

Retraction

Retracted: The Effect of Exercise Training on the Detection of Heart Rate and Body Temperature Sensors in Adolescents

Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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] W. Xiao, "The Effect of Exercise Training on the Detection of Heart Rate and Body Temperature Sensors in Adolescents," *Journal of Sensors*, vol. 2022, Article ID 5763019, 9 pages, 2022.

Research Article

The Effect of Exercise Training on the Detection of Heart Rate and Body Temperature Sensors in Adolescents

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The aim of this study is to study the effect of exercise training on heart rate and body temperature sensor detection in adolescents. For the methods of logical analysis, test, and mathematical statistics, this paper takes 60 students aged 13-15 in the experimental middle school as the research subjects to explore the characteristics of heart rate changes of middle school students under different high-intensity intermittent exercise schemes. Then, it analyzes the characteristics of heart rate change in exercise center and heart rate change in high-intensity intermittent exercise. The experimental results show that the high-intensity intermittent exercise of adolescents aged 13-15 presents the stage of rapid recovery and buffer recovery. Whether in the quiet heart rate buffer stage or the rapid heart rate increase stage, as well as the “extreme heart rate maintenance stage” and heart rate recovery stage, the heart rate change point of 15-year-old adolescents is 1-3 seconds later than that of 13-year-old and 14-year-old adolescents. In addition, in the heart rate maintenance stage of 15-year-old adolescents, the heart rate fluctuates greatly. The rapid recovery stage of boys is 1 minute, and the heart rate can reach the quiet heart rate after 4-5 minutes. The rapid recovery stage of girls is 1.5 minutes, and the heart rate can reach the quiet heart rate after 4-5 minutes. The older the age of high-intensity intermittent training of adolescents aged 13-15, the longer the rapid rise stage of heart rate change, and there was no significant change in quiet heart rate buffer stage and body temperature.

1. Introduction

The latest physical education and health curriculum standard (2017 Edition) issued by the Ministry of education and the relevant documents and policies of the youth sports promotion plan jointly issued by the State General Administration of sports, the Ministry of education, the Communist Youth League, and other central 7 departments all take teenagers' participation in sports activities, promoting physical and mental health and physical fitness as the main objectives. In many guiding programmatic documents, it not only emphasizes the time and measurement of teenagers' participation in physical exercise but also makes significant requirements on the load intensity of teenagers' participation in physical exercise. More and more studies pay more attention to how teenagers effectively participate in physical exercise [1].

In recent years, the continuous deterioration of teenagers' physical health has attracted the great attention of

the national education department. The deteriorating situation of middle school students' myopia rate and obesity rate has pushed the school physical education reform to the forefront.

As a target measure based on the rapid improvement of teenagers' physical health, the high school entrance examination physical education system has once again attracted the attention of the national educational circles, and the physical health education has returned to the public's vision. With the continuous improvement of the sports score of the middle school entrance examination, the proportion of the teaching mode taking the sports performance of the middle school entrance examination as the assessment standard has been strengthened in the physical education teaching of junior middle school. At the same time, with the rapid development and expansion of relevant theories and application methods in the field of foreign sports training in China, the advanced concept expands people's understanding of teenagers' physical training from the traditional

“unified” thinking of overemphasizing technical action teaching to the “diversified” thinking of physical health, sports ability, social health, mental health, and so on. Good and efficient physical training is the base for technical and tactical training and improving sports performance and performance. It is the base for maximum load training and high-intensity competition [2]. Therefore, it is of great practical significance to study the physical health of teenagers, monitor the potential risks in the physical education movement, protect the physical and mental health of students, and provide a solid scientific research guarantee for them, which requires a lot of work. Heat acquisition occurs when the body moves in a hot environment, resulting in heat stress. Heat acclimation can improve body temperature regulation, water and electrolyte metabolism, and cardiovascular function, so as to improve the body’s heat tolerance. However, when the body’s heat stress is excessive, it will cause heat damage, causing the body to manifest the symptoms of syncope or even shock. The damage brought by the heat environment has affected people’s life, study, living, and other aspects. The heart rate is 120~150 times/min during the exercise of moderate-intensity physical activity. The state of mind is a kind of emotional state that people continue to exist in a quite long time.

Therefore, this paper takes teenagers aged 13-15 as the survey object and designs the corresponding high-intensity intermittent exercise program for this age group, to explore the characteristics of the change of heart rate of adolescents during high-intensity intermittent exercise (Figure 1) and the law of recovery period after exercise and try to find the heart rate change and recovery characteristics of adolescents during high-intensity intermittent exercise, in order to provide theoretical basis and practical guarantee for the application of high-intensity intermittent exercise in adolescents [3].

2. Literature Review

Wang and others sorted and summarized the contents of the literature by searching the papers on high-intensity intermittent exercise in recent years. It is found that the main application groups of high-intensity intermittent exercise are ordinary people, obese people, chronic patients, and exercise people [4]. Babio and others found that HIIT can acutely increase fat oxidation rate, reduce blood glucose content, and maximize metabolic equivalent by comparing a series of physiological indexes such as BM worker (body mass index), HRmax (maximum heart rate), WHR (waist hip ratio), WC (waist circumference), glucose tolerance, body fat rate, and visceral fat rate [5]. What is more surprising is that during the training process, most teenagers can get greater pleasure in causing maximum cardiopulmonary function than continuous aerobic training. This shows that HIIT has more profound significance for the increasing exercise intervention of teenagers with chronic diseases, because most teenagers with poor exercise ability will voluntarily give up participating in exercise. The research on HIIT found that high-intensity training can arouse teenagers’ interest and enjoyment

and gain more self-confidence. Halén and Khan believe that the rapid development of science and technology has increased the prevalence of sedentary behavior, and less physical movement has become one of the factors leading to the increased risk of death all over the world. Compared with the pursuit of children’s and teenagers’ sports performance, we should pay more attention to sports opportunities, because many teenagers cannot distinguish too complex sports types. If they pay too much attention to technology teaching, some teenagers will stay away from sports [6]. Chu and others believe that in this subversive era when obesity has become a common health problem, increasing the amount of physical activity of children and adolescents needs to be done in more innovative ways, rather than as a branch of competitive sports in the traditional sense [7]. Blue and others concluded that physical exercise is the most significant and protective result for adolescents to reduce the risk of cardiac metabolism through the cross-sectional study data of 548 adolescents and the study on the relationship between physical activity and sedentary behavior in European adolescents [8]. At the same time, Landgraff and others concluded through the observation of 16 intensity threshold data of 38306 international children and adolescents aged 11.1-13.6 that the time spent on high-intensity physical activity is the main determinant of the change of cardiac metabolic risk factors, not the duration [9]. Kalkhoven et al. made a corresponding research on the application of strength training in children and adolescents and concluded that it is a very important measure to encourage young people to take physical exercise. Strength training has been proved to be a safe and effective method, which plays an important role and significance in preventing sedentary behavior in adolescents. Research on the impact of strength training on children and adolescents is safe and effective when receiving a professionally qualified program [10]. Smart et al. found in their own research that by comparing the average heart rate of Changquan, Nanquan, and Taijiquan, it was found that there were significant differences in the average heart rate of the three boxing types ($P < 0.05$), so they were treated differently according to the intensity of training [11]. Schomann et al. suggested that thermal adaptation enables the body to perform more activities before fatigue or exhaustion occurs. However, even if the body adapts to the thermal environment, related activities cannot be carried out without fear, otherwise it is easy to cause excessive stress of the body to the environment, and fever also occurs. Therefore, the thermal environment or the thermal environment after the adaptation of the relevant activities must be moderate, not to mention because it is the adaptation of the activities without scruple [12]. Massa et al. conducted three studies on 12-minute running at different intensities and concluded that 12-minute running is not suitable for college students to carry out at full strength. It can be used as an effective means to improve aerobic metabolism capacity by maintaining an intensity of about 80% and heart rate index below 180 beats/min. Keeping about 60% of the intensity, heart rate index in 160-150 times/min, is a good low-

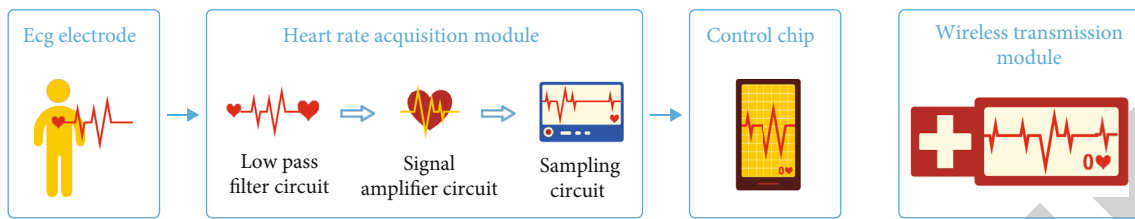


FIGURE 1: Exercise heart rate monitoring system.

intensity fitness exercise and adjustment exercise, for students to form a habit of exercise which has special significance [13].

To sum up, heart rate index is a very important and commonly used index in sports research. It is easy to measure and noninvasive. It is mostly used to monitor the intensity of exercise and recovery after exercise and is widely used in various monitoring. Previous studies have laid a foundation for this paper to explore the characteristics of heart rate changes in adolescents with high-intensity intermittent exercise.

3. Research Object and Method

3.1. Research Object. *Research object:* this paper takes the heart rate change characteristics of 13-15-year-old adolescents during high-intensity intermittent exercise as the object.

Test object: this paper takes 60 students from a provincial experimental middle school as the test object (see Table 1 below for details).

Generally speaking, teenagers are divided into two stages, teenagers and young people. Teenagers are generally considered to be under the age of 16, while young people are considered to be over the age of 16. This study takes teenagers aged 13-15 as the research object [14, 15], that is, junior middle school students as the research object. From a medical point of view, because teenagers are in the period of growth and development, their heart development is far less than that of adults, especially in the volume and weight of the heart, which is far from that of adults. Moreover, the neuromodulation ability and development degree of the heart of teenagers are not as perfect as those of adults, and the ability of the heart to provide blood and contraction for all parts of the body is not developed. Because the weight ratio of teenagers is not different from that of adults, teenagers should be faster than adults in terms of metabolism, and the contraction frequency of the heart when pumping blood also becomes faster, so that the blood circulation of the body can be smoothly transported to all parts of the body during exercise, which also leads to the heart rate of teenagers being a little higher than that of adults [16].

Inclusion criteria: teenagers aged 13-15

Exclusion criteria: medical conditions, leg problems, and disagreeing or not cooperating with the investigator

3.2. Research Methods

(1) Logical analysis

Logical analysis is a philosophical analysis of relevant literature based on the principle of mathematical statistics. This paper makes a logical analysis of the concept of high-intensity intermittent training, combs and summarizes the context of the whole paper according to this method, and obtains the framework of the whole paper. In the process of testing 60 students in the experiment, the logical analysis method is used to deliberate on the design of the whole test scheme and specific operation steps, which can finally make the whole test go smoothly [17].

(2) Test method

In this paper, 60 students (30 girls and 30 boys) in the experimental middle school were tested for high-intensity intermittent exercise through the test method, and the heart rate of each student was measured. Finally, the data were processed and analyzed to draw a conclusion. Because this paper is mainly aimed at the heart rate analysis of students participating in high-intensity intermittent exercise, we can only analyze the changes of students' heart rate through the test method.

(3) Mathematical statistics

In this paper, the students' heart rate is simply statistically processed through Spss12.0. After the test data is recovered, all the data are checked. The students' heart rate data are descriptively counted by using Excel statistical software, and the heart rate change curve is drawn. After recovering the test data, check all the data, and analyze the test data by using the processing system of polar sports tester (PST) made in the Netherlands [18].

In the postprocessing, due to the large amount of data, we take the fixed heart rate per minute for statistical analysis. For example, in the high-intensity interval training, according to the changes of heart rate of students of different ages, we take the heart rate of students aged 13, 14, and 15 at the first, second, and third minutes of exercise and 1, 2, 3, 4, and 5 minutes after exercise for mapping analysis.

3.3. Test Scheme. The maximum heart rate refers to the oxygen consumption and heart rate which will increase with the increase of intensity until the heart rate reaches the maximum value. Generally speaking, the maximum heart rate can be calculated by using the formula "220 - age". The scheme design is based on Tabata training proposed by Tian Canquan, a professor at Tokyo

TABLE 1: Basic information of test objects.

Age	13 years old	14 years old	15 years old
Male (person)	10	10	10
Female (person)	10	10	10
Total (person)	20	20	20

Sports Training University, Japan. Relevant research shows that full-strength running is a little boring in actual teaching and cannot better improve physical pleasure. Therefore, design high-intensity intermittent training in the form of action combination that can arouse students' interest. Compare the two schemes and compare the heart rate change characteristics of different forms of high-intensity intermittent training [19, 20].

- (1) Scheme 1: divide the students into groups, 10 boys and 10 girls, each with a track, and conduct high-intensity intermittent exercise in the form of 20 m turn back run, with a total of 6 groups. According to the music, each group sprints for 20 seconds with all its strength and then has an interval of 10 seconds (the rest means of walking is used during the interval) and then carries on to the next group. This is repeated until the sprint of the sixth group is completed, which takes a total of 3 minutes
- (2) Scheme 2: high-intensity intermittent exercise in the form of action combination, with a total of 6 groups of action combination exercises ((1) high leg lifting, (2) open and jump, (3) fast alternation, (4) left and right jumping, (5) elbow-knee alternation, and (6) bobby jump). Follow the music prompt; each group of actions adopts full-strength exercise for 20 seconds; then, rest intermittently for 10 seconds (the rest means of walking is used during the interval); then, carry out the next group of actions for 20 seconds; and then, rest intermittently for 10 seconds. This is repeated until the sixth group of actions is completed, with a total time of 3 minutes [21]

According to the test process, after completing scheme 1 on the first day of the test, it is stipulated that all students are prohibited from violent activities and can carry out light load exercise. On the second day, all students will carry out the test of scheme 2. Refer to the test process for specific test steps.

3.4. Research Results and Analysis. As we all know, heart rate is the number of times the heart beats per unit time. From a medical point of view, heart rate is one of the main bases for judging the life span of others; that is, the slower the heart rate, the longer the life span. In addition, the speed of heart rate will also be applied to physical exercise. By measuring the heart rate of athletes, we can explain the training intensity of athletes in the process of exercise. Generally speaking, people's heart rate fluctuates little in a quiet state. Generally, except for infants, people's

quiet heart rate is normal at 60-100 beats per minute, and it is unhealthy below 60 beats per minute or above 100 beats per minute.

From the heart rate change diagram of 13-15-year-old students in the two schemes in Figures 2 and 3 above, it is obvious that in high-intensity intermittent training scheme 1, the heart rate change characteristics of each age stage are similar, and the overall situation is coincident. In scheme 2, the heart rate change point of Qiao-year-old teenagers is delayed. It is concluded that the intermittent training of action combination has less impact on the older students. On the contrary, the younger the age, the greater the impact of scheme 2. Therefore, in the later application, students of younger pupils or lower grades should appropriately strengthen the movement combination training. When comparing the two kinds of high-intensity interval training, it is found that the subjects' heart rate fluctuation change is larger than that of turn-back running scheme in the 1-2 minutes of action combination interval training scheme, and the heart rate change is smaller in the following 3 minutes [22].

By comparing the above two pictures, it can be seen that high-intensity interval training program 2 has a great impact on teenagers aged 13-15—the heart rate changes greatly in the first few seconds. Scheme 1 has little effect on the change of heart rate. Specifically, in scheme 2, the heart rate of students aged 13-15 has increased rapidly 1 minute ago, while in scheme 1, the heart rate of students begins to rise rapidly 1 minute later, and scheme 1 has little impact on the heart rate of students at all ages.

It can be seen from Figure 4 that the average value of quiet heart rate of 13-year-old students is about 80 beats per minute—the heart rate value in Figure 4 is the average value obtained after data processing with SPSS after real-time receiving data through polar team heart rate meter. After entering the training state, there is a fluctuation stage of less than one minute, and the heart rate of students in this age stage is basically maintained within the quiet heart rate range. Then, in about 0.8-1.4 minutes, the heart rate and body temperature quickly reach the highest point and finally continue until the third minute after exercise [23]. Comparing the two schemes, it can be seen that scheme 2 has a greater impact on 13-year-old students. Compared with scheme 1, students' heart rate enters the rising stage in advance. It shows that the high-intensity intermittent training of action combination has a great impact on the change of heart rate of 13-year-old students. In an appropriate range, students at this age can carry out more high-intensity action combination training.

As shown in Figure 5, when processing the heart rate data of all 14-year-old students, it is found that the heart rate change of students at this age also has a relatively gentle quiet heart rate buffer stage within 1 minute, but the buffer stage of 14-year-old students is longer than that of 13-year-old students. After that, the highest heart rate point was also delayed compared with 13-year-old students, and the heart rate of students decreased when they exercised for nearly 3 minutes. In addition, the effect of

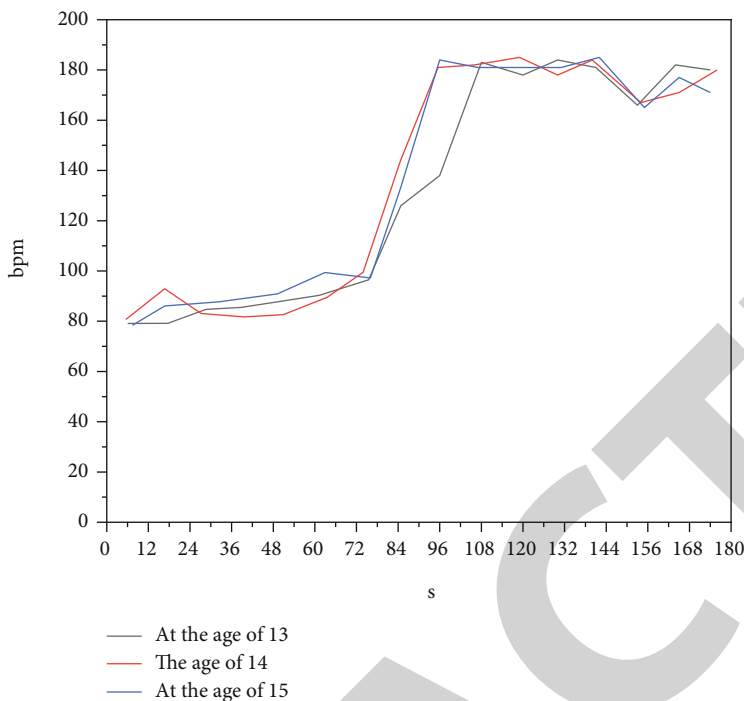


FIGURE 2: Heart rate change of the 13-15-year-old group in scheme 1 high-intensity intermittent exercise.

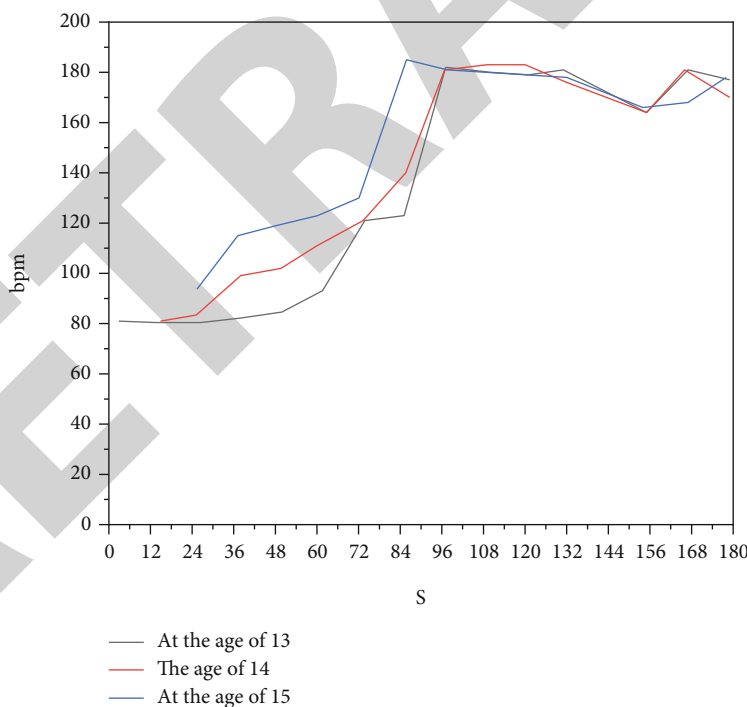


FIGURE 3: Heart rate change of the 13-15-year-old group in scheme 2 high-intensity intermittent exercise.

two kinds of high-intensity intermittent training on students' heart rate is basically the same as that of 13-year-old students. The difference is that the image of scheme 2 is always above the image of scheme 1, indicating that the action combination high-intensity intermittent training has a great impact on 14-year-old students' heart rate and body temperature.

As shown in Figure 6, from the beginning of the test, the average quiet heart rate of 15-year-old students is 71, which is lower than that of 13- and 14-year-old students. The quiet heart rate buffer stage is maintained for nearly 1 minute, and the heart rate reaches the highest point after 2 minutes of exercise, and the maximum heart rate is the lowest among students of all ages. Moreover, the heart rate of 15-year-old students

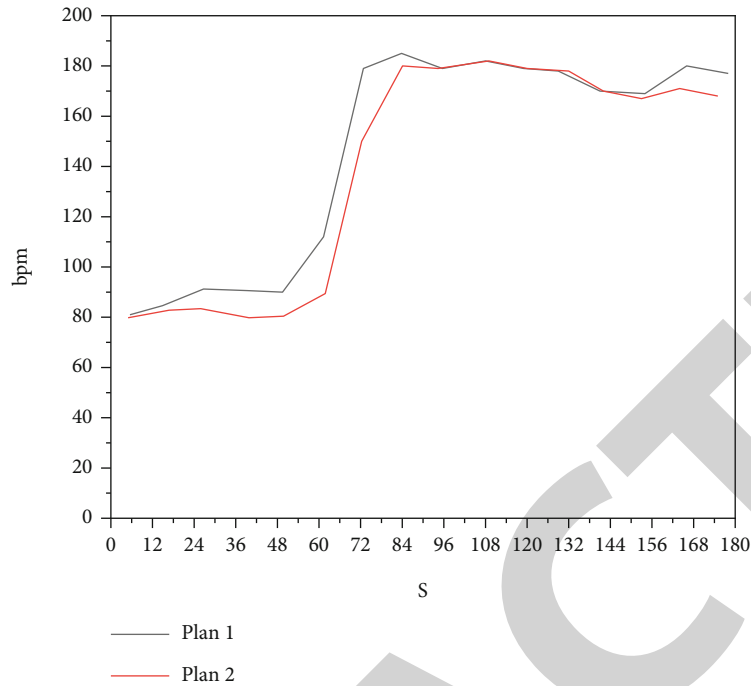


FIGURE 4: Heart rate changes of the 13-year-old group in different schemes of high-intensity intermittent exercise.

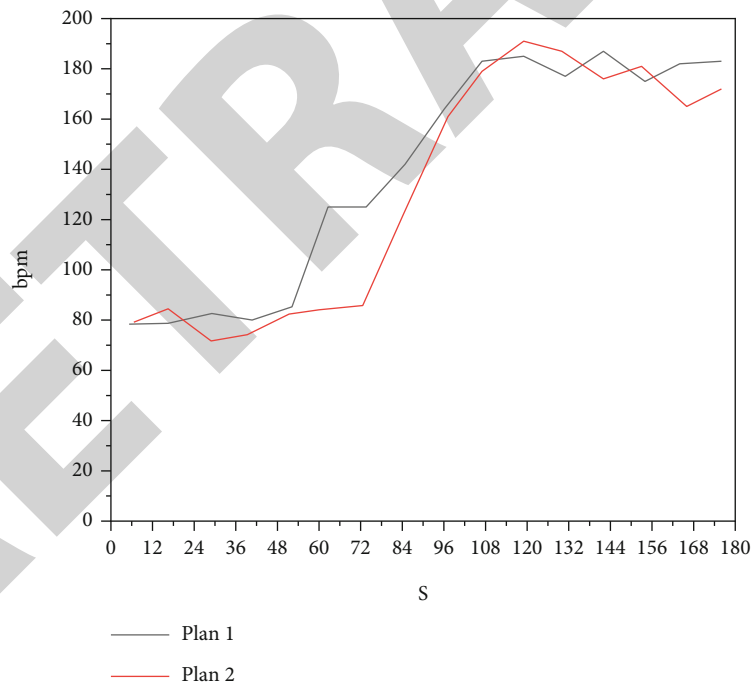


FIGURE 5: Heart rate changes of the 14-year-old group in different schemes of high-intensity intermittent exercise.

decreased after the second minute. From the influence of the two schemes on the heart rate change of 15-year-old students, the two schemes basically overlap, indicating that the two schemes have a high similarity on the heart rate of 15-year-old students; However, the heart rate change curve of scheme 2 for 15-year-old students is always higher than that of scheme 1- for 15-year-old students. In compar-

ison with the students of the other two age groups, during the period between the end of the second minute and the beginning of the third minute, the change degree of students' heart rate is more gentle with the change of time. In the subsequent exercise duration, the heart rate fluctuation of 15-year-old students is greater than that of 13-year-old and 14-year-old students.

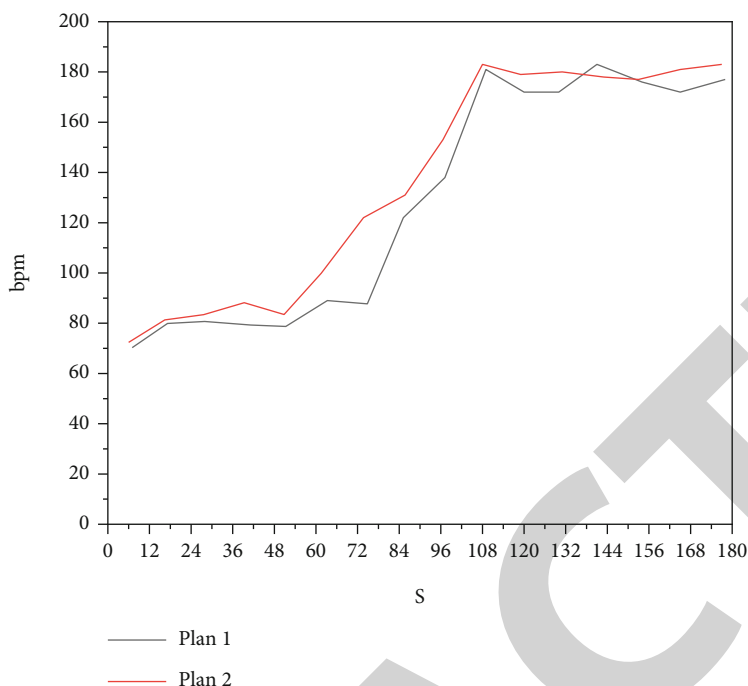


FIGURE 6: Heart rate changes of the 15-year-old group in different schemes of high-intensity intermittent exercise.

4. Discussion

4.1. Analysis of Characteristics of Movement Center Rate and Body Temperature Change

(1) Quiet heart rate buffer phase

From the above research results, it is found that the quiet heart rate buffer stage is a unified law of the heart rate change of all students in this stage. Generally speaking, this stage is a phenomenon within one minute after the beginning of training. The reasons are as follows: at this stage, the inherent ATP energy source in teenagers' body is used preferentially, which does not affect the changes of material form and energy in the body, so there is a quiet heart rate buffer stage.

In addition, many experts and scholars also mentioned that there is a buffer stage in the initial stage of heart rate change after high-intensity training. The conclusions of many experts and scholars also confirm the conclusion of this study; that is, 13-15-year-old adolescents have a quiet heart rate buffer stage within one minute after high-intensity interval training [24].

(2) Heart rate and body temperature soared in one minute

For 13-15 years old, because they are in puberty, from a medical point of view, because teenagers are in the period of growth and development, their heart development is far less than that of adults, especially in the volume and weight of the heart, which is far from that of adults. In addition, the neuromodulation ability and development degree of the heart of teenagers are not perfect as

adults, and the ability of the heart to provide blood and contraction for body institutions is not developed. However, teenagers have strong metabolism, so their heart rate increases much faster than adults, but their recovery ability is also faster than adults.

From the above measurement results, after one minute of training, the heart rate of 13-15-year-old teenagers rapidly increased to 180 beats per minute, the heart rate of girls increased faster, the heart rate increased to about 180 beats per minute, and the rapid heart rate increase process of boys was about 1.5 minutes, indicating that the heart rate increase speed of girls is faster than boys, and the heart rate increase degree is large.

To sum up, in this age stage of students aged 13-15, with the increase of age, the slower the change of heart rate and body temperature, the stronger the adaptability to high-intensity intermittent training. However, in general, in the two high-intensity intermittent training schemes, the changes of heart rate of students at all ages are similar. Therefore, the age stage of junior middle school students is generally 13-15 years old. For younger students, we should strengthen some strength training and carry out aerobic training and auxiliary exercises according to the students' personal physique. For older college students, they can be trained through the combination of action combination training and aerobic endurance training according to their personal physical quality.

4.2. Analysis of Heart Rate Change and Body Temperature Characteristics of High-Intensity Intermittent Exercise.

To sum up, the characteristics of heart rate in the whole change process of high-intensity intermittent training for adolescents aged 13-15 can be divided into the following stages:

- (1) In the quiet heart rate buffer stage, that is, about one minute after high-intensity intermittent training, the subjects' heart rate is stable within the quiet heart rate range, and the boys' quiet heart rate buffer stage is about 1.5 minutes
- (2) In the stage of rapid rise of heart rate, after the end of the quiet heart rate buffer stage, the heart rate rapidly rises to the heart rate corresponding to the intensity, and the rise time is within 1 minute; that is, after the exercise lasts for 2 minutes, the heart rate reaches the maximum heart rate corresponding to the intensity
- (3) Extreme heart rate maintenance stage, which corresponds to the time of exercise, that is, the time of high-intensity interval training minus one minute or 1.5 minutes [25]
- (4) The recovery stage after exercise is divided into two stages. The first stage is the rapid recovery stage of heart rate, which lasts for 1-2 minutes, boys within 1 minute and girls within 2 minutes. In the stable recovery stage of heart rate, that is, after the rapid recovery of heart rate, the subject's heart rate recovers slowly in the future
- (5) After the study, we found that the heart rate recovered more slowly than 1-5 times per minute, which was generally higher than that after tranquilization

In the whole process of heart rate and body temperature changes, we have summarized the relationship between age differences and heart rate changes: the older the age, the more the heart rate change point moves backward. Whether in the quiet heart rate buffer stage or the rapid heart rate increase stage, as well as the "extreme heart rate maintenance stage" and heart rate recovery stage, the heart rate change point of 15-year-old adolescents is 1-3 seconds later than that of 13-year-old and 14-year-old adolescents. In addition, in the heart rate maintenance stage of 15-year-old adolescents, the heart rate fluctuates greatly. In view of the above two problems, through consulting relevant literature and analyzing the investigation of different students, it is found that the older the students are, the stronger their cardiopulmonary function is, and the body has strong adaptability to high-intensity training, which eventually leads to the delay of the change point of students' heart rate. For junior three students, they are mentally mature, spend most of their time on learning, spend less time on sports, have high academic pressure, and have large fluctuations in heart rate [26, 27].

5. Conclusion

Using the methods of literature and logical analysis, this paper consults and grasps a large number of research literature at home and abroad and explores and analyzes the mechanism of different schemes of high-intensity intermittent exercise for teenagers from the aspects of theory, law, scheme, and method of high-intensity intermittent exercise. Using the methods of test and mathematical statistics, 60

students aged 13-15 in the experimental middle school were studied to explore the characteristics of heart rate changes of middle school students under different high-intensity intermittent exercise programs. The heart rate of 13-15-year-old teenagers in high-intensity intermittent training shows a rising trend of surround heart rate as a whole. The rising trend of heart rate has a certain buffer stage, extreme rise stage, and limit heart rate maintenance stage, which is operable for monitoring the changes of students' heart rate and body temperature in teaching.

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 there are no conflicts of interest.

References

- [1] J. Steinhard, A. D. Debbih, K. T. Laser, H. David, and J. Weichert, "Oc11.07: randomised controlled study on the use of systematic simulator-based training (opus fetal heart trainer) for learning the standard heart planes in fetal echocardiography," *Ultrasound in Obstetrics and Gynecology*, vol. 54, no. S1, pp. 28-29, 2019.
- [2] C. Kataoka, T. Sugiyama, H. Kitagawa et al., "Temperature-dependent toxicity of acetaminophen in Japanese medaka larvae," *Environmental Pollution*, vol. 254, Part 2, article 113092, 2019.
- [3] L. Srinivas, R. Vineet, O. Tatsuya et al., "Individualized estimation of human core body temperature using non-invasive measurements," *Journal of Applied Physiology*, vol. 124, no. 6, pp. 1387-1402, 2018.
- [4] G. Wang, S. Zhang, S. Dong et al., "Stretchable optical sensing patch system integrated heart rate, pulse oxygen saturation, and sweat pH detection," *IEEE Transactions on Biomedical Engineering*, vol. 66, no. 4, pp. 1000-1005, 2019.
- [5] G. D. Babio, G. V. Janavel, I. Constantin, G. Masson, and P. Stutzbach, "Atrial size and sports. A great training for a greater left atrium: how much is too much?," *The International Journal of Cardiovascular Imaging*, vol. 37, no. 12, pp. 1-8, 2021.
- [6] P. Halén and K. M. Khan, "Finland's sports physiotherapy conference—athlete training and loading: Helsinki 7-8 June 2019," *British Journal of Sports Medicine*, vol. 53, no. 3, pp. 137-138, 2019.
- [7] C. C. Chu, C. Shih, W. Y. Chou, S. I. Ahamed, and P. A. Hsiung, "Artificial intelligence of things in sports science: weight training as an example," *Computer*, vol. 52, no. 11, pp. 52-61, 2019.
- [8] C. Blue, S. Coomes, and Y. Yoshida, "A novel downhill gait-training program following a total knee arthroplasty: a case report highlighting the impacts of self-selected speed on gait symmetry," *Journal of Orthopaedic & Sports Physical Therapy*, vol. 48, no. 2, pp. 104-110, 2018.
- [9] H. W. Landgraaf, A. Riiser, M. Lihagen, M. Skei, and J. Hallén, "Longitudinal changes in maximal oxygen uptake in adolescent girls and boys with different training backgrounds,"

- Scandinavian Journal of Medicine and Science in Sports*, vol. 31, no. S1, pp. 65–72, 2021.
- [10] J. Kalkhoven, A. J. Coutts, and F. M. Impellizzeri, “‘Training load error’ is not a more accurate term than ‘overuse’ injury,” *British Journal of Sports Medicine*, vol. 54, no. 15, pp. 934–935, 2020.
- [11] N. A. Smart, N. King, J. R. Mcfarlane, P. L. Graham, and G. Dieberg, “Effect of exercise training on liver function in adults who are overweight or exhibit fatty liver disease: a systematic review and meta-analysis,” *British Journal of Sports Medicine*, vol. 52, no. 13, pp. 834–843, 2018.
- [12] S. Timo, L. Mezzanotte, I.-. A.-. L. M. Lourens, J. C. M. J. de Groot, J. H. M. Frijns, and M. A. Huisman, “Lentiviral transduction and subsequent loading with nanoparticles do not affect cell viability and proliferation in hair-follicle-bulge-derived stem cells in vitro,” *Contrast Media & Molecular Imaging*, vol. 11, no. 6, pp. 550–560, 2016.
- [13] S. Massa, N. Vikani, C. Betti et al., “Sortase A-mediated site-specific labeling of camelid single-domain antibody-fragments: a versatile strategy for multiple molecular imaging modalities,” *Contrast Media & Molecular Imaging*, vol. 11, no. 5, pp. 328–339, 2016.
- [14] F. Beckermann, “Changes in phase angle and handgrip strength induced by suspension training in older women,” *International Journal of Sports Medicine*, vol. 39, no. 6, pp. 442–449, 2018.
- [15] G. Gorges, “High-intensity interval training as a tool for counteracting dyslipidemia in women,” *International Journal of Sports Medicine*, vol. 39, no. 5, pp. 397–406, 2018.
- [16] R. Domínguez, J. L. Matémuñoz, N. Serrapaya, and M. V. Garnachocastaño, “Lactate threshold as a measure of aerobic metabolism in resistance exercise,” *International Journal of Sports Medicine*, vol. 39, no. 3, pp. 163–172, 2018.
- [17] M. Buckthorpe, “Recommendations for movement re-training after acl reconstruction,” *Sports Medicine*, vol. 51, no. 8, pp. 1601–1618, 2021.
- [18] H. Anetzberger, S. Reppenhagen, H. Eickhoff, F. J. Seibert, and R. Becker, “Ten hours of simulator training in arthroscopy are insufficient to reach the target level based on the diagnostic arthroscopic skill score. Knee Surgery Sports,” *Traumatology*, vol. 19, pp. 1–9, 2021.
- [19] M. D. Jones, M. A. Wewege, D. A. Hackett, J. W. Keogh, and A. D. Hagstrom, “Sex differences in adaptations in muscle strength and size following resistance training in older adults: a systematic review and meta-analysis,” *Sports Medicine*, vol. 51, no. 3, pp. 503–517, 2021.
- [20] T. B. Davies, D. L. Tran, C. M. Hogan, G. G. Haff, and C. Latella, “Chronic effects of altering resistance training set configurations using cluster sets: a systematic review and meta-analysis,” *Sports Medicine*, vol. 51, no. 4, pp. 707–736, 2021.
- [21] I. Jukic, B. V. Hooren, A. G. Ramos, E. R. Helms, M. R. Mcguigan, and J. J. Tufano, “The effects of set structure manipulation on chronic adaptations to resistance training: a systematic review and meta-analysis,” *Sports Medicine*, vol. 51, no. 5, pp. 1061–1086, 2021.
- [22] J. Weakley, M. Morrison, A. García-Ramos, R. Johnston, L. James, and M. H. Cole, “The validity and reliability of commercially available resistance training monitoring devices: a systematic review,” *Sports Medicine*, vol. 51, no. 3, pp. 443–502, 2021.
- [23] D. Trowell, B. Vicenzino, N. Saunders, A. Fox, and J. Bonacci, “Effect of strength training on biomechanical and neuromuscular variables in distance runners: a systematic review and meta-analysis,” *Sports Medicine*, vol. 50, no. 1, pp. 133–150, 2020.
- [24] M. Raj, P. Manimegalai, P. Ajay, and J. Amose, “Lipid data acquisition for devices treatment of coronary diseases health stuff on the Internet of Medical Things,” *Journal of Physics: Conference Series*, vol. 1937, article 012038, 2021.
- [25] R. Huang, “Framework for a smart adult education environment,” *World Transactions on Engineering and Technology Education*, vol. 13, no. 4, pp. 637–641, 2015.
- [26] S. Shriram, J. Jaya, S. Shankar, and P. Ajay, “Deep learning-based real-time AI virtual mouse system using computer vision to avoid COVID-19 spread,” *Journal of Healthcare Engineering*, vol. 2021, Article ID 8133076, 2021.
- [27] L. Xin, L. Jianqi, C. Jiayao, Z. Fangchuan, and M. Chengyu, “Study on treatment of printing and dyeing waste gas in the atmosphere with Ce-Mn/GF catalyst,” *Arabian Journal of sciences*, vol. 14, no. 8, p. 737, 2021.