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ORIGINAL

RESEARCH ON EFFECTS OF HIGH INTENSITY INTERVAL TRAINING ON CARDIOPULMONARY FUNCTION IN ADOLESCENTS

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ABSTRACT

High intensity interval training (HIIT) is now a very exercise attention by society, scholars from all over the world have to look into the training methods. At present, most studies on HIIT in the market compare it with moderate intensity continuous aerobic exercise. From another perspective, this study compares HIIT training with typical Repetition Training (RT) in strength training to study the changes of cardiopulmonary function indicators in adolescents. The aim is to find a more suitable and efficient way for youth sports training, so as to improve their physical fitness level.

KEYWORDS: High-Intensity Interval Training; Cardiopulmonary Function; Adolescent

1. INTRODUCTION

Since ancient times, the foundation of human happiness is physical health and mental peace, so it is very important to have the healthy development of body and mind, which is the premise of the continuation and development of our human life in the long history. Young people are the future of the country and the hope of the nation (C. Wang, 2019; Z. Wang, 2017). They are in an important stage of physical and mental healthy development, and their physical health determines the living conditions and development prospects of the next generation. Especially for modern high school students, their study pressure is very large, almost all the time is used for cultural learning, which will

lead to the inevitable physical exercise time is greatly reduced, resulting in the decline of physical quality, physical and mental health risks and other problems. This requires high school physical education teachers to improve the original traditional teaching methods, improve the overall specification of education and teaching, so that students can gain more under limited exercise conditions (Y. Li, 2015; ZHAO, 2019).

HIIT as an intervention can play a positive role in the growth of cardiorespiratory endurance of adolescents. This study takes high school students as the research object to explore the impact of HIIT training on the cardiorespiratory function of adolescents, in an attempt to provide strong evidence for HIIT to improve the cardiorespiratory function of adolescents, save the precious time in the learning phase of adolescents and obtain more effective training programs. It provides forward-looking preparation for promoting the education of physical quality of school students (Sun, Xu, & Zuo, 2023).

2. Research object and method

2.1 Research object

In this paper, the effects of HIIT on cardiopulmonary function in adolescents were studied. Eighty high school students (40 male and 40 female) were divided into no-intervention group, HIIT1 group, HIIT2 group and RT group for the experiment, and the experimental results were processed and analyzed.

2.2 Research Methods

2.2.1 Literature method

In China National Knowledge Network, Wanfang data knowledge service platform, school library and other databases with the keywords "HIIT training", "high school students", "cardiopulmonary function" were searched, and relevant international literature was consulted to understand and analyze the impact of HIIT training on cardiopulmonary function of high school students.

2.2.2 Experimental measurement method

2.2.2.1 Experimental subjects

Two weeks of voluntary registration through class registration. A total of 120 students signed up during the week. Finally, 80 students were selected as experimental subjects according to their health status and physical fitness. The selected students are all students in Grade One (I am responsible for the physical education teaching of Grade One), and students with serious diseases (such as asthma) will be persuaded to leave. See Table 2.1. Experiment group 1: HIIT training was performed twice a week; Experiment 2: HIIT training was

performed three times a week; Control group 1: RT training twice a week; Control group 2: No experimental intervention, only normal physical education activities (D. Wang, 2017).

Table 2.1 Relevant physical data of sample students

ITEM	MALE	FEMALE
QUANTITY（N）	40	40
AGE（Y）	16.65±1.5	16.6±1.4
HEIGHT（CM）	175.30±6.43	162.30±2.35
WEIGHT（KG）	65.17±12.64	50.12±5.53

2.2.2.2 Measurement of experimental indexes

2.2.2.2.1 Measurement of resting heart rate

2.2.2.2.1.1 Measuring instrument: stopwatch

Test method: Invite the subjects to the laboratory, keep quiet for 5 minutes, and then use a stopwatch to measure the pulse of the student's wrist with the index finger. When starting to collect information, ensure that the test environment is quiet, close all the curtains, ensure that there is no too bright light, and keep the indoor temperature at about 22 degrees Celsius. The data was collected in a resting position for 1min. During this period, the students kept breathing naturally, opened their eyes, relaxed their whole body, and did not talk or move.

2.2.2.2.2 Measurement of vital capacity Experimental equipment: electronic spirometer

Measurement method: First, the student inserts the disposable mouthpiece into the spirometry tester, and then after hearing the instruction from the measuring instrument, the subject takes a deep breath and quickly and completely exhales the gas from the mouthpiece with force to measure the maximum spirometry value. And then we do a second test, the same way we did the first test. Finally, the maximum value is taken as the measurement value to record.

2.2.2.2.3 Measurement of endurance running performance

1000m running test: The subjects were 10 male students in a group. They adopted a standing starting position before the starting point and were ready to start when they heard the teacher's instructions for positioning. When they heard the whistle, they started running immediately.800 meters running test: 10 female subjects were in a group. They were in a standing starting position before the starting point. They were ready to start when they heard the teacher's instructions for positioning, and started running when they heard the

whistle.

2.2.2.2.4 Cardiac Function Index Test (SMT solution)

Calculation formula: Cardiac work index (CI)= cardiac index (SVI)× heart rate (HR), unit is liters/min/square meter. First of all, the basic information of the subject is input, and then the sitting height of the power bicycle is adjusted. The sitting height is generally about 120° of the thigh and calf of the subject sitting on the bicycle. Then the subjects were asked to perform adaptive exercises, maintaining a speed of about 60 RPM and wearing a heart rate test band. After the subjects' heart rate index stabilized, the test was officially started. After the formal test was started, the subjects sat still for 1 minute, then began to pedal their bicycles for 1 minute, exercised for 3 minutes in the first stage, and then rested for 2 minutes for 3 minutes in the second stage. Load setting: Sitting load is 0 watts, starting from 60W, revolution is maintained at 605rMP, lasting 3 minutes, then rest for 2 minutes, start the second stage load is 150W, revolution is maintained at 605rMP, lasting 3 minutes. After the test, the immediate heart rate of the first and second stages was obtained (G. N. LI, 2017).

2.2.2.3 Technical Route

See Figure 2.1

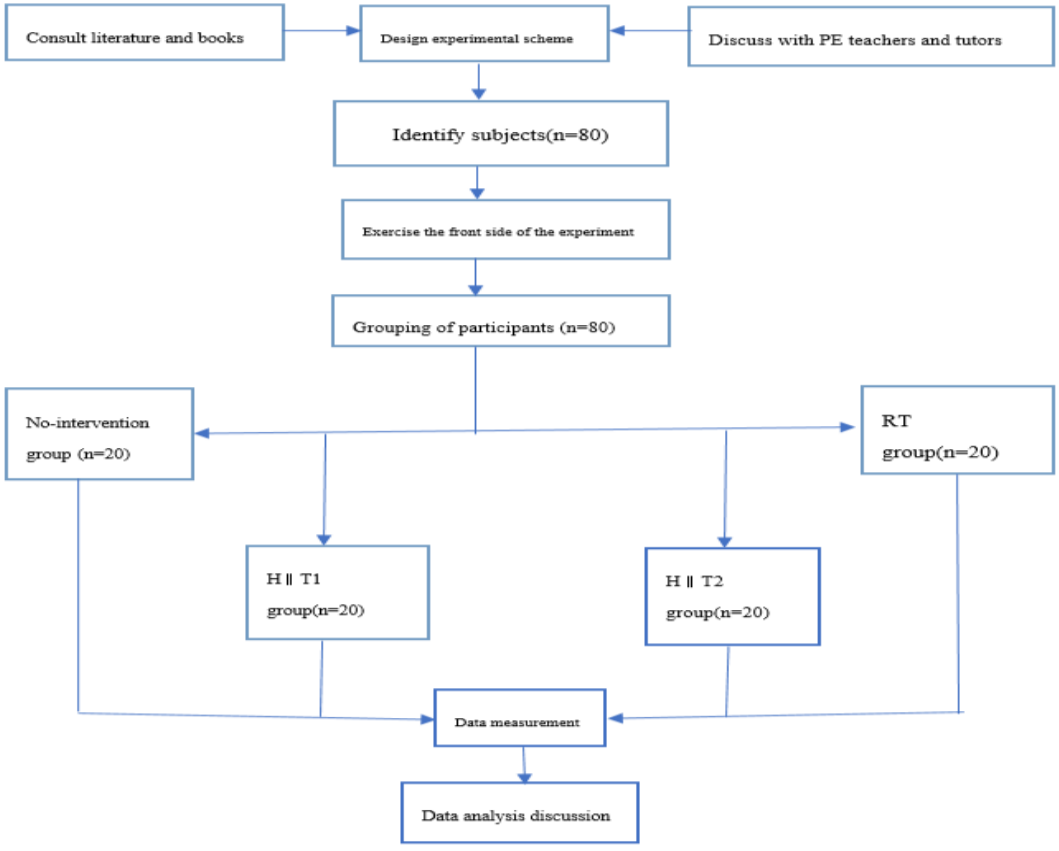

Figure 2.1 Technical roadmap of this experiment

2.2.2.4 Experimental instruments

(1) Monark928 power bike. (2) Heart rate test tape. (3) Stopwatch. (4) Sports Bracelet (Rambler)

2.2.2.5 Intervention means

See Table 2.2

Table 2.2 HIIT intervention plan

INTERVENTION ORDER	INTERVENTION CONTENT	TRAINING TIME	INTERVAL TIME BETWEEN GROUPS
1	3 min jog warm-up	3min	0
2	2 min dynamic stretching	2min	0
3-6	Squat with bare hands + kneeling position push-ups+ lunge alternate jump + plank	15s*3	10s (20 seconds between projects)
7-10	Poppy jump + dynamic balance + High leg lift + side to side jump	15s*3	10s(20 seconds between projects)
11-14	Squat jump + prone mountain climbing + Jumping jacks + crawling	15s*3	10s(20 seconds between projects)
15	5min static stretching	5min	0

According to the definition of HIIT in Tian Maijiu's "Sports Training Science" theory, the key factor of HIIT is to control the load intensity, duration, intermittent heart rate and intermittent time. This experiment draws on some previous research theories, combines all aspects of the experiment conditions, and finally determines the HIIT training intervention plan in the above table through a lot of preparatory work.

In view of the HIIT training method does not have a fixed operation scheme, so the actions of this intervention scheme are optional, but in strict accordance with the principles of HIIT training, control the heart rate during exercise and interval, in line with the requirements of HIIT training. In addition, according to the definition of repetitive training method, the RT training plan is developed as shown in the table above.

The training time of HIIT1 group and RT group was physical education class twice a week. In addition to the two training sessions in physical education class, HIIT2 group also had another training session in the self-study class on Wednesday afternoon every week with the approval of the head teacher. Among them, HIIT1 and HIIT2 groups are different in weekly training frequency, and the training content, intensity, capacity and interval time are the same. Exercise cycle: September 20, 2021 - December 20, 2021, a total of 12 weeks.

Exercise methods: HIIT group 1 received HIIT training intervention twice a week as shown in the above table; HIIT group 2 received HIIT training intervention three times a week as shown in the above table; RT group received RT training twice a week as shown in the above table.

Exercise intensity: The two HIIT intervention groups strictly control the exercise heart rate (80%-90% maximum heart rate) during exercise. Students in each group are asked to observe their exercise bracelets in time to reflect the heart rate state. If they are not in the specified heart rate range, they can raise their hands to increase or reduce the exercise intensity.

Intermittent heart rate (50%-55% maximum heart rate) control also takes the heart rate reflected by the sports bracelet as a reference and maintains the heart rate within a specific range with medium and small intensity exercises (leg lifts, etc.) during the intermittent period. RT training group take a full rest at the end of each training session (1 minute rest)(Cao & Shao, 2010).

Exercise time: Each exercise time of the three intervention groups was 1 PE class (40 minutes), including warm-up, basic part and stretching part. The HIIT group 1 and RT group were trained twice a week, and the HIIT group 2 was trained three times a week. At the beginning of the training, the subjects first did 3min warm-up jogging, 2min dynamic stretching, and formally entered the training after the warm-up.

The specific training content, training time and interval control between groups are shown in the table above. In the training process, strive to carry out real-time heart rate monitoring for each subject. When the subject's heart rate is not up to the standard or too much, the PE teacher needs to remind individual students in time to ensure the effectiveness of the experimental results.

2.2.2.6 Control means

HIIT1 group had physical education training every Monday and Wednesday, HIIT2 group had physical education training every Tuesday and Thursday and one self-study class on Wednesday, and RT group had physical education training every Tuesday and Thursday. During the experiment, I acted as the physical education teacher for all courses.

The training of the two HIIT groups was consistent in intensity control, training time, interval time, training mode and other aspects except weekly training frequency. The training intensity, number of groups and total training time of RT group were also similar to those of HIIT group. In addition, strict requirements were given to the daily diet and daily behavior of the subjects during the experiment. Besides normal training, no additional physical exercise was carried out, and the monitoring feedback of extra exercise was carried out every week.

2.2.3 Statistical method

In this study, SPSS17.0 statistical software was used for statistical analysis of the collected data, and the data was displayed in the form of mean standard deviation. The paired sample T-test was conducted for the collected data, and the significance level was $P < 0.05$, and the high significance level was $P < 0.01$.

2.2.4 Comparative analysis

According to the research results, some correlation conclusions are drawn by comparing the data of pre-test and post-test, so as to make suggestions on the experimental results.

3. Research Results

3.1 Pre-test data of subjects

Table 3.1: Pre-test data of male subjects

PROJECT (N=10)	NO INTERVENTION GROUP (N=10)	HIIT1 GROUP (N=10)	HIIT2 GROUP (N=10)	RT GROUP	LEVENE (SIG)
VITAL CAPACITY	3517±568	3725±365	3442±415	3552±422	0.611
RESTING HEART RATE	77.8±9.5	77±9.8	76±5.4	75±8.6	0.442
QUANTITATIVE LOAD HEART RATE	134.7±14.9	135.6±12.8	139.9±14.4	138.6±11.7	0.102
FUNCTIONAL HEART RATE (60W)	118.3±7.6	119.6±10.2	118.7±10.7	116.5±10.5	0.275
FUNCTIONAL HEART RATE (150W)	167.2±10	166.3±9.5	164.9±5.7	168.5±7.7	0.343
CARDIAC FUNCTION INDEX	11±2.2	12.1±4.4	11.5±3.2	10.7±4.1	0.412
CARDIAC FUNCTION SCORE	3.2±1.5	3.1±0.8	3.2±3.6	3.4±1.2	0.512
1000M RUN TIME	4.14±0.4	14.17±0.4	24.14±0.4	44.16±0.48	0.963

Table 3.2: Pre-test data of female subjects

PROJECT (N=10)	NO INTERVENTION GROUP (N=10)	HIIT1 GROUP (N=10)	HIIT2 GROUP (N=10)	RT GROUP	LEVENE (SIG)
VITAL CAPACITY	2517±556	2735±621	2435±358	2569±428	0.612
RESTING HEART RATE	78.8±9.5	78±9.2	81±3.4	85±8.1	0.412
QUANTITATIVE LOAD HEART RATE	131.7±14.2	131.6±12.1	129.9±14.2	135.6±11.3	0.202
FUNCTIONAL HEART RATE (60W)	111.2±6.6	110.5±4.6	110.7±11.6	108.9±9.8	0.245
FUNCTIONAL HEART RATE (150W)	155.6±8.7	159.8±5.5	157.8±4.4	159±7.7	0.325
CARDIAC FUNCTION INDEX	10.2±3.3	10.8±3.7	10.5±2.9	10.9±2.8	0.414
CARDIAC FUNCTION SCORE	2.2±0.9	2.1±0.8	2.6±1.7	2.4±1.4	0.456
800M RUN TIME	3.99±0.41	3.95±0.5	23.97±0.3	13.96±0.44	0.913

Table 3.1 and 3.2 above present the pre-experiment statistical data of male and female HIIT group (HIIT1 group, HIIT2 group) and RT group. The variance analysis was performed on the data, and the observed data showed that sig coefficients were all greater than 0.05 in the homogeneity test of variance (LEVENE), indicating that there was no significant difference in the distribution of the data (F. Liang, 2014).

The hypothesis of homogeneity test of variance data was valid, so the next data detection could be carried out, that is, there was no significant difference between the two groups of tested students in the pre-test data.

It can be proved that the difference in physical quality between the two groups of students will not affect the experimental results and experimental conclusions. By establishing that there is no significant difference in pre-test data, researchers can be more confident that any observed effects are indeed due to the treatment or condition being tested.

3.2 Changes of subjects' vital capacity indexes after exercise intervention

3.2.1 Changes of pulmonary capacity indexes of male subjects after exercise intervention

Table 3.3: Changes in pulmonary capacity indexes of male subjects

GROUP	NO INTERVENTION GROUP	HIIT1 GROUP	HIIT2 GROUP	RT GROUP
PRE-INTERVENTION VITAL CAPACITY	3517±568	3725±365	3442±415	3552±422
POST-INTERVENTION VITAL CAPACITY	3546±691	4153±521**	4165±434**	3721±323*

Before and after 12-week HIIT intervention, the lung capacity data of the 4 groups of male students were shown in Table 3.3 above. It was found that HIIT1 group, HIIT2 group and RT group all had different degrees of change, except no change in the no-intervention group. Among them, the number of HIIT1 group increased from 3725 before intervention to 4153 after intervention, an increase of 12.1%, and the result had a very significant change ($P < 0.01$).

HIIT2 group increased from 3442 before intervention to 4165 after intervention, an increase of 20.5%, and the result had a very significant change ($P < 0.01$). The RT group increased from 3552 before intervention to 3721 after intervention, an increase of 5.7%, and the result had significant change ($P < 0.05$).

3.2.2 Changes in pulmonary capacity indexes of female subjects after exercise intervention

Table 3.4: Changes in pulmonary capacity indexes of female subjects

GROUP	NO INTERVENTION GROUP	HIIT1 GROUP	HIIT2 GROUP	RT GROUP
PRE-INTERVENTION VITAL CAPACITY	2517±556	2735±621	2435±358	2569±428
POST-INTERVENTION VITAL CAPACITY	2335±525	3115±526**	3356±321**	2674±325

Before and after 12-week HIIT intervention, the pulmonary capacity data of girls in the 4 groups were shown in Table 3.4 above. It was found that HIIT1 group, HIIT2 group and RT group all had different degrees of change, except no change in the no-intervention group.

HIIT1 group increased from 2735 before intervention to 3115 after intervention, an increase of 14.8%, and the result had a very significant change ($P < 0.01$). HIIT2 group increased from 2435 before intervention to 3356 after

intervention, an increase of 37.5%, and the result had a very significant change ($P < 0.01$).

The RT group increased from 2569 before intervention to 2674 after intervention, an increase of 4%, and the result was not significant ($P > 0.05$). In conclusion, 12 weeks of HIIT training can significantly improve the lung capacity of boys and students. After intervention, RT group also has significant changes in the lung capacity of boys, but no significant changes compared with girls.

3.3 Changes of subjects' quiet heart rate index after exercise intervention

3.3.1 Changes of quiet heart rate index of male subjects after exercise intervention

Table 3.5: Changes of quiet heart rate index of male subjects

GROUP	NO INTERVENTION GROUP	HIIT1 GROUP	HIIT2 GROUP	RT GROUP
QUIET HEART RATE BEFORE INTERVENTION	77.8±9.5	77.6±9.8	76.3±5.4	75.4±8.6
QUIET HEART RATE AFTER INTERVENTION	78±9.8	62.3±6.7**	61.2±6.6**	72.1±5.5

Before and after 12-week HIIT intervention, the quiet heart rate data of the 4 groups of male students were shown in Table 3.5 above. It was found that HIIT1 group, HIIT2 group and RT group all had different degrees of change, except no change in the no-intervention group. The HIIT1 group decreased from 77.6 before intervention to 62.3 after intervention, a decrease of 19%, and the result had a very significant change ($P < 0.01$).

HIIT2 group decreased from 76.3 before intervention to 61.2 after intervention, a decrease of 19.4%, and the result had a very significant change ($P < 0.01$). The RT group decreased from 75.4 before intervention to 72.1 after intervention, a decrease of 4%, and the result was not significant ($P > 0.05$).

3.3.2 Changes of quiet heart rate index of female subjects after exercise intervention

Table 3.6: Changes in resting heart rate indicators of female subjects

GROUP	NO INTERVENTION GROUP	HIIT1 GROUP	HIIT2 GROUP	RT GROUP
QUIET HEART RATE BEFORE INTERVENTION	78.8±9.5	78.5±9.2	81.4±3.4	85.1±8.1
QUIET HEART RATE AFTER INTERVENTION	79.2±5.8	69.7±4.5**	68.1±6.2**	77.3±5.4*

Before and after 12-week HIIT intervention, the quiet heart rate data of girls in 4 groups were shown in Table 3.6 above. It was found that HIIT1 group, HIIT2 group and RT group all had different degrees of change, except no change in the no-intervention group. In the HIIT1 group, the rate decreased from 78.5 before intervention to 69.7 after intervention, a decrease of 11.5%, and the result had a very significant change ($P < 0.01$).

HIIT2 group decreased from 81.4 before intervention to 68.1 after intervention, a decrease of 16%, and the result was very significant ($P < 0.01$). The RT group decreased from 85.1 before intervention to 77.3 after intervention, a decrease of 9.4%, and the results had significant changes ($P < 0.05$).

In summary, in terms of quiet heart rate index, HIIT1 group and HIIT2 group had significant effects on it, HIIT2 group had better effect, and RT group had no significant effect. The results of the three intervention groups of female students were significant, and the overall effect of HIIT2 group was the best, followed by HIIT1 group and RT group.

3.4 Changes of quantitative load heart rate index of subjects after exercise intervention

3.4.1 Changes of quantitative load heart rate index of male subjects after exercise intervention

Table 3.7: Changes of quantitative load heart rate index of male subjects

GROUP	NO INTERVENTION GROUP	HIIT1 GROUP	HIIT2 GROUP	RT GROUP
QUANTITATIVE LOAD HEART RATE BEFORE INTERVENTION	134.7±14.9	135.6±12.8	139.9±14.4	138.6±11.7
QUANTITATIVE LOAD HEART RATE AFTER INTERVENTION	135±13.2	123.1±9.1**	122±8.2**	130±11*

Before and after 12-week HIIT intervention, quantitative load heart rate data of the 4 groups of male students were shown in Table 3.7 above. It was found that HIIT1 group, HIIT2 group and RT group all had different degrees of change, except no change in the no-intervention group.

In the HIIT1 group, the rate decreased from 135.6 before intervention to 123.1 after intervention, a decrease of 9.2%, and the result had a very significant change ($P < 0.01$). HIIT2 group decreased from 139.9 before intervention to 122 after intervention, a decrease of 12.7% ($P < 0.01$), and RT group decreased from 138.6 before intervention to 130 after intervention, a decrease of 6.2% ($P < 0.05$), the result was significant.

3.4.2 Changes of quantitative load heart rate index of female subjects after exercise intervention

Table 3.8: Changes in quantitative load heart rate index of female subjects

GROUP	NO INTERVENTION GROUP	HIIT1 GROUP	HIIT2 GROUP	RT GROUP
QUANTITATIVE LOAD HEART RATE BEFORE INTERVENTION	131.7±14.2	131.6±12.1	129.9±14.2	135.6±11.3
QUANTITATIVE LOAD HEART RATE AFTER INTERVENTION	132±10	120.8±8.8**	120.4±8.2**	130.2±11*

Before and after 12-week HIIT intervention, quantitative load heart rate data of girls in 4 groups were shown in Table 3.8 above. It was found that HIIT1 group, HIIT2 group and RT group all had different degrees of change, except no change in the no-intervention group. Among them, the rate of HIIT1 group decreased from 131.6 before intervention to 120.8 after intervention, decreased by 8.8%, and the result had a very significant change ($P < 0.01$). HIIT2 group decreased from 129.9 before intervention to 120.4 after intervention, decreased by 7.6%, and the result had a very significant change ($P < 0.01$). The RT group decreased from 135.6 before intervention to 130.2 after intervention, a decrease of 4.1%, and the result was significant ($P < 0.05$).

In summary, the three intervention groups can all have a significant impact on the quantitative load heart rate index. The effect of HIIT2 group was the best, followed by HIIT1 group and RT group. Female HIIT1 group had the best effect, followed by HIIT2 group and RT group.

3.5 Changes in cardiac function index of subjects after exercise intervention

3.5.1 Changes in cardiac function index of male subjects after exercise intervention

Table 3.9: Changes in cardiac function index of male subjects

GROUP 1	STAGE (60W)	SECOND STAGE (150W)	CARDIAC FUNCTION	INDEX SCORES
NO-INTERVENTION GROUP	118.2±7.8	168.3±10	11.2±1.1	3.3±0.8
HIIT1	105.6±10.1**	152.8±12.1**	14.5±3.7**	4.4±0.5**
HIIT2	104.7±9.9**	152.4±6.8**	15.1±7.7**	5.2±2.8**
RT	115±4.4	164±7.8	11.8±2.1**	3.8±1.2**

As can be seen from Table 3.9, the data in the no-intervention group did

not change much, so separate analysis was not conducted. After the rated load of 60W and 150W, the heart rate of male subjects in HIIT1 group and HIIT2 group decreased to a great extent, and the cardiac work index and cardiac work index scores showed an overall upward trend, and reached a very significant difference (P < 0.01>). The cardiac function index of HIIT1 group was increased by 19.8% from 12.1 to 14.5 after intervention. HIIT2 group increased from 11.5 to 15.1 after intervention, an increase of 31.3%. It can be considered that after HIIT training, male subjects had a great improvement in heart function. The comparison before and after the training of the RT group changed from the original 10.7 to 11.8 after the intervention, an increase of 10.2%, and the results also showed a very significant change. It can be considered that RT training also has a significant effect on the heart function index of male subjects (X. C. Li, 2018).

4. Analysis and Discussion

4.1 Indicators of vital capacity

(Q. LIANG, Jiao, & Jiang, 2011) Vital capacity is a common index to evaluate lung function intuitively in physical measurement, which can reflect the ability of gas exchange. In this experiment, HIIT group and RT group were compared, and the results showed that the improvement of lung capacity in RT group was not as good as that in the two HIIT groups. In his article, (Q. Shen, 2022) made a comparative study between HIIT training method and MICT training method, and finally proved that HIIT was better than MICT in improving students' vital capacity and 800m performance. Dou Li et al.(Dou Li, Chen Huawei, Zhang Lingling, & Guo Hongbo, 2020) also conducted HIIT experimental intervention on college students, and the results showed that subjects in the HIIT group significantly improved their vital capacity performance after exercise intervention, although there was no statistical difference, but the improvement was greater than that of students in the control group, which was significantly higher than before the experiment. Liu Xin et al. (X. LIU, TAN, ZHANG, & JIN, 2015) selected 45 female students with BMI < 18.5 to conduct a controlled test of HIIT and continuous aerobic exercise, and found that both HIIT and continuous aerobic exercise groups could significantly improve the subjects' lung capacity, and HIIT was superior to the continuous aerobic group. He Yeheng et al. (He, ZHAO, & Miao, 2017) pointed out that HIIT can effectively improve the vital capacity of young race walkers, increase the concentration of HB, and reduce the production of BU by reducing the amount of training, which is conducive to the improvement of athletes' physical function and positive training adaptation. Gao Hongyu (H. Y. Gao, 2021) conducted HIIT intervention in water and HIIT on land for obese adolescents, and the results showed that HIIT in water and HIIT on land had significant improvement effects on lean body mass of body form and lung capacity of body function. Other studies have proved that 8-week HIIT is significantly better than MICT in

improving the lung capacity of sedentary female college students. Wang Miaomiao (M. Wang, 2020) also proved in his article that the effect of 12-week HIIT is better than MICT. Shen Yan and Che Guangwei (CHE, 2015 ; Y. Shen, 2009) found that after HIIT exercise intervention on college students, the vital capacity, maximum gas volume and maximum oxygen uptake were significantly improved. These results are consistent with the results of this study, so it can be preliminarily judged that the impact of HIIT training on the elevated vital capacity of high school is superior to RT training. However, other studies have shown that HIIT training and other training methods have the same degree of impact on human cardiopulmonary function, and studies have pointed out that 60 times of maximum intensity aerobic training (SCT) and HIIT have no significant difference in improving the maximum expiratory flow parameters and respiratory muscle strength of healthy college students. However, this experiment only compares HIIT training with RT training to provide some theoretical basis for the practical application of HIIT training in physical education (G. Gao & Ji, 2013).

When HIIT was compared between the two groups, HIIT training three times a week increased the lung capacity of the high school students. The reason for this is that higher frequency of training and greater load will have a stronger effect on the body, resulting in a more adaptive increase in the body's capacity. This is consistent with previous research results, that is, the effect of exercise training is positively correlated with exercise intensity and total amount, and the higher the exercise intensity, the more obvious the appreciation of exercise tolerance. The comparison between boys and girls found that the lung capacity of girls in both HIIT groups was higher than that of boys. Analysis of the reason, it may be that the original girls' cardiopulmonary function level is lower than that of boys, so they have more space for development, and the training "novice welfare period" is longer, so they improve more.

4.2 Quiet heart rate index

Quiet heart rate is a common indicator of cardiopulmonary function. Under normal circumstances, the lower the quiet heart rate in the same age group, the better the cardiopulmonary function. Usually, athletes have a lower quiet heart rate due to long-term systematic training. Many studies have shown that HIIT training helps reduce the body's resting heart rate. Hou Lili (Hou, 2021) proved that both HIIT and MICT can significantly reduce resting heart rate and improve cardiopulmonary function through 10-week exercise intervention. Wang and Wang (W. WANG & Wang, 2018) proved that HIIT had a significant effect on the resting heart rate of male and female students through the exercise experiment intervention of middle school students, and could save the heart work after training. Chen Jianming et al. (Chen, Wu, & Su, 2021) concluded in their study that HIIT training can improve the pleasure of college students in sports, and also significantly improve the maximum oxygen uptake, quiet heart

rate and muscle mass

There are also experiments that have proved that after systematic exercise training, it can effectively improve the heart blood supply function of the subjects, so that the heart contractility is enhanced after training, and the heart rate is decreased, usually manifested in the quiet state, the stroke output is increased, and the myocardial oxygen consumption is reduced, thus improving the heart rate regulation ability. Heart rate is used to assess the load intensity during HIIT (Xu, 2018).. During the training process, the heart rate will rise with the increase of the exercise intensity, the heart rate will decrease during the interval period, and the heart rate will be adjusted accordingly with the extension of the exercise time. Therefore, during the HIIT process, the heart rate can be monitored to know whether the subject can meet the load intensity required by the training (H. Liu, Wu, & Li, 2019). Usually manifested as boys and girls in the resting heart rate, not through exercise intervention, just natural physiological development, is not conducive to the decline of resting heart rate. Through the comparison between HIIT training and RT training, the decrease of resting heart rate index of boys and girls in the two groups of HIIT training is better than that in the RT group, indicating that HIIT training has a better effect on the control of resting heart rate and blood pressure of high school students than RT training. In addition, the effect of HIIT2 group (3 times per week HIIT training) was better than that of HIIT1 group (2 times per week HIIT training), and it was finally concluded that the optimal training methods for resting heart rate exercise were HIIT2 group > HIIT1 group > RT group > no intervention group (T. Liu, 2020).

The comparison between boys and girls showed that HIIT training was better for boys than for girls, and RT training was better for girls than for boys. The analysis of reasons does not rule out the difference in results caused by the different attitudes of boys and girls towards training. In addition, the experimental results may also be affected by physiological development, and girls may be affected by factors such as menstrual period.

5. Concluding Remarks

This paper investigates the effect of 12 weeks HIIT training on cardiopulmonary function in adolescents. To prove that HIIT is feasible for the implementation of physical exercise in physical education classes for adolescents, the study draws the following conclusions:

(1) Both HIIT and RT programs implemented in this study can improve the cardiopulmonary function of adolescents, and the effect of HIIT2 group > HIIT1 group > RT group; (2) HIIT exercise intervention has a significant difference in training effect in terms of gender. This paper confirms the effect of HIIT on the cardiopulmonary function of adolescents through experimental

research, provides scientific and efficient theoretical support and practical exploration for improving the physical fitness of adolescents, saves precious learning time for adolescents, and provides more scientific, reasonable and efficient training methods to make specific programs.

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