A Comparison of Exercise Intensity on Different Player Levels in Table Tennis

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Abstract: The aim of the present study is to compare the physical fitness of table tennis players and the exercise intensity during a table tennis singles match with special reference to the different player levels. Thirty-three healthy men volunteered to participate in this study. They were divided into three samples: recreational level, regional level and league level. All players were subjected to a VO_2max Fitness Test on the motorized treadmill. Measuring heart rate was realized with the monitors Polar RS800 during three table tennis matches. The samples of heart rate were stored in 1 second intervals and were transferred to the software ProTrainer 5. The matches were played on 3 games to 11 points with opponent from the same player level. The results showed significant differences in aerobic capacity (VO_2max) and resting heart rate among the players on the recreational, regional and league level. The best values were in the league players. We found a significant positive relationship between player levels and heart rate responses. The table tennis skill level was a significant factor in the level of exercise intensity in the singles matches.

Keywords: exercise intensity, table tennis, heart rate.

1. INTRODUCTION

Exercise intensity is the amount of physical power, expressed as a percentage of maximum, the body uses in performing an activity [5, 13].

There are several ways to measure exercise intensity. The first method measures the amount of oxygen consumed by the body as an activity is performed. This method is expressed in studies as the percentage of maximum oxygen consumption (% VO_2max). Another method of measurement works with the increased heart rate that occurs with exercise. This method is usually expressed as a percentage of maximal heart rate (% MaxHR) [5, 7]. A simpler method than monitoring heart rate is the Rating of Perceived Exertion (RPE). RPE is a subjective measure and asks the exerciser to think about how hard they feel their body is working against a standardized scale. RPE can be the primary means of measuring exercise intensity if individuals do not have typical heart rate responses to graded exercise [3]. Another method for measuring exercise intensity is the Talk Test. Like the RPE, the Talk Test is subjective and should be used in conjunction with taking a pulse. The Talk Test has been confirmed as a simple and accurate method of gauging intensity that doesn't require any equipment or learning [5].

In our study we used monitoring heart rate to measure exercise intensity in the table tennis matches. The heart rate increases (approximately) linearly up to the deflection point, where the heart rate reaches lactate threshold. In the aerobic mode, in the range of heart rates of about 120–180 beats/min, a linear relation exists between exercise intensity and heart rate. At increased levels of intensity oxygen supply becomes insufficient and the required energy will have to be produced by the muscle without oxygen (anaerobic). The blood supply to the muscle and the accompanying heart rate will increase at a lower degree. The curve will show a kink, or a deviation from the straight line will become visible [4, 5, 7].

Measuring heart rate is the method most often used to evaluate intensity in everyday life or to set the level of exercise in physical training. Low, moderate and high levels of exercise intensity, as measured by heart rate, are defined as follows: Low (or Light) is about 40-54 % MaxHR, Moderate is 55-69 % MaxHR, High (or Vigorous) is equal to or greater than 70 % MaxHR [5, 7].

Heart rate monitoring during table tennis competition can be a sign of the exercise intensity especially in the aerobic mode, the condition of players and a useful indicator for further planning of the training process with the aim of achieving the best possible results [2]. We also must reflect that heart rate can response to mental stress during the table tennis game. A table tennis match involves a combination of periods of maximal or near maximal work and periods of moderate and low intensity activity. Match intensity can vary considerably depending on the players´ level, style and sex [8, 12].

2. PURPOSE

The purpose of the present study is to compare the physical fitness of table tennis players and the exercise intensity during a table tennis singles match with special reference to the different player levels.

3. METHODS

3.1 Method of selecting subjects

Thirty-three healthy men between the ages 18 and 30 volunteered to participate in this study. The subjects

were divided with regard to their player (skill) levels into 3 samples with 11 individuals:

a) The recreational level – beginners. These individuals play table tennis only as a recreational sport 5-10 times a year. They can play the basic stroke. They never played table tennis competition.

b) The regional level - players from regional competition. These individuals play table tennis 2-3 times a week. They played regular table tennis competition for minimum 5 years.

c) The league level - players from the first league. These individuals play table tennis 5-6 times a week. They played the highest table tennis competition for minimum 3 years.

In table 1, characteristics (mean ± standard deviation) of age, height, weight and body fat are shown for selected samples.

Table 1 Basic characteristics of selected samples

	Recreational players	Regional players	League players
Number	11	11	11
Age [years]	25.4 ± 2.5	23.6 ± 3.1	24.7 ± 4.6
Height [cm]	177.8 ± 7.2	185.4 ± 7.7	174.1 ± 6.8
Weight [kg]	81.6 ± 7.8	86.9 ± 9.3	71.6 ± 5.2
Body fat [%]	21.5 ± 5.3	18.2 ± 5.9	12.5 ± 3.1

3.2 Methods of data analysis

All players were subjected to a VO_2max Fitness Test on the motorized treadmill at the Laboratory of Sport Medicine. To begin the exam, subjects were fitted with a respiratory mask, covering their mouth and nose, and were connected to a cardiac monitoring device - 12 Lead EKG. The workload increased every minute until maximum heart rate was achieved and the test concluded with a three minute recovery period at a light workload. All data were recorded continuously throughout the test period. Testing was administered using the motorized treadmill HP Cosmos Pulsar 4.0 MED. Specifications: speed 0 to 40 km/h; elevation -25 % to +25 %; running surface 190 cm x 65 cm.

Measuring heart rate was realized with the Polar RS800 wrist heart rate monitor (Polar Electro Oy, Kempele, Finland). The RS800 is designed for the elite level endurance athletes. The new Wear Link W.I.N.D. transmitter with 2.4 GHz transmission is disturbance free of all other electronic devises. The samples of heart rate were stored in 1 second intervals and were transferred to the software ProTrainer 5 (Polar Electro Oy, Kempele, Finland). This is sophisticated software designed to analyze the results with versatile graphs and to use different reports for long-term development follow-up. This telemetric system has been previously validated [4].

Measuring heart rate was realized in every player during three table tennis matches. The matches were played on 3 games to 11 points with opponent from the same player level.

Mathematical-statistical data processing was done using the software S-PLUS (mean, standard deviation, Kruskal-Wallis test - chi square, 2 degrees of freedom).

4. RESULTS AND DISCUSSION

4.1 Characteristics of physical fitness

Maximal oxygen uptake or aerobic capacity (VO_2max) is the maximum capacity of an individual's body to transport and utilize oxygen during incremental exercise, which reflects the physical fitness of the individual. In our study VO_2max is expressed as a relative rate in milliliters of oxygen per kilogram of bodyweight per minute (ml/kg/min). This expression is often used to compare the performance of athletes. We measured VO_2max when oxygen consumption reached a steady state despite an increase in workload [1].

Absolute values of VO_2max are typically 40-60 % higher in men than in women. The average young untrained male will have a VO_2max of approximately 3.5 liters/minute and 45 ml/kg/min. The average young untrained female will score a VO_2max of approximately 2.0 liters/minute and 38 ml/kg/min. These scores can improve with training and decrease with age, though the degree of trainability also varies very widely: conditioning may double VO_2max in some individuals, and will never improve it at all in others. World class male athletes, cyclists and cross-country skiers typically exceed 75 ml/kg/min and a rare few may exceed 85 ml/kg/min for men and 70 ml/kg/min for women [1,6].

Heart rate is determined by the number of heartbeats per unit of time, typically expressed as beats per minute. It can vary as the body's need for oxygen changes, such as during exercise or sleep. Resting heart rate (RHR) is a person's heart rate at rest. We found out the RHR in the morning, after a good night's sleep, and before individuals get out of bed. RHR is usually between 60-80 beats/min; males tend to have a lower rate than females, and the resting rate tends to fall with age. Resting heart rate is also generally lower in those who are physically fit. A sharp increase in resting heart rate is usually a sign that something is wrong. It may indicate illness, injury, emotional stress, or overtraining [5, 7, 10].

Maximal heart rate (MaxHR) is the highest number of times the heart can contract in one minute. MaxHR is good index to set an individual's training. MaxHR serves as a marker for exercise intensity. MaxHR is genetically determined, it's an individual number. MaxHR does not reflect the level of fitness and tends to be higher in women than men. MaxHR testing requires the person to be fully rested. We measured MaxHR during the VO_2max Fitness Test as the highest beat frequency during this test. MaxHR is usually assumed to be 220 minus the person's age in years, but actual

measurements indicate a wide variation [5, 7, 10].

In table 2, characteristics (mean ± standard deviation) of VO_2max, RHR and MaxHR are shown for selected samples.

Table 2 Functional characteristics of selected samples

	Recreational players	Regional players	League players
Number	11	11	11
VO_2max [ml/kg/min]	42.7 ± 4.2	48.6 ± 4.8	**62.1 ± 5.1**
RHR [beats/min]	67 ± 5	62 ± 4	**54 ± 4**
MaxHR [beats/min]	189 ± 5	191 ± 6	**196 ± 5**

The results showed significant differences in VO_2max (KW test: 21.34 > $\chi^2_{0.01;2}$) and RHR (KW test: 18.56 > $\chi^2_{0.01;2}$) among the players on the recreational, regional and league level at the 0.01 level of significance. The best values were in the league players.

4.2 Heart rate responses

During a table tennis match the heart rate slowly increased as the game continued (see Fig. 1).

Fig. 1 Variations of the heart rate during a table tennis match (the league level).

The mean heart rate (MeHR) and % MaxHR during table tennis matches are shown in table 3 (mean ± standard deviation).

Table 3 Heart rate responses of selected samples during table tennis matches

	Recreational players	Regional players	League players
Number	11	11	11
MeHR [beats/min]	115 ± 11	141 ± 12	**156 ± 15**
% MaxHR [%]	57 ± 5	70 ± 6	**78 ± 7**

We found out a significant positive relationship between player levels and heart rate responses - MeHR (KW test: 36.11 > $\chi^2_{0.01;2}$) and % MaxHR (KW test: 27.73 > $\chi^2_{0.01;2}$) at the 0.01 level of significance.

The recreational players´ value corresponds to value 110 beats/min of Seliger [11], to the mean value 119 ± 17 beats/min of Yukiya [14] and to mean heart rate 112 ± 17 beats/min of Yoshida [13]. This level of exercise intensity cannot develop the cardio respiratory fitness.

The regional players´ value corresponds to results of Shimizu et al. [12] in trained students (143 ± 9 beats/min). Our mean values are lower than the value of 167 beats/min [Rittel and Waterloh, 9], of the Kagaya´s [8] values 160 to 170 beats/min and of the average values from 162 to 172 beats/min during official competition matches [Djokic, 2].

The fact that the results thus vary from literature to literature might have arisen from the difference in the individual endurance ability and also in the quantity of physical exercise depending on the technical level of the opponents during the match.

5. CONCLUSION

Our study investigated the physical fitness of table tennis players and the heart rate responses to playing table tennis with special reference to the skill levels. The results showed significant differences in VO_2max and RHR among the players on the recreational, regional and league level. The best values were in the league players. We found out a significant positive relationship between player levels and exercise intensity. The table tennis skill level was a significant factor in the level of exercise intensity in the official matches. This has implication for the training of table tennis players, which should resemble match intensity.

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