51 A feasibility study of interval hypoxic training of table tennis players

X. B. Lin
Guangzhou Institute of Physical Education, Guangzhou, China. linxiao – bing@163. com.

1 Introduction

In accordance with the Sports Event Classification Theory, the table tennis falls into the category of skill – leading dual events over the net. In other words, skill is the decisive factor in a table tennis match. As far as the Chinese national table tennis team is concerned, the ever – victorious exploits in the past fifty years mainly resulted from the excellent skills. However, with the gap of skills narrowing down among the world's top players, and the rules undergoing quick changes, the Chinese players are gradually losing their competitive edge in technical skills. As a result of the exceptional heredity and the well – balanced diet of European athletes, they are generally superior to the counterparts in China in terms of physical strength. Suppose two equally skilled players have a match. Winning the match calls for not only excellent tactics and psychology, but great physical strength as well. Nothing but great stamina enables players to bring their skills and tactics into full play. So, how to use scientific training methods to improve Chinese players' physical strength is a big challenge we have to take up.

2 Methods

Literature review; theoretical analysis; inductive method; statistical method.

3 Results and discussion

3. 1 An analysis of table tennis energy supplying features

Ever since the 1980s, table tennis scholars have carried out a series of in – depth researches into the energy – supplying characteristics of this sport and achieved extensive consensus on this subject. The research findings by Welble (1985), Liu Xun (1986) and other scholars indicate that table tennis is an aerobic metabolism sport requiring great endurance, which often alternates with short – interval intense non – aerobic metabolism. The main ways of energy supplying can be seen in table 1.

The energy – supplying characteristics show themselves not only in the come and go of the ball, but also in games, sets and the length of days. For example, an international table tennis tournament often takes six to ten days.

Fine players usually enter for quite a few items of the event, and the games he participates in often come up to seven a day. In each game there are often five sets on the average (see also table 2 and table 3). Since the international tournament often adopts the single elimination system, the gap of the professional skills among contestants becomes smaller as the match goes on. Usually players are not only exhausted in the body but also highly tensed in the mind, so the great endurance performance is the decisive factor in the success.

Table 1. A comparison of Table Tennis Energy Supplying Systems

Energy systems	ATP ~ CP energy supply	Sugar anaerobic glycolysis	Sugar aerobic oxidation	Fat aerobic oxidation
Energy - supply time	6 ~ 8 s	2 ~ 3 min	Over 3 min	Over 10 min
Characteristics of metabolism	Anaerobic	Anaerobic	Aerobic	Aerobic
Characteristics of Exercise	Maximum intensity over a brief interval	Great intensity over a somewhat long interval	Moderate intensity over a long interval	Moderate intensity over a long interval
Corresponding movements	Attack (drive) or backhand attack (drive) with maximum strength; Fastest pace movement	Drive, chop and other skills with moderate strength	Return the shot with a chop, stop to pick up the ball and take a rest between intervals	aerobic oxidation

Table 2. The Number of Games for Top Chinese Players at the 47th World Table Tennis Championships

Name	Kong Linghui	Ma Lin	Wang Liqin	Wang Hao	Wang Nan	Zhang Yining	Li Ju	Niu jianfeng
Number of Games	12	16	15	15	19	17	12	16

Note: No mixed doubles for Kong Linghui and Li Ju

Table 3. The average sets in each game & the sets in the finals for the Top Eights at the 47th world table tennis Championships

Event	Men's singles	Men's doubles	Women's singles	Women's doubles	Mixed doubles
Total sets	90	81	78	77	84
Total games	15	15	15	15	15
Average sets	6	5.4	5.2	5.1	5.6
Total sets in finals	6	6	7	5	7

3.2 The Endurance performance and features of chinese table tennis players

Zhang Hua and other scholars conducted a survey of the endurance performance of 20 Chinese Table Tennis players (10male and female each). Their findings show that the somatic function of the Chinese national team is excellent on the whole, but the cardiovascular and respiration function is relatively weak. This mainly manifests itself in the following ways: Judged from the morning pulse and blood pressure, the Chinese players' cardiovascular function ranks only among the average; Seen from the vital capacity and height – to – vital capacity, the cardiovascular function of some Chinese players is even not so good as that of the average teenagers of the same age in some European countries. Peng Rui and other research fellows once conducted a survey of the somatic function of the Guangdong table tennis players, and they found that the testees' anaerobic metabolism is fairly good while their aerobic metabolism is poor. Lu Yunxia's findings indicate that the coach often attaches much importance to the skills and tactics training, but pays scanty attention to the training of their physical strength, for they think players' achievement is not so closely related to their physique. From the researches above, it can easily be seen that the Chinese table tennis players are inferior to their counterparts in terms of endurance performance and so their physique in this respect remains to be strengthened.

3.3 A Comparison of the advanced endurance training methods

At present there are three universally recognized training methods to improve the endurance performance and physical strength of table tennis players: altitude training; living high – training low; interval hypoxic training. The three methods mentioned above are fairly advanced in improving players' physique, and aerobic endurance in particular. Besides, the methods have already been widely used in long – and medium – distance running, cycling, kayaking, basketball and football playing, and other sports events.

3.3.1 Mechanism for altitude training

By altitude training we mean transporting table tennis players to a certain region of a moderate altitude, where they receive special training at regular intervals. The main mechanism is as follows. When athletes receive training in the environment of hypoxia and depression at a moderate altitude, the dual stimulation of anoxia and intense training helps to arouse their potentials in the body, and thus produce a series of anti – anoxic physiological reflections that are conducive to sports capabilities. This method will go a long way in helping improve the function of the athlete's respiration and cardiovascular systems, and especially the ability of the aerobic metabolism.

3.3.2 Mechanism for living high – training low

The living high – training low method is a very innovative way of endurance performance training in comparison with the altitude training. Its main pur-

pose is to effectively handle the somewhat low intensity of training that exists in the altitude training. As the term living high – training low suggests, athletes live at an altitude and train near sea level. The athletes living at an altitude can acclimatize themselves to the changes brought about by training at sea level and thus improve their endurance performance, while athletes training at sea level can keep away from the adverse influences brought about by altitude training. However, this kind of training is hard to be put into practice as a result of the high cost and the high demand for the terrain.

3.3.3 Mechanism for interval hypoxic training

In view of the huge costs of living low – training high, scholars come up with the idea of interval hypoxic training in table tennis. It has the following advantages. Firstly, athletes can receive special training at simulated altitudes without having to go to the plateau areas. Besides, the simulated altitudes can be adjusted according to the individual conditions of athletes. By interval hypoxic training we mean athletes breathe in low – oxygen gases through apparatuses so long as the gas doesn't exceed the scope that the human body permits. Often the higher the simulated altitude, the lower the oxygen content. Intrinsically speaking, the interval hypoxic training is to use artificial methods to create a hypoxic environment to boost the athlete's aerobic endurance capacity. Hopefully, it can achieve the desirable effects of the simulated altitude training. At the same time the other training programs and the regular rest time will not be disrupted.

Table 4. A Comparison of the Three Endurance Capacity Training Methods

Training Method	Altitude Training	Living high – training low	Interval hypoxic training
Main training results	Improved aerobic endurance capacity	Improved aerobic endurance capacity	Improved aerobic endurance capacity
Effects on training intensity	yes	less	less
Adjustment of altitude	impossible	impossible	possible
Effects on athletes' original movements	yes	no	no
Effects on athletes living	Most obvious	A little	Not obvious
Domestic implementation of the methods	yes	yes	no
Abating after workout	yes	yes	A little
Cost	Fairly much	immense	Not much

As Table 4 shows, the interval hypoxic training has not only the merits of the altitude training and the living high – training low methods, but also the advantages of low costs, adjustable simulated altitudes, little effect on

athlete's living and regular training, and the like. In short, it is a most fitting physical strength training method for table tennis players.

3.4 Effects of the interval hypoxic training on athletes' locomotion capacities

3.4.1 Effects on the overall locomotion capacities

Great physical strength is essential for athletes to bring their tactics and skills into full play. The interval hypoxic training can improve the athlete's overall locomotion capacity. Li Qiang and other scholars conducted experiments of interval hypoxic training on after – workout badminton players for the purpose of researching into their physical strength characteristics. The results show that it can effectively enhance the locomotion capacity of athletes, registering an obvious improvement in locomotion capacity after the completion of a fixed amount of training load. Lei Zhiping's researches show that interval hypoxic training can greatly improve athletes' respiration function, enhance metabolism efficiency and thus promote the locomotion capacity.

3.4.2 Effects on anaerobic metabolism performance

Table tennis is an aerobic & anaerobic energy supplying sport event, but anaerobic metabolism occupies a dominant place in this game. For example, Li Shicheng and other scholars carried out a four – week interval hypoxic training experiment on white mice. The findings show that the metabolism of the lactic acid in the skeletal muscle of the mice greatly improved after simulated altitude training, which is evidenced by the decreased concentration of lactic acid, and the approach of the resting value at the sea level. This suffices to prove that the interval hypoxic training can enhance aerobic metabolism performance as well as anaerobic metabolism efficiency.

3.4.3 Effects on the excitability of the nervous system

As ping pong ball is small in size, quick in speed and spinning in motion, table tennis players are required to be agile and respond quickly. Chen Gengchun and other scholars' findings show that the interval hypoxic training can boost the brain's power against anoxia, enhance the nervous system's reflexive ability in the face of anoxia, and increase the athlete's locomotion capability as well. In short, the interval hypoxic training plays an active role in enhancing the nervous system's excitability and reflexive competence.

3.5 Present researches into the interval hypoxic training of table tennis players

Since the altitude training goes a long way in helping table tennis players enhance their physical strength and the nervous system's fatigue resistance, scholars carried out a lot of researches into the effects and characteristics of the training method. For example, the main researches in this field are as follows: some European athletes were transported to receive altitude training at

Granada, Spain, but the effects are unknown in the newspaper. Xu Xingguo and other scholars once studied the effects of altitude training on the speed, the skills of attacking and looping. They believed that an altitude of more than 2500 m exerts a considerable effect on table tennis skills. Cheng Yunfeng and other scholars (1990, 1996) believe that the merits in the altitude training outweigh the demerits, such as enhancing athletes' aerobic metabolism performance and increasing their explosive force. The table tennis team of Yunnan University received altitude training regularly, which significantly improved the athletes' performance. Thus it can be seen that the value and significance of the altitude training has been widely recognized in the circles of table tennis, but scholars have not paid due attention to the training – oriented practice. To the author, there are two main reasons behind it. 1) The theory and methods of the interval hypoxic training is still new to the table tennis circles. 2) There are no effective channel of communication between the academic circles and the instructing circles.

4 Conclusions

(1) It is widely acknowledged that table tennis is an aerobic metabolism sport requiring great endurance, which often alternates with intense anaerobic metabolism over a short interval.

(2) Among the three methods of the altitude training, the living high – training low, and the interval hypoxic training, the last one is most fitting for the training of athletes' endurance.

(3) Both the academic circles and the instructing circles need to redouble their efforts to research into the theory and practice of the interval hypoxic training.