Estimation of Energy Consumption from Heart Rates of Chinese Professional Table Tennis Players in Training Conditions

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Abstract:

Thanks to the characteristics of table tennis, different recreational players can have different aims. The movement intensity varies with such aims. It can be expected that the energy consumption in different levels will be remarkably different.

In competitive table tennis, the movement intensity varies with skill levels. For athletes at a lower skill level, it is difficult to compete continuously, and the sphere of action will be relatively limited, which consequently reduces the energy consumption. Opposite is true for the athletes at a higher skill level. So far, in order to investigate the relationship between movement intensity and energy consumption among different athletic levels, typical junior high school students and skilled university students have been tested as experimental subjects, and the energy consumption over a 60-minute table tennis practice has been surveyed. In competitive table tennis, for advancing the contestants' skill, the implementation method of the physical ability and the training should be investigated. Therefore, in this paper professionalcontestants are tested as subjects to investigate and compare a variety of pulse rates and energy consumption quantities in training conditions.

Keywords: Professional Table Tennis Player, Heart Rate, Energy Consumption.

1. Characteristics of Table Tennis Competition.

Compared with other sports, the competition characters of Table Tennis can be listed as:

It can take place relatively safely.

The motion strength of table tennis can be adjusted widely.

It can take place in the presence of a few people (but at least two) [1)].

In addition, because the speed of struck ball is quite fast, it is necessary for athletes to have balance of entire body and speed of reaction time. Furthermore, judgment and concentration is required as physical elements such as agility and dexterity. Because the equipment used in table tennis is so light in weight and the moving range is not so wide, there are not so much requirements for the young age, specific skill or purpose for the players. Body contact, accidents and injury in the midst of playing are also few. Rules of table tennis are relatively simple. It is an indoor sport which is not influenced by weather conditions. Regardless of age and sex, between different generations can enjoy the sport, seems to be widely known [2)].

2. Objective.

As for the quality of table tennis, based on the fact that it has a large population of players, it is expected that there is substantial difference even in motion strength over such a population. You stimulate fat combustion by playing table tennis. You can achieve the health maintenance, increase the physical strength, and consume excessive calories without growing tired. Contrary to what is generally supposed, playing table tennis can consume many calories. By playing table tennis periodically, therefore, you can expect substantial preventive effects against metabolic syndromes[3.4)].

In this paper change in the heart rate and change in the energy consumption during practice sessions are studied with test subjects drawn from the pool of professional players at the highest level of competition.

3. Method.

3-1. Composition of the Chinese Professional Table Tennis League Each team consists of 4 to 5 players, and is placed in the following four categories according to its strength.

The last two teams of A groups and top two teams of B ,whom winning the top two teams, upgraded to A group.

Super League: Men and women each in 10 teams (40~ 50 foreign players are included)

A League: Men and women each in 16 teams (64~ 80 players)

B League: Men and women each in 32 teams (128~160 players)

C League: Men and women each in 60 teams (240~ 300 players)

3-2. Subjects

The experimental subjects are 12 male contestants and 10 female contestants in Heilongjiang professional table tennis team (They have representatives Heilongjiang team made the top eight groups and individual achievements in the National Youth Competition.). As for the 12 male players, 4 in A League, 5 in B League, and 3 in C League, age: 16.7±1.56 year, height: 171.8±5.36cm and weight: 60.5±1.86kg, competition history 8.7±1.37 years. Each subject exercise 6 hours every day and 5 days every week.

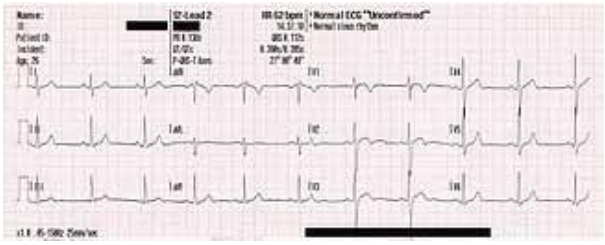
3-3 Condition of the league which subjects belong to

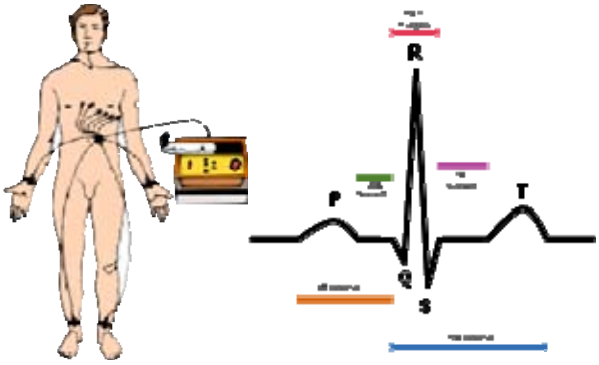
Table1: Condition of the league which subjects belong to

	Male	Female
A League	9 10 11 12	8 9 10
B League	4 5 6 7 8	4 5 6 7
C League	1 2 3	1 2 3

3-4 Equipment and method

Heart rate is surveyed by Radio electrocardiograph (heart beat meter Polar S610i,Show pictures.). The chest double pole induction electrocardiogram QRS wave is applied to survey the heart rate every 5 seconds continuously and energy consumption quantity of 60-mintutes training is surveyed by this method[5].





http://en.wikipedia.org/wiki/Electrocardiography

3-5 Practice contents

Content and practice of male players

[1] Forehand

[2] Forehand drive

[3] Forehand-backhand alternate

[4] Footwork and on loop drive-smash .

[5] Block

Content and practice of female players

[1] Forehand

[2] Forehand drive

[3] Forehand-backhand alternate

[4] Footwork and on loop drive-smash

Because male and female athletes, the physical conditions are different ， the ball and power are different, so the contents of training are not the same.

3-6 Practice times

60 minutes approximately

4. Results

Heart rate numbers to come up with a minimum value of maximum heart rate for each process． In forehand practice [1] the heart beat rate was the lowest, and the energy consumption was also the lowest. At the time of the footwork practice with drive and smash [4] the heart beat rate reached its maximum, and the energy

consumption was also the highest.

In order to improve the heart performance by playing table tennis, the footwork type practice with drive and smash [4] is considered to be the most effective training[6].

Table2 Male professional players character and results

	age	cm	kg	play	history	kcal	kcal/kg	SumIHR (bpm)	MINHR (bpm)	MAXHR (bpm)	AVGHR (bpm)	Motion Strength
sub.pm1	15	166	46	loop	7	324	7.04	6729	89	165	122	65.5%
sub.pm2	15	165	43	loop	7	288	6.70	6789	87	155	123	57.6%
sub.pm3	15	161	44	loop	8	320	7.27	6909	84	178	125	77.7%
sub.pm4	17	172	53	loop	9	335	6.32	6789	73	160	123	66.9%
sub.pm5	18	177	62	loop	10	446	7.19	7089	77	158	128	64.8%
sub.pm6	19	178	76	loop	11	593	7.80	7450	73	159	124	67.2%
sub.pm7	16	174	69	loop	8	506	7.33	7149	83	159	129	62.8%
sub.pm8	15	173	57	loop	8	472	8.28	7570	98	176	130	72.9%
sub.pm9	17	174	65	loop	9	528	8.12	7570	77	160	136	65.9%
sub.pm10	16	169	64	wse pimpled	7	626	9.78	8411	95	197	140	93.6%
sub.pm11	19	176	72	wse pimpled	10	526	7.31	7029	88	159	137	62.8%
sub.pm12	18	176	75	loop	10	741	9.88	8471	82	180	141	81.7%
Mean	16.7	171.8	60.5		8.7	475.4	7.75	7329.6	83.8	167.2	129.8	69.9%
SD.	1.56	5.36	11.86		1.4	140.16	1.11	595.84	8.04	12.76	6.97	0.10

Table3 Female professional players character and results

	age	cm	kg	play	history	kcal	kcal/kg	SumIHR (bpm)	MINHR (bpm)	MAXHR (bpm)	AVGHR (bpm)	Motion Strength
sub.pw1	15	165	57	loop	8	271	4.75	6068	71	161	111	67.2%
sub.pw2	17	167	50	loop	10	373	7.46	7149	91	145	119	48.2%
sub.pw3	15	162	55	loop	8	355	6.45	6729	83	153	112	57.4%
sub.pw4	15	166	58	loop	10	406	7.00	6969	86	143	116	47.9%
sub.pw5	16	167	54	loop	9	406	7.52	7270	84	144	121	50.0%
sub.pw6	18	163	52	loop	10	402	7.73	7390	79	157	123	63.4%
sub.pw7	19	165	51	loop	11	420	8.24	7630	89	171	127	73.2%
sub.pw8	17	165	54	loop	9	509	9.43	8171	96	156	136	56.1%
sub.pw9	15	162	51	loop	9	423	8.29	7630	104	165	127	60.4%
sub.pw10	18	166	59	loop	11	548	9.29	8111	88	185	135	85.1%
Mean	16.5	164.8	54.1		9.5	411.3	7.62	7311.7	87.1	158.0	122.7	60.9%
SD.	1.51	1.87	3.14		1.1	76.67	1.37	634.04	9.05	13.23	8.68	0.12

As for the male professional players, maximum heart rate is 167.2±12.76bpm and average heart rate is 129.8±6.97bpm; the energy consumption is 475.4±140.16kcal, the specific energy consumption (per unit body weight) is 7.75±1.11kcal/kg and motion strength is 69.9±9.99%.

After the athletes with an average weight 60.5kg have practiced table tennis for 60 minutes, the energy consumption is: 60.5 (kg) ×0.128 (kcal/kg/minute) ×60 (minutes) = 464.64 kcal.

As for the female professional players, maximum heart rate is 158.0±13.23bpm and average heart rate is 122.7±8.68bpm; the energy consumption is 411.3±76.67kcal, as for specific energy consumption is 7.62±1.37kcal/kg and motion strength is 60.9±11.86%. After the athletes with an average weight 54.1kg have practiced table tennis for 60 minutes, the energy consumption is: 54.1（kg）×0.127（kcal/kg/minute）×60（minutes）＝ 412.24 kcal.

5. Change of heart rate and energy consumption of Chinese professional Table Tennis athletes under the various modes of practice

5-1 Change of heart rate and energy consumption at fore hand practice

The two red bars show the athletes whose game type is soft. The maximum heart rate of forehand practice for male athletes is 124.3±9.5 bpm and average heart rate is 107.0±8.2bpm, average energy consumption is 30.3±9.1kcal, and specific energy consumption is 0.49±0.09 kcal per kilogram.

The maximum heart rate of forehand practice as female athletes is 129.0±12.7 bpm The maximum heart rate of male athletes is 111.8±9.5bpm, energy consumption is 28.9±5.7kcal, and specific energy consumption is 0.54±0.11kcal per kilogram.

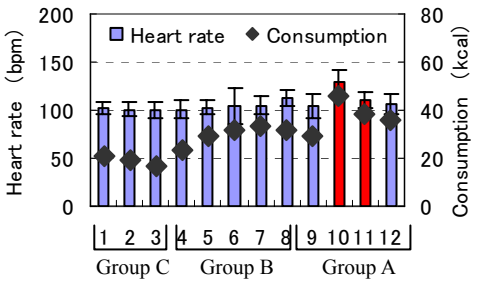


Fig. 1 Male: Heart rate and energy consumption in forehand practice.

The two red ones stand for the players who use pimpled rubber.

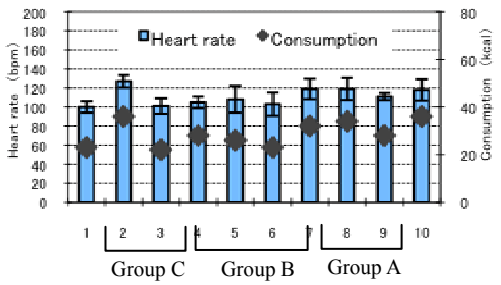


Fig. 2 Female: Heart rate and energy consumption in fore hand practice.

5-2 Change of heart rate and energy consumption at drive-counter drive practice

The maximum heart rate of male athletes at drive-counter drive practice is 152.6±11.9bpm and average heart rate is 130.1±8.2bpm, energy consumption

is 86.5±20.6kcal, specific energy consumption is 1.38±0.24kcal per kilogram. The maximum heart rate of female athletes is 141.2±14.4bpm and average heart rate is 124.5±11.9bpm, energy consumption is 72.1±13.0kcal, specific energy consumption is 0.54±0.11kcal per kilogram.

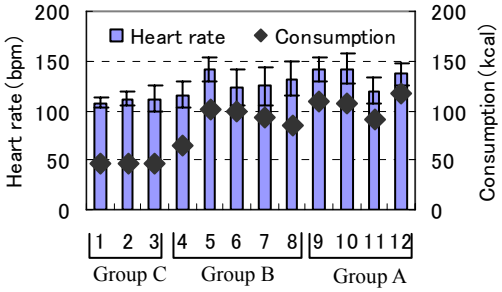


Fig.3 Male:Heart rate and energy consumption at drive-counter drive practice.

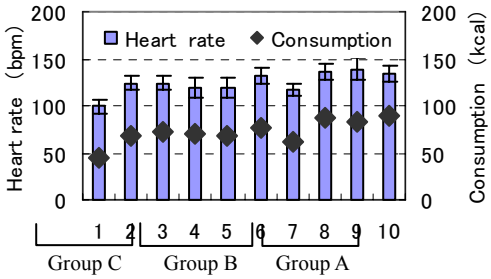


Fig. 4 Female: Heart rate and energy consumption at drive-counter drive striking practice.

5-3 Change of heart rate and energy consumption at forehand and back hand alternate practice

The maximum heart rate of male athletes at forehand and back hand alternate practice is 145.9±14.9bpm and average heart rate is 126.8±12.5bpm, energy consumption is 83.3±30.2kcal, specific energy consumption is 1.35±0.29kcal per kilogram.

The maximum heart rate of female athletes is 136.7±12.2bpm and average heart rate is 122.4±11.6bpm, energy consumption is 70.2±11.6kcal, specific energy consumption is 1.29±0.22kcal per kilogram.

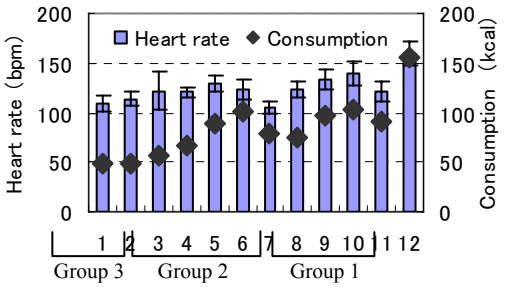


Fig. 5 Male: Heart rate and energy consumption at forehand and backhand alternate practice.

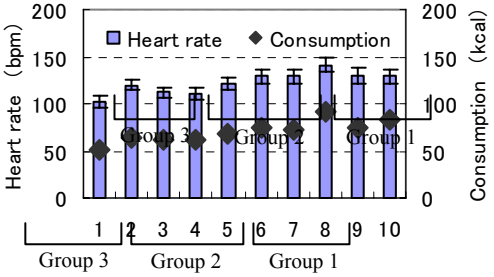


Fig. 6 Female: Heart rate and energy consumption at forehand and back hand alternate practice.

5-4 Change of heart rate and energy consumption at loop drive-smash and footwork practice

The maximum heart rate of male athletes while practicing is 167.1±14.0bpm and average heart rate is 143.8±14.3bpm, energy consumption is 105.2±31.8kcal specific energy consumption is 1.73±0.31kcal per kilogram.

The maximum heart rate of female athletes is 159.1±14.9bpm and average heart rate is 134.4±16.1bpm, energy consumption is 83.0±21.0kcal, specific energy consumption is 1.52±0.36kcal per kilogram.

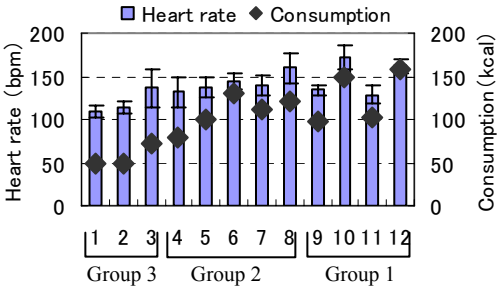


Fig. 7Male: Heart rate and energy consumption at loop drive-smash and footwork practice.

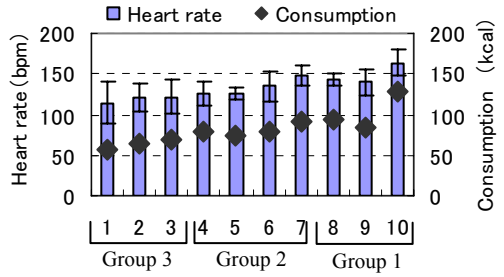


Fig. 8Female: Heart rate and energy consumption at loop drive-smash and footwork practice.

5-5 Change of heart rate and energy consumption at block practice

The maximum heart rate of male athletes at block practice. is 133.1±14.1 bpm and average heart rate is 114.5±9.0 bpm and energy consumption is 35.3±10.4 kcal, specific energy consumption is 1.14±0.17 kcal per kilogram.

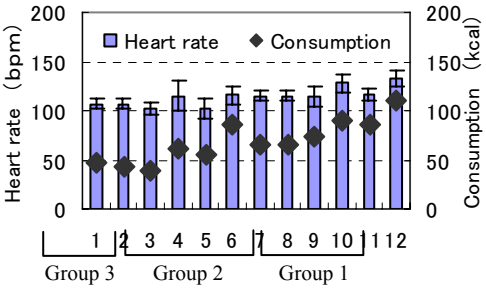


Fig. 9Male: Heart rate and energy consumption at block practice.

6.Review

As far as the prevention of recently prevalent illness caused by ill life style (metabolic syndrome) is concerned, table tennis is considered as one of the best medicine. Thus, it has become important to perform quantitative analysis of the energy consumption as a result of playing it.

"Q&A system Table Tennis sports science handbook" which has been published by the sports science committee of Japanese Table Tennis Association asserts that "table tennis is one of the typical aerobic sports which consume oxygen in the atmosphere and produce energy are all classified as "aerobic" exercises. In aerobic exercises the fat combustion is efficiently performed. Table tennis is considered as a "lifetime sport" of ideal.with it has done[3].

There is a significant difference between the RMR disclosed to the public and the energy consumption with table tennis calculated in this paper. Energy consumption per body weight per unit time shows a range of exercise intensity: 0.050 ~ 0.083 kcal/kg/min. For example, a person with weight 70 kg who conducts medium intensity practice for an hour is estimated to consume a total energy 70 (kg) × 0.065 (kcal / kg / min) × 60 (minutes)=273kcal.

However, our results show that professional table tennis players in this experiment have consumed nearly twice more energy during their 60-minute exercise.

Some of the causes of discrepancy are the age, weight, height, sex, and history of athletic activities.

After all, what is the best index of exercise intensity?

7. Conclusion

Table tennis has been played at all levels, from the recreational level up to the professional level.

Therefore, this study examined the heart rate and energy consumption of high level professional Chinese table tennis players in training sessions. The results are as follows.

7-1. Depending on the type of exercise, energy consumption varies.

7-2. Competitive athletes at high levels tend to consume more energy in the Professional Table Tennis Player.

7-3. In the women's and men's differences competitive level energy consumption is not the same as the performance difference.

In order to enhance their strength and improve the skill levels, I think it is necessary regulate the content and practice exercises to enhance the density

8. References

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