LOSE2SWON	0.05	0.11	0.47	0.64
LOSELESS11S	-0.25	0.10	-2.43	0.02
LOSELESS11BOTHS	-0.25	0.08	-3.05	**p<0.01**
WIN/LOSE1SLOST	0.06	0.12	0.52	0.61
WIN/LOSE2SLOST	0.59	0.11	5.17	**p<0.01**
WINLESS11S	0.13	0.09	1.51	0.14
WINLESS11BOTHS	0.15	0.08	1.89	0.07
WIN/LOSEW1L2S	-0.25	0.13	-1.90	0.07
WIN/LOSEW2L1S	0.22	0.13	1.73	0.10

On basis of results, one could carefully presume that *winning the first, respectively loosing the second set* is 'most critical' for the final outcome of the match, at least for the examined sample of entities. Winning the first set (Table 1) statistically forecasts significantly well the final outcome of the match, as well as '*loosing*' the second set. Namely, considering that stated parts of the game can be 'psychologically' decisive for the final outcome of an individual table tennis match, it would be necessary for a specific entity sample to plan two more basic strategies, when planning scholastic transformation process:

- to attempt to steer the players to focus on the importance of maximum well motoric performance and psychological engagement in *first set* of an individual table tennis match – with the goal of winning that part of the match. At the same time, additional engagement is necessary in aspiration to *prevent the defeat in second set*.
- to aspire to assure optimal motoric performance and psychological stability of an individual in situations when unfavourable outcome for the same has already occurred (when the player lost first set, respectively second set).

It is desirable to in any case inspect the proposed indexes in future researches, on multiple larger samples of examinee of players' efficiency, for the examined entity sample.
'Collective indexes' are strongly or medium strongly correlated, except EQUALIZATION.

Inclusive, all three null-hypotheses may be rejected. Namely, except from particularly strong correlation between so called *direct indicators of competition efficiency* (indexes no. 1 and 2); most of other indexes are medium strongly to strongly correlated. Same situation is with so called 'collective indexes'. Statistically significant predictive value of used indicators has been determined for the prognosis of direct indicators of efficiency (indexes no. 1 and 2) on basis of other indexes (no. 3-14). Both coefficients of multiple regression are statistically significant. However, due to sample characteristics, the generalization of results is not possible.

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ON THE ANALYSIS OF BACKHAND ATTACKING TACTICS OF WORLD FAMOUS MALE SHAKEHANDS GRIP PLAYERS

Abstract

Through the analysis and statistics of the backhand attacking play of world famous male shakehands grip players, this paper summarizes some of the common and disciplinary issues and investigates the ongoing trends of shakehands grip backhand attacking tactics, and supplies reference for the further developments. Methods applied are the methods of literature review, video, statistics, segmental index evaluation, percentage analysis, single attack analysis and logic analysis.

Key words: *shakehands grip; backhand attacking play; service combat state; receiving combat state; deadlock combat state.*

In recent years, the ITTF has refined the table tennis game regulations three times in succession, including that the ball should be 40 millimeter in diameter, a game shall be won by the player or pair first scoring 11 points and the ball shall not be hidden from the receiver by the server or his doubles partner or by anything they wear or carry. These new regulations not only helps to speed up the tempo and add intensity to confrontations, but also brings new reformation trends, which still favor the trends of being active, having outstanding specialty, all-round skills, and no obvious defect. Shakehands grip attacking play is maturing and governing today, and the backhand attacking tactics is crucial to the combat of the first three balls, to the switches of attack and defense and to the final victory. So shakehands grip attacking play must be kept up with the new developments in tactics and skills.

Through the analysis and statistics of the backhand attacking play of world top male shakehands grip players, this paper summarizes some of the common and disciplinary issues and investigate the ongoing trends of shakehands grip backhand attacking tactics, and supply reference for the further developments. Methods applied are the methods of literature review, video, statistics, segmental index evaluation, percentage analysis, single attack analysis and logic analysis.

1. Research Goals and Research Methods

Research Goals

Wang Liqin, Timo Boll, Vladimir Samsonov, Chen Qi and Kalinikos Kreanga

1.2 Research Methods

1.2.1 Literature Review

A large number of literatures on table tennis backhand attacking play were studied.

1.2.2 Video Review

The performances of the players mentioned above in the 28th Olympic Games, the 48th WTC and other ITTF level-A events were observed and worked out on the basis of videos.

1.2.3 Single Play Analysis

The scores, defaults, neutral balls and other backhand skills of backhand attacking players were studied by three successive time periods, i.e. serving and attack period, receiving and attack period and rallies period. The rate of offensive balls, scores, defaults, neutral balls and net scores of the backhand attacking play in these periods are calculated.

Rate of offensive balls= (scores+ defaults+ neutral balls) / (scores+ defaults+ neutral balls+ other backhand skills) × 100%

Rate of scores= scores/ (scores+ defaults+ neutral balls) × 100%

Rate of defaults= defaults/ (scores+ defaults+ neutral balls) × 100%

Rate of neutral balls= neutral balls/ (scores+ defaults+ neutral balls) × 100%

Rate of net scores= rate of scores－rate of defaults

1.2.4 Logical Analysis

The application of logic theories makes the research systematic and theoretical.

2. Research Results and Analysis

Analysis of Backhand Attacking Play of World Top Male Shakehands Grip Players

2.1.1 Analysis of Backhand Attacking Play of Wang Liqin

Chinese player Wang Liqin, champion of man's singles and man's team in the 48th WTC, is a right-handed shakehands grip player, excelled in loops and surprise attacks.

Table 1 Analysis of Backhand Attacking Play of Wang Liqin

	Rate of offensive balls	Rate of scores	Rate of defaults	Rate of neutral balls	Rate of net scores
Serving and attack	70	31	17	53	14
Receiving and attack	79	29	16	55	13
Rallies	53	24	43	34	-19

From table 1, the rate of offensive balls in Wang's backhand play in serving and attack period is 70%, that in receiving and attack period is 79%, showing that Wang's backhand play in the first 4 balls is very active. Wang's rate of scores in serving and attack period is 31% and in receiving and attack period is 29%, along with a low rate of defaults, which in serving and attack period is 17% and in receiving and attack period is 16%. Statistics show that in the first 4 balls, Wang's backhand attack is active but not fierce and he is more likely to lead up to use offensive balls before the opponent, and this is why there are not so many direct scores and defaults, and a larger half of balls go into rallies period, which in serving and attack period is 53% and in receiving and attack period is 55%. According to videos, Wang prefers to use stirring-ups, twistings and drives when receiving backspins in his backhand attacking play. When returning the opponent's offensive balls, if they have low quality, Wang would like to drive the drives with backhand; if they have high speed and quality, Wang will quickly block the balls with backhand, which usually leads to direct scores due to their agile tracks, high speed and strength. Even when failing to win the point directly, Wang can lead into rallies period. One of Wang's frequently used plays is to firstly block the ball in straight line with backhand, then push or drive the ball with forehand.

In rallies period, Wang has the highest default rate (43%). According to videos, when his offensive balls in the first 4 balls haven't high qualities, his opponent will drive his drives or block his blocks and lead into rallies state, in which Wang's backhand defense is the weakest link. In rallies, Wang can confront his opponent in rallies with drives well, but lack sustainable ability. When his backhand attack is limited and cannot switch to forehand attack, his rate of scores is low (24%).

Wang should strengthen his backhand attack in the first 4 balls and the backhand ability of switch between attacks and defenses in rallies, together with the middle and backcourt strength.

2.1.2 Analysis of Backhand Attacking Play of Timo Boll

German player Timo Boll, world rating No. 2, is a left-handed Shakehands grip player, excelled in loops.

Table 2 Analysis of Backhand Attacking Play of Timo Boll

	Rate of offensive balls	Rate of scores	Rate of defaults	Rate of neutral balls	Rate of net scores
Serving and attack	94	22	28	50	-6
Receiving and attack	88	28	32	40	-4
Rallies	42	24	45	31	-21

From table 2, the rate of offensive balls in Boll's backhand play in serving and attack period is 94% that in receiving and attack period is 88%, the highest among the 5 players studied in this paper. According to videos, Boll prefers to actively shot offensive balls once possible. Generally speaking, except the medium-high balls, he prefers to shot lobs or drive loops diagonally so as to easily make topspin rallies within court and prepare for rallies period. Boll is excelled in the combination of firstly spinning the ball and then accelerating the ball, with firstly shooting to the right court and then pushing down to the left court. In rallies, Boll's backhanded accelerated half-off court balls and skills of driving the drives and tearing the tears are maturing; his switch of backhand and forehand skills in drives and pushes are fluent. His topspin confrontation is the most important pillar of his skills.

Boll's switch of backhand and forehand play, backhand tearing, quick driving and diagonally shot angled returning can make good preparation of forehand attacks. But his direct points winning skills, like backhand successive attacks and back court returning, still need improving. Through the rates of net scores in three periods are negative, his backhand play is strong and all-sided, excelled in tearing, leading, pushing and lobs. He is good at closing over the off court balls and he can directly put on strength to backhand attacks. According to videos, his hand position is high, and he can shoot the ball earlier; his actions aren't straightforward, there are also transverse actions. He strikes the racket more to the left, so he needn't make loops actively and he returns the ball quickly and lowly, killing some of the spins. It is a breakthrough that Boll can use backhand to counterattack and drive the topspin drives in close and middle court, as this means there will be no dead angle in topspins.

2.1.3 Analysis of Backhand Attacking Play of Vladimir Samsonov

White Russian player Vladimir Samsonov is an all-sided right-handed shakehands grip player, using loops with surprise attack.

Table 3 Analysis of Backhand Attacking Play of Vladimir Samsonov

	Rate of offensive balls	Rate of scores	Rate of defaults	Rate of neutral balls	Rate of net scores
Serving and attack	93	21	18	61	3
Receiving and attack	69	24	22	55	2
Rallies	50	24	43	34	-19

From table 3, in serving and attack period, Samsonov's rate of offensive balls is high (93%), showing that his backhand attack is active in this period. The rate of offensive balls in receiving and attack period is lower (69%), showing that in this period, he is not so eager to shot offensive balls, but prefers to take active control first. His backhand skills like backhand short stirring up and long drives are excellent instead of fierce, as a result, most balls go into rallies and the rates of direct scores in serving and attack (3%) and receiving and attack (2%) are the lowest among the five. So his backhand attacking play is not outstanding, though no obvious flaw.

In rallies, Samsonov's backhand confronting ability is very strong. Though his rate of defaults (43%) is highest and the rate of net scores (-19%) is the lowest, his rate of scores (24%) is the highest. According to videos, his forehand defense in middle-close court is weak, but the speed of backhand block is high. His defensive backhand skill is outstanding, after backhand returning, he often actively shoots successive attacks in a sidled position. While in equipollent confrontation, his backhand and forehand attacks are outstanding with an agile track in which he often leads the drive-drive rallies and switch to the opponent's forehand position.

2.1.4 Analysis of Backhand Attacking Play of Chen Qi

Chinese outstanding young player Chen Qi, left-handed shakehands grip, favors loops with surprise attack. He is the champion of the Athens Olympics table tennis man's doubles and the champion of the 48^{th} WTC man's teams.

Table 4 Analysis of Backhand Attacking Play of Chen Qi

	Rate of offensive balls	Rate of scores	Rate of defaults	Rate of neutral balls	Rate of net scores
Serving and attack	85	26	12	62	14
Receiving and attack	76	27	36	37	-9
Rallies	51	23	47	30	-24

From table 4, the rate of offensive balls in Chen's backhand play in serving and attack period is 85%, showing that his backhand attack, especially backhanded drives and pushes in this period is fierce with a 14% rate of net scores as a result of his outstanding force, agile tracks and excellent serves. Chen's backhand attack in receiving and attack period is also fierce, having a high rate of scores at 27%. But his backhand rate of defaults (36%) in this period (36%) is much higher than that in serving and attack period (12%), two factors attributed to which are that his fierce returning leads to direct defaults and that when his opponent takes the control, Chen's transition between the second and fourth balls is weak, making a poorer defense ability in the fourth ball and a harder switch to attack from defense.

In rallies, the rate of scores rests with his performance of switch to attack from defense at a backhand position. In active rallies, the switch from backhanded drives and pushes to forehand attacks is excellent. After his powerful backhanded angle drives, he can frequently make forehand successive loops, which leads to a large control area, a strong middle-back court confrontation and powerful skills in driving backhand loops, though sometimes his backhand position is also the goal of attack from his opponent when he is in passive rallies.

According to statistics, Chen's backhand play is still not stable. When his performance isn't satisfactory, there will be a large number of unnecessary defaults. So for Chen Qi, it is crucial to reduce the number of unnecessary defaults on the basis of keeping his fierceness and at the same time to improve his ability on actively switching from defense to attack.

2.1.5 Analysis of Backhand Attacking Play of Kalinikos Kreanga

Greek player Kalinikos Kreanga, right handed Shakehands grip, is good at loops with surprise attack. His backhand attacking play is outstanding among world players.

Table 5 Analysis of Backhand Attacking Play of Kalinikos Kreanga

	Rate of offensive balls	Rate of scores	Rate of defaults	Rate of neutral balls	Rate of net scores
Serving and attack	89	34	18	48	16
Receiving and attack	81	26	33	41	-7
Rallies	67	21	51	28	-30

From table 5, the rate of offensive balls in Kreanga's backhand play in serving and attack period is 89%, the rate of scores is 34% and the rate of net scores is 16%, showing a prominent performance in this period. According to videos, Kreanga prefers to shoot upside midmost shorts and forehand upside shorts in service. After serving, he likes to stand at the central front of the table so as to lead backhand attacks. When serving with backhand, he likes to stand at the right half of table so as to shoot shorts from his right side, which spin to the forehand position of his opponent's. This kind of service will set free a lot of space for backhand attacks, putting on more force to the offensive balls. The angle shots can often win points because Kreanga's backhand serving and attack is very fierce, quick-moving and powerful, after which he can quickly organize threatening attacks and make fluent transitions between the third and fifth balls.

In receiving and attack period, he also has active backhand attacks, as the rate of offensive balls is 81%. According to videos, when receiving shorts, he likes to twist and swing the balls, along with stirring up the balls backhandedly. Although the quality of his backhand stirring up is not so high, the returning of the fourth ball is quick; mainly using backhand counter-driving and counter-tearing and the track is angled. When blocking the opponent's attacks, he will shoot one backhanded straight humping ball. When receiving the opponent's long balls, he will drive and rush with backhand fiercely and decidedly, which often lead to unnecessary defaults. Besides, he is weak in receiving the half off-court and low spins, so the rate of defaults in this period (33%) is the highest.

In rallies, the rate of offensive balls is the highest (67%) among the five players. Kreanga's backhand confrontation ability is very high using a lot of counter rushing and counter driving, which is different from the other players who like to use forehand. He is able to put on force backhandedly from middle-back court and his loops are powerful. Once he catches his opponent's weaker force, wrong falling point and slower spin, he can often make his attacks in drive-drive confrontations and driving the drives. When defending his opponent's sided attack with backhand, Kreanga usually block his forehand position quickly, making his opponent unprepared. When facing the opponent's forehand and backhand attacks, he will drive back backhandedly to the opponent's backhand position, which often wins points. Backhand following sided forehand successive attacks are also efficient in winning points, though his rough forehand skills and defense and an easily agitated temperament have bad impact on him.

2. 2 A Synthesized Analysis on the Characteristics of Backhand Attacking Play of the Five Male Shakehands Grip Players

As the representatives of the most outstanding shakehands grip players in the world, the five players studied above, namely Wang Liqin, Timo Boll, Vladimir Samsonov, Chen Qi and Kalinikos Kreanga, have both similarities and specific features in their backhand attacking play.

Wang Liqin is an all-rounded backhand attacking player, excelled in the use of different backhand skills, like stirring up, twisting, driving, tearing, and pushing, and with no dead corner in full-table attacks. The purpose of his backhand attacks is to make preparation for forehand play by leading up the offensive balls. In rallies, Wang's backhand play is no worse than his opponents, to say nothing of the middle-back court confrontations. Though there are few "eruptive strikes", his quickness-ferocity balanced play, which has an outstanding forehand play, a backhand play that is no worse than anybody else, and powerful enough in-court balls, represents both the highest level of Chinese male table tennis players and the technical trend of world players.

When Boll backhandedly leads up offensive balls against backspins, he likes to drive accelerated loops, mostly with diagonal tracks, which shoot straight and are less threatening, but favor a quick switch between forehand and backhand successive attacks. In returning the opponent's offensive balls, Boll's backhand drives and tearing are powerful, and he is excelled in the combination of firstly spinning the ball and then accelerating the ball, with firstly shooting to the right court and then pushing down to the left court.

Samsonov's first offensive ball is not threatening, but shoot straight and with less defaults, leading to less point losing and top-quality successive attacks in the following period. He has a better backhand defense ability and an outstanding transformation from defense into attacks, in which when finding chances, he will quickly turn sideways, actively switch to forehand play and balance his forehand and backhand attacks.

Chen Qi tends to drive fiercely backhandedly, which usually adopts drives and rushing with great force, high speed and at the same time more defaults. In active and equipollent rallies, Chen's backhand play is fairly strong, being able to lead middle-close court drive-drive confrontations, and taking the advantage of his left-handedness, he drives tricky tracks, and after track changing, he can quickly turn sideways to successively drive the balls using forehand. But in passive rallies, his performance is not satisfactory, in which his backhand defense and the ability of transforming into attacks are to be improved.

From statistics, in the periods of serving and attack, receiving and attack and rallies, Kreanga favors the highest rate of the use of backhand attacking play and the highest rate of scores. Being regarded as having the best backhand skills, Kreanga excels in a fierce backhand attack, great force, and a good switch from defense to attack, and he can eruptively strike and drive at middle- back court, and even successfully perform counter drives; while, his ferocity also results in unnecessary defaults. Backhand play is the core of everything for him. His relatively lower world rating among the five players studied here may result from the fact that he depends too much on backhand attacking play so that he lacks all-around skills and strong psychology. So even with the most outstanding backhand skills, if there are enough defects in other skills, it's hard for players to mount the peak of achievements in table tennis world.

The five players in this paper represent the highest level of world shakehands grip players. Their backhand attacking skills are used expertly, such as stirring up, twisting, driving, springing, arching, tearing and smashes, and the switch between forehand and backhand is fluent, eliminating the blind corner of their attacks. But the problems in the backhand defense and switch from defense to attack in rallies period are checked up and considered an urgent problem for shakehands grip players in the world.

3. Conclusions

3.1 The history of shakehands grip backhand attacking play originated in the 1950's, when European players began to favor attacks. With the over 10 years' continual explorations, in the 1970's, the European backhand loop drive tactics was led by the trends towards lob shot loops; until the end of the 1980's and the beginning of the 1990's, the backhand accelerated loop had become the most advanced backhand play; today, players add more innovations and a variety of backhand plays have been developed, i.e. stirring up, twisting, springing, tearing with backhand, driving with backhand and arching, etc.

3.2 Shakehands grip attacking play, represented by players like Wang Liqin, Timo Boll, Vladimir Samsonov, Chen Qi and Kalinikos Kreanga, has a variety of performances and features and problems as well. The common problems are that in the first four backhanded balls, they are very fierce, but the number of direct scores is not satisfactory, leading the strikes into rallies; the tactics combination most commonly applied is that firstly change the track of the ball with backhand and then follow successive forehand attacks.

3.3Wang Liqin's switch of forehand and backhand play, Boll's backhand tearing and backhand topspin and Kreanga's backhand bursting forth at middle and back court and backhand driving have added vigor to the development of backhand shakehands grip attacking play, with the innovations and skills referred making the tactics more successful.

3.4 Today's table tennis game has become an all-sided confrontation; with attacks can be forehand and backhand, from backcourt, middle court and short court. Backhand attacking play helps a full court attack and an all-sided tactics.

3.5 Under the new regulations and new game system, Chinese shakehands grip players should strengthen the trainings on backhand attacking play abilities. Only on the basis of keep the advantage of forehand attacking play abilities, can these trainings help us to get ahead of our competitors.

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The 10th Anniversary ITTF Sports Science Congress

Part eleven:

Table tennis databases and new proposals

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TRIPLES IN TABLE TENNIS: A PROMISING NEW TEAM COMPETITION SPORT - "Introduction and First Findings"

Abstract

A new form of table tennis is presented, with teams of three players playing each other. Apart from recreational applications it is seen as the ultimate test of combined team strength in team competitions, where presently teams never face each other as a team. With 3-player teams now competing in the 2008 Olympics, the new game presents a timely and relevant new table tennis possibility.

Some salient points from a comprehensive textbook on "Table Tennis Triples", covering the rationale for the new game, its equipment, rules, game plans, umpiring, and possible integration into existing table tennis events [1] are presented. A general introduction to Triples and its rationale is given, focusing on its theoretical basis and rules. Some first evaluation trials are discussed, as is the possible integration of Triples into existing events.

The basic change from conventional table tennis is that Triples is played preferably, but not exclusively, on a circular table, and that net height increases towards the table periphery. Consistent with recent rule changes in table tennis, and apart from its novelty, the Triples game offers major benefits. Compared to the conventional game these include the whole team playing at once, a larger table playing area, increases in 'baseline length' and player movement space, and a greater range of shot directions and lengths.

Triples is based on a clearly structured game plan. Its basic rules are those of conventional table tennis, accompanied by some new features firstly necessitated by the simultaneous interaction of three players, but secondly also designed to progressively increase player, spectator and media excitement and appeal.

All aspects of the new game were successfully tested in trials with prototype equipment, using top pennant competition players. Players overwhelmingly accepted all rules, and felt comfortable in their new team roles, suggesting that the team-oriented Triples game has major potential.

Key words: *Team competition, Table tennis innovation, New 'Triples' sport, New rules, Equipment design, Team psychology & tactics, Event management, ITTF support, Global acceptance testing.*

1. Introduction

Ever since the first congress of the International Table Tennis Federation (ITTF, on 12.12.1926) the boundaries of table tennis have been pushed out further and further. The evolution from singles to doubles to "Triples" is seen as a natural part thereof. The latter has so far not happened primarily because the technical means to do so did not exist. Following extensive research and development the author has succeeded in overcoming that hurdle, as described in a comprehensive textbook covering the theory, equipment, rules, strategies and future possibilities of this new form of table tennis as played by 3-person teams [1], and based on his earlier invention of, and work with the circular table tennis table [2-9].

The timing of that book coincides with yet another stepping stone in table tennis history, namely the decision to include table tennis TEAM events into the next Olympic Games in 2008 - with teams consisting of three players. This is also very common among existing table tennis team competitions, collectively representing the major part of the international table tennis repertoire, with teams typically consisting of 3 to 6 players.

1.1 Rationale

Why Triples in Table Tennis?

To let three people experience the thrills of team interaction while playing the fastest sport on earth - as a real team*.*

Table tennis "Team Competitions" today are actually played as a combination of singles and doubles matches. However, one basic feature of sporting team games is that *all* players play the game *at once.* So far table tennis teams do not, with the exception of doubles matches, as the most rudimentary example of a "team" (which, according to the *Oxford Dictionary*, consists of "two or more persons working together"). Doubles in table tennis therefore qualifies as a "team game", but strictly speaking all present table tennis "team" competitions, with their mixture of singles and doubles matches, do not.

Moreover, the ongoing "World *Team* Rankings" in table tennis are based on the ranking points of the three highest ranked players in each association/country – without them ever having played each other *as a team*: the term "team ranking" is actually a misnomer. It would be more appropriate and desirable to replace, or at least complement, the present accumulation of individual player contributions by an event which tests the true *combined strength* of the team. Only then can all the special attributes of sporting teams truly come to bear. - Adding up individual players' contributions to arrive at an overall team score may obviously be *representative* of *combined* team strength. But this method lacks the ultimate test, and that certain "spark" and magnetism which only interactive full-team engagement can deliver, and which make "real" team games so attractive to spectators.

Table Tennis Triples was conceived to provide an answer to these shortcomings. It has the potential to raise the image of table tennis from a sport *essentially* dominated by individuals to that of a real team sport. - The primary purpose of this paper is to substantiate that claim, by outlining the major features of, and first experiences with Triples. And secondly, it is hoped that it will incite the table tennis world – players, coaches, organisers and administrators alike –to try out the new game.

2. Triples Geometry

Table tennis Triples is played by two teams of 3 players. In order to create the extra space needed to accommodate these 6 people a circular table is used (although other shapes are possible [1]), as is a single net. The notation and terms shown in Figure 1 will be used to explain the game. Team A plays team B. Each team has players numbered 1, 2 and 3. Both playing fields consist of three 60-degree sectors: a "Centre Court" CC and two outside courts, the "Right Wing", RW, and "Left Wing", LW. Their boundaries are defined by the net and the diagonal Right and Left "Triples Lines", respectively.

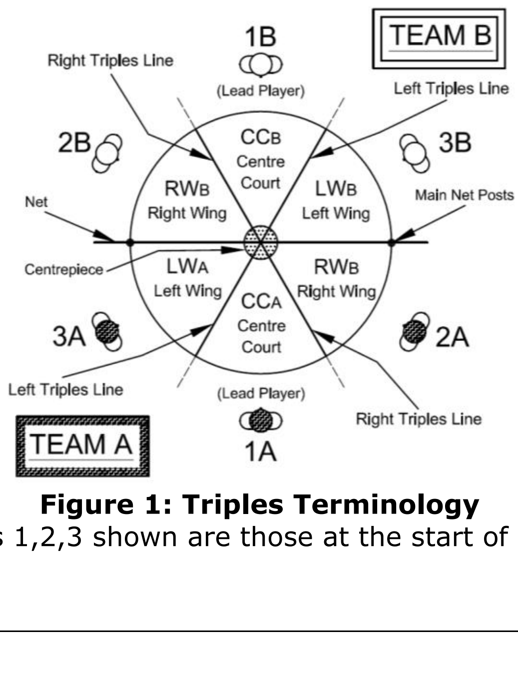


Figure 1: Triples Terminology
(Player positions 1,2,3 shown are those at the start of a Triples game).

Before explaining the rules and scoring system necessary to achieve the practical implementation of Triples, its advantages in terms of player movement will be briefly investigated.

2.1 Edge Length

The diameter of the "standard" Triples table is 3.14 metres, corresponding to the diagonal of the conventional table, i.e. it envelops the latter as a circumscribed circle. Other sizes are possible, but not recommended [1]. This means that it is effectively 40cm "longer" (in all directions) than the conventional table, and results in a peripheral "playing edge" or baseline length of 4.935m, i.e. 3.23 times the conventional 1.525m, and an "edge length per player", or sector, of 1.645m, an increase of 8%. It may therefore be argued that from the viewpoint of pure baseline length allocation per singles player alone, and under playing conditions equivalent to those of the conventional *singles* game, the number of players on one table may be logically increased by a factor of 3, to six: two Triples teams.

2.2 Playing Area

This argument becomes even more convincing when considering areas. The overall playing area of the 3.14m diameter table is 85% larger than the conventional table area. Collectively this means that players have that much more "target area" to play to, thereby allowing them to move further back from the table than in the conventional game, if necessary, and still "hit the target". Each 60-degree sector area for the 3.14m Triples table is 1.29m^2, i.e. 23% bigger than the conventional doubles court area, of 1.05m^2. Hence from the point of view of "surface area per player", Triples play may be considered rather "better" than doubles play in conventional table tennis.

2.3 Player Action Space

The other intrinsic advantage of play on the round table is that the 'Action Space' *behind* the table increases with the square of the distance away from it ($A \propto r^2$), i.e. players have a larger area available in which to move than with the conventional table. There the predominantly "one-dimensional" nature of the game effectively only results in a corresponding linear increase in action space. For comparison, Figure 2 shows a hypothetical half-conventional and half-Triples table with single and double conventional competition court size boundaries of 14x7m and 14x14m, respectively, together with the "typical" floor areas - or action spaces - in which an individual player would reasonably be expected to move during a game. The overall "extreme" region areas shown are 30.4m^2 for (doubles) conventional table tennis, and 84.2m^2 for Triples, an increase of M_T/M_C= 2.8, again approaching a factor of 3.

As will be seen later, the rules of Triples allow a player to *stay and continue playing from* far behind the table, while the other two team members "cover up" for her/him close to the table. The opportunity is therefore created for a revival of the "lost art" of long-distance shots and its spectator appeal, (e.g. shots returned from 6m behind the table…). This has also been one of the aims of the so-called "Longer-Reach Team Play Format" involving 2 standard tables, which in that regard is somewhat similar to Triples [10]. The alternating play rule in doubles effectively restricts the action space of each player. No such limitation exists in Triples, which incorporates a fundamental change in the "order of play" rule, aimed at allowing the players and team more freedom in movement and strategy. Apart from the return of service, any one member of the team can return the ball. Hence each player can theoretically play from anywhere inside the 180-degree space available. Practical considerations limit this approximately to the individual 90-degree spaces indicated as M_1, M_2 and M_3 in Fig. 2, together with their "nominal" counterparts defined by the Triples lines N_1, N_2 and N_3.

From a geometrical viewpoint it can therefore be concluded that

- Triples allows an *edge length* per player *equal* to that in the conventional game,
- Triples allows *stroke directions* virtually extending through a full 180 degrees,
- Triples offers a greater *"action space"* per player than that typically feasible in singles or doubles games on the conventional rectangular table,
- Triples allows the reappearance of *long-distance shots* and -play in competitive table tennis.
- The extra Triples table "length" allows up to 15% more *decision time* for players to react than in conventional table tennis.
- Triples allows a wide range of *"shot lengths"*, - from 9cm to around 9 metres.

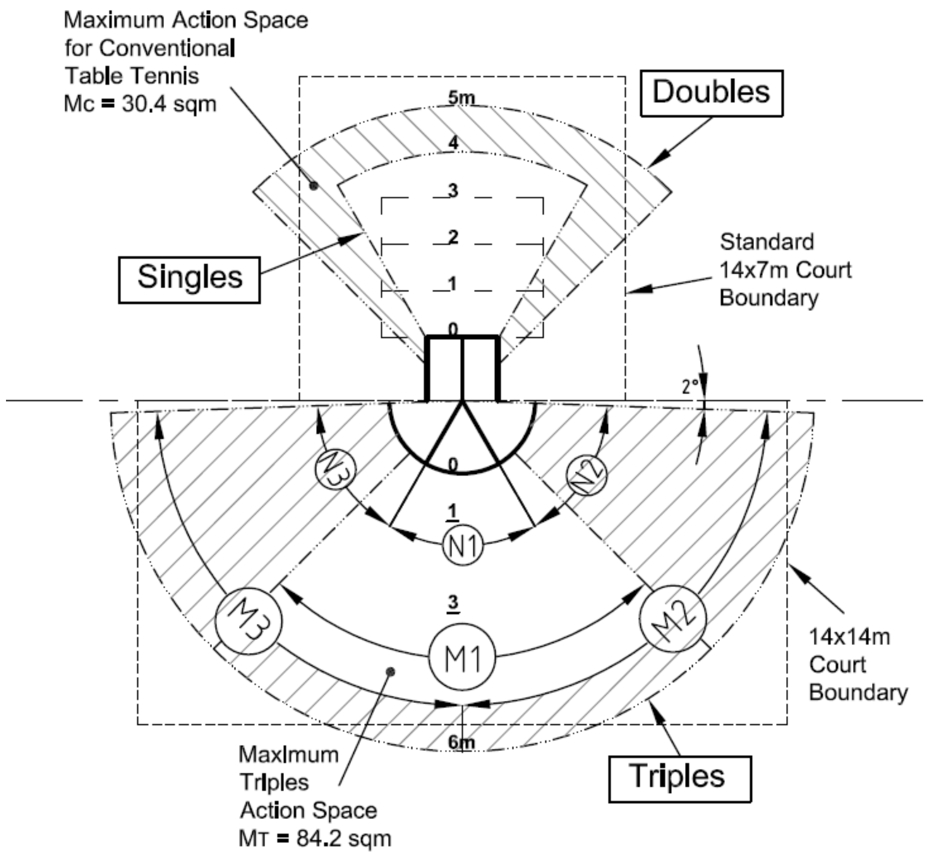


Figure 2: Comparison of Doubles and Triples Team Action Spaces

Clearly the actual court for competitive Triples has to be larger than the14x7m standard size. Various solutions are possible [1], the most convenient and easily achievable being two standard courts side by side, i.e. 14x14 metres, as indicated in Figure 2.

3. Triples Equipment

Apart from conventional table tennis rackets and balls, the three basic "equipment elements" of the Triples game are the table, the "Centrepiece", and the net assembly. Each of these must conform to the boundaries set by the basic geometry and other physical requirements of Triples. The materials and general manufacturing and quality parameters must be identical to those of conventional table tennis. However, within these boundaries various design possibilities exist for each of the three elements, as described elsewhere [1]. Only their generic parameters will be described here.

3.1 The Table
Triples tables have been constructed according to three distinct designs, each of which has its particular advantages: in two folding halves as are most conventional tables, as a "Composite Table" by adding removable extension leaves to the conventional table, and as a "Modular Table" consisting of 6 interconnected 60º modules. The table has a 2cm white "perimeter line" and two 1cm-wide "Triples Lines" as shown in Figure 1.

3.2 The "Centrepiece"
Since the Triples table is 40cm 'longer' than the conventional table, a shallow conical disc 40cm diameter and 31mm high is located at the centre, as shown in Figure 3. It has two functions. Firstly, to prevent balls coming to rest "irretrievably" at the centre of the table, and secondly to effect an angled rebound for balls landing within the central region – a new challenge for table tennis players.

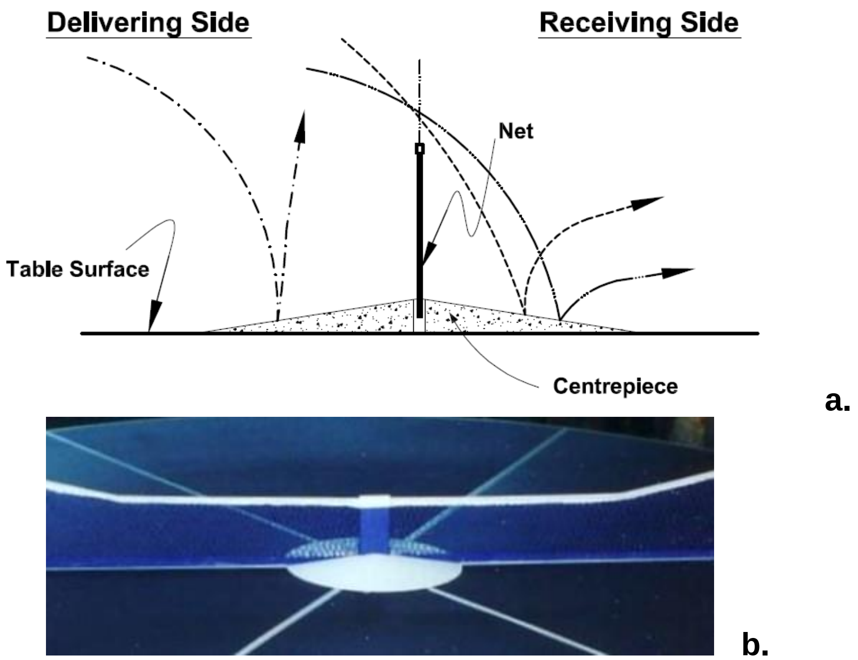


Figure 3: The Triples "Centrepiece" (PATENT APPLIED FOR)
a. Effect of cone angle on ball rebound
b. 40cm diameter Centrepiece with net joint cover

The surface of the Centrepiece is part of the playing area and must therefore have the same bounce characteristics as the parent table. Its cone angle has been chosen such that any balls landing on it can still be reasonably played/returned.

3.3 The Triples Net
As for the conventional table, the Triples net, shown in Figure 4, is arranged over the parting line between the two table halves, and follows the same colour scheme. Over the central third (1.05m) of its length it has the same height as the conventional net, i.e. 15.25cm. Obviously it would be very easy for the players in the wing courts to smash the ball into the adjacent opposite court if the net was the same height along all of its length, thereby creating a completely impractical situation. For this reason its height increases over the two outside thirds (each 1.05m) to a height of 41cm at the periphery of the table. From there the net describes a downward radius as shown. Although the wing players can come very close to the net, they ("or anything they wear or carry" - ITTF rule 2.10.1.9) must not touch the net assembly during play, as is

the case in the conventional game. Again various designs are possible within the parameters shown [1].


a.

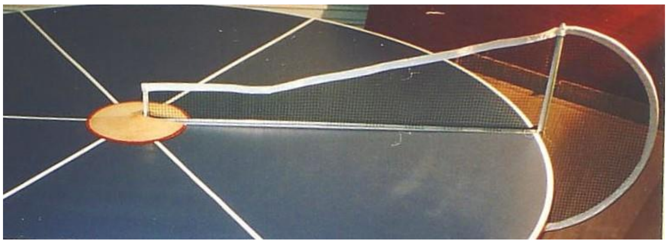

b.

Figure 4: Triples Net Configurations (PATENT APPLIED FOR)
a. Example of Framed "Clear Net" Construction (half table removed)
b. Example of Peripherally Adjustable Half-Net Construction

The "three thirds" net height variation means that each player is essentially "in charge" of one-third of the net, and that "quasi-normal" table tennis can be played over the central table and net portion. Apart from the circular table shape, the sweeping and aesthetically pleasing net configuration characterises the physical layout and visual impact of Triples, - and its relatively large net area can be used as even more sponsorship promotion and advertising space than is possible with conventional nets.

Examples of the "composite" and "modular" Triples table assemblies, which themselves can be used in interesting new combinations [1], are shown in Figure 5.

4. The Rules of Triples

Since Triples is simply a new variant of table tennis, all of the basic ITTF rules of conventional table tennis also apply. The extra rules of Triples are simple and logical. Obviously some new features and terms have to be introduced when compared to the conventional games of table tennis. Apart from these some variations to the standard rules are included, aimed specifically at making the game even more exciting.

4.1 The "Service Rally" and "Service Round"

These are new concepts. The *"Triples Service Rally"* consists of *two* shots, the actual service *and* its return. Referring to Figure 1, all services must be delivered from the *Centre Court* i.e. from CC_A or CC_B, also referred to as the "Server Courts". Each server makes a total of 6 consecutive services, viz. two services to each opponent. These six services constitute one "*Service Round*", as illustrated in Figure 6.

Figure 5: Sample Triples Table Constructions (PATENT APPLIED FOR)
a. Composite b. Modular

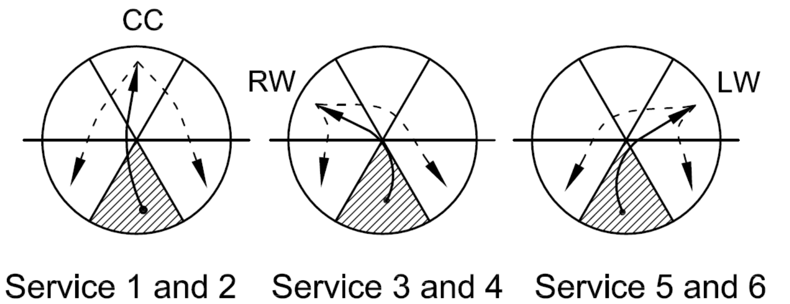


Figure 6: The six Service Rallies in each Service Round

________ Service ------------ Possible Returns

4.2 Service

During the service the racket must strike the ball behind the table edge and within the hypothetical radial "extensions" behind the table of the left and right Triples lines. The server (in Fig.1 initially 1A), first serves two services to player 1B at CC_B, followed by two services to player 2B at the opposite Right Wing, RW_B, and hence two services to player 3B at the opposite Left Wing, LW_B.

The reason for the six services is twofold. Firstly players are used to serve two services at a time from the conventional game. This feature therefore remains the same, but is simply extended to challenge all 3 players of the opposing team. Secondly, since the possibility of multi-directionality, or "sideways play" is a fundamental property of Triples, this is emphasised straight away by the server having to deliver services not only "straight down the middle" as in the conventional game (although this familiar "conventional" service still starts off the Service Round), but also, and more importantly, to the two Wing Courts. The interpretation of net and line balls during service is standard.

4.3 Return of Service

After the server has made a good service, the receiver must return the ball to *either* of the two wing courts on the opposite side, as per Fig. 6. The receiver can therefore choose to which of the two Wing Courts s/he returns the ball. This means that the wing players in the serving team do not know to whom the service will be returned, and must therefore be alert: all three players of the serving team become immediately "involved". Also the inherently new Triples feature of "lateral" play is fully exploited and stressed not only during the service, but also during its return. The successful execution of the service *and* its return thus provides an "entry ticket" to the main rally for *both* teams – what happens *after* these two introductory shots is entirely up to the players/teams themselves.

Line balls are treated as before, i.e. any ball landing on the respective Triples line is deemed "in". However, since the return of service is a compulsory part of the "prescribed" service action, and contrary to conventional table tennis, any *net ball* during the *return* shot must also be re-played, i.e. *both* the service *and* its return - the whole "Service Rally" - is repeated.

The "Service Rally" hence introduces the game proper. Logically one "Service Round" incorporates 6 service rallies, and also 6 game rallies and hence 6 scored points:

1 Service Round = 6 Service Rallies = 6 game rallies = 6 scored points.

4.4 "Free Play" and the "3-Shot Rule"

After the Service Rally players are free to play the ball back to *anywhere* on the opposing teams table half, and *any member of the opposing team* can then likewise return it to any player/court on the other side. From there onwards there are essentially no restrictions as to *who* plays the ball at any one time, nor *where* it should land, i.e. the *playing order is arbitrary:* any team member can hit/return the ball to anywhere in the other team's field. – This is the "Free Play" phase of Triples. The only qualification to "Free Play" is that any one player cannot play more than three shots in succession. After that another team member must play the ball. This is the Triples *"3-Shot" Rule*, imposed to ensure balanced participation. If the ball is played by the same player a fourth time *in a row* his/her team loses the point. However, once another player has taken over from the "3-shot-player", i.e. "broken" his/her run, the latter can in turn play again. There is no limit to the number of "3-shot-runs" per player in any rally.

Free Play, as a basic feature of any "real" team sport, is one of the most exciting features of Triples, and a breakaway from the conventional game. - It could even be argued that doubles in table tennis, with its alternating play rule, does not really qualify as a "real" team sport. Even in other two-player team sports such as tennis or badminton such "free play" is a basic prerequisite.

4.5 Player Identification and Team Rotation

The relative positioning of players is important in most team games. This also applies to Triples, where one must not only know and monitor which player occupies what position at any one time, but also strategically allocate the players to the three Triples positions 1, 2, and 3. These numbers ensure proper service sequencing and player rotation, and effective umpiring. Removable bibs are the most effective way for that, as shown in Figure 7.

Whenever a player has completed a Service Round, his/her *team "rotates" clockwise* around its table half by one court, as also indicated in Fig. 7, and the service changes sides. After this *"Team Rotation"* the other team plays its Service Round, and the process is repeated until all six players have had their Service Rounds.

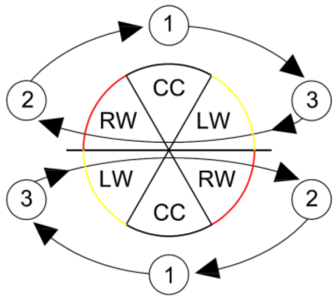


Figure 7: Player Identification and Triples Team Rotations

4.6 The "Triples Cycle" and 31-point "Straight Game"

From this it is seen that Triples play is cyclic, in 36-point *"Triples Cycles".* After each cycle, every player has served twice to, and received two services from, each opponent, and has played from each of the three positions/courts on his/her team's field. After each cycle both teams change sides and take up their initial player positions on the other side. Play then continues until the winning score of 31 is reached with 2 advantage points: the *"Straight Game".* With this cyclic playing pattern, and with every player having served to, and received services from, every opposing player and on both sides, a completely fair and equitable game foundation is established and maintained in Triples. No player is advantaged or disadvantaged in any way by virtue of the rules, environment or game proceedings. The Straight Game rules have been summarised in Table 1.

Playing to a winning score of 31 stresses a fundamental aspect of team games: the necessary stamina and gradual 'excitement buildup' of prolonged player engagement. It also follows the author's 'unified theory' of table tennis, according to which singles are played to 11, doubles to 21, Triples to 31, and 'Quadruples" (which can also be played on the 3.14m table) to 41 points - or to 41 minutes: with such player numbers in a team the game could also be time-based [1].

4.7 "Tie Break" and "Shoot-Out"

In the event of a 30:30 score, i.e. a "close" Triples game, two departures from the conventional rules of table tennis come into play, resulting in a fairer treatment of close game outcomes: the *"Tie Break".* With 60 points played, corresponding to 1⅔ Triples Cycles, the third players of each team (3A and 3B) have not yet had their second Service Round. The new features, which lead to a number of interesting team tactics [1] are:

- Play must continue *irrespective of scores* until the second 36-point cycle has been completed, so that thereafter each player has also served from each side
- to win the Tie Break, a team must *lead by* at least *the "Triples Advantage" of three points* (not just two) *at the end* of the twelve Tie Break rallies.

If at the end of the Tie Break phase a score of 36:36 or 37:35 is reached, all player and service combinations have been played, and both teams are back at their starting positions. For a 36:36 score both teams are of course at a completely equal position, whereas for 37:35 the leading team is just "one point away" from winning the game – which will happen *if* they win the next point…

Table 1: Triples Rules Part 1: The "Straight Game" to 31

The basic ITTF laws of conventional table tennis also apply in Triples, with the following modifications:

1. A Triples Team consists of three players numbered 1, 2, 3
2. Both halves of the round Triples table have a Centre Court CC, Right Wing RW, and Left Wing LW
3. All *Services* are delivered from the Centre Court CC
4. Two consecutive services must be delivered to each opposite court: First to CC, then to RW, then to LW. These *six* services constitute a *Service Round*
5. All *Service Returns* must be played to *EITHER of the opposite Wing Courts*
6. The service together with its return constitutes a *Service Rally.* Any net ball during these 2 shots (*also* the return) leads to a replay of the Service Rally. *Note:* Apart from this, any line calls, net balls and edge balls are treated in the same way as in conventional table tennis
7. After each Service Rally *Free Play* starts: any player can return any ball to anywhere on the opposite table half. The only restriction during Free Play is a maximum of *three consecutive shots* by any player (the "3-Shot Rule")
8. Players must be at their *Designated Positions* for the Service Rally only. After this they can play from any position
9. After each Service Round each player of the team that just served moves clockwise to the next court and service changes sides. After this *Team Rotation* the next Service Round starts
10. Six Service Rounds constitute one *Triples Cycle.* After each Triples Cycle teams *change sides*
11. A Triples *Game* is normally played to *31* points, with the usual 2-point lead: the *"Straight Game".*
12. New "Close Game" Rules apply if the score reaches 30:30 – *see Part 2*

At this crucial stage the even more exciting *"Shoot-Out*" phase and rules come into force, which essentially give both teams complete freedom in how to play. It begins with the existing score, and ends *as soon as one team gains a lead of 3 points*, or after another 18 rallies have been played. During Shoot-Out the service alternates, but the team decides *who* serves *when,* with each player serving up to 3 times. Ball placement and player positioning is completely free, teams change sides after 9 points, and, to eliminate chance and player frustration at this crucial stage, *ALL net balls and edge balls* lead to *a "let" call* and hence *rally replay*: another breakaway from the standard rules.

4.8 The "Draw" and "Golden Triplets" Finish

At the end of the Shoot-Out phase 90 points have been played, and the game should not be prolonged any further. If no 3-point lead has been achieved the score is either 45:45 or 46:44. The fact that both teams have come through the Tie-Break and Shoot-Out phases, and arrived at such a close final score, proves conclusively that the two teams are really "equal"- especially in view of the fact that chance has largely been eliminated towards the end. This is acknowledged in Triples by declaring a *Draw* at this stage, as is the case in other team sports, irrespective of whether the score is 45:45 (a *"Straight Draw")* or 46:44 (an *"Advantage Draw").* This will typically be the case in pennant matches or ongoing team competitions, where cumulative scores over time determine the teams' standing. The possibility of a Draw hence brings Triples in line with other team sports.

However, in championship finals and some other instances a single "clear" winner must emerge, so that an alternative and quick finish to the game is needed. The decision as to which alternative is chosen has to be taken by the body organising the event. The simple alternative is to play for the best of three more "golden" points, the three *"Golden Triplets",* thereby bringing the maximum total point score in Triples to 93.

Table 2 : Triples Rules Part 2: The "Close Game" Plan and Scoring

13. <u>Tie Break:</u> If both teams score 30 points the *"TIE BREAK"* phase as well as 3-point*"Triples Advantage"* come into effect:
    a. play must continue for *two more Service Rounds* (12 rallies), irrespective of score
    b. the game ends if a team *at the end* of the Tie Break phase leads by *3 or more points*
14. <u>Shoot-Out:</u> If at the end of Tie Break the game score is 36:36 or 37:35 the *"SHOOT-OUT"* phase comes into effect. After a *3- minute time-out* break:
    a. the game is won by the team *first scoring* the 3-point "Triples Advantage" lead
    b. choice of *sides* ("ends") and of *first service*:
        i. at *36:36* both teams automatically change sides again, and the first service is determined by an umpire - tossed coin.
        ii. At *37:35* the leading team has choice of side or service, the lagging team choosing the other.
    c. *service alternates* between teams, changing sides after every rally / scored point. Apart from being delivered from Centre Court, all restrictions on placement of service and service return are waived: play is completely "free".
    d. the teams decide *who serves when*, with:
        i. no more than 2 consecutive services per player
        ii. no more than 3 services per player in total (3 x 6 = 18 points)
    e. The three consecutive shots limit ("3-Shot Rule") still applies
    f. *ANY net ball or edge ball* during Shoot-Out leads to a *"let",* hence rally replay
    g. teams *change sides* after 9 points have been scored.
15. <u>Draw:</u> If no winner has emerged at the end of the Shoot-Out Round, a *"DRAW"* is declared and the game ends:
        i. at *45:45* a *"Straight Draw"*
        ii. at *46:44* an *"Advantage Draw".*
16. <u>Golden Triplets:</u> If the event or situation calls for a "clear winner" (e.g. championship finals) the *"GOLDEN TRIPLETS"* rule comes into effect, which overrides the DRAW rule and quickly ends the game: Three more final rallies are played for the 3 "Golden Triplets" points:
    a. after a *I-minute time-out* break, play starts from a 0:0 "Triplets Score", irrespective of the previous 45:45 or 46:44 score. Shoot-Out rules apply.
    b. *First service* and choice of *sides* is determined as before:
        i. At *45:45* both teams automatically change sides again, and the first service is determined by an umpire - tossed coin.
        ii. At *46:44* the leading team has choice of side or service, the lagging team choosing the other.
    c. The team scoring 2 out of the 3 "Triplets points" wins the game.

Both the final Shoot-Out score as well as the final Triplets score are recorded.

The above has been summarised in the "Close Game" rules shown in Table 2. As an overall guide to Triples play Figure 8 then shows the overall Triples game proceedings in an easy-to-follow flowchart layout.

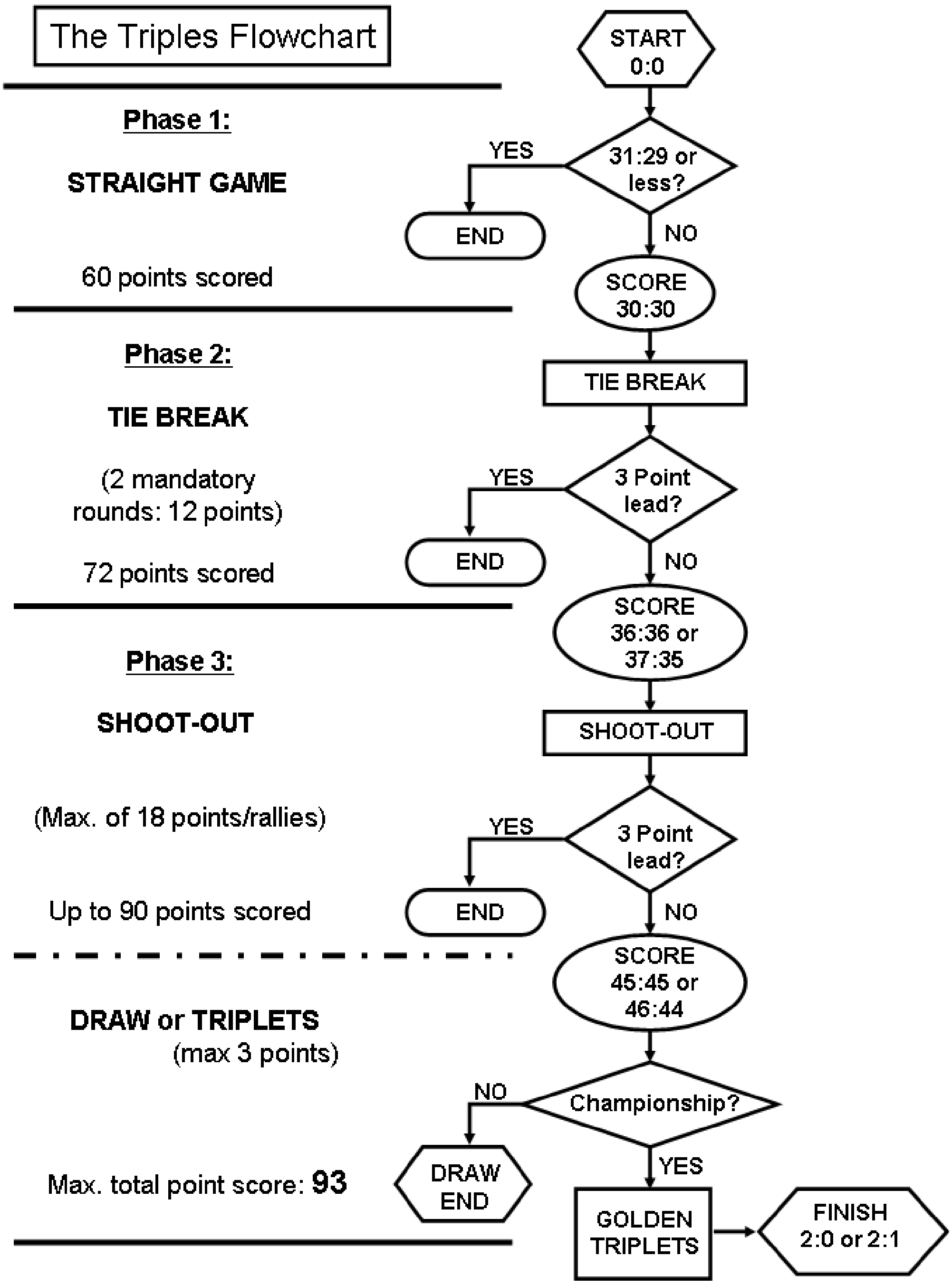
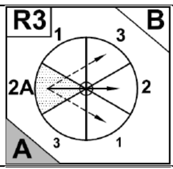


Figure 8: The Triples Flowchart

4.9 Scoring and Umpiring

To facilitate game management and scoring, a Triples scoreboard should, apart from the two scores, show current player positions and Service Round numbers. Since these are prescribed for every single point/rally, they are also included in the score sheets, and help players, umpires and spectators alike to readily follow game proceedings. Examples are given in Figure 9, showing score sheet extracts and their corresponding prototype (flipchart) scoreboard settings during point/rally number 18 in Service Round 3, and number 70 in SR12. Apart from operating the scoreboard, Triples umpires necessarily have to attend to some extra tasks when compared to the standard game. However experience has shown that these can still be managed by a single person, especially when assisted by electronic scoreboards and displays. Further details and a complete set of score sheets are given in [1].

Point No	Player Positions and Round No's	Serv	Rec	Points won by		RUNNING SCORE	Comments
				A	B	A : B	

13 14		2A	2B 2B			: :
15 16			3B 3B			: :
17 18			1B 1B			: :
			Team A rotates			

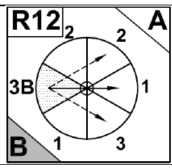
67 68		3B	1A 1A			: :
69 70			2A 2A			: :
71 72			3A 3A			: :
			Team B rotates			

Figure 9: Triples Score Sheet Extracts and Scoreboard Settings

5. First Triples Trials

A new game can only be accepted once it has been thoroughly tested and proven in practice. From a conventional table tennis perspective, this applies particularly to the new, unusual and what will initially be perceived as "uncomfortable" aspects of the Triples game. All its rules and regulations were therefore thoroughly tested in practical verification trials, and in fact incorporate various improvements based on feedback from and discussions with players, and on their practical Triples playing experience gained during these trials.

Fourteen players currently playing in regional "A-grade" and "B-grade" table tennis competitions took part, in a series of three 3-hour trials. These started with warm-up sessions using three balls, followed by team formation, player identification using bibs, and hence playing and timing of all three game phases as per Fig. 8. Players were asked to critically assess the equipment and all the rules, with particular emphasis on their use in serious competitive play. The new scoring and umpiring aspects, and the practicality of the Triples score sheets were also verified. Sample photos taken during the 'warm-up' and 'serious competition' phases of these trials are shown in Figure 10.

Feedback was obtained during de-briefing sessions and from a 22-question evaluation form, made up of 10 general questions and 12 ratings (bad/good/excellent). These and their consolidated responses are shown in Table 3 and Figure 11, respectively. It can be seen that player reactions were generally very positive.

Figure 10: Action shots from 'Warm-up' and 'Competition Triples' trials

Apart from the supportive comments summarised in Table 3, the quantified player assessments of all the specific new 'Triples concepts' shown in Fig. 11 especially support that. All the rules were rated as 'good' or 'excellent', with no 'bad' entries, except for the introduction of a "Draw" outcome (No. 20), and re-starting a rally (or 'let' call) in case of a net or edge ball occurring *anywhere* during a Shoot-Out rally (No. 22). The latter two also included an - albeit minor - 'bad' assessment, indicating that these two concepts were simply 'too radical' for some players – at this point in time. With the future detection of net/edge/line balls in table tennis using electronic sensors, this resistance is likely to change [11, 12].

Table 3: Trial Feedback: General Questions 1-10

	Question	Response Commentary/Descriptors
1	Your first impression of the *Triples Setup (table/net)*	Surprise – fascinating – novel – excellent –tops - interesting
2	How did you feel about playing with *3 Players* 'in a semicircle'	Comfortable – not cramped – not lost – no problem - enjoyable
3	Your general reaction to the *New Rules*	Easy to follow and comprehend – well thought out – will take time to get used to – fair – greater participation
4	What do you think of *"Free Play"*	Best part of the game - needs team understanding – exciting – makes you think – players aware of each other
5	Did you have problems with *Game Proceedings*	No – scoreboard helpful – challenging – easy to follow and understand – takes time to adjust
6	Did you really feel part of a coherent Table Tennis *Team*	Yes: 71% (10 players - *others confessed to being ingrained individualists…)* – 'this will improve with practice' …
7	Could Triples succeed as a *Serious Competition* Game	Yes: 86% (12 players). Others 'maybe'. 'definitely incorporates all competitive elements'…
8	What feature did you like *least* about Triples	Initial lack of teamwork - the net – lack of control as a team player – getting used to team characteristics
9	What feature did you like *most* about Triples	Free play - player rotations – the 3-shot rule – scope for tactics – thrives on team communication – the round table
10	Any other *Comments*:	Team communication a prerequisite - play can be more physical and tactical– 'opens new horizons for table tennis'

11. The 2-shot "Service Rally" concept
12. The "Service Return to Wings Only" rule
13. The 6-service "Service Round" concept
14. The "Player Rotation" system
15. The "3-Shot Limit" rule
16. Playing to 31 points ("Straight Game")
17. The 3-point "Triples Advantage"
18. The "Tie-Break" system
19. The "Shoot-Out" (S/O) system
20. The possibility of a "Draw" result
21. The "Golden Triplets" rule
22. S/O net/edge ball full rally replay

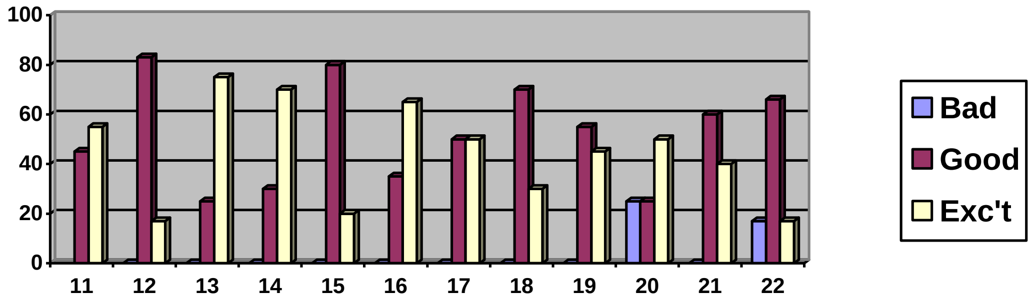


Figure 11: Trial Feedback: Percentage Responses to Questions 11-22

It can be concluded from these trials that Triples, on the round table and with the rules described, not only meets the approval of experienced table tennis players, but can potentially qualify as a serious competitive version of table tennis: players enjoyed playing 'their game 'as part of a real TEAM. Based on the collective experience and wisdom of these trial players (and that of the author) it therefore appears safe to claim that Triples can join the ranks of singles and doubles games as another serious table tennis competition game. Suggestions on how this might be done will now be briefly indicated.

6. Combination Team Events: Singles, Doubles, Triples

It could be argued that he ultimate test to determine conclusively which of two teams really is the better, is to have them compete on an individual *as well as* a team basis, with a combination of singles, doubles and Triples matches counting towards the final match outcome. Various possibilities exist as to how, and how many, of each type should be played to make up a "*Combination Match*", and still complete the event within an acceptable time frame. Also, the character of such Combination Matches is influenced by the relative weightings for each of its three components. Some possibilities are shown in Table 4 [1]. Of the three alternatives shown the 1-5-12 weighting system tends to give the best overall balance, and best represents the player effort and team contribution from each of the three game types. For consistency the overall point total for the match has been taken as 31 – obviously other options exist.

Table 4: Comparison of Weighting in Combination Team Events

Game	Weighting			Matches played	Contribution to 31 points		
	1-3-16	1-4-14	1-5-12		1-3-16	1-4-14	1-5-12
Each singles	1	1	**1**	9	9	9	**9**
Each doubles	3	4	**5**	2	6	8	**10**
Triples	16	14	**12**	1	16	14	**12**

Although all of the matches shown in Table 4 could be played on one re-configurable "composite table" as per Fig. 5, a preferable ('low-cost') solution is to use another conventional table with it. Table 5 shows such a 'two-table' team match schedule, which should typically take 3 to 4 hours, i.e. half a day or one evening, to complete. The Triples match should preferably consist of the best of 3 Triples games. Naturally a (round) Triples table could also be used, together with two standard tables.

Table 5: Two-table Team Match Schedule

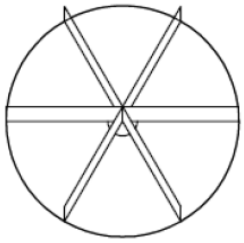
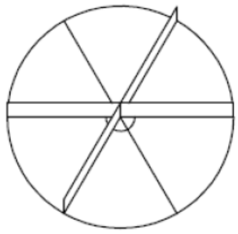
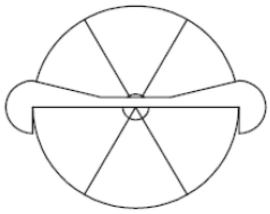
Match Part	Approx. Duration	Player Activity						Table 1 (Conventional	Table 2 (Composite)
		1A	2A	3A	1B	2B	3B		
1	45 min	1	1	1	1	1	1	1A-1B	2A3A-2B3B
		--	1	1	--	1	1	2A-2B	3A-3B
2	45 min	1	--	1	1	1	--	1A-2B	3A-1B
		1	1	1	1	1	1	2A-3B	1A3A-1B2B
3	1 hour	1	--	--	--	--	1	1A-3B	Triples con-version to round table
		--	1	--	1	--	--	2A-1B	
		--	--	1	--	1	--	3A-2B	
4 Triples	1 hour	1	1	1	1	1	1	vacant	1A2A3A v. 1B2B3B
Totals	3 ½ hrs	5	5	6	5	6	5	9 Singles 2 Doubles 1 Triples	

6.1 Round-table Modifications

In fact *all* of the matches shown in Tables 4 and 5 could be played on *one* Triples table. Provided some of the conventional rules of table tennis are relaxed – such as playing on 'triangular courts' - the feasibility of playing more than one game of table tennis simultaneously on one table has been proven before. Figure 12 shows one example, with three singles games being played simultaneously [8, 1]. One can therefore schedule the complete team event on one round Triples table, as shown in Table 6. Apart from equipment savings, the advantages of this 'modified' team event are that players are engaged continuously, and that every player plays an equal number of matches, i.e. six.

Figure 12 : Three Simultaneous Singles Matches

Table 6: Modified Combination Team Event Schedule

Match Phase	Net / Ball Arrangement	Matches	Playing Schedule	A 1	A 2	A 3	B 1	B 2	B 3
1: SINGLES	6 low half-nets 3 balls 	Round 1							
		S1	1A – 1B	1			1		
		S2	2A – 2B		1			1	
		S3	3A – 3B			1			1
		Round 2							
		S4	1A – 2B	1				1	
		S5	2A – 3B		1				1
		S6	3A – 1B			1	1		
2: MIXED MODE DOUBLES and SINGLES	4 low half-nets 2 balls 	Round 3							
		D1	2A3A-1B2B		1	1	1	1	
		S7	1A – 3B	1					1
		Round 4							
		D2	1A3A-2B3B	1		1		1	1
		S8	2A – 1B		1		1		
		Round 5							
		D3	1A2A-1B3B	1	1		1		1
		S9	3A – 2B			1		1	
3: TRIPLES	1 Triples net 1 ball 	Round 6							
		T	1A2A3A v. 1B2B3B	1	1	1	1	1	1
	Event Totals: 31 points	9 Singles : 9 points 3 Doubles : 9 points 1 Triples : 13 points		6	6	6	6	6	6

6.2 Triples in Major Table Tennis Events?

Having established the practical feasibility of Triples, it may be appropriate to consider its possible inclusion into major and/or international table tennis *team* events. First suggestions are shown in Table 7. Some such events, the number of players, and their present composition of singles and doubles matches are listed in the first four columns. The last three then contain the possible addition of Triples matches and the likely effect of that on the overall and winning points scores. A hypothetical and 'pure' *"New Olympics Team Event"* has been added, with teams of three players playing for the best of 7 Triples games.

Team match scenarios such as these are just examples of the many possibilities, in terms of new tactics, match structures and match organisation, opened up by the Triples game and the use of the round table. Many more are feasible and will no doubt be developed and tested in the future.

Table 7: Possible Triples-augmented Team Events

Event	No. of Players in Team	Singles Matches (max)	Doubles Matches	**Triples Matches**	Total Points	Winning Point Score
Corbillon Cup	(4)	4	1	**1***	7	4
Swaythling Cup	3	9	-	**1***	11	6
Modified Swaythling Cup	3	6	1	**1***	9	5
Swedish League	3	9	1	**1****	13	7
World Team Championships	3	5 → 4	-	**1****	7	4
European Champ. League	3	5	-	**1***	7	4
German Bundesliga	6	12	4	**3 (1 game)**	19	9
Olympics 2008	3	4	1	**1***	7	4
New Olympics Team Event	3	-	-	**1 7 games**	**7**	**4 games**
Typical Pennant Competitions	3	6	2	**1****	11	6

* Triples match counts double **Triples match counts triple

7. Conclusion and Outlook

The objective of this paper was to introduce a new table tennis game for teams of 3 players, and to point out the accompanying parent text for full details. Triples for the first time in history allows table tennis to be played as a true team sport. Only its main elements have been presented here. The main text not only provides all other necessary details, but also discusses further possibilities of the game and its equipment, limited only by one's imagination – for example, the use of the Triples sectors in a *"Table Tennis Hurdles Race"*, or using the standard Triples table for *"Quadruples"* [1]. Both these are shown in Figure 13. It is hoped that collectively this paper and book will stimulate the table tennis world to test and hopefully embrace the new game, en route "*to an even more vibrant sport*" [13]. The author now invites comment, whether positive or negative, and looks forward to lively discussion – and to seeing table tennis Triples played in future Olympic Games….

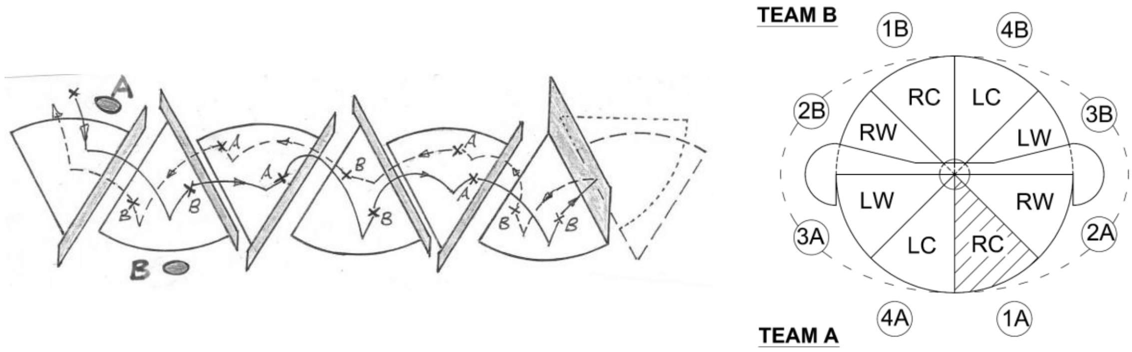


Figure 13 : Triples extensions: – *"Table Tennis Hurdles"* and *"Quadruples"* [1]

8. References

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ACTUAL STATE OF TABLE TENNIS RESEARCH THROUGHOUT SPORT DISCUS DATABASE ANALYSIS

Abstract

Introduction. Research activity of a group, institution or country can be defined by scientific production indicators. These indicators, a key piece in bibliometric studies are closely related to the most important scientific databases in the world. The aim of this study is to know the actual state of investigation on table tennis from specific database analysis. **Method.** We've quantified all of scientific publications on tennis table registered by Sport Discus database (last actualization: December 15th, 2006). From Sport Discus' Thesaurus we selected several key words related to table tennis for to combine them in different search fields and to determine: a) matters with the most scientific interest; b) countries with a greater level of scientific production; c) types of publication sources; d) level of understanding; e) publications' language, and f) evolution of number of publications throughout the last years. **Results.** Scientific publications on table tennis only show 0.4% from total of references that are registered in Sport Discus database. The matters most developed are those related with training while France is the country with the most important scientific activity on table tennis. Evidently, English is the predominant language in tennis table publications and it is necessary to remark an important rise in publications during 1981 to 1990 period. **Conclusions**. It's possible to determine the scientific production on table tennis from a bibliometric study based on specific database analysis. There is a lack of investigation on table tennis compared with other sports, especially racket sports.

Key words: *table tennis, database, bibliometrics, research*

Introduction.

Quantitative analysis of scientific production had its origin in the beginning of the last century. Since that moment technical evolution (computerized databases proliferation) have permitted a more quick and precise data treatment. In the last two decades bibliometry, defined like "application of mathematical and statistical methods to books and other mass media" (Pritchart, 1977), have supposed a common tool for the management of the scientific and research politics (European Commission, 1997).
It is possible to evaluate research capacity of a group, institution or indeed of a country taking into account several scientific production indicators. These indicators, key pieces in bibliometric studies, are closely related with the most prestigious databases in the world of each one of matters which are sciences recognized. In this sense, there is a great number of investigations in different disciplines: education (Fernández-Cano and Bueno, 1999); physics (De la Viesca and Pérez, 1977); chemistry (Perez et al., 1994); medicine (Myscko, 1990); biology (Ferreiro, 1981), social sciences (Villagrá and Román, 1981), psychology (Carpintero and Tortosa, 1996), and so on.

Although the study of the sport sciences is in full development, is interesting to determine the research lines that are predominant or to know what countries are able to maintain a higher scientific activity into this knowledge area. Several investigations have been carried out over specialized journals and doctoral thesis providing some information about sport research capacity (Calatayud, 1997; Delgado and Medina, 1997). However, and for to define the actual state of investigation in any sport discipline it is necessary a detailed analysis of the most specialized database: Sport Discus (Schwarz, 1989).

SPORTDiscus database was created in 1986, thanks to a UNESCO's proposal, and with the intervention of the International Council for the Sport Sciences and Physical Education (ICSSPE) and the International Association of Sport Information (IASI) which designed to the Canadian Sport Information Resource Center (SIRC) to be the neuralgic center where this database is elaborated. *SPORTDiscus* is actualized periodically since 1975, although references of publications edited before can be consulted too. *SPORTDiscus* is presented in CD format and can be consulted on line.

SPORTDiscus is the most comprehensive, bibliographic database covering sport, physical fitness, exercise, sports medicine, sports science, physical education, kinesiology, coaching, training, sport administration, officiating, sport law & legislation, college & university sport, disabled persons, facility design & management, intramural & school sport, doping, drugs, health, health education, biomechanics, movement science, injury prevention rehabilitation, physical therapy, rehabilitation, nutrition, exercise physiology, sport & exercise psychology, recreation, leisure studies, tourism, allied health, occupational health & therapy, public health and more. With full bibliographic coverage, this database includes over 750,000 records with journal and monograph coverage going back to 1800; over 20,000 dissertations and theses and reference to articles in 60 different languages. The content also consists of international references from journal and magazine articles, books, book chapters, conference proceedings and more. The search process in *SPORTDiscus* can be structured by different searchable fields, such as any database (Table 1).

Table 1. *SPORTDiscus' searchable fields list.*

Tag	***Description***	***Tag***	***Description***	***Tag***	***Description***
TX	All text	CA	Corporate author	PB	Publisher
AU	Author	CY	Country of publication	RE	Report number
TI	Title	GE	Geographic subject	SO	Source
SU	Subjects (descriptors)	IS	ISSN	PG	Total pages
AB	Abstract	IB	ISBN	PT	Publication type
KW	Key words	LA	Language	PY	Publication year
RW	Book reviews	OL	Language of Origin	SB	Database subset
CO	Company	PE	Person/Team	AB	Abstract
CN	Conference	PS	Products	AN	Accession number

One of the limitations of *SPORTDiscus* database and of this study too is the coexistence of several similar terms referred to a specific concept in Thesaurus. For this reason it is necessary to review carefully the terms contained in *SPORTDiscus'* Thesaururs for to carry out an accurate search. Moreover, in some cases authors don't define appropriate key words in their manuscripts, an aspect that can generate difficulties and put limits to the search possibilities (Lepkowski, 1991). By other side, it is possible that some references are incompletely catalogued or it can exits lack of information in their search fields.

The aim of this study was to define the actual state of table tennis research by quantification of publications indexed in *SPORTDiscus* database, determining the main research lines in this matter.

Methods.

Instrument.

The two basic elements for data collection were *SPORTDiscus* database and its Thesaurus. The online search was developed in February 2007, under license of University of Sevilla.

Procedure.

For to obtain an actualized and complete analysis of table tennis investigation the following information was collected: a) total volume of table tennis references (total volume of other racket sports was determined for comparison); b) number of publications per countries; c) specific areas of investigation; d) document types and e) evolution (number of publications in different time periods).

Keywords related to table tennis were selected from *SPORTDiscus'* Thesaurus and introduced in *subjects* field (SU). As result we obtained the total volume of table tennis references in *SPORTDiscus* database, a starting point to develop the remaining searches. All terms used here were combined by boolean search operators (and, or, not) for the search in each one of the fields.

Results.

a) Total volume of table tennis references.

A total of 1436 references were registered in *SPORTDiscus* until February 2007. Taking into account that *SPORTDiscus* database contains over 750000 references, table tennis publications only represents a 0.2 per cent respect to the total. Comparing with results obtained in other racket sports, table tennis is ranked in fourth place, beyond tennis (20029 references), squash (1738 references), and badminton (1695 references). Paddle tennis (platform tennis) occupies the last position in this ranking with a total of 47 references (Figure 1).

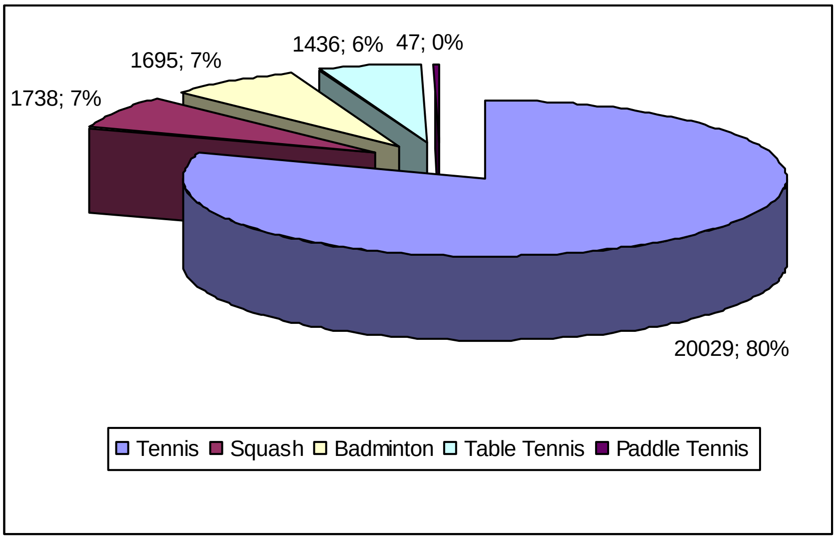

Figure 1. *Distribution of publications on racket sports.*

b) Number of publications per countries.

France is the country with the largest number of publications on table tennis (399 references). Other countries with an important scientific production in this matter are United States, United Kingdom, China and Canada, with all of them above 100 references. By the other side, countries with a poorest production are, between others, Brazil, Bulgaria, Finland, Korea, Norway and Romania (see details in Table 2).

Table 2. *Scientific production (number of publications on table tennis) per country.*

Country	***Number of publications***	***Country***	***Number of publications***
France	399	Israel	4
United States	161	Japan	3
United Kingdom	135	Spain	3
China	111	Croatia	2
Canada	93	Greece	2
Germany	61	Hungary	2
Australia	58	Netherlands	2
Switzerland	20	Sweden	2
Belgium	17	Brazil	1
Italy	17	Bulgaria	1
Argentina	11	Finland	1
Hong Kong	7	India	1
New Zealand	6	Korea	1
Portugal	4	Norway	1
Turkey	4	Romania	1

c) Specific areas of investigation.

From all areas analyzed, only two showed more than one-hundred references: training (218 references) and coaching (115 references). Other remarkable areas of investigation are teaching (84 references) and women (56 references). Surprisingly, areas such as biomechanics, medicine and technique seem to be less developed (30, 16 and 7 references, respectively). For details, see Table 3.

Table 3. *Main areas of investigation in table tennis.*

Specific areas	**Number of publications**	**Specific areas**	**Number of publications**
Training	218	Technique	7
Coaching	115	Health	5
Teaching	84	Sociology	5
Women	56	Recreation	5
Education	47	Children	4
History	37	Culture	4
Physiology	32	Philosophy	4
Biomechanics	30	Aging	3
Statistics	23	Association	3
Medicine	16	Doping	2
Facilities	11	Mass media	2

d) Document types.

Journal articles are the type of publication preferred for to spread the results of investigation in table tennis. *SPORTDiscus* contains a total of 1093 articles on table tennis, a 76.1% of table tennis references in this database. The second place is occupied by monographs, with 171 references (11.9% of table tennis references in this database), followed by universal resource locators (URL) or internet sites (97 references; 6.7%), book analytic (81 references; 5.6%), serial publications (31 references; 2.1%), videocassettes (8 references), doctoral thesis (7 references), and microforms (4 references).

e) Publications' language.

There is no doubt that the main scientific language is English. Indeed, table tennis publications wrote in English are the most numerous in *SPORTDiscus* (631 references; 43.9% of table tennis references in this database). However, and according to the number of publications edited in France and Canada, there is a important amount of table tennis publications wrote in French (525 references; 36.5%). Other languages are German, Spanish, Russian and Italian (Figure 2).

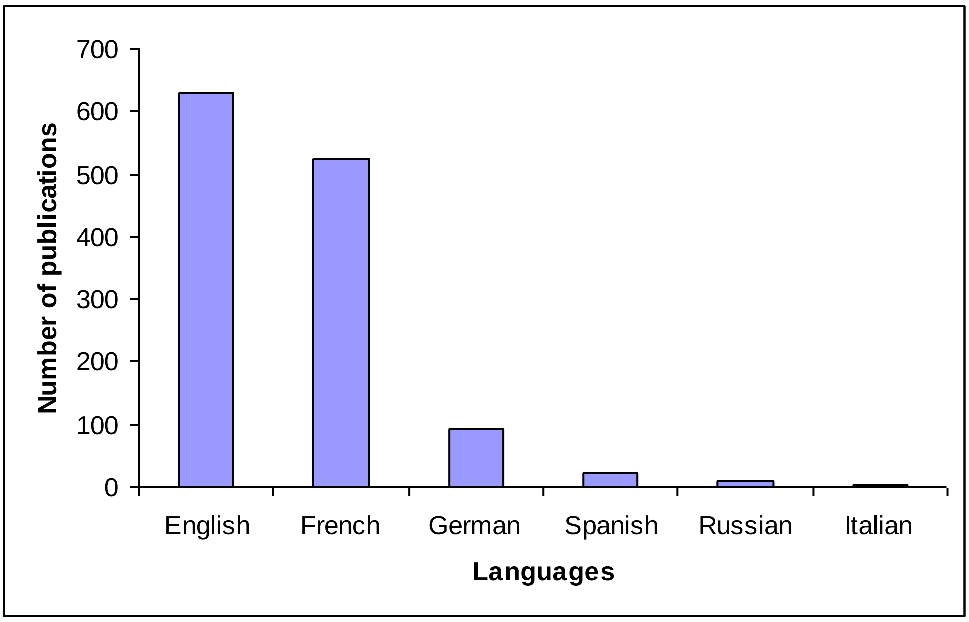

Figure 2. *Languages of table tennis publications.*

f) Evolution.

Until 1980 there are 291 references on table tennis registered in *SPORTDiscus* database. The 80's decade was the most productive reaching 505 references. From 1991 to 2000, the number of references falls to 411 references, a drop that it being more evident in the last seven years, a period in which the number of references on table tennis only reach 198 (Figure 3).

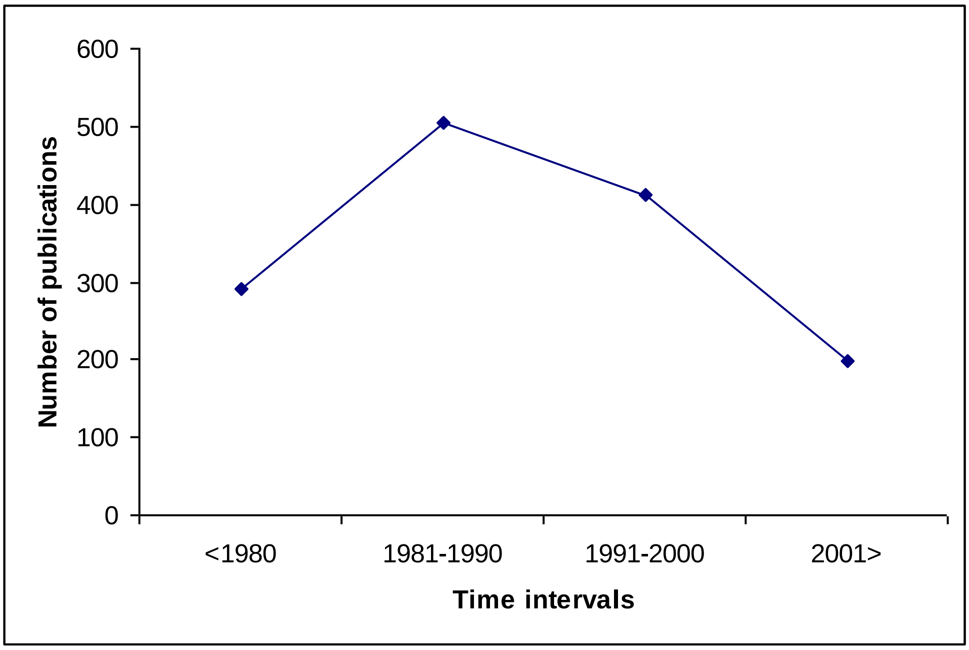

Figure 3. *Evolution of table tennis publications.*

Discussion.

The aim of this study is to offer a global and actual vision of table tennis research. A simple bibliometric analysis permits to quantify the scientific production taken into account references registered in a specific database. In this case, we've used *SPORTDiscus*, the most important database on physical activity and sport sciences.

Research on table tennis is poorly developed. The number of references on table tennis only represents a 0.2 per cent of the total registered in *SPORTDiscus* database. However, this lack of investigation is more evident when it is compared to the number of publications related to tennis. Number of references on table tennis is very similar to publications on badminton and squash but in any case this scientific production is ten times minor than tennis one. Nature and characteristics of sport, level of practice, and economy associated to tennis can be the causes of a higher interest of sport scientists.

Attending to the origin of publications, that is to say, country of publication, it seems clear that there is no correspondence between sport performance and scientific production. While France is the country with a greater number of publications on table tennis (the sum of number of publications of United States, United Kingdom and China is slightly higher than the France's production), China is the main country that dominates the world ranking.

The results show a strong scientific interest in table tennis training. In this sense the highest number of publications is related to specific areas like training, coaching and teaching. However, physiology, biomechanics, medicine, and technique are important areas that present a lack of investigation. It is possible that a great number of publications under the search field "training" are related to the study of physiological/medical parameters or biomechanical analysis of table tennis technique. One of the limits of this type of investigations is the use of a single term in descriptors search field because in many occasions authors don't select the correct terms to describe their manuscripts. In any case, the influence of table tennis in social environment is poorly investigated since health, sociology, culture, and association areas have a little scientific production.

As was to be expected, journal articles are the type of publication that has higher number of references. *SPORTDiscus* collect the main journals of sport sciences, many of them indexed in the Journal Citation Report with impact factor. Experimental research under a rigorous review process is the principal content of these journals so it is remarkable that more than a 75% of the table tennis references are corresponding to these publications. Monographs and URL or Internet sites, with more general information, sum a total of 268 references, a 23.6% of total volume. Doctoral thesis, an academic and scientific document, have only 7 references a poor quantity that indicates a lack of table tennis treatment at universities.

English is the main language in table tennis publications. International publications, especially journal articles, are written in English and for this reason we've registered a great number of publications in this language. However, and if it take into account that France and Canada present an important volume of publications, it is easy to understand the high percentage of publications written in French.

Lastly, and referred to publications' evolution, we've perceived an important rise in publications during 1981 to 1990 period following by an evident decrease of number of publications in the last 17 years, a negative trend that must be broken in the next years.

In conclusion, it is possible to determine the scientific production on table tennis from a bibliometric study based on specific database analysis. There is a lack of investigation on table tennis compared with other racket sports, especially tennis, being table tennis training the main interest of the sport scientists.

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DEVELOPMENT OF A DATABASE SYSTEM "TABLE TENNIS KNOWLEDGE BASE"

Abstract

The aim of this paper is to describe the possibility of using computer software when searching for table tennis databases. There is a lack of information in the field of table tennis science. Due to the problems of finding relevant information for PhD students in Slovenia, we have developed software for searching for information about different table tennis issues (literature, authors, tests…). At the present time the database includes more than 300 entries.

Using the TT Knowledge Base programme, table tennis scientists, coaches, PE students and others can regularly follow published table tennis and table tennis research work from all over the world.

Key words: *table tennis, computer, knowledge base, literature, authors, tests*

Introduction

The computer has inexorably penetrated various spheres of human activity, including sport. A multitude of information, competition results, testing results and similar data have become readily available through IT technology. A modern coach who wishes to be up-to-date with all the available information has to have a good command of computer skills.

Performance in table tennis and in any sporting event is the result of a number of factors which include the amount and structure of training performed, the body's predisposition and adaptation to training, motivation level, facilities, socio-cultural background etc. Nevertheless, when trying to maximise performance it is important to determine the player's ability in individual aspects of performance. If a coach does not have enough relevant information about the training process there is a good chance the player will not achieve a top performance. The lack of information is not only a problem for table tennis coaches but also for PE students. Therefore, the information gathered in the 'Table Tennis Knowledge Base' provides a platform for better work with table tennis players of all levels.

Scientific findings are spreading very quickly. New findings supersede old ones which is why a coach has to keep up with novelties in the international literature and search for the latest findings so as to maximise the planning and proficiency of their work. It is sometimes difficult to keep up with the novelties in the professional and scientific literature on table tennis due to the vast number of professional and scientific magazines published worldwide. Nowadays, the Internet enables fast communication between people around the globe and facilitates the search for and exchange of information. However, the problem of the dispersion of new professional and scientific findings remains since many professional magazines are not published on the Internet.

For this reason, we decided to develop an information system to keep track of professional and scientific literature, authors, player tests etc. in the domain of table tennis. The system consists of a central database on table tennis, into which relevant information on various professional or scientific articles, test descriptions and authors is entered. This information includes data on the authors, titles and topics of articles, the magazines in which the articles are published, the country and language of publication etc. Each entry in the database is defined with some key words that facilitate the search of a specific source. In addition to all the mentioned data, the database may also contain an abstract briefly describing the contents of an article.

As these data are entered in the central database, it is simple to manage them using a computer programme. Database management software was designed that enables the user to enter, correct, search and filter data (displaying data that meet one or several criteria) as well as sort and print them.

The basic idea of the information system is to enable any user interested in these topics to access the database and enter the latest information regarding table tennis. The data entry is controlled by the software, meaning that the same article cannot be entered in the database more than once. The data entry system ensures the uniqueness of each individual reference.

For unregistered users the data entry consists of two phases; in the first phase the unregistered user can enter an article and add it to the waiting list to be reviewed and confirmed by the database administrators. In the second phase, the article is incorporated in the database. This method helps to prevent any malicious entering of nonsense data in the database (i.e. spam). When an individual contributes a certain number of articles in the database they become a registered user. Registered users are trustworthy individuals who are granted the right to make direct entries in the database without adding their entry to the waiting list. In exchange for their contributions, they are granted access to all the data in the central database.

It is in table tennis experts' interest to enter information which is still lacking in the database. Thus the database of professional and scientific articles, authors, test descriptions etc. is growing daily, while any individual can acquire the status of a registered user by contributing a number of entries. As mentioned earlier, registered users can enter new articles directly into the database while at the same time retrieving articles and other information from the database without limitations. This system involves mutual dependency between its administrators and users.

The information system was designed in two versions. The first is a classical Windows application enabling all tasks related to databases (entry, correction, search, filtering, sorting etc.). This version is used by individuals without access to the Internet. They receive the complete system on a CD and install the programme and the related databases on their computer. They record their new entries in the database on a CD and send it to the central database administrators for confirmation and integration in the central database. Each user then receives a new CD with the updated central database also encompassing their most recent entries and those of other users (the complete database).

Individuals with an Internet connection access the central database through a web application (currently being tested). The web application enables the direct entry of articles into the central database. The registered Internet users of the database can access the complete database at any time and find the desired information.

The information system encompasses a central database of professional and scientific articles on table tennis, a database of authors, a database of tests for table tennis measurements and a database of registered users who have the right to directly enter data and use the database without limit. The registered users can access the system by logging in with a username and a password.

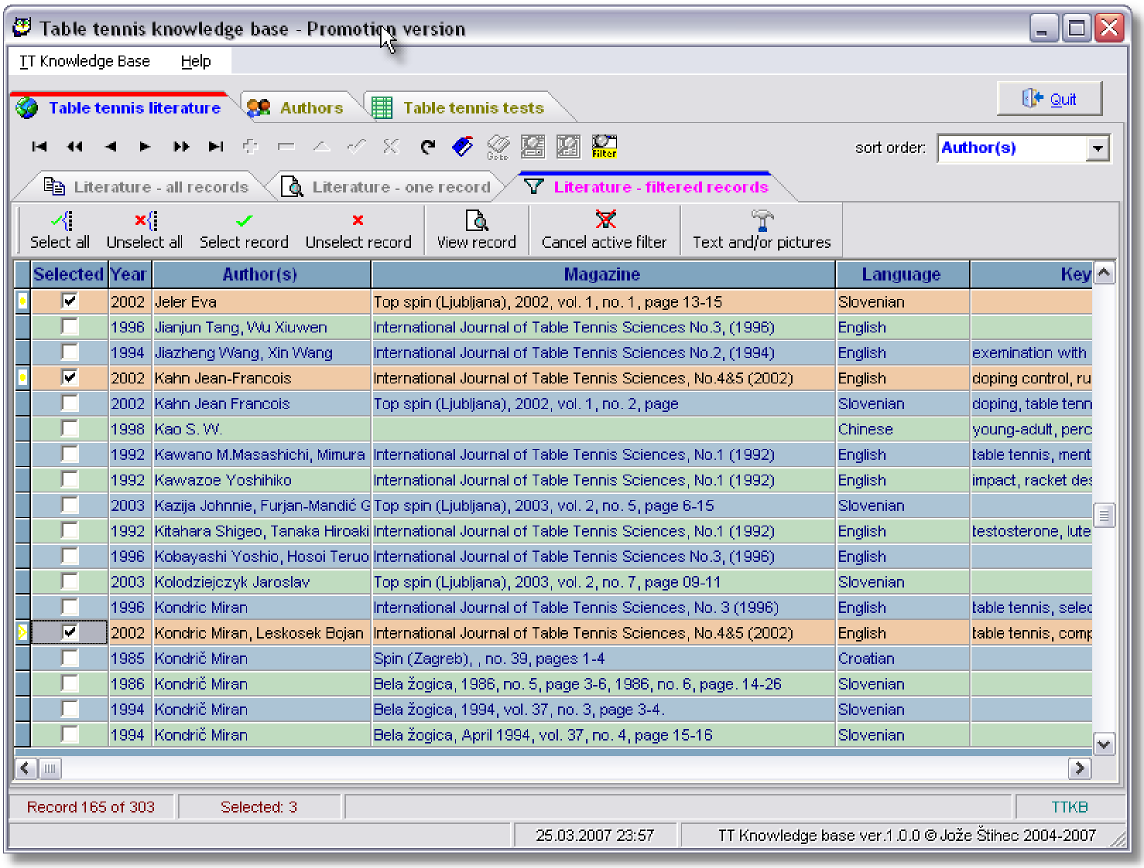

Figure 1 – The main window

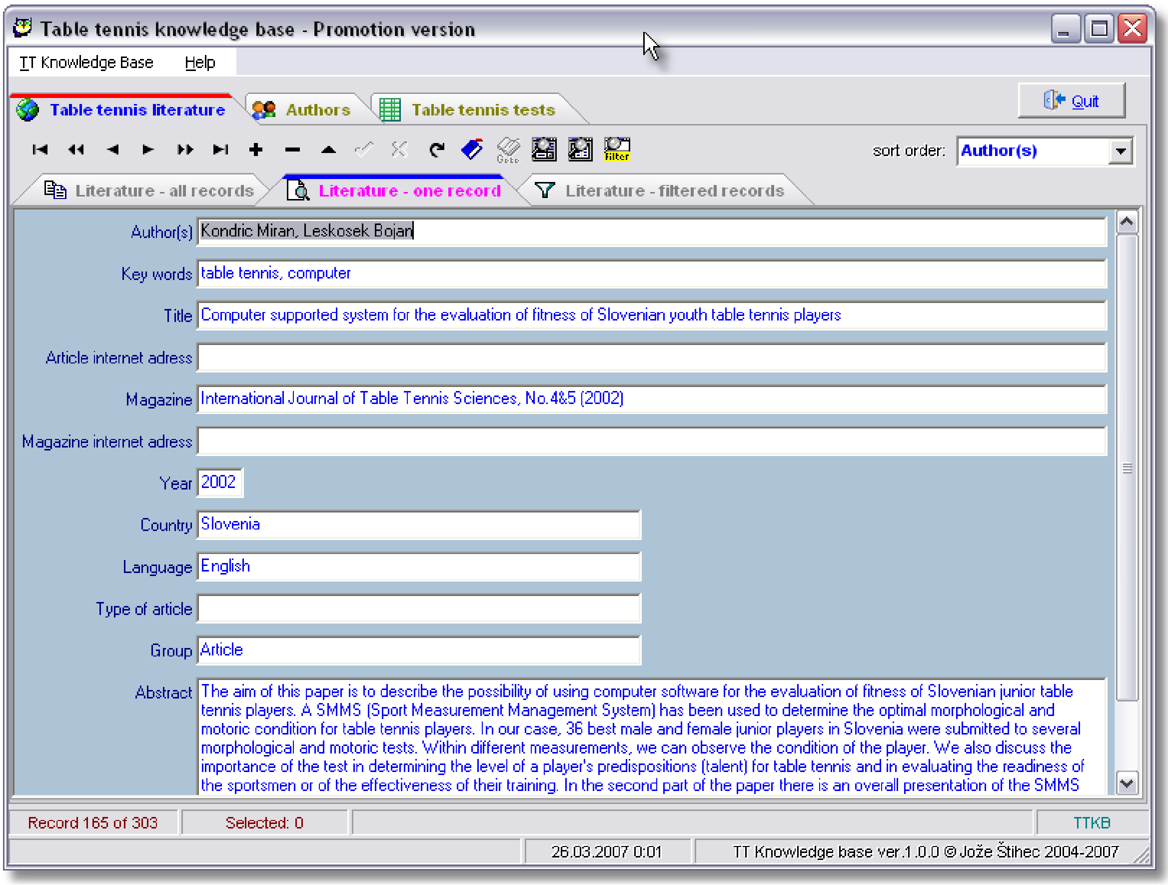

Figure 2 – Data entry & overview

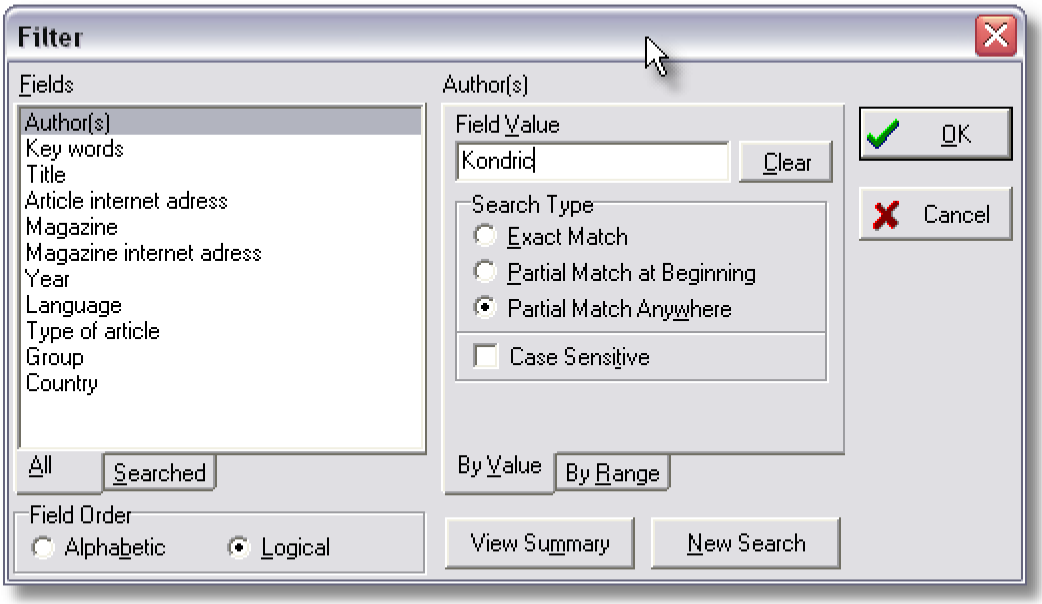

Figure 3 – Filtering data by selected field(s) criteria

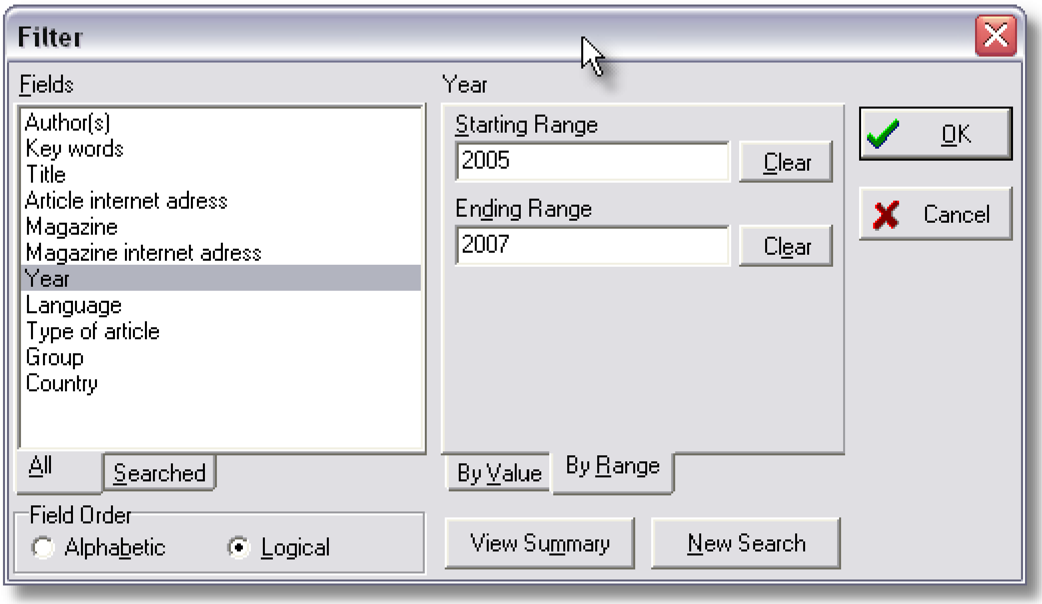

Figure 4 – Filtering data using range

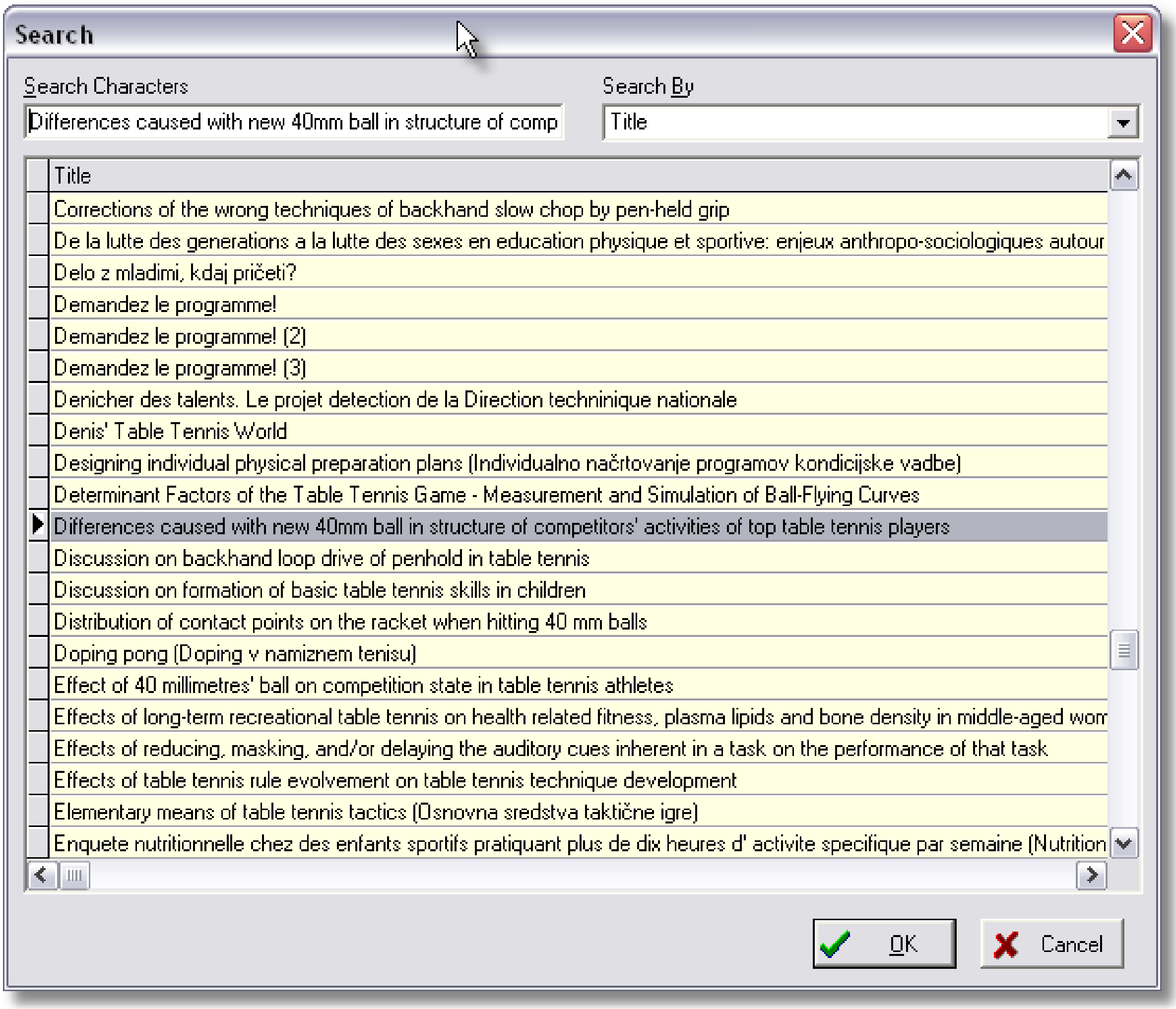

Figure 5 – Incremental searching for data by indexed fields

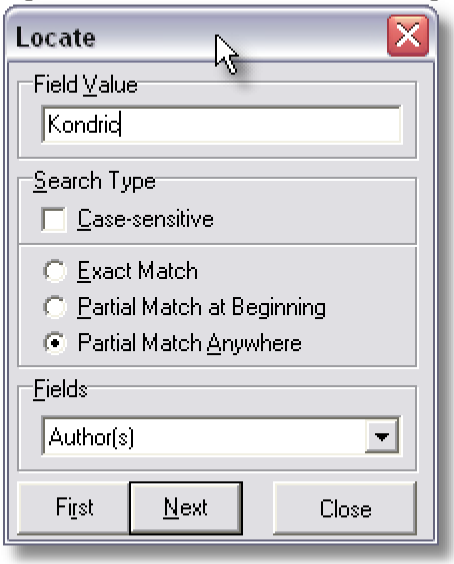

Figure 6 – Locating data by any database field

The aim of this information system is to attract experts around the world to enter data on new articles on table tennis – each from an individual field of expertise and their own country. In this way they acquire the status of a registered user and are granted unlimited access to the database.

Analysis of entries made so far

The information system is in the testing phase in Slovenia. So far, the functioning of the system has been tested and the problems promptly solved. Data entry has been unproblematic and the Internet version of the programme is currently being tested.

The following can be established based on an analysis of the entries made so far:

no. of database hits	301
no. of authors	246
no. of different types of literature	14
no. of web articles	168
no. of articles from different countries	34
no. of users entering data	11

Conclusion

We believe the 'Table Tennis Knowledge Base' information system will be very useful for table tennis coaches and researchers as it will enable fast access to data on articles from various countries. The system is designed in such a way as to motivate every individual to contribute to the central database. Thus, the most relevant data on table tennis will be available in the one place which will save a lot of time and help in keeping track of novelties from various fields of expertise.

Given adequate financial support, the information system will develop even faster and become fully implemented in practice.

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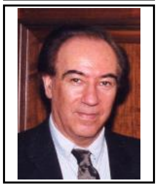
5	**Baron, Ramon**		ramon.baron@univie.ac.at	University of Vienna, Faculty of Sport Science	AUT	
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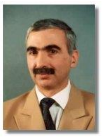
47	**Kahn, Jean Francois**		kahn@ccr.jussieu.fr	*Pierre and Marie Curie University, Faculty of Medicine, Paris, France*	FRA	
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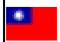
64	**Ling-Chun, Chen**		vicky-1222@yahoo.com.tw	Taipei Physical Education College	TWN	
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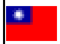
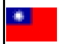
72	**Ming-Hua, Hsu**		mhhsu@mail2000.com.tw	Physical Education Office, National Chung-Hsing University, Taiwan	TWN	
73	**Ming-Yueh, Wang**		mywang@mail.cyut.edu.tw	Chaoyang University of Technology	TWN	
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