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Retraction

Retracted: Modeling and Simulation of Basketball Players' Cardiopulmonary Endurance Sensor under Different Intensity Training

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] Y. Dai, "Modeling and Simulation of Basketball Players' Cardiopulmonary Endurance Sensor under Different Intensity Training," *Journal of Sensors*, vol. 2022, Article ID 6787984, 7 pages, 2022.

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Research Article

Modeling and Simulation of Basketball Players' Cardiopulmonary Endurance Sensor under Different Intensity Training

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In order to explore the effects of HIT and MICT on aerobic endurance of college basketball players. By analyzing the difference between the cardiorespiratory endurance of basketball-specialized college students and the certain correlation between their athletic ability, it can better serve the practice of basketball training and provide certain theoretical guidance and theoretical guidance for the improvement of basketball-specialized college students' athletic fitness, with a practical application value. 37 male college basketball players were randomly divided into the HIT group and MICT group. They were trained four times a week for 10 weeks. The special indexes of cardiopulmonary and basketball were measured during and before and after exercise. The experiment shows that the heart rate in HIT fast running stage is significantly higher than that in MICT, and the stimulation to cardiopulmonary function is stronger. HIT and MICT are difficult to improve athletes' VO_{2max}, but they can significantly improve the utilization rate of VO_{2max} of VAT, and the effect of HIT is better than MICT. HIT and MICT have significant effects on improving the performance of $15\,m \times 17 \times 4$ run, and the former has obvious advantages. However, in terms of improving the performance of 3/4 sprint, HIT improved significantly.

1. Introduction

Basketball is a highly confrontational sport, which integrates the overall team cooperation strategy, personal tactics, and ability and should be carried out smoothly in the whole game, including running, jumping, fighting, dribbling, and pitching [1]. This uniqueness of basketball determine that basketball players need excellent tactical ability, strong consciousness control, and good physical quality. The most important and basic point is focused on the link of cardiopulmonary endurance in athletes' physical quality. Excellent basketball players should not only have good anaerobic ability but also have good aerobic ability. 89.58% of the energy in basketball is provided by aerobic metabolism. In the intense competition, basketball players are required to run back and forth about 180~200 times, about 5400~6000 meters, lasting about 60 minutes, jumping and changing positions repeatedly. There are high requirements for athletes' endurance level. Aerobic metabolism is the foundation. Good aerobic metabolism ability plays a protective role in accelerating the recovery rate after anaerobic metabolism, delaying the occurrence of sports fatigue, and making athletes bear high-intensity and heavy load [2]. Cardiopulmonary endurance plays a very important role in all ball games that require a long time (more than 30 minutes). As shown in Figure 1, in such a long time, athletes stop running, jogging after sprint, etc., if cardiopulmonary endurance is lacking, the competition in the second half of each movement will be unable to give full play to their skills and tactics due to physical decline, It will even affect the athletes' sports level and competition results. The test and research on cardiopulmonary endurance of college students majoring in basketball can make basketball safer and more scientific and make coaches more clearly understand the physical condition and skill level of players, which is undoubtedly beneficial to the long-term development of basketball [3].

Training frequency	At least 5 days aweek	At least 5 days aweek	At least 5 days aweek
The intensity of training	Maximum heartrate HR (220 -age) 55% to70%	> HR70%	HR 55% -70%moderate intensity combined with HR more than 70% high intensitytraining
Training time	150min/week	75 min/week	
The training type			
Suitable for personal	Knee injurycan choose to swim and other knee training without impact	Knee injurycan choose to swim and other knee training without impact	

Figure 1: Cardiopulmonary endurance under different intensities.

2. Literature Review

Yu and others found that cardiopulmonary endurance is a research hotspot in the field of sports in recent years. Most of the research is on common aerobic endurance sports such as football and long-distance running, and there is little research on basketball [4]. Esposito and others tested various indexes such as cardiopulmonary endurance, balance, and lower limb muscle strength of college students majoring in basketball; analyzed the differences of college students' cardiopulmonary endurance and some correlation between their exercise ability; and explored the impact of cardiopulmonary endurance on college students' exercise ability, sensitivity, and lower limb muscle strength [5]. Karmaker and others provide effective data and analysis, in order to provide useful reference and help and better serve the practice of basketball training, and provide certain theoretical guidance and practical application value for the improvement of competitive fitness of college students majoring in basketball [6]. Cardiopulmonary endurance refers to the ability of the circulatory system to promote blood circulation and deliver oxygen and nutrients to the body through pulmonary respiration and cardiac activities. Carbone and others found that it is the ability of the human body to continue physical activity and is regarded as one of the most important core indicators in the evaluation index system of health and physical fitness [7]. Hysa found that modern medical research has proved that people with low cardiopulmonary endurance have a significant increase in the risk of cardiovascular diseases [8]. Luo believe that improving the body's cardiopulmonary endurance level can not only improve the cardiopulmonary adaptability, enhance physical ability, and increase exercise efficiency but also reduce the incidence of cardiovascular diseases, metabolic diseases, and other diseases caused by bad lifestyle and improve people's living standards [9]. Rusdiana found that the important indexes used to evaluate cardiopulmonary endurance at present include maximum oxygen uptake, the velocity at VO_{2max}, and lactate/ventilation threshold [10]. Cattagni and others believe that VO_{2max} is one of the reliable indexes used in the current experiment to evaluate the level of cardiopulmonary endurance. The concept of VO_{2max} evaluating cardiopulmonary endurance was put forward by physiologist hill in 1920 and gradually improved [11]. Chen et al. studied the decline of cardiopulmonary endurance of healthy adults with age and the impact of daily work forms on cardiopulmonary endurance. They followed 3429 adult women and 1689 adult men. From 1974 to 2006, they followed the subjects' lifestyle, including body mass index (BMI), aerobic exercise status of self-sensory evaluation, and smoking [12]. It is proposed that the level of cardiopulmonary endurance and age show a nonlinear decline process, which accelerates after 45 years old. It is found that body mass index (BMI) is negatively correlated with cardiopulmonary endurance. The level of cardiopulmonary endurance of individuals who exercise more is much better than that of individuals who do not exercise. Nonsmokers also have better cardiopulmonary endurance than smokers. It is suggested that people maintain a low level of BMI (body mass index) and participate in regular aerobic exercise. Nonsmoking is conducive to maintaining a high level of cardiopulmonary endurance and health. Kostrzewa-Nowak and others also mentioned in the study that there is no linear relationship between cardiopulmonary endurance level and age and mentioned that in the age stage of about 30 to 40, the peak oxygen consumption (VO_2 peak) will be reduced by 3% to 6% every ten years, and the decline after 70 will be reduced by 20% every ten years. However, with the accelerated decline of aging, this situation is related to personal physical activity habits [13]. Emoto et al. believe that these unique features of basketball determine that basketball players need to have excellent tactical ability, strong conscious control, and good physical fitness. The most important and basic point is the cardiorespiratory endurance in the physical fitness of athletes on the link [14].

3. Method

The study found that the exercise load test is more suitable for athletes, but for some people, it is difficult to meet the VO_{2max} test standard, so there is a degree of physical exhaustion and unable to maintain exercise. Therefore, in Bruce's

treadmill test, the oxygen uptake level measured by the treadmill test is divided into three levels: (1) In the whole treadmill test process, based on the curves and graphs described by the theoretical interpretation and measured data, the mathematical method is expressed in the form of log curve to obtain the relationship between oxygen uptake and minute ventilation. (2) The point where the oxygen uptake of the body no longer increases with the increase of exercise intensity indicates that it can reach the maximum value of the aerobic ability level of the subjects in the plateau stage. (3) When the maximum oxygen uptake is reached, the treadmill running speed at this time is the maximum oxygen uptake speed, as shown in Figure 2.

This study intends to use two methods, HIT (high-intensity interval training) and MICT (moderate-intensity continuous training), to explore the impact of these two training methods on the aerobic endurance of basketball players, and to provide reference for training. 37 male basketball players from two universities were selected as subjects, including 19 in the HIT group and 18 in the MICT group (see Table 1 for age, height, weight, and training years) [15]. The criteria for the subjects are as follows: maintain normal diet and living habits during training and have no history of major injury in the past 6 months. 3 to 4 recorders were arranged at each point to record the exact starting time of the fast running and jogging stages of 2 to 3 athletes in the HIT group, corresponding to the polar table time for HR extraction analysis. The MICT team assigned 2 recorders to record the start of the entire test.

The training cycle is 10 weeks, 4 times/week, 60 min/time. The training contents of the HIT group and MICT group are divided into three parts: preparation part, basic part, and end part [16, 17]. The preparation part and the ending part of the two groups are the same, and the daily contents specified by the coach are adopted. In the basic part, the HIT group and MICT group were the 4-lap X1 group (rest: 2 ~ 3 min), 5-lap X1 group (rest: 4-5 min), and 6-lap X1 group. The HIT group adopted 100 m fast running (straight track fast running, 80% ~90% v), 100 m jogging (curve slow running, 35% ~45% Vmax), and the MICT group adopted whole process uniform running (60% ~70% Vmax). There are 19 sets of polar watches (model: sb10). When preparing for the activity, wear the reflector, which is required to be placed on the left side of the heart socket, and wear the receiver on the left or right hand. After opening the watch, record the opening time of each athlete and the accurate test time of each stage of the two runs. With 100 m of track and field as the measurement unit, four recording points are set, and 3 ~ 4 recorders are arranged at each point to record the accurate starting time of 2 ~ 3 HIT group athletes in the fast running stage and jogging stage, respectively, so as to correspond to the polar table time for HR extraction and analysis. The MICT team arranged two recorders to record the starting time of the whole test [18, 19].

Test twice and measure before and after training. VO_{2max} measurement: exercise cardiopulmonary tester VO_{2max} measurement: exercise cardiopulmonary tester (max II), GXT treadmill scheme (3 min for each level, 5-6 levels in total, and the speed load of each level is determined according to the athlete's ability), and the gas sampling frequency is 30 s. VO_{2max} is determined according to three criteria for determining VO2max, and VAT is determined according to three criteria for VAT. Before and after 10 weeks of training, the results of 314 sprints and 15 m × 17 × 4 runs of the two groups of basketball players were tested, respectively, which are required to be carried out according to the test competition standards 3/4 sprint. Test method: sprint between the end line of the basketball court and the opposite free throw line (the two ends of the front free throw line are extended and pasted with sign lines, which are perpendicular to the two sidelines and intersect the two sidelines).4 ~ 5 people/group. The starting line is behind the end line. Hear the password "5, 4, 3, 2, run!" After that, the athletes sprint with all their strength. After crossing the opposite free throw line, they use the automatic electronic infrared scanning timer to run 2 ~ 3 times and get the best result. 15 m × 17 runs (4 groups): the players turn back 17 times between the two sidelines of the basketball court, a total of 4 groups, with an interval of 2 minutes, 5 ~ 7 people/group, and hear the command "5, 4, 3, 2, run!" After that, the athletes set out and the timing began. After crossing the sideline for the 17th time, the automatic electronic infrared scanning timer was used to record the results of four groups. Test requirements: start without stepping on the line, and turn back must "step on the sideline of the court" [10, 11].

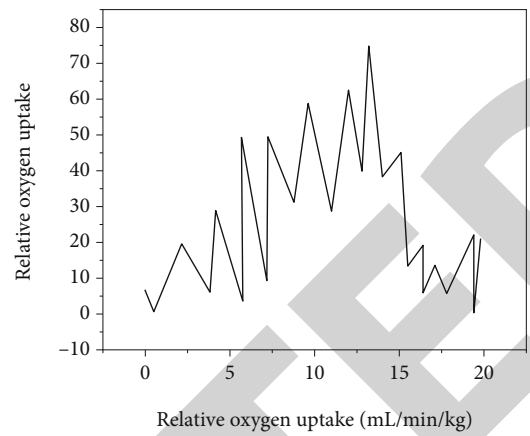

Figure 2: Relative oxygen uptake curve of a subject obtained from Bruce's exercise scheme.

SPSS 15.0 software was used for statistical analysis. The mean value and standard deviation showed that the significance levels of intergroup comparison after the experiment between the HIT group and MICT group, intragroup comparison before and after the experiment in HIT group, and intragroup comparison before and after the experiment in the MICT group were $P < 0.05$ and $P < 0.01$.

4. Results and Discussion

The heart rate test results of the HIT group and MICT group are shown in Table 2.

Table 1: Basic information of subjects.

	Number of people	Gender	Age (y)	Height (cm)	Weight (kg)	Training years (y)
HIT group	$n = 19$	Male	21.42 + 2.17	183.3 + 4.67	77.1 + 4.32	8.47 + 2.12
MICT group	$n = 18$	Male	21.17 + 2.16	182.7 + 5.37	76.5 + 5.26	8.20 + 2.43

Table 2: Heart rate test results of the HIT group and MICT group (unit: b/min)

HIT group				
	Fast running stage	Jogging stage		MICT group
		Front 1/3 distance	Rear 2/3 distance	
HR	170.3 ± 8.5▲	173.2 ± 7.3▲	149.7 ± 12.5	157.7 ± 9.6
		154.2 ± 8.9		

Table 3: VO_{2max} and VAT test results of the HIT group and MICT group (unit: ml/min).

	HIT group		MICT group	
	Before training	After training	Before training	After training
VO_{2max}	4418.0 + 395.8	4457.3 + 380.2	4462.7 + 468.5	4504.2 + 442.7
VAT	2928.8 + 246.0	3402.1 + 263.4**▼	2985.1 + 283.3	3220.4 + 297.7*

Table 4: Test results of 314 sprints and 15 m × 17 × 4 runs in the HIT group and MICT group (unit: s).

	HIT group		MICT group	
	Before training	After training	Before training	After training
3/4 sprint	3.62 + 0.43	3.41 + 0.34**▼▼	3.61 + 0.47	3.58 + 0.52
15 m × 17 × 4 run	67.46 + 3.97	63.24 + 3.41**▼	67.05 + 4.28	65.13 + 4.92

The heart rate of the HIT group changed greatly (▼ means ▼$P < 0.05$). In the fast running stage, the heart rate was 170.3 + 8.5 b/min, and in the jogging stage, the heart rate was 154.2 + 8.9 b/min, of which the first 1/3 stage of jogging was 173.2 + 7.3 b/min, and the last 2/3 stage was 149.7 + 12.5 b/min [20, 21]. The average of MICT group was 157.7 + 9.6 b/min, which was significantly lower than the first 1/3 stage of fast running stage and jogging stage in HIT group ($P < 0.05$).

The VO_{2max} and VAT test results of the HIT group and MICT group are shown in Table 3.

There was no difference in VO_{2max} and VAT between the two groups before the experiment, $P > 0.05$. After training, there was no significant change in VO_{2max} between the two groups, $P > 0.05$. VAT changed significantly. Before and after the experiment, there was significant difference in the HIT group, which increased from 2928.8 ± 246.0 to 3402.1 ± 263.4 ml/min, $P < 0.01$. In the MICT group, it increased from 2985.1 ± 283.3 to 3220.4 ± 297.7 ml/min, $P < 0.05$. After the experiment, the effect of the HIT group was significantly better than that of the MICT group, $P < 0.05$ [22, 23].

The test results of 3/4 sprints and 15 m × 17 × 4 runs in the HIT group and MICT group are shown in Table 4.

Before training, there was no significant difference in the results of 3/4 sprints and 15 m × 17 × 4 runs between the two groups ($P > 0.05$). After 10 weeks of training, there were different changes in the results of 3/4 sprints ($P < 0.01$, $P > 0.05$) and 15 m × 17 runs ($P < 0.01$, $P < 0.05$) in the two groups. After training, the results of 3/4 sprints in the HIT group ($P < 0.01$) and 15 m × 17 runs in the X4 group ($P < 0.05$) were better than those in the MICT group.

Heart rate (HR) refers to the number of beats of the heart per minute. It is an important index to evaluate cardiopulmonary function. During exercise, within a certain range, the change of HR is in direct proportion to the change of exercise intensity. With the gradual increase of exercise intensity, HR also increases gradually. Therefore, in aerobic exercise, HR is often used to evaluate the intensity of aerobic exercise and monitor the critical point of the transition from aerobic exercise to anaerobic exercise [24, 25]. HIT and MICT are two exercise methods often used in aerobic exercise. The former can also be called variable speed running, combining speed and slow, while the latter has a relatively stable speed in the whole process. The purpose of both is to stimulate the heart and lungs and improve the heart and lung function of the human body. In this experiment, the heart rate of the HIT group reached 170.3 ± 8.5 b/min in the fast running stage and 154.2 ± 8.9 b/min in the jogging stage. The heart rate in the first third stage of jogging stage reached the highest, 173.2 ± 7.3 b/min, and the heart rate in the second third stage decreased to 149.7 ± 12.5 b/min. The average heart rate of MICT group was 157.7 ± 9.6b / min. Comparing the HIT group with the MICT group, it is found that the heart rate in the first third stage of fast running stage and jogging stage in the HIT group is significantly

higher than that in the MICT group, about 13 times and 16 times, respectively, and the last two-thirds of jogging stage is lower than that in the MICT group, about 7 times on average. On the whole, the lowest average heart rate in the HIT group was about 150 b/min and the highest was about 173 b/min, in which the heart rate remained in the range of 170-173b/min for nearly 2/3 of the distance (fast stage +1/3 before slow speed). It can be seen that HIT running has high cardiopulmonary stimulation and changes in intensity. From the perspective of energy consumption by muscle contraction, in the slow stage of HIT running, the muscle contraction speed decreases and the energy consumption decreases. In this distance, the muscle is in a relatively low-intensity stimulation environment, which can also be considered as a relatively "rest" stage, so as to prepare for rapid contraction for the accelerated running in the fast stage of the next cycle. This combination of speed and slowness not only stimulates the cardiopulmonary function at a high level but also ensures that the muscles have a short "rest" time, which provides a basis for prolonging the training time and increasing the total amount of exercise. The speed of MICT running is relatively stable, and the stimulation of exercise intensity on the heart and lung is always in a stable state, but the muscle activity has not been adjusted, and it is always in a stimulation environment of certain intensity. Compared with HIT running, MICT running can always keep the heart and lung at a high stimulation level, but the muscles lack a short "periodic rest" moment during MICT running. It is easy to cause muscle fatigue after a certain period of exercise, which is also the reason why the total amount of exercise completed by MICT practice is lower than HIT. When the maximum oxygen uptake (VO_{2max}) is measured by GXT method, the ventilation anaerobic threshold (VAT) can also be measured. The former reflects the maximum oxygen intake of the body in unit time, and the latter reflects the critical point from aerobic to anaerobic. The change of VO_{2max} is greatly affected by heredity, and the improvement of acquired training is not obvious. Most scholars hold this view, but some studies believe that VO_{2max} has been improved to a certain extent. The research on anaerobic threshold believes that VAT can be changed and affected by various training methods. The application of VAT to evaluate the aerobic capacity of the body is very effective [26]. In this study, there was no difference in VO_{2max} (4418.0 ± 395.8 ml/min, 4462.7 ± 468.5 ml/min, $P > 0.05$) and VAT (2928.8 ± 246.0 ml/min, 2985.1 ± 283.3 ml/min, $P > 0.05$) between the HIT and MICT groups before the experiment. After 10 weeks of training, VO_{2max} increased slightly in the two groups, but there was no statistically significant change (4457.3 ± 380.2 ml/min, 4504.2 ± 442.7 ml/min, $P > 0.05$). It can be seen that the improvement of VO_{2max} is greatly affected by genetic factors and may also be related to the short training cycle time or the limited level of athletes, which is consistent with the conclusions of most studies. VAT changed significantly before and after the experiment. In the HIT group, it increased from 2928.8 ± 246.0 ml/min to 3402.1 ± 263.4 ml/min, $P < 0.01$, nearly 470 ml/min. In the MICT group, it increased from 2985.1 ± 283.3 ml/min to 3220.4 ± 297.7 ml/min ($P < 0.05$). The increase of the HIT group was about twice that of the MICT group, and the effect was significant ($P < 0.05$). It can be seen that the two training methods can improve the VAT of college basketball players and promote the improvement of cardiopulmonary function. VAT/VO_{2max} index reflects the maximum oxygen uptake utilization required when lactic acid accumulation is just caused during incremental load exercise. The efficacy study using VAT/VO_{2max} index shows that the change before and after exercise in the HIT group is 66.3% →76.3% and that before and after exercise in the MICT group is 66.9% →71.5%. Although they are significantly improved, the increase range in the HIT group is 10% and that in the MICT group is 4.6%. It can be seen that HIT running has a better effect on improving VAT. The analysis shows that HIT running has a "periodic rest" time due to muscle activity, which can prolong the exercise time, complete a large amount of exercise, and stimulate cardiopulmonary function, which is the key factor for the significant improvement of VAT in the HIT group.

After 10 weeks of training, the HIT group and MICT group carried out special physical performance test and selected two indexes: 3/4 sprints representing speed and 15 m × 17 × 4 runs representing speed endurance. The 3/4 field sprint is generally completed within 4S, which is a typical short-distance speed test project. It requires not only fast start-up ability but also fast acceleration ability, which requires a very high utilization rate of ATP-CP. In this test, the sprint time of 3/4 field in the HIT group was reduced by 0.21 s on average and that in MICT group was reduced by 0.03 s on average. HIT achieved significant results, but there was no difference in the MICT group. It can be seen that HIT is effective in improving the sprint performance of 3/4 field. The analysis shows that in the process of basketball game, athletes start and accelerate quickly, and the application frequency of instantaneous direction change and speed change is high. There are also several rounds of rapid attack and defense, which has a great impact on physical consumption. ATP-CP needs to be used repeatedly for rapid energy supply. Due to the limited energy supply of the human ATP-CP system, it is necessary to give active aerobic recovery while continuously consuming. HIT training features not only maintain a high level of stimulation to the heart and lungs but also take into account the straight track fast sprint. It not only plays a significant role in improving the 3/4 field sprint but also provides a strong guarantee for ATP-CP aerobic recovery. MICT training is characterized by maintaining constant speed intensity, which has no significant effect on improving the sprint performance of 3/4 field, which is also the reason why MICT has not significantly improved the sprint performance of 3/4 field. In this test, the average exercise time of 15 m × 17 × 4 runs in the HIT group was reduced by 4.22 s and that in the MICT group was reduced by 1.92 s. Both of them were significantly lower than that before training. The reduction range of the HIT group was significantly greater than that of the MICT group. For 15 m × 17 × 4 runs, both HIT and MICT training have good results, and HIT is better than MICT. The analysis shows that the 15 m × 17 × 4 run test generally takes about 1 min to complete, and the rest for 2 min to complete four groups

continuously. It takes about 10 min to complete before and after. When a group is completed separately, it seems that the energy consumption mainly comes from glycolysis from the point of view of completion time, but careful analysis shows that there is a cycle of "acceleration → deceleration → braking → turnaround → start → acceleration" in the turnaround run between the lines on both sides of the basketball court. The distance between the lines on both sides is 15 m, the starting acceleration is about 11 m, and the deceleration braking is about 4 m. Deceleration braking is very important for aerobic recovery of energy. Therefore, the energy supply characteristics of 15 m × 17 runs are that ATP-CP plays a decisive role, aerobic recovery plays a basic supporting role, and glycolysis plays an auxiliary role. In addition, the four groups need about 10 minutes before and after the test. The support of aerobic endurance is very important, especially in the recovery stage of the intermittent period. Combined with the HR and VAT of the two groups, HIT training has greater stimulation to cardiopulmonary function, longer action time, and more total exercise completed. After 10 weeks of training, the VAT of the HIT group increased significantly, which is of great significance for 15 m × 17 × 4 runs. It can ensure the efficient supply of oxygen during long-term exercise. In addition, the length of basketball game is 48 min, but the actual game time is often more than 2 h, sometimes even more than 3 h. It can be seen that the importance of special aerobic endurance in basketball. Both training methods can keep athlete's heart rate at a high level. The heart rate in the fast running phase of HIT running is significantly higher than that of MICT running, which stimulates the cardiopulmonary function more strongly. The muscles in the slow stage of HIT running get more adequate periodic rest which is conducive to the acceleration of the fast stage and the improvement of the total amount of exercise.

5. Conclusion

Both training methods can keep the athlete's heart rate at a high level. The heart rate in the fast running stage of HIT running is significantly higher than that of MICT running, which has stronger stimulation on cardiopulmonary function. The muscles in the slow running stage of HIT running get more sufficient periodic rest, which is conducive to the acceleration in the fast stage and the improvement of the total amount of exercise. The two training methods are difficult to improve athletes' VO_{2max}, but they can significantly improve the utilization rate of VO_{2max} of VAT, and the effect of HIT running is better than that of MICT running. HIT and MICT have significant effects on improving the performance of 15 m × 17 × 4 run, and HIT is better than MICT. However, in terms of improving the performance of 3/4 sprint, HIT improved significantly.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that they have no conflicts of interest.

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