Effects of High-Intensity Interval Training Group (HIIT), Moderate-Intensity Continuous Training Group (MICT) and Control Group on Body Composition, Cardiorespiratory Fitness and Muscle Fitness of Overweight and Obese Male and Female College Students

Xuan Li

A Thesis Submitted in Partial Fulfillment of Requirements for
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May 2025

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เสนอต่อมหาวิทยาลัยมหาสารคาม เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตร

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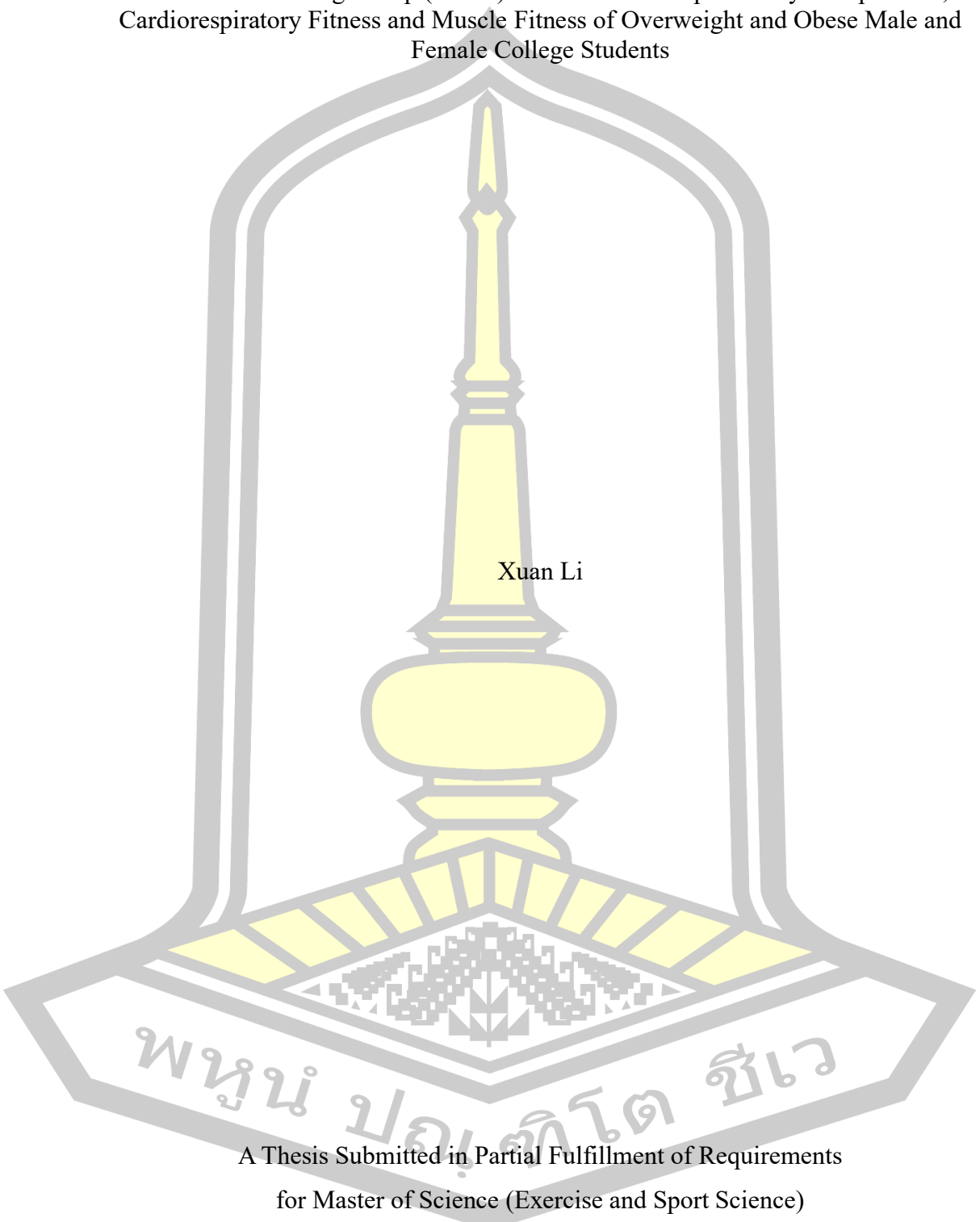

A Thesis Submitted in Partial Fulfillment of Requirements

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TITLE Effects of High-Intensity Interval Training Group (HIIT), Moderate-Intensity Continuous Training Group (MICT) and Control Group on Body Composition, Cardiorespiratory Fitness and Muscle Fitness of Overweight and Obese Male and Female College Students

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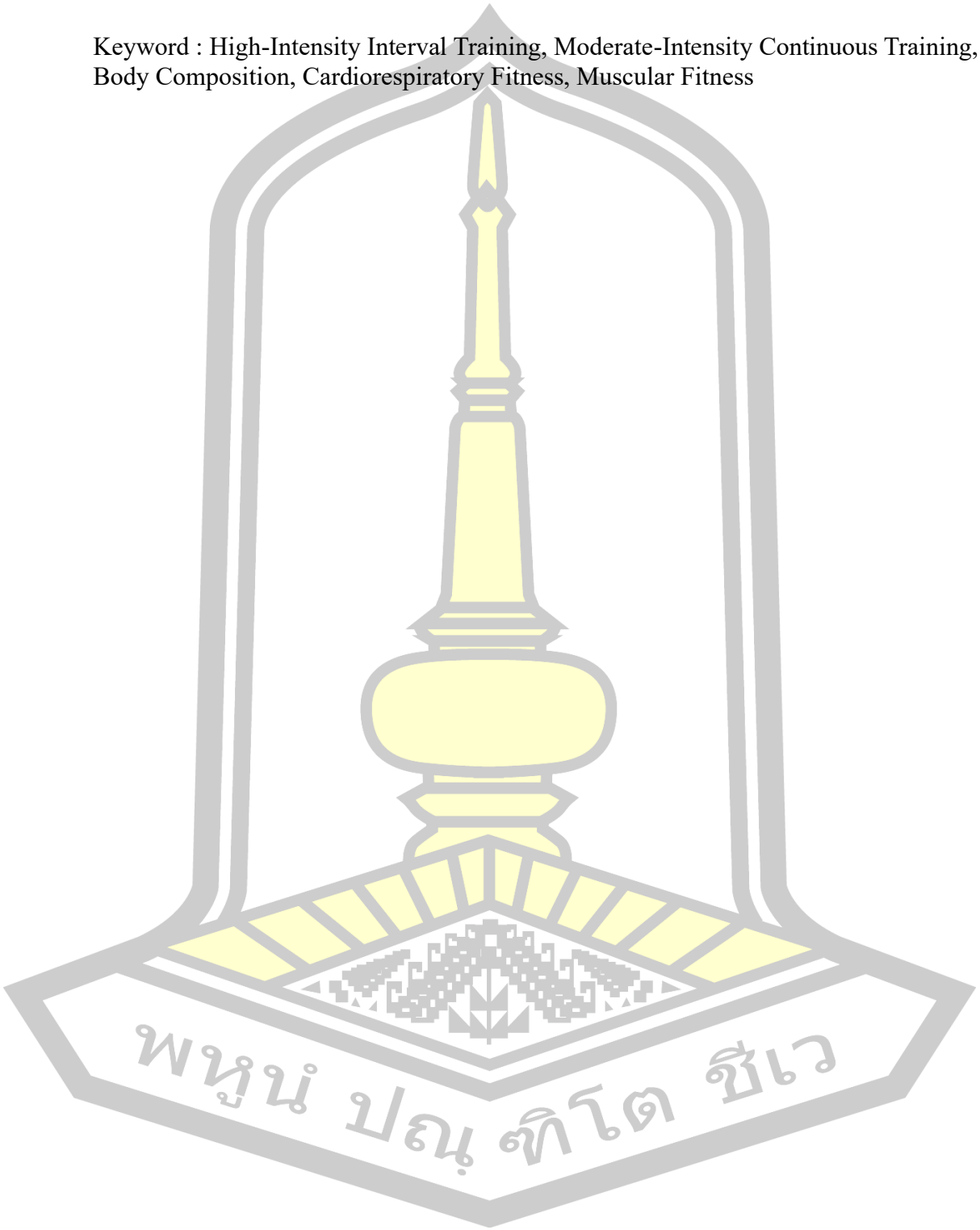
ABSTRACT

This study aimed to evaluate the effects of HIIT and MICT on body composition, cardiorespiratory fitness, and muscular fitness in overweight college students. The subjects were 66 college students aged between 18 and 20 years from Sichuan Health Vocational College, including 33 boys and 33 girls. The students were randomly divided into three groups, with 22 students in each group, including 11 boys and 11 girls. A body composition analyzer measured their BMI, waist-to-hip ratio, and skeletal muscle, and their vital capacity, 800 meters, 1000 meters, standing long jump, and sit-up data were tested using Shenzhen Hengkang Jiaye Physical Fitness Testing Instrument. The first group performed 8 weeks of HIIT, the second group performed 8 weeks of MICT, and the third group only performed daily teaching. The data before and after the experiment were analyzed using paired t-test, and the differences between the groups were analyzed using one-way analysis of variance. The paired t-test results showed that the body composition, cardiorespiratory fitness, and muscular fitness of the overweight boys and girls in the first HIIT group were significantly improved after the experiment compared with before the experiment ($P<0.01$). The BMI, lung capacity, 1000-meter push-ups, and 1-minute sit-ups of the second MICT group were significantly different before and after the experiment ($P<0.05$), while WHR, skeletal muscle content, and standing long jump were not significantly different ($P>0.05$). The third control group had no significant improvement in body composition, cardiorespiratory fitness, and muscular fitness ($P>0.05$). The one-way ANOVA showed that there were significant differences in body composition, cardiorespiratory fitness, and muscular fitness among the groups, among which the improvement of the first HIIT group was the most significant, followed by the second MICT group. The results of the study show that HIIT can significantly improve the body composition, cardiorespiratory fitness, and muscular fitness of overweight boys and girls. These results highlight the potential benefits of training methods in improving various physical indicators, which deserve further

research to explore their long-term effects and optimize exercise interventions.

Keyword : High-Intensity Interval Training, Moderate-Intensity Continuous Training, Body Composition, Cardiorespiratory Fitness, Muscular Fitness



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Xuan Li

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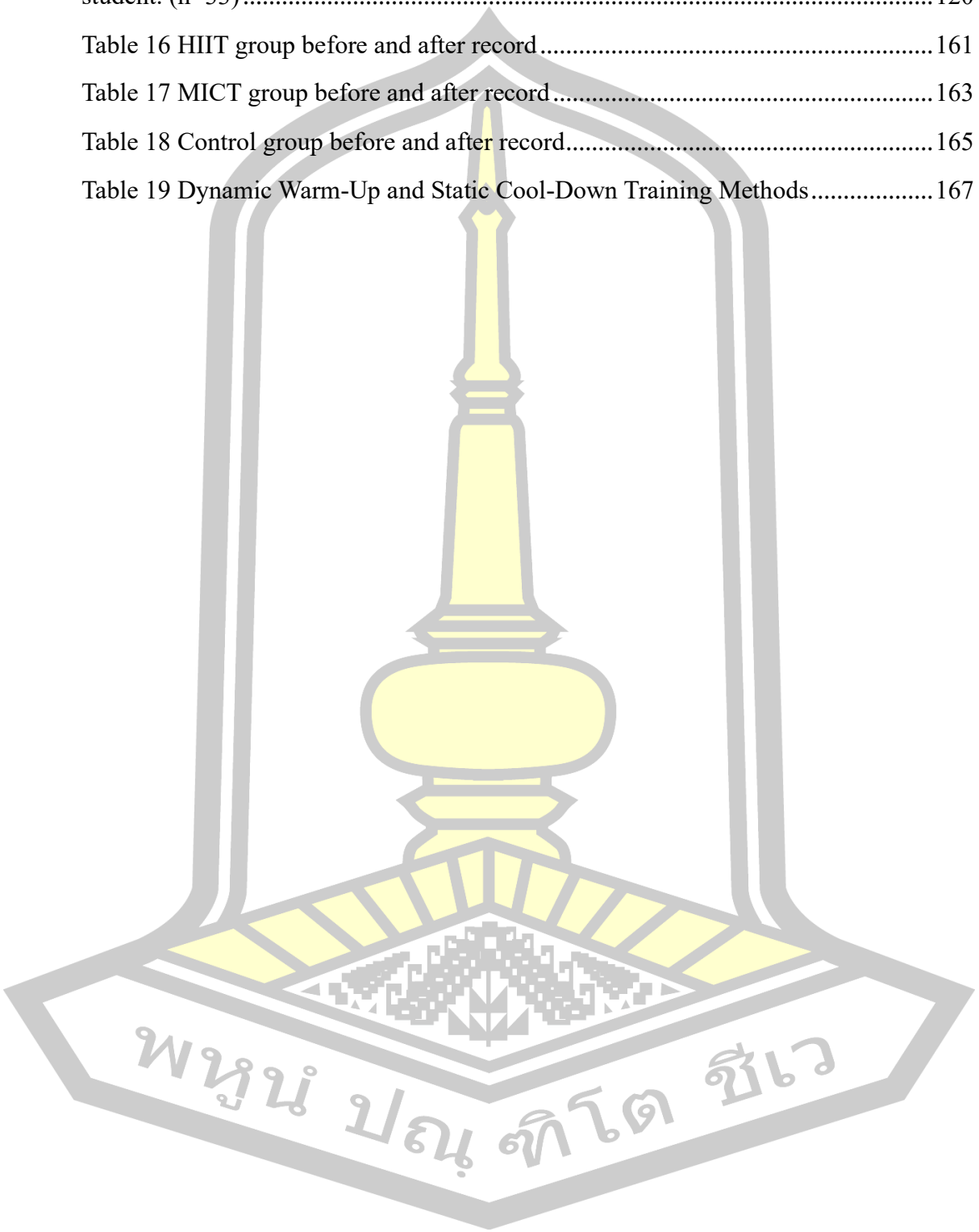

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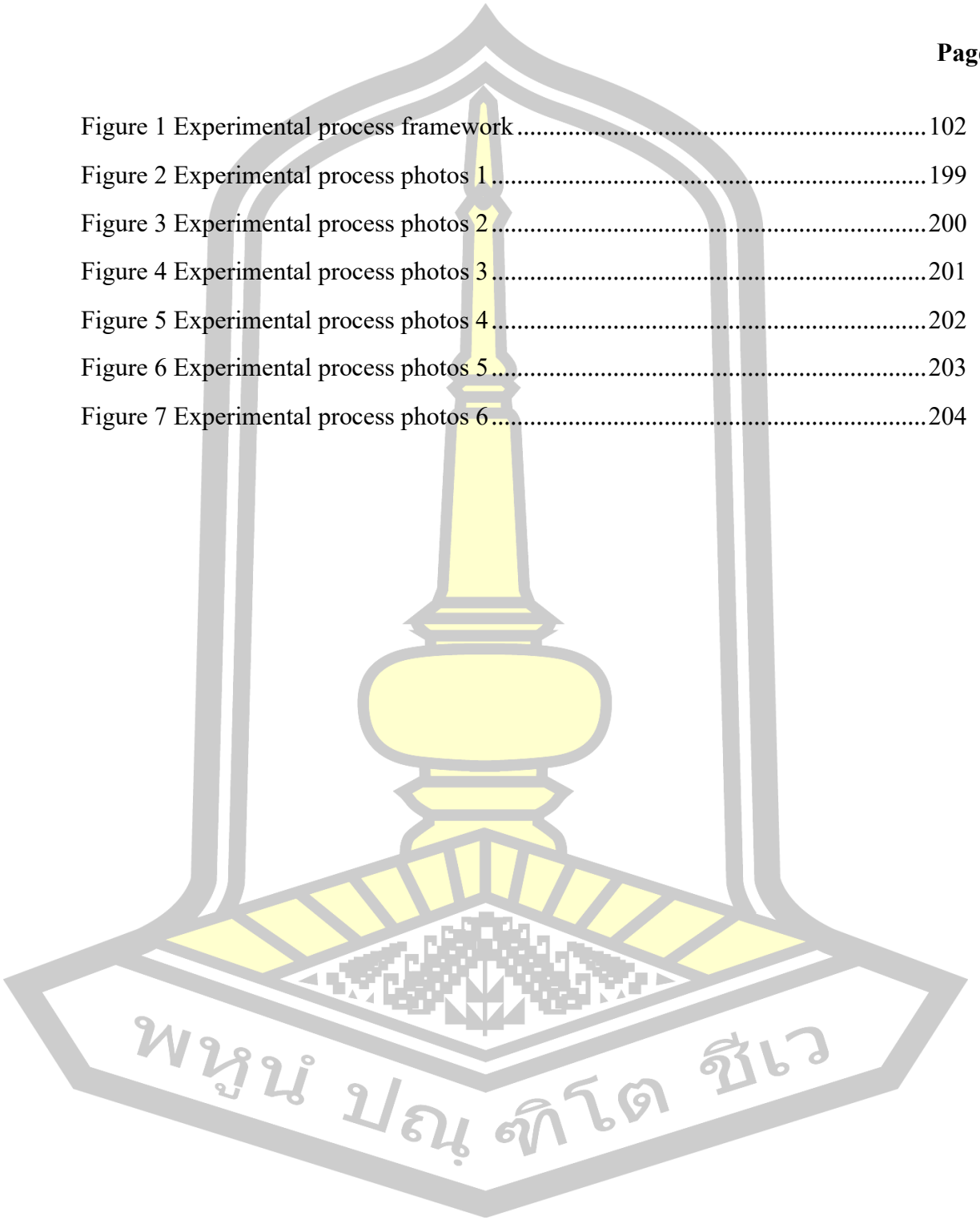

CHAPTER I
INTRODUCTION

1. Background

Obesity is one of the major public health problems in the world. It is also an important risk factor for chronic non-communicable diseases and is prone to secondary diseases such as cardiovascular diseases, coronary heart disease and hypertension. According to the statistics of the Non-communicable Chronic Disease Risk Factors Collaboration (NCDs), as of 2016, the prevalence of global obesity has gradually intensified and shown an upward trend. Among them, the obesity rate has risen to 5.6% (4.8% - 6.5%). Among them, the obesity rate of boys rose from 0.9% (0.5% - 1.3%) in 1975 to 7.8% (6.7% - 9.1%) in 2016. According to statistics, there are approximately 50 million girls and 74 million boys worldwide suffering from obesity. The Body Mass Index (BMI) of children and adolescents in most high-income countries has reached a relatively high level, and the upward trend of this index has tended to be stable. Compared with some regions in Asia, the upward trend of the BMI index is increasingly higher. And the correlation with adult obesity has gradually weakened. Katzmarzyk P T et al. (2014)， Early national physical survey data from the Chinese Student Physique and Health Research Group (2014) showed that the number of overweight people is gradually increasing, regardless of whether they are urban or rural college students, and the overweight and obesity rates among Chinese college students are increasing year by year [1]. "Physical Activity and Health of Children and Adolescents in China: Expert Consensus Statement" was jointly released by more than 20 domestic and foreign experts in the field of exercise and health in November 2020. The report shows that from a national perspective, children's obesity rate among adolescents has increased fourfold. Chen Pet al. (2020) predicts that the incidence of overweight children and adolescents in China will reach 28% in 2030, that is, the number of people will reach 49.5 million. Wang Liwei et al. (2020) The physical health level of college students is continuing to decline, and more than a quarter of college students have failed the "National Student Physical Health Standards (Revised in 2014)" test results.

PAN Trends, China has become the country with the largest number of overweight people in the world. Zhang Hanyue et al. (2023) The overweight and obesity rates among Chinese college students have shown a continuing upward trend. The overweight rates in 2016, 2018 and 2020 were 15. 8%, 18. 6% and 20. 1% respectively, with an average annual increase of about 1. 1 percentage points. Comparison between groups found that the overweight and obesity rates of boys were significantly higher than Girls. From 2016 to 2020, the overweight rate among college students increased from 15. 8% to 20. 1%, and the obesity rate increased from 3. 4% to 5. 3%. Overweight and obesity in different genders, age groups, ethnic groups and geographical regions Rates also show an upward trend. Overweight college students is a complex problem caused by the interaction of multiple factors such as bad living habits, unreasonable dietary structure and habits, and insufficient physical activity.

Survey data show that the number of overweight and obesity is gradually increasing among both urban and rural college students, and the overweight and obesity rates of college students in China are increasing year by year. Li Yan et al. (2022) 《Physical Activity and Health in China's Children and Adolescents: An Expert Consensus Statement" was jointly released by more than 20 domestic and international experts in the field of exercise and health in November 2020. The report shows that nationally, the obesity rate among children and adolescents increased four-fold from 1995-2014, with experts predicting that the prevalence of overweight children and adolescents will reach 28% or 49.5 million people in 2030, and the number of children and adolescents will reach 1.5 million in 2030, with the prevalence of obesity reaching 1.4 million. The prevalence of overweight children and adolescents is predicted to reach 28% in 2030, i.e. 49.5 million people. Chen Pet al. (2020)

From Sichuan Health and Rehabilitation Vocational College, my university, there is a serious decline in physical fitness. According to statistics from the China Student Physical Health Network, the number of failing students in our school in 2021 is 536, and by 2023, the number of failing students will increase to 1,089. There are many reasons for the decline in students' physical fitness and the increase in obesity. The number of overweight or obese people will increase from 976 in 2021 to 1,167 in 2023. Lack of physical exercise is one of the main reasons. How to mobilize students'

interest in physical exercise, strengthen physical exercise, and improve students' health levels has become an urgent problem for Sichuan Health and Rehabilitation Vocational College. Zhang Hanyue et al. (2023) College students are in the final stage of education before entering society. Having a strong body is the cornerstone for contemporary college students before entering society. Our country should formulate and improve corresponding prevention and control measures for this group.

Physical exercise has a variety of intervention methods to improve college students' physical fitness. Many scholars have been conducting research on improving the physical fitness of college students. Liang Xiaodong (2016) used football to explore the impact on college students' physical health. The training content mainly involves coaches training college students through decomposed teaching, so that students can master basic dribbling, passing, and shooting, combined with tactical exercises. The results show that after one semester of football training, the students' cardiopulmonary function, flexibility and lower limb explosive power have improved. Yang Tianshu et al. (2019) found in their research that intervening in the form of martial arts can improve the physical health level of college students. The results show that martial arts can improve the cardiopulmonary function and body composition of college students, and long-term martial arts exercise can improve the immune system of college students. Support, especially for college students who are experiencing heat and energy, can calm emotions and improve overall physical and mental health. To sum up, the above-mentioned research shows that there are currently many related studies on improving the physical health level of college students, which can improve the physical health level and physical exercise participation of college students to varying degrees. At present, most sports activities in domestic colleges and universities are conducted in the form of physical education classes and club classes. The training content is mostly medium-intensity jogging or freehand exercises, which belongs to medium-intensity continuous exercise (MICT). Through longer-term continuous exercise, you can effectively improve cardiopulmonary function and vital capacity and enhance the body's aerobic metabolism. This type of exercise is relatively gentle and less likely to cause excessive fatigue or injury. Highly accessible to students at all levels. Ma Sheng (2015) conducted an 8-week moderate-intensity continuous training intervention

comparative experiment on 80 male college students. Through the before and after data, it was found that the subjects' vital capacity, pulse value, and 400-meter running time were all significantly correlated, and the conclusion was drawn: Conclusion: Long-term medium-intensity continuous training can have an impact on the human body's muscle endurance and cardiopulmonary function, thereby improving muscle endurance. However, in today's fast-paced lifestyle, lack of time has become one of the main factors affecting people's lack of physical exercise. How to conduct short-term and effective training is a hot issue currently studied by many scholars. In recent years, some scholars have proposed an innovative exercise model called HIIT . HIIT was initially used in the field of competitive sports and was later widely used in fat reduction for obese people and rehabilitation of patients with chronic diseases. It is thought to be suitable for any form of fitness, from cycling or swimming to home aerobics is possible. Some studies believe that this exercise mode can not only increase the basal metabolic rate, shorten the weight loss process, improve muscle strength and joint protection, and improve exercise ability, but can also improve the levels of inflammatory factors caused by obesity to a certain extent, improve insulin sensitivity, and regulate Dyslipidemia is scientific and innovative to a certain extent.

When Li Kang (2018) studied the impact of High-intensity interval training (HIIT) on the institutional physical fitness test of high school girls, he took 92 high school girls aged 15-18 as experimental subjects and divided the students into different experimental groups and control groups according to grade. The HIIT group used short sprints as a training method, while the control group used school physical education classes for training. After 8 weeks, the high school girls' vital capacity, speed running, standing long jump, flexibility and VO2max had significantly improved. Wang Hui (2023) studied the effect of high-intensity interval training on obese male college students. After 8 weeks of training, the weight, BMI, body fat percentage, and waist-to-hip ratio of the experimental group decreased significantly, and their maximum oxygen uptake increased significantly. There were no significant changes in the control group, highlighting the effects of HIIT. With the application of HIIT among college students, more consistent research results are that HIIT can improve college students' aerobic exercise capacity and improve lipid metabolism-related indicators.

To sum up, moderate-intensity continuous training and HIIT have a good effect on improving college students' physical fitness. Moderate-intensity continuous training enables the body to adapt stably through longer-term stimulation, thereby causing adaptive changes in internal organs and improving aerobic metabolism and energy supply capacity. The advantage of HIIT is that it can effectively improve athletes' aerobic energy supply efficiency, enhance anaerobic exercise capacity (Liu Ruidong et al., 2017), and improve fat oxidation efficiency. In training, using high-intensity interval training can reduce training volume and shorten training time, thereby improving training efficiency and making our training more efficient and economical (Zhang Ge, 2016).At present, two-intensity exercise intervention, High intensity interval training(HIIT) and Moderate intensity continuous training(MICT), have been widely used in the field of sports and fitness at home and abroad. Most of the research focuses on fat reduction for obese people and rehabilitation treatment for patients with chronic diseases. In order to compare various training intensities between high-intensity interval training and medium-intensity continuous training, there are relatively few studies on the effects of high-intensity interval training and moderate-intensity continuous training on body composition, cardiorespiratory fitness, and muscle fitness of college students. Liu Canke. (2022) Most of the current domestic academic research on high-intensity interval training focuses on fat reduction for obese people and rehabilitation treatment for patients with chronic diseases. There are relatively few studies involving all indicators of body composition, cardiopulmonary fitness, and muscle fitness. There is a relative lack of research on overweight or obese college students. Obesity caused by factors such as lack of exercise and bad living habits has caused many problems for the development of college students.

Nowadays, college students are facing pressure from various aspects, including academic, life and employment pressure. In addition, college students' weak health consciousness, decreasing physical activities, long-term lack of physical exercise and sedentary for a long period of time, many bad habits in diet, sleep, etc., and serious reliance on electronic products will aggravate the health problems of college students. All these will aggravate the health problems of college students. College is an important turning point in all stages of life, during which college students are

gradually maturing physiologically and psychologically and gradually developing their own behavioral habits. It is important to pay great attention to it (Luo Shao Song, 2020).

This study investigated the effects of (HIIT), (MICT) and control group on body composition, cardiorespiratory fitness and muscle fitness of overweight male and female college students so as to find a training method more suitable for the development of overweight male and female college students physical fitness and health. In this way, we can find a training method more suitable for the development of overweight male and female college students' physical fitness, provide better choices for overweight male and female overweight male and female college students self-exercise, and provide methodological references for the promotion of overweight male and female college students physical fitness and health. What is the difference between HIIT and moderate-intensity continuous training and daily teaching control group? Which method is more effective on the indicators of body composition, cardiorespiratory fitness, and muscular fitness, and which method is more effective, is the origin of this study.

2. Objective of the study

2.1 To compare before and after of (HIIT), moderate-intensity continuous training group (MICT) and control group on body composition, cardiorespiratory fitness and muscle fitness of overweight male and female college students

2.2 To compare between group of (HIIT), (MICT) and control group on body composition, cardiorespiratory fitness and muscle fitness of overweight male and female college students

3. Research Questions

3.1 Does HIIT affect body composition, cardiorespiratory fitness and muscle strength?

3.2 Does HIIT have a more significant effect compared to MICT in improving body composition, cardiopulmonary function and muscle strength?

4. Research Hypothesis

4.1 After practicing the HIIT and MICT overweight male and female college students have better body composition, cardiorespiratory fitness and muscle fitness.

4.2 overweight male and female college students who train with HIIT and MICT will have different body composition, cardiorespiratory fitness and muscle fitness.

5. Population and target group

5.1 Population

the volunteers were composed of 66 college students majoring in rehabilitation, nursing, clinical research and other non-sports disciplines among overweight male and female college students from health and rehabilitation vocational colleges in Sichuan Province. The subjects were aged between 18 and 20 years old. The body mass index was tested using a body mass index tester. Overweight male and female college students with a BMI ranging from 24 to BMI<27.9 were selected according to the body mass index standard of "Chinese Physical Fitness Test Standard".

5.2 Target Group

Three groups (CG, EGI and EG2) will be determined using the fishbowl method. The sample size is calculated by the G*Power Software (Version 3.1.9.7). Type I-α error for two-tailed test is set at 0.05 while the power of the study is set at 0.80. The effect size is set at 0.4 and the calculated sample size is 66 participants with 22 participants in each group. A 20% drop out rate is considered and thus a total of 80 participants will be recruited in this study.

The 66 subjects were randomly divided into three groups. 14 replacements. Experimental group A was a HIIT, experimental group B was a MICT, and control group C was a daily training group without HIIT and MICET. The randomization was performed as follows: first, the 66 subjects were divided into a group of 33 boys and 33 girls. The boys and girls were then randomly grouped by cardboard singles and doubles. Experimental group A and experimental group B consisted of 22 subjects each. Control group C consisted of 22 subjects. Experiment A was a HIIT (11 boys and 11 girls). Experiment B was a MICT (11 males and 11 females). The control group used subjects who participated in regular physical education classes (11 males and 11 females).

6. Scope of research content

This study is experimental research aimed at investigating the effects of the following factors:

Effects of HIIT, MICT and control group on body composition, cardiorespiratory fitness and muscle fitness of overweight male and female college students

Variables used in the study:

6.1 Independent Variables

1) High-intensity interval training group

2) Moderate-intensity continuous training group

3) Control groups

6.2 Dependent Variables

1) Body composition (BMI, WHR, skeletal muscle)

2) Cardiorespiratory fitness (lung capacity, Cardiorespiratory endurance)

3) Muscle fitness (Power, Muscular strength, Muscular endurance)

7. Basic Agreement

7.1 The weight was stable 2-3 months before the experiment, with no obvious weight fluctuations.

7.2 The researchers compared the sample data before and after the experiment. Comply with Chinese physical health measurement standards

7.3 Except for weekly fixed physical education classes, do not participate in any organized, systematic and regular physical activities and physical exercises, such as morning running, night running, etc. In order to ensure the safety of the experimental subjects, the experimental subjects were informed of the relevant training knowledge and signed a consent form before the experiment.

7.4 Define the properties of the following samples

7.4.1 Overweight male and female college students aged between 18 and 20 are freshmen at Sichuan Health and Rehabilitation Vocational College. Overweight male and female college students with a BMI ranging from 24 to

27.9 were selected according to the body mass index standard of the "Chinese Physical Fitness Test Standard"

7.4.2 The sample is students majoring in rehabilitation, nursing, clinical and other non-sports majors at Sichuan overweight male and female college students

7.5 samples received a high-intensity interval, moderate-intensity continuous training program.

7.6 Participants voluntarily participated in the research project and agreed to participate in the study.

7.7 Body composition (BMI, WHR, Skeletal Muscle), measured by a Body Composition Tester.

7.8 Cardiopulmonary function (vital capacity, cardiopulmonary endurance), by vital capacity tester, 1000-meter run tester for men, and 800-meter run tester for women.

7.9 Muscle function (power, muscular strength, muscular endurance), by standing long jump tester, sit-up tester, and stopwatch.

8. Definitions of Terms

8.1 HIIT is a cardiovascular exercise strategy characterized by alternating short periods of high-intensity anaerobic exercise with lower-intensity recovery phases. Scholar Zhang Ge (2016) pointed out that HIIT is a training method that exercises at an intensity of 85% of maximum oxygen uptake within 45 seconds or between 2 and 4 minutes, with intervals of 10 to 20 seconds. The research of Paulo Gentil et al. (2017) shows that HIIT requires at least 2 to 8 weeks of intervention to have a positive impact. In addition, after reviewing a large number of literatures, it is found that a large proportion of HIIT intervention periods are 8 to 12 weeks. The research of Deng Jianwei et al. (2019) shows that the frequency of high-intensity interval training is mostly 2 to 3 times per week.

8.2 MICT refer to form of cardiovascular exercise characterized by sustained, steady-state physical activity at a moderate intensity, typically lasting for 20 minutes or more without interruption. This training intensity is generally defined as 50% to

70% of maximum heart rate, allowing individuals to maintain the activity for extended periods without excessive fatigue. MICT includes a variety of exercises such as jogging, cycling, swimming, or any activity that maintains a continuous and steady rhythm. This method of training is widely regarded as effective for improving cardiorespiratory endurance, promoting cardiovascular health, and burning fat, making it suitable for people of all ages and fitness levels. I implemented a 30-minute training session, starting with a 5-minute warm-up, followed by 20 minutes of moderate-intensity continuous training, and concluding with a 5-minute stretching and relaxation period. The training exercises were the same as those used in the experimental group, but the intervention method was different. Training for the next set began immediately after completing one set, with no rest intervals between sets, maintaining a continuous training intensity of 60% to 70% HRmax for 20 minutes.

8.3 Cardiorespiratory fitness: It includes cardiopulmonary endurance and lung capacity, reflecting the oxygen supply capacity of the body's organs such as the heart, blood vessels, and lungs to the muscle tissue. Cardiopulmonary fitness is closely related to human health and exercise ability, and it is the basic condition for human metabolism and endurance exercise. In this study, lung capacity and cardiopulmonary endurance were selected to test Cardiorespiratory fitness by using the 1,000-meter run for men and the 800-meter run for women.

8.3.1 lung capacity： Lung capacity is the volume of air that a person can sustain between maximum inhalation and maximum exhalation. In other words, vital capacity is the maximum volume of air that can be exhaled after a maximum inhalation, usually measured in liters. It is one of the most important indicators for assessing an individual's lung function and respiratory health. In physical fitness testing, lung capacity is usually measured using a breathalyzer or a series of specific maneuvers.

8.3.2 Men's Cardiorespiratory Endurance The college men's 1000-meter test is a commonly used track and field test to evaluate the physical fitness and endurance level of college students. In this test, participants are required to run 2.5 laps on a standard 400-meter track for a total distance of 1,000 meters. The purpose of the test is to measure the time it takes participants to complete a set distance, thereby

assessing their cardiorespiratory endurance and long-distance running ability. The shorter the completion time, the better the individual's endurance and cardiorespiratory fitness. This test is common in college athletic programs and fitness assessments to monitor a student's physical health and fitness progress. In my research, I measured 1000-meter endurance and cardiorespiratory fitness in male volunteers using a fitness tester.

8.3.3 Women's Cardiorespiratory Endurance women’s 800 meters is a physical fitness test that mainly evaluates college women's speed endurance and cardiopulmonary function. In this test, participants are required to run two laps on a track for a total distance of 800 meters. The purpose of this test is to measure the time it takes participants to cover the distance as an indicator of their cardiorespiratory endurance and mid-distance running ability. The shorter the time required, the better the speed endurance and cardiorespiratory fitness of the participants. The 800-meter run is a standard event in track and field competitions. It is also a common assessment item in school physical education classes and physical fitness tests, aiming to understand students' physical fitness levels. In my research, I measured 800-meter endurance and cardiorespiratory fitness in male volunteers using a fitness tester.

8.4 Body composition Body composition refers to the various components that make up the human body, including mainly the fat and non-fat parts (lean body mass). The adipose fraction is the fat tissue stored in the body; the non-fat fraction covers muscle, bone, water, and internal organs. Three items, BMI, WHR, and skeletal muscle, were selected for comparison in this study.

8.4.1 BMI：BMI (kg/m2) is body mass index, an international standard for measuring human weight and health. The objective parameter values of weight and height are used to determine the weight within the BMI range. This study used body composition analyzer to measure BMI (kg/m2).

8.4.2 WHR: Waist-to-hip ratio is the ratio of waist to hip circumference. It is an important indicator of central adiposity and an important indicator of estimating body symmetry. This study used body composition analyzers to measure waist-to-hip ratio.

8.4.3 Skeletal muscle weight: Skeletal muscle is a muscle attached to the bones and is an important part of the human locomotor system. It is governed by consciousness, and through contraction and diastole, it pulls the bones to produce movement, helping the body to accomplish various movements, such as walking and lifting hands. Skeletal muscle also plays an important role in maintaining body posture, protecting bones and joints, and consumes energy during metabolism, which has a positive effect on body metabolism. In this study, a body composition analyzer was used to measure skeletal muscle

8.5 Muscular fitness: mainly includes muscle strength and muscle endurance and power. Muscle strength mainly refers to the instantaneous load-bearing capacity and explosive power of the muscle, which mainly relies on anaerobic exercise, while muscle endurance is mainly reflected in the ability to handle lactic acid concentration in the cell blood. Endurance quality is a necessary quality in all sports. The higher the aerobic endurance quality, the more training volume the body can withstand, and the more exercise with a greater amount of exercise and energy can be carried out. This study selected three items: muscular strength uses 1-minute push-ups for overweight male and female college students, muscular endurance uses 1-minute sit-ups for overweight male and female college students, and power uses the standing long jump of overweight male and female college students to compare muscle functions.

8.5.1 Power: The Power test using the standing long jump is a physical fitness assessment aimed at evaluating lower limb strength and overall body coordination. In this test, the subjects start from a static standing position and try to jump as far forward as possible without taking a step or running. This study uses college students' standing long jump testers.

8.5.2 Muscular endurance: Muscular endurance refers to the ability of the muscles to contract continuously or repeatedly under a certain load for a long time. The 1-minute sit-up test is a commonly used physical fitness test to evaluate an individual's abdominal muscle endurance. This study uses the college students' physical fitness measuring instrument to measure sit-ups.

8.5.3 Muscular strength: Muscular strength refers to the ability of the muscles to exert force. Muscular endurance refers to the ability of the muscles to contract

continuously or repeatedly under a certain load for a long time. Specifically, it reflects the muscles' ability to resist fatigue. The 1-minute push-up test is a strength assessment aimed at evaluating an individual's upper body muscle strength and endurance. This study uses a stopwatch to measure push-ups.

8.6 Overweight: Overweight refers to a state where the body takes in too much food, accumulates excessive fat and triglycerides in the body, and has improper metabolism, resulting in excessive weight gain. Currently, internationally, the "Body Mass Index" (also known as body mass index or body mass index) is commonly used to measure the degree of obesity in the human body, abbreviated as BMI. The calculation method is BMI= weight (kg)/height (m^2). At present, the standards for judging overweight or obesity vary from country to country. College students usually adopt the "National Standards “According to the "National Physical Fitness Test Standards", the BMI for male underweight should be no more than 17.8, and for female underweight, it should be no more than 17.1. Normal weight$17.9<BMI\leq 23.9$, normal weight for female. $17.2<BMI\leq 23.9$, the overweight and obesity standards for both male and female are the same, overweight$24\leq BMI<27.9$, obesity $BMI\geq 28$

CHAPTER II
LITERATURE REVIEW

This experiment referred to the following literature materials.

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    1.2 High-Intensity Interval Training Exercise Program
    1.3 Advantages and disadvantages of high-intensity interval training
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    5.1 Research on body composition of HIIT and MICT
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    5.21 Body Mass Index (BMI)
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1. High intensity interval training

1.1 Definition of High-Intensity Interval Training

Liu Ruidong et al. (2017) High Intensity Interval Training (HIIT) refers to a steady state that reaches or exceeds the anaerobic threshold (Anaerobic threshold, AnT) or the maximum lactate steady state (MLSS) in multiple sets. It is a type of exercise that focuses on load-intensity movement exercises, during which low-intensity exercises of different lengths or rest recovery are performed. Li Yongming (2015) HIIT can be performed using equipment or body weight training with bare hands. Based on the training content, HIIT mainly includes five aspects: load intensity, load duration, interval intensity, interval time and load times. In addition, HIIT also includes exercise methods, exercise groups and training duration. The exercise process is divided into an explosive period and a recovery period. During the explosive period, all movements are explosive movements, while the recovery period is carried out in the form of relaxed running or complete rest. The two processes are carried out alternately. Research shows that this kind of training method can increase athletes' oxygen uptake and utilization of oxygen in a short period of time. The article by Reindell H et al. (2001) mentioned that Hans Reindell of Germany first proposed the HIIT training method in 1959 and gradually applied it to competitive superstability L V et al. (2001) In recent years, as HIIT has been widely paid attention to and spread, HIIT has been gradually used in fields such as rehabilitation training

and fitness. HIIT can keep athletes' oxygen uptake at or near their maximum oxygen uptake level for a longer period of time, thereby improving their cardiopulmonary endurance and effectively improving their competitiveness. Stensvold D et al. (2010) With the development of society and economy, lack of time for exercise and insufficient physical activity are one of the factors leading to obesity. According to existing research results, in addition to improving the body's aerobic capacity and controlling weight, HIIT also has certain effects in improving vascular endothelial function, lowering blood pressure, and improving heart function. Fu T et al. (2013) HIIT exercise method has gradually extended to areas such as fitness and chronic disease control. In addition to athletes, the research subjects also include people with sarcopenia, obesity, chronic diseases, etc. How to achieve better fat loss results within a limited time is an important issue faced by obese people. In recent years, HIIT has gradually become favored by weight loss people and is widely used in exercise to lose weight.

1.2 High-Intensity Interval Training Exercise Program

Sijie T et al. (2012) conducted a 12-week high-intensity interval training intervention on overweight people, performing 3 minutes of 85% VO2max intensity exercise followed by 3 minutes of 50% VO2max intensity exercise as intervals, with 5 repetitions each time. 5 times a week; results show that HIIT has a good fat loss effect. Scholar Wang Jingjing et al. (2015) randomly divided 24 young obese women into 2 groups and conducted exercise intervention 4 times a week for 12 weeks. The high-intensity interval group used 85%~95% HRmax exercise for 4 minutes, followed by 50% exercise. ~60%HRmax 3 minutes of exercise followed by 7 minutes of rest; research results show that high-intensity intermittent exercise has a significant effect on reducing abdominal fat content and waist-to-hip ratio in young obese women. Qi Yugang et al. (2013) conducted exercise training intervention on 60 obese female college students (BMI≥26, Fat%≥30%) 5 times a week for 12 weeks. The HIIT group exercised at an intensity of 85% VO2max for 25 minutes, and the control group Without exercise intervention, it was found that HIIT can significantly improve aerobic capacity and reduce body fat. The reason may be that the proportion of anaerobic exercise during HIIT is higher, and the excess post-exercise oxygen

consumption (EPOC) after exercise is significantly higher than Traditional continuous training still maintains high oxygen consumption during the recovery period, requiring more energy and fat consumption's T et al. (2012) conducted a 12-week high-intensity interval training intervention on overweight people, performing 3 minutes of 85% VO2max intensity exercise followed by 3 minutes of 50% VO2max intensity exercise as intervals, with 5 repetitions per week, each week 5 times; the results show that HIIT has a good fat loss effect. Scholar Wang Jingjing [61] randomly divided 24 young obese women into 2 groups and conducted exercise intervention 4 times a week for 12 weeks. The high-intensity interval group used 85%~95% HRmax exercise for 4 minutes, followed by 50%~60% exercise. HRmax: 3 minutes of exercise followed by 7 minutes of rest; research results show that high-intensity interval exercise has a significant effect on reducing abdominal fat content and waist-to-hip ratio in young obese women.

1.3 Advantages and disadvantages of high-intensity interval training

The article by Wu Zhi-Jian et al. (2020) pointed out that HIIT can effectively increase peak oxygen consumption and change body composition in adults. It was also found in a meta-analysis on HIIT, and Liu Y et al. (2020) also proposed HIIT helps maintain weight, slow muscle loss, and lower blood triglyceride and glucose levels, improving cardiac muscle contractile function and cardiorespiratory fitness. Animal experiments have also shown that HIIT can significantly reduce the content of TG in mice, increase the phosphorylation of HSL-Ser563 in subcutaneous fat, reduce adipocyte resistance to catecholamines, and improve fat mobilization during exercise. Wang Xinbo (2014) and Zhang Xin (2018) confirmed the fat reduction effect of HIIT. Compared with traditional exercise training, HIIT can achieve better results in less training time. HIIT has a significant impact on BMI, body fat rate and waist of obese people. The hip ratio reduction effect is obvious. However, there are few studies on the mechanism of HIIT fat reduction, and the principle is still unclear.

1.4 Research related to high-intensity interval training

Reindell et al. (1959) first proposed the concept of "interval training" and published it. Ernil Zatopek was the first to come into contact with and use this method for training. He used this training method to win gold medals in the 5,000 meters, 10,000 meters and marathon events at the 1952 Olympic Games in Helsinki. He was therefore dubbed the "most unforgettable athlete". After that, high-intensity interval training was widely discussed and many people tried to add this training method to their training, and it was initially confirmed to have a good effect in improving athlete performance. Experts and scholars from various countries creatively came up with the HIIT training method after researching and analyzing existing physical exercise methods. Because this training method can consume a large amount of energy and fat in a short period of time, it has become rapidly popular in European and American countries since its inception and is widely used in fitness and athlete training. As research on it continues to deepen, experts and scholars have discovered that it is not only suitable for modern people's lifestyle, and can be used to improve people's cardiopulmonary function and impact speed, which is of great benefit to the training of athletes.

Bartlett (2011) used the "Perceived Physical Activity Enjoyment Rating Scale" in his study to conclude that high-intensity interval exercise training is more pleasurable than moderate-intensity continuous exercise. For high-intensity interval exercise, it belongs to the scope of aerobic exercise. Its exercise time is shorter, and the exercise method also has certain particularities, which can make the effect of aerobic exercise manifest. Costigan et al. (2015) pointed out in the study that high-intensity interval training is a feasible and effective strategy to improve the health-related physical fitness of adolescents. The research results show that HIIT training has a greater impact on cardiopulmonary function and has a general impact on body composition. Conclusion: HIIT training is an effective method to improve cardiorespiratory fitness and body composition in adolescents. Researchers then verified that improving aerobic capacity is a reflection of effective adaptation of the heart and peripheral organs, that is, effective adaptation of cardiovascular and skeletal muscles. Historically, HIIT training has been used in competitive sports and rarely in people with disease or the general population due to safety concerns. However, in recent years, it has been concluded through research that the general population or some

people with heart and other diseases do not experience any adverse reactions when implementing high-intensity interval exercise rehabilitation. Then researchers began to study it in depth. Because this method has its own special characteristics (full force, burst, short time, etc.), young people like it very much. Many researchers began to study the impact of this training method on human health. , and concluded that the high-intensity interval training method is safer and has strong acceptability. Because the exercise time is not long, it is not difficult for people to stick to this exercise method. At the same time, this training method can improve aerobic capacity, reduce blood sugar, reduce fat, and improve vascular endothelial function. These results have been effectively verified.

Sijie T et al. (2012) conducted a 12-week high-intensity interval training intervention on overweight people, performing 3 minutes of 85% VO2max intensity exercise followed by 3 minutes of 50% VO2max exercise as intervals, repeating 5 groups each time, every week 5 times; the results show that HIIT has a good fat loss effect. Scholar Wang Jingjing (2015) randomly divided 24 young obese women into 2 groups and conducted exercise intervention 4 times a week for 12 weeks. The high-intensity interval group used 85%~95% HRmax exercise for 4 minutes, followed by 50%~60% exercise. HRmax: 3 minutes of exercise followed by 7 minutes of rest; research results show that high-intensity interval exercise has a significant effect on reducing abdominal fat content and waist-to-hip ratio in young obese women.Qi Yugang et al. [2013] conducted exercise training intervention on 60 obese female college students (BMI≥26, Fat%≥30%) 5 times a week for 12 weeks. The HIIT group exercised at an intensity of 85% VO2max for 25 minutes, and the control group exercised at an intensity of 85% VO2max for 25 minutes. Without exercise intervention, it was found that HIIT can significantly improve aerobic capacity and reduce body fat. The reason may be that the proportion of anaerobic exercise during HIIT is higher, and the excess post-exercise oxygen consumption (EPOC) after exercise is significantly higher than Traditional continuous training still maintains high oxygen consumption during the recovery period, requiring more energy and fat consumption.

2. Moderate intensity continuous training

2.1 Definition of medium-intensity continuous training

Wang Hongyu (2015) pointed out in the article that moderate intensity continuous training (MICT) refers to a training method with medium load intensity during exercise, a relatively long duration and continuous practice without interruption. The principle is that the body produces stable adaptation through longer-term stimulation, thereby causing adaptive changes in internal organs and improving aerobic metabolism and energy supply capacity.

Li Pu (2017) pointed out in the article that MICT refers to a training method of continuous exercise with a long duration and relatively low exercise intensity. Relatively speaking, MICT is not highly professional, so both professional athletes and ordinary people can use this training method for sports and fitness. This training method can significantly improve the cardiopulmonary function of the trainer, effectively consume the fat stored in the body, and is a more effective way to lose weight. Zhang Li (2019) pointed out through experimental research that when the intensity is maintained at 25% V0 2max, the fat energy supply ratio generated by aerobic exercise reaches the maximum value, which can maximize the body's energy balance during weight loss. Tang Hongbin et al. (2017) MI C T training time of at least half an hour to 1 hour every day can have a significant weight loss effect. If the training time is longer, the weight loss effect will be more obvious, but the exercise intensity needs to be appropriately adjusted. control.

2.2 Moderate-intensity continuous training exercise program

There were 20 people in the moderate-intensity continuous training group (MICT group) of the training program in Yu Zhendong's (2023) study. The HIIT group and the MICT group underwent swimming training intervention at the same time, three times a week for 8 weeks. Training plan: The HIIT group performs 30s*12 groups of sprint swimming, with an interval of 60s between groups, and an exercise intensity of 90%-95% HRmax. The MICT group performed 30 minutes of non-stop swimming with an exercise intensity of 70%-75% HRmax. The training plan of Li Jiajia (2021) has three parts for both the HIIT group and the MICT group, namely preparation,

basic and end. The preparation and ending of the two groups were exactly the same, and both used the daily content prescribed by the teaching: the preparation part was 10 minutes of resistance training, and the ending part was 8 minutes of stretching. There are differences in the basic parts between the two groups. The same training content includes 4×400m running (rest: 2~-3min), 5×400m running (rest: 4~5min), and 6×400m running. The HIIT group took 100m fast running (fast running on a straight road, using 80%~90% VO2max). 100m jogging (slow running on curves, using 35%~45% VO2max). The MICT group took the whole process of running at a constant speed (using 60%~70% VO2max). %VO2max). Deng Heping (2022) selected sixth grade students (sample size about 300) and randomly divided them into HIIT group, MICT group and control group, three times a week for 8 weeks. The HIIT group performed the basic portion of the class for 26-38 minutes. There are three sets of actions, each set of 8 actions, each action lasts 15 seconds, and the interval is 10 seconds. The intensity of exercise intervention is 80-90% HRmax, and the interval between groups is 40 seconds. The total time is 12 minutes; in the basic part, the MICT group completed 12 minutes of running at 65%-75% HRmax intensity at 26min-38min.

2.3 Advantages and Disadvantages of Moderate-Intensity Continuous Training

Yu Zhendong's (2023) article stated that the MICT group's weight, BMI, body fat content, body fat percentage, waist-to-hip ratio, arm circumference, hip circumference, and leg circumference were significantly reduced. Not as obvious as HIITModerate aerobic exercise can not only effectively lower blood lipids, but also affect the level of inflammation in exercisers, thereby helping to reduce the risk of cardiovascular disease. During long-term low-intensity exercise, fat is the main energy supply substance, and the capillary permeability of skeletal muscles changes during exercise, increasing lipoprotein lipase activity, promoting the decomposition of plasma TG, and improving the utilization of fatty acids by muscles and other tissues, thereby It promotes the transport of TG out of the liver; the reduction of TG in the body can inhibit the secretion of inflammatory cytokines by adipocytes and reduce the infiltration of macrophages; it can also increase the expression of anti-inflammatory genes and improve the inflammatory state in the body. Liu Shanyun et al. (2008)

showed that after 12 weeks of continuous aerobic exercise, the condition of patients with dyslipidemia was significantly improved, and the content of high-sensitivity C-reactive protein decreased by 43.41%. Obesity is one of the main factors in the development of type 2 diabetes. A meta-analysis showed [51] that long-term physical activity can regulate tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), lipid adipocytokines such as catenin, visfatin, omentin-1 and leptin to improve the inflammatory state in patients with diabetes.

2.4 Research on medium-intensity continuous training

Rowley et al. (2019) pointed out that in terms of health promotion for the general population, the general population is the main research object for comparative studies of high-intensity interval and moderate-intensity continuous training, which is mainly evaluated through changes in indicators such as VO2max, exercise capacity, fat content, and material metabolism. . Wang Jingjing (2015) et al. experimentally compared medium- and high-intensity exercise and found that both different intensities had fat-reducing effects, but high-intensity interval training was less effective in reducing abdominal visceral fat content, abdominal subcutaneous fat, Fat%, and total body fat content in obese young women. The effects are better than moderate intensity aerobic training.

Cao Haojia (2018) pointed out that under the condition of equal energy consumption, members of the MICT and HIIT groups showed varying degrees of weight loss, and the HIIT group better retained their original weight while losing weight. Some skeletal muscles and water, etc., while the MI C T group achieved weight loss mainly through the consumption of fat, significantly reducing the body fat rate of the trainees. In view of this, it is recommended that athletes or participants choose a more appropriate way to lose weight based on their own needs and their actual situation.

Tian Maijiu (2000) The intensity of moderate-intensity continuous training is usually below the anaerobic threshold. The amount of oxygen consumed by the body is basically equal to the oxygen demand during exercise, reaching a physiological balance state. Moderate-intensity continuous training is low-intensity exercise, mainly

aerobic exercise, and lasts for a long time. A large number of studies have proven that moderate-intensity continuous training can help regulate glucose and lipid metabolism, reduce fat content, enhance and improve cardiopulmonary function, and is one of the main ways of exercise. Increasing energy consumption through exercise is recognized as the greenest and healthiest way to lose weight. According to the American Academy of Sports Medicine (ACSM), the average heart rate during exercise should be maintained at around 65% of the maximum heart rate (HRmax), and exercise every week 3 to 5 times, each lasting 30 to 60 minutes, is helpful to maintain a healthy state.By continuing to perform moderate-intensity exercise (55%~75% VO2max), the body will gradually use fat as the main source of energy, gradually increasing the fat oxidation rate. Zhang Yong (2010) increased the proportion of fat as energy source. Jordy B (2015) research shows that the proportion of fat energy supply increases with the extension of exercise time. The longer the exercise time, the more fat is consumed. Many literatures have reported that moderate-intensity continuous exercise can alleviate liver lipid deposition and chronic inflammation of adipose tissue [44]. Colberg S R et al. (2010) increased fat consumption and aerobic fitness, and improved glycolipid levels in the body. The American Diabetes Association's exercise prescription suggests that continuous training for at least 2h to 3h per week can reduce the risk of type 2 diabetes. Guo Yin et al. (2011) research shows that 30 days of continuous aerobic exercise can improve the physical function of obese children, significantly increase the serum HDL-C/LDL-C ratio, reduce the content of TG and TC in the body, and help control BMI, reduce body fat percentage. Choi K M et al. (2007) found that obese people have significantly higher visfatin levels, and continued exercise training 5 times a week (60%~75%VO2max, 45min/b) can reduce plasma visfatin levels., reduce weight, and the combination of aerobic and resistance training has better effects. Rugbeer N et al. (2021) A meta-analysis of exercise-related randomized controlled trials shows that MICT can reduce the body fat rate of the population, is beneficial to cardiopulmonary health, and has a benign effect on chronic renal failure. Moderate aerobic exercise can not only effectively lower blood lipids, but also affect the level of inflammation in exercisers, thereby helping to reduce the risk of cardiovascular disease. During long-term low-intensity exercise, fat is the main energy supply substance, and the capillary

permeability of skeletal muscles changes during exercise, increasing lipoprotein lipase activity, promoting the decomposition of plasma TG, and improving the utilization of fatty acids by muscles and other tissues, thereby It promotes the transport of TG out of the liver; the reduction of TG in the body can inhibit the secretion of inflammatory cytokines by adipocytes and reduce the infiltration of macrophages; it can also increase the expression of anti-inflammatory genes and improve the inflammatory state in the body.

3. Overweight and Obesity

3.1 Concepts of overweight and obesity

Overweight refers to excessive food intake by the body, excessive accumulation of fat and triglycerides in the body, and improper metabolism of the body. A state that causes excessive weight gain. Currently, internationally, "Body Mass Index" (also known as body weight index or) is commonly used The body Mass Index is used to measure the degree of obesity in the human body, abbreviated as BMI. The calculation method is BMI= weight (kg)/height (m ^{2}).At present, the standards for judging overweight or obesity vary from country to country. In China, the "Chinese Obesity Standard" is usually adopted The "National Guidelines for the Prevention and Control of Overweight and Obesity in Adults" sets the assessment criteria for body mass index: underweight BMI<18.5Normal weight: 18.5≤BMI≤23.9; overweight: 24≤BMI<27.9. College students usually adopt the "National “According to the "National Physical Fitness Test Standards", the BMI for male underweight should be no more than 17.8, and for female underweight, it should be no more than 17.1. Normal weight17.9<BMI≤23.9, normal weight for female. 17.2<BMI≤23.9, the overweight and obesity standards for both male and female are the same, overweight24≤BMI<27.9,

4. Test indicators

4.1Selection of test indicators

The test indicators for healthy physical fitness of college students are selected based on the test standards for healthy physical fitness of the American Dance Sports Association, the American College of Sports Medicine and the Hong Kong Physical Fitness Federation, which have earlier research on physical fitness, and draw lessons from China's "Student Physical Fitness" "Health Standards", Zhang Lei et al. (2014) pointed out that the test content of this standard is easy to operate and can basically reflect the health and fitness of students. After combining various aspects, the health fitness test indicators of this study were determined, as shown in Table 1.

Table 1 Body composition, cardiopulmonary fitness, and muscle fitness test indicators

Test content	Test indicators	Test equipment
body composition	BMI	Body Composition Tester
	WHR	Body Composition Tester
	striated muscle	Body Composition Tester
cardiorespiratory fitness	lung capacity(ml)	lung capacity tester
	Cardiorespiratory endurance(s)	1000m running tester
	Cardiorespiratory endurance(s)	800m running tester
muscle fitness	Power	Standing Long Jump Tester
	Muscular endurance (rep)	Stopwatch YS-810
	Muscular strength (rep)	sit-up test instrument

5. Body composition

5.1 Research on body composition of HIIT and MICT

In terms of body composition, Wang Jingjing et al. (2015) conducted two different intensities of exercise training on 24 young obese women, requiring the exercise intensity to be between 85%-95%HRmax and 60%-70%HRmax throughout the process. Fluctuate within a range of intensity. After training, it was found that both intensities can reduce abdominal subcutaneous fat, but the effect of high intensity more significant. Fat content (visceral fat and subcutaneous fat) is an important influencer of body composition. Zhu Lin et al. (2020) analyzed the 11 finalized literature on adolescent fat loss through the inclusion and exclusion of literature, and found that high-intensity short intervals (10-30 seconds of exercise, 10-30 seconds of rest) can improve internal organs Fat, high-intensity long interval (exercise for 2-4 minutes, rest for 1-3 minutes) can improve body composition and reduce body fat content in overweight/obese adolescents. Similar results also appeared in the study of Gao Siyao et al. (2019). Cao et al. (2019) studied that high-intensity interval training has the same fat-reducing effect as moderate-intensity continuous training. Peng Xu (2020) pointed out that HIIT did not significantly change the weight and waist circumference of obese adults. In addition, foreign scholars Logan G R(2016) conducted 8 weeks of HIIT + resistance training on male youth and found that body composition was significantly improved, and believed that there was not much correlation between the total amount of exercise and each indicator, which means that there is no need The interference of resistance training and HIIT can also produce good effects on the body to a certain extent.

5.2 Definition of body composition

Body composition fitness is closely linked to human health. Body composition refers to the content of various components in the human body, which constitutes the total composition of various tissues and organs of the human body. It is divided into two types: fat component and non-fat component. The fat component is body fat weight, and the non-fat component is lean body mass (also known as lean body mass). Lean body mass), including organs, bones, muscles, water and minerals and other components Jiang Chongmin et al. (2008). Body composition is an important indicator of human tissue, which can reflect the body's physical condition, body

characteristics and body size, while the composition of fat can reflect the body's fatness and thinness.

5.2.1 Body Mass Index (BMI)

Li Jiajia. (2021). The article proposes that the body mass index (abbreviated as BMI) was invented and proposed by the famous Belgian scholar Ketler in the 19th century. The index has been generally recognized by the industry as soon as it came out, and it is still internationally recognized. BMI is used as an important indicator to judge human health. The specific calculation method of BMI is BMI = weight (kg) / height 2 (m2). The World Health Organization and the International Society for the Study of Obesity, together with a number of authoritative experts, announced to the public the latest obesity standards in the Asia-Pacific region in 2002. This standard considers a BMI value higher than 23 to be overweight, and a BMI value higher than 25 to be defined as overweight. for obesity. Domestic scholars have conducted systematic research based on the specific conditions of Chinese citizens. The research results show that the latest obesity standards in the Asia-Pacific region are only applicable to adults over 18 years old in China. Because I studied college students over the age of 18, I used the Asia-Pacific obesity standards. Details are shown in Table 2.

Table 2 Asian Standard for Body Mass Index (BMI)

Less than 18.5	weight below standard
18.5-22.9	symmetry
23.0-24.9	overweight
25.0-29.9	obesity
from 30	dangerous obesity

5.2.2 Waist-to-hip ratio (WHR)

Yang Luhua (2014) pointed out that the waist-to-hip ratio is the ratio of waist circumference to hip circumference. This indicator is an important indicator to evaluate central obesity and overweight. The waist-to-hip ratio can evaluate the health level of the human body to a certain extent. The waist-to-hip ratio is an important indicator to evaluate human health. A weathervane, a larger waist circumference indicates that fat is stored in the abdomen. Waist and abdominal obesity can easily cause diabetes, hypertension, coronary heart disease and other diseases, stroke, hyperlipidemia and other diseases. It marks a threat to human health; A larger hip circumference indicates that the lower body muscles are well developed, which is a good sign for human health. Li Buyi (2022) studied that when the waist-to-hip ratio of men exceeds 0.9 and the waist-to-hip ratio of women exceeds 0.8, it can be regarded as central obesity.

5.2.3 striated muscle

Skeletal muscle is the muscle attached to the bones, which consists of multinucleated muscle fibers (also called myocytes). These muscle fibers are encased in connective tissue, which serves to support, protect, and nourish the muscle. Each skeletal muscle contains both a muscle belly and a tendon. The muscle belly is the middle part of the muscle, mainly composed of muscle fibers, elastic, and able to contract to produce force; tendon is located at the ends of the muscle belly, composed of dense connective tissue, tough and non-contractile, which attaches the muscle to the bone.

6. Cardiorespiratory fitness

6.1 Research on the effects of HIIT and MICT on cardiorespiratory fitness

In terms of cardiopulmonary fitness, common indicators such as maximum ventilation and aerobic capacity can be used to reflect the strength of cardiopulmonary function. Wang Zheng (2015) pointed out that more than a month of low, medium and high-intensity exercise can improve the aerobic capacity of young male groups, but relatively speaking, high-intensity exercise has a more obvious improvement effect. In

addition, measures to improve aerobic capacity In terms of physiological mechanisms, high-intensity exercise is also more complex. Wang Wei et al. (2016) studied that HIIT can cause adaptive changes in skeletal muscle by affecting the morphology and recruitment of muscle fibers, the glucose metabolism capacity of skeletal muscle, and the activity of skeletal muscle mitochondrial oxidase. They also pointed out that HIIT can reflect aerobic exercise. There are inconsistent results on the impact of VO2max, an important indicator of ability. The study by Tjnna A E et al. (2008) showed that it can significantly increase the VO2max level. The study by Burgomaster, K.A et al. (2005) pointed out that "the subjects' VO2max level has no influence." Significant difference. "In addition to aerobic capacity, indicators such as maximum oxygen uptake and vital capacity can reflect the state of cardiorespiratory fitness. Janyacharoen et al. (2016) conducted resistance training intervention on sedentary and inactive young people and found that the subjects' vital capacity (VC) and maximum ventilation (MVV) were significantly improved. In addition, HIIT and MICT have a good promotion effect on the cardiorespiratory fitness of young people. Zhang Ping et al. (2021) research shows that compared with MICT, which was previously recommended for patients, high-intensity interval training can also improve post-cardiac surgery and hypertension. The patient's cardiopulmonary function is even better.

6.2 Definition of cardiorespiratory fitness

Cardiorespiratory fitness is an important component of a healthy constitution, reflecting the ability of the human body's heart, blood vessels, lungs, and other organs to supply oxygen to the muscle tissue. Cardiorespiratory fitness is closely related to human health and exercise capacity and is the basic condition for the human body to carry out metabolism and endurance exercises. Cardiorespiratory fitness refers to the ability of the human body to supply oxygen and nutrients to the body tissues through the cardiovascular system (heart and blood vessels) and the respiratory system (lungs and respiratory muscles) and to eliminate metabolic wastes, thereby maintaining the ability to carry out continuous physical activities. Cardiorespiratory fitness is usually evaluated through cardiopulmonary function tests, including heart rate, respiratory rate, blood pressure, and oxygen uptake during exercise. According to the "National

Physical Fitness Test Standards," lung capacity is an important indicator to measure the cardiorespiratory health of students. One of the indicators, 1000 meters/800 meters, as a measure of cardiorespiratory endurance for overweight college students, can also reflect the cardiorespiratory health status of students.

6.2.1 Overweight college students lung capacity

He Jinwei (2009) pointed out that vital capacity refers to the maximum ventilation capacity of the lungs when the human body makes a maximum effort to exhale after taking a deep inhale. Vital capacity reflects the degree of human cardiopulmonary function and is a commonly used indicator for cardiopulmonary function evaluation. Huang Hao (2020), Su Quansheng et al. (2012) pointed out that the human body is inseparable from the supply of oxygen when carrying out various life activities. During exercise, The body needs a lot of oxygen, so the strength of our cardiopulmonary function greatly affects our exercise ability. The article by Wang Zheng et al. (2013) pointed out that the vital capacity of college students is one of the required test items in the "National Student Physical Health Standards", which is used to reflect the growth and development level of students.

6.22 Overweight college students Cardiorespiratory endurance

Cardiorespiratory endurance of overweight college students is a common sports event to evaluate the cardiorespiratory endurance level of male and female college students. This event requires overweight male college students to run 1000 meters within the prescribed time, and overweight female college students to run 800 meters within the prescribed time. It is usually conducted on the track and field track. This test is designed to assess an individual's cardiorespiratory health, endurance, and stamina. Generally, candidates are required to run 1000 meters as fast as possible within the prescribed time. The candidates' scores are usually measured by the time it takes to complete a certain distance, and the final scores are calculated in seconds or minutes. The goal of the 1000-meter physical fitness test for male college students is to measure the aerobic endurance level of the participants and to evaluate their cardiopulmonary function and exercise ability. This test is of great significance for

measuring the overall health and exercise level of college students and is commonly used in school physical education courses and physical fitness tests.

7. Muscle fitness

7.1 Research on the effects of HIIT and MICT on muscle fitness

In terms of muscle fitness, muscle fitness, as one of the elements of healthy physical fitness, mainly includes muscle strength and muscle endurance. Wang Bin. (2018) pointed out in the article that muscle strength mainly refers to the instantaneous weight-bearing and explosive power of muscles, which mainly relies on anaerobic exercise, while muscle endurance is mainly reflected in the ability to process lactic acid in the concentrated cellular blood. Endurance quality is a must-have sports quality in all sports. Higher aerobic endurance quality can enable the body to withstand increasing training volume and perform sports with a higher level of physical activity and more energy. Wu Haitan et al. (2017) asked students to perform exercise interventions of different intensities and times in a physical education class. After 8 weeks, they found that to significantly improve the students' muscle strength quality and the students' muscle endurance quality, they need to continue for at least 10 minutes. High-intensity exercise above. Wang Wei et al. (2016) research pointed out that high-intensity interval training can improve exercise ability and promote the development of two different abilities, aerobic and anaerobic. Bartlett J Det al. (2011) research shows that high-intensity intermittent exercise stimulates muscles much more than long-term moderate continuous exercise, and the increase in muscle mass is also much higher than long-term moderate continuous exercise. There is still controversy over which of two different intensity exercises, moderate and high intensity, has a better impact on muscle fitness. Yu Ping's (2020) study showed that a 12-week comparative study of high-intensity and regular physical education classes was conducted on two classes of second-year junior high school students. After the intervention, it was found that there was no difference in muscle endurance between the groups.

7.2 The definition of Muscular fitness for overweight college students

As one of the elements of physical health, muscular fitness mainly includes power, muscular endurance, and muscular strength. Power mainly refers to the instantaneous load-bearing and explosive power of the muscles, which mainly relies on anaerobic exercise, while muscular endurance is mainly reflected in the ability of cells to concentrate and handle lactic acid in the blood. Endurance is an essential quality in all sports. A higher aerobic endurance quality allows the body to withstand an increasing amount of training, thereby achieving a higher level of physical activity and more energy. Wang Bin (2018) muscular endurance and muscular strength are two main components of muscular fitness and therefore are both elements of a healthy body fitness. Power is measured by the standing long jump for both men and women, muscular endurance is measured by one-minute sit-ups, and muscular strength is measured by one-minute push-ups.

7.2.1 The definition of Power for overweight college students

Using the standing long jump test is a physical fitness assessment aimed at evaluating lower limb strength. In this test, the subjects start from a static standing position and try to jump as far forward as possible without taking steps or running. In this study, the college students' standing long jump tester is used. This test requires athletes to start from a static standing position, complete the jump by landing a certain distance, and then jump as far as possible. It is required to stand on the starting line, with feet shoulder-width apart, body straight, and hands on the sides or chest of the body, ready to jump. When the jump signal is given, quickly bend forward and jump forward, using the strength of the legs to take off. Use both legs simultaneously, push off the ground with the toes, and propel the body forward to jump as far as possible. Stand straight at the highest point in the air to maintain balance. Then, try to land with both feet at the same time. The position where the heel is closest to the starting line after the jump is used as the long jump score. The measuring tool (the standing long jump tester) can accurately record the distance.

7.2.2 Muscle strength of overweight college students

Muscle endurance refers to the ability of the muscles to contract continuously or repeatedly under a certain load for a long time. Specifically, it reflects the muscles' ability to resist fatigue. The one-minute push-up is a common physical fitness test used to evaluate muscle strength. Participants are required to complete as many push-ups as possible within the specified time. This test can effectively evaluate the endurance and strength level of the upper limb muscle group and is one of the commonly used items in many physical fitness tests and training. Testers are required to stand on the ground with hands slightly wider than shoulder-width apart, the body straight, toes on the ground, and the back and buttocks in a straight line. At the designated starting signal, start the push-ups. Squat down until the chest is close to the ground, and then push up with the arms until the arms are straight. Complete the push-ups like this. Within the specified one minute, complete as many push-ups as possible while maintaining the standard and rhythm of the movements. When the one minute is over, stop and record the number of push-ups completed.

7.2.3 Muscular endurance of overweight college students

It refers to the ability of the muscles to contract continuously or repeatedly under a certain load for a long time. The one-minute sit-up test is a commonly used physical fitness test to evaluate an individual's abdominal muscle endurance. Participants are required to complete as many sit-ups as possible within the specified time. This test can effectively evaluate the endurance and strength level of the abdominal muscles and is one of the commonly used items in many physical fitness tests and training. When conducting the one-minute sit-up test for college female students, the following steps are generally required: Before starting, the participants should lie flat on the ground with knees bent and feet flat on the ground. Cross hands on the chest or gently touch behind the ears to maintain a stable posture. At the designated starting signal, start doing sit-ups. Use the abdominal muscles to lift the upper body off the ground until the elbows touch the knees, and then slowly lower the body until the scapula touch the ground. Complete one sit-up like this. Within the specified one minute, complete as many sit-ups as possible while maintaining

standard and rhythmic movements. After one minute, stop the movement and record the number of sit-ups completed.

8. Related research

8.1 Domestic research

Li Zhaoquan (2019) This study conducted an experiment to study the impact of HIIT on the physical fitness of female college students. 34 female college students from Tianjin Vocational University were selected for investigation and experimental testing to understand and analyze the current research status of HIIT and its use as a form of exercise in universities. feasibility of popularization. By comparing the students' BMI index, vital capacity, 50m, 1min sit-ups, standing long jump, seated forward flexion and 800m with exercises of different intensities, the conclusion shows that in terms of cardiopulmonary function, the vital capacity and vital capacity of the subjects in the HIIT group The 800-meter performance was significantly improved, and was better than the improvement in vital capacity and 800-meter performance of the subjects in the control group. In terms of 1-minute sit-ups, the scores of both HIIT subjects and those in the control group were significantly improved, and the improvement of the subjects in the HIIT group was better than that of the subjects in the control group. In terms of 50 meters and standing long jump, HIIT significantly improved the subjects' 50 meters and standing long jump to varying degrees. The control also had a limited improvement in the subjects' 50 meters and standing long jump. However, the 50m performance of the HIIT group was significantly improved. The improvement effect was higher than that of the control group's 50m performance; there was no significant difference in the standing long jump performance between the two groups. In terms of body composition, after eight weeks of exercise intervention, the BMI index of subjects in the HIIT group and the control group was reduced. The reduction in the HIIT group was significantly greater than that in the control group. The weight of the HIIT group was reduced. The changes are more obvious.

Dou Li et al. (2020) conducted a study on the effects of high-intensity interval training (HIIT) on college students, focusing on health fitness, energy consumption, and heart rate. The research involved 108 male college students aged 18 to 19, who were divided into a control group, which followed regular physical education classes, and an experimental group, which incorporated HIIT into their regular classes and also performed HIIT sessions outside of class twice a week. The study measured body composition, energy consumption, muscle strength, cardiorespiratory fitness, and heart rate before and after the 12-week period. Results indicated that the experimental group saw significant improvements in cardiorespiratory and muscle fitness, as well as energy consumption, with notable increases in standing long jump performance, resting and total energy consumption, maximum heart rate, and a decrease in resting heart rate (all $P < 0.05$). Additionally, improvements were observed in the experimental group's standing long jump, vital capacity, and middle and long-distance running scores compared to their initial tests. The study concluded that HIIT is an effective and safe exercise method that requires less time commitment while significantly enhancing energy consumption, muscle and cardiorespiratory fitness, and positively affecting maximum and resting heart rates.

Hu Fei (2020) An experimental study on the impact of high-intensity interval training on the physical health of ordinary male college students. A group experimental study was conducted on 62 ordinary male college students in non-physical education majors at Anyang Normal University. Two physical education natural classes were set to high-intensity An 8-week experimental intervention was conducted on 31 subjects in the experimental group with interval training as the main training content and 31 in the control group with moderate-intensity continuous training as the main training content. Under the same conditions and background, the experimental group and control group were uniformly measured. Multiple related indicators before and after, the data of the two groups were obtained, and then the data was sorted through Excell and spss was used to conduct independent sample T test analysis between the two groups for each test conducted on the experimental group and the control group. In addition to testing and quantifying the physical fitness test content of college students, additional testing and analysis of basal heart rate,

maximum aerobic speed running, and maximum oxygen uptake were conducted to more comprehensively evaluate the two types of training, high-intensity interval training and moderate-intensity continuous training. The training effect brought by the method, the conclusion shows that both high-intensity interval training and moderate-intensity continuous training can effectively improve the body composition of ordinary male college students, and there is no difference in the training effect brought by the two training methods. In terms of cardiopulmonary function, high Both intensity interval training and moderate-intensity continuous training can significantly reduce the resting heart rate and significantly increase the maximum oxygen uptake level of ordinary male college students, and high-intensity interval training is more significant in increasing the maximum oxygen uptake. However, for the improvement of vital capacity level, obvious effects were only seen in the high-intensity interval training group. In terms of athletic ability, both training methods can significantly improve the results of 50m run, 1000m run, 5min run, MAS, and 12min run, and High-intensity interval training is more effective.

Ma Xipeng (2020) conducted an empirical study on the impact of high-intensity interval training on the weight loss effect of obese college students: the subjects were separated from men to women, and boys and girls were divided into high-intensity interval training groups and moderate-intensity aerobic continuous exercise groups. Perform high-intensity interval training and moderate-intensity aerobic continuous training for 12 weeks. A 10-min warm-up was performed before training. High-intensity interval training subjects completed specified actions at an intensity of 85%-95% HR_(MAX), 20 seconds of exercise, and 10 seconds of intermission, lasting 20 minutes. Moderate-intensity aerobic continuous exercise uses an intensity of 60%-70% HR_(max) to complete treadmill running, and 5 minutes of stretching and relaxation are performed at the end of the training. The experimental group and the control group trained 4 times a week for 12 weeks. The conclusion shows that under the same oxygen consumption, both high-intensity interval training and moderate-intensity aerobic continuous training can reduce body fat percentage, increase maximum oxygen uptake, and effectively reduce body weight and BMI index. However, high-intensity interval training is more effective in these areas. In addition,

both training methods had significant effects on reducing waist circumference, hip circumference, and waist-to-hip ratio, but there was no significant difference between them.

Wang Miaomiao (2020) studied high-intensity interval training as a method to improve the physical health of college students. 60 students from Shandong Institute of Physical Education with no significant difference in physical health levels were selected and randomly divided into groups to determine the experimental group and the control group. The experimental group (15 males and 15 females) and the control group (15 males and 15 females) respectively conducted high-intensity interval training and moderate-intensity continuous training for 12 weeks according to a predetermined plan. Weekly experimental intervention and analyze the test data before and after the experimental intervention. The conclusion shows that high-intensity interval training (HIIT) has a significant positive impact on the weight, BMI and waist-to-hip ratio of college students, and can significantly improve the body shape of the male and female experimental groups. In addition, HIIT can also significantly improve the vital capacity of the male and female experimental groups. Regarding the 800/1000-meter running performance, female college students have a more significant improvement than men, indicating that HIIT has a better improvement effect on women in the 800-meter running. . HIIT also resulted in significant performance improvements for the 50-meter dash, standing broad jump, male pull-ups, and 1-minute sit-ups. In the seated forward bend project, female college students performed significantly better than men, indicating that HIIT is particularly effective in improving the flexibility of female college students.

Xu Pengfei (2020) To study: An experimental study on the impact of high-intensity interval training on the physical health level of college students. This experiment studied the impact of high-intensity interval training on college students' physical health levels, compared with college students' daily traditional medium-intensity continuous training (MICT), and compared the effects of the two training methods on improving college students' physical health levels. Exercise methods suitable for developing the physical health of college students and promoting the

healthy development of college students' physical and mental health. This article conducts research through literature methods, expert interview methods, experimental methods and mathematical statistics methods. The experimental subjects are 60 undergraduate students from Beijing Sport University who have not received systematic training. Through random grouping, the subjects are divided into male and female experimental subjects. There are 15 people in each group, the experimental group uses high-intensity interval training, and the control group uses regular medium-intensity continuous training for college students. After an 8-week experiment, all subjects were subjected to a physical health test for college students. The data were compiled and the data before and after the experimental group and the control group were compared horizontally and vertically. After statistical analysis, the following conclusions were drawn: (1) In terms of body shape: Both HIIT and MICT training can significantly improve the BMI index of college students. HIIT has a better effect, but it does not show a more significant improvement effect than the latter. (2) In terms of physical function: Both HIIT and MICT training can significantly improve the vital capacity level of college students. HIIT has a better effect, but it does not show a more significant improvement effect than the latter. (3) In terms of physical fitness: In terms of strength and fitness, HIIT has significantly improved the long jump, pull-ups and sit-ups. MICT has improved all three items to varying degrees, but only the sit-ups have significantly improved. Pull-ups and standing long jumps have poor improvement effects; in terms of endurance quality, both types of training can significantly improve endurance running levels, and HIIT has a significantly better improvement effect than MICT; in terms of speed and agility quality, MICT has poor effects on 50-meter running training. However, HIIT can significantly improve this performance, and the effect is better than the former; in terms of flexibility quality, although HIIT has a better improvement effect than MICT, neither training can significantly improve the performance of seated forward flexion. (4) In terms of the total physical health test scores of college students: both HIIT and MICT can improve the total physical health test scores of male and female students and have a positive impact on the physical health level of college students, among which HIIT training is more effective than MICT. (5) In terms of subject acceptability: Judging from the feedback after this experiment, the satisfaction rate of

the HIIT group was 90%, and the satisfaction rate of MICT was 93%. The satisfaction rate of both training modes showed a high level. level.

Yang Xitai (2020) investigated the impact of high-intensity interval training (HIIT) on the physical fitness of male university students, aiming to provide a new reference for physical education teaching in schools. The study involved 40 students from Shandong Radio and TV University, divided into an experimental group and a control group of 20 each, undergoing an 8-week intervention. It utilized the "National Physical Fitness Test" indicators for college students. The results showed significant improvements in the 50-meter sprint, lung capacity, standing long jump, and sit-and-reach in the experimental group post-training, unlike the control group, demonstrating HIIT's effectiveness in enhancing male college students' physical fitness levels.

Chen Nan (2021) explored the impact of a 12-week HIIT training program on body composition and aerobic capacity in college students. The study aimed to identify an effective HIIT training model to enhance fitness levels among college students and to investigate gender differences in outcomes. Researchers conducted HIIT sessions three times weekly for 12 weeks with 80 non-sports major students, evenly split between males and females, measuring changes in body composition and aerobic fitness before and after participation. The findings indicated that the HIIT program significantly improved aerobic capacity in college students, with noted gender differences in intervention effects.

Ge B (2021) studied the effect of high-intensity interval training on lower limb muscle endurance and muscle strength in college students. Through volunteer registration and questionnaire survey, 60 male college students and 42 female college students were selected as research subjects. The study subjects were randomly divided into a control group, a common exercise group and a high-intensity interval exercise group. The control group did not receive any intervention. The ordinary exercise group and the high-intensity interval exercise group received aerobic endurance exercise and high-intensity intermittent exercise for 8 weeks respectively.

intervention. Before and after the 8-week intervention, the basic indicators (height, weight, BMI), lower limb muscle endurance indicators (1 minute continuous squat, 1 minute half squat, 1 minute sitting test) and lower limb muscle strength indicators (8RM squat test) of each group were tested. rise, 1RM squat, standing long jump, vertical jump) and body composition indicators (whole body skeletal muscle mass, right lower limb skeletal muscle mass, left lower limb skeletal muscle mass). Research results show that 8 weeks of aerobic endurance training and high-intensity interval training intervention can improve the lower limb muscle strength and muscle endurance of college students, among which high-intensity interval training is more effective in improving lower limb muscle strength.

Hou Li li (2021) conducted a comparative study on the effects of high-intensity interval training (HIIT) versus moderate-intensity continuous training (MICT) on body composition in overweight young women, focusing on potential mechanisms of action. The 10-week intervention involved 30 participants, divided into two groups, with sessions lasting 45 minutes, three times a week. The study found that both HIIT and MICT improved body shape and composition, with HIIT being more efficient in reducing body fat and circumference. Both training methods also lowered resting heart rate and blood pressure, suggesting improvements in lipid metabolism and inflammation through alterations in triglycerides, cholesterol levels, and inflammatory markers.

Liu Wei jun (2021) conducted an empirical study on the effects of high-intensity interval training (HIIT) on body composition and energy metabolism in college students over 12 weeks. The study involved 70 healthy students, split between 36 males and 34 females. Measurements included body composition, resting metabolic rate (RMR), energy expenditure efficiency (EE), and maximum oxygen uptake. Post-intervention, significant reductions in body weight were observed in both male and female groups, with notable improvements in resting heart rate and oxygen uptake, but no significant changes in EE.

Liu Xing (2021) studied the comparison of the effects of high-intensity interval training and medium- and low-intensity continuous training on fat loss among middle-aged male members of fitness clubs. They selected 30 middle-aged obese men from Dazhang Fitness Club in Jingzhou, and finally passed relevant experiments and questionnaire screening. 20 middle-aged obese men were randomly divided into two groups of the same number to perform high-intensity interval training and medium-low intensity continuous training. The test period was 8 weeks, and 60 minutes of targeted training began in the afternoons of every Monday, Tuesday, Thursday, and Friday. The conclusion shows that high-intensity intermittent training combined with exercise prescription is better than medium- and low-intensity continuous training in reducing fat in middle-aged obese men. In terms of reducing the body shape indicators of middle-aged men, both medium- and low-intensity continuous training and high-intensity interval training have a good intervention effect. In terms of reducing the weight, body fat, BMI, and waist-to-hip ratio of obese middle-aged men, high-intensity training has a good intervention effect. Interval training combined with exercise prescription is more efficient than medium- and low-intensity continuous training. Both medium-low-intensity continuous training and high-intensity interval training have significant effects in improving subjects' heart rate and blood pressure indicators.

Lu Meng yi (2021) studied the experiment of high-intensity interval training in promoting the physical health of college students. They selected 80 non-sports major college students who had no sports exercise habits to conduct high-intensity training three times a week for 60 minutes each time for 12 weeks. Interval training. The study adopted methods such as literature review, mathematical statistics, questionnaires, and experiments, and took 40 male and female college students from Inner Mongolia Normal University as subjects. From the three dimensions of body shape, body function, and physical fitness, Test students' speed, strength, flexibility, agility, endurance and balance and coordination abilities. The conclusion shows that in terms of body shape, high-intensity interval training for 12 weeks can effectively control body shape and reduce the risk of obesity among college students. The weight and BMI body shape indicators of the experimental subjects obviously tended to normal

levels. The experimental results showed that boys were more obviously different than girls. The body fat percentage and waist-to-hip ratio scores of both male and female students have significantly improved. .In terms of physical function, 12 weeks of high-intensity interval training can significantly improve college students' lung capacity and physical function levels. .In terms of physical fitness, 12 weeks of high-intensity interval training can effectively improve college students' strength, endurance, flexibility, speed, agility and balance qualities. However, the improvement effect on boys' upper limb muscle strength and speed quality is not obvious.

Wang Jie (2021) studied the effects of high-intensity interval training and moderate-intensity continuous training on executive function and cardiorespiratory fitness of adolescents aged 11-12 years old, selecting sixth-grade students (11-12 years old) from Pudong Foreign Languages School Affiliated to Shanghai International Studies University in Pudong New Area, Shanghai 96 people were randomly divided into control group (C, n=32, 16 males, 16 females), high-intensity interval training group (HIIT, n=32, 16 males, 16 females), moderate-intensity training group according to the ratio of 1:1:1. Continuous training group (MICT, n=32, 16 males, 16 females). The HIIT group underwent exercise intervention for 8 weeks, three times a week, with 25 minutes each time; the MICT group underwent exercise intervention for 8 weeks, three times a week, with 35 minutes each time. The conclusion shows that the maximum oxygen uptake of subjects in the high-intensity interval training group and the moderate-intensity continuous training group was significantly improved compared with before the intervention, and the improvement effect of the high-intensity interval training group was better, while the improvement effect of the control group was not significant. High-intensity interval training and moderate-intensity continuous training have a significant promotion effect on the refresh function performance, conversion function performance, and maximum oxygen uptake of adolescents aged 11-12 years old. The functional performance improvement effect is better. The two training methods have similar improvement effects on conversion functional performance and VO2max improvement, but the high-intensity interval training effect is better.

Yu Ping (2021) studied the impact of 12 weeks of high-intensity interval training on the health and fitness of adolescents, using experimental methods as the main method. 35 people (16 boys and 19 girls) were randomly selected from a class in the second grade of Chongqing Hongen Experimental School. people) as the experimental group (HIIT group), and 35 people in one class (17 boys and 18 girls) as the control group (CON group). The experimental group underwent 12 weeks of high-intensity interval training (20×20 meters, 30 seconds of exercise, 30 seconds of rest, 3 times/week), while the control group underwent 12 weeks of traditional physical education classes according to the physical education plan. Both the experimental group and the control group performed the same warm-up and relaxation activities, and the participants in both groups followed their original eating habits and were restricted from engaging in additional physical activities outside of physical education classes. At the same time, after the intervention, participants in the experimental group and the control group will be tested on relevant indicators, and the collected data will be statistically analyzed. Research shows that 12 weeks of high-intensity interval training can improve the cardiorespiratory fitness and muscle strength of normal-weight teenagers, and the effect is better than traditional physical education classes, but the improvement effect on muscle endurance, flexibility fitness and body composition of normal-weight teenagers is not obvious.

Deng Heping (2022) To study: An experimental study on the impact of HIIT in physical education class on the physical health of primary school students. To study: This article aims to optimize primary school physical education classes and promote students' physical health. It integrates HIIT and MICT intervention methods into primary school classrooms. Through comparative analysis of HIIT, MICT and conventional teaching, it explores the impact of different intervention models on primary school students' physical health. . This article uses literature and experimental methods to select sixth grade students (sample size is about 300) and randomly group them into HIIT group, MICT group and control group for an 8-week intervention three times a week. The HIIT group performed 26-38 minutes in the basic part of the class. There were three groups of movements, each group had 8 movements, each movement lasted 15 seconds, with a 10-second interval. The intensity of the

movement intervention was 80-90% HRmax, with a 40-second interval between groups. The total The time is 12 minutes; in the basic part, the MICT group completes 12 minutes of running at an intensity of 65%-75% HRmax at 26min-38min; the control group is in a regular physical education class. The experiment was conducted three times before the intervention, 4 weeks into the experiment, and 8 weeks into the experiment. The first part of the test content was body composition and physical health indicators: weight, body fat, BMI, vital capacity, 50 meters, one minute sit-ups, and one minute rope skipping. , 50 meters × 8; the second part is the subjective feeling scale: feeling scale (FS for short) and subjective exertion scale (RPE for short). Finally, SPSS20.0 software was used to conduct statistics and analysis on the data, and repeated measurement variance in the general linear model was used to conduct comparative analysis on the pretest, midtest, posttest and between groups within the HIIT, MICT, and conventional teaching groups. The following results were obtained: (1) HIIT, MICT intervention and regular classes can effectively promote the physical health level of primary school students over time. In a short-term physical education class, the promotion effect of HIIT is better than that of MICT, and the effect of MICT is better than that of MICT. Regular class. (2) HIIT can bring a stronger sense of exercise pleasure and reflect a high degree of flexibility, fun, and sustainability. It can be used as an effective exercise model in primary school physical education classes and be integrated into primary school physical education teaching. It is reasonable, and we can try to experimentally promote the HIIT method to other levels of primary schools.

Jia Xinlei (2022) investigated the effects of moderate-intensity continuous training (MICT) and high-intensity interval training (HIIT) on executive function in obese adolescents aged 12-15. The study enrolled 100 participants from a Beijing weight loss camp and divided them into MICT and HIIT groups, with a control group recruited from a middle school in Shijiazhuang. The experimental groups underwent 4 weeks of training, 10 sessions per week, each lasting 110 minutes, while the control group received no intervention. The results indicated that both MICT and HIIT could improve executive function in obese adolescents, with varying effects on different aspects of executive function depending on the training method.

Liang Zhide (2021) To study: The impact of aerobic interval exercise and moderate-intensity continuous exercise on the cardiorespiratory fitness of high school girls. This study used aerobic interval exercise (AIT) and moderate-intensity continuous exercise (MICT) to conduct an 8-week exercise intervention on 40 high school girls to explore the impact of the two exercise programs on the cardiorespiratory fitness of high school girls and the scientific rationality of the exercise. The acceptability and fun of the two exercise programs were analyzed through the Physical Activity Pleasure Scale (PACES). This study used the literature method, questionnaire survey method, and expert interview method to obtain theoretical basis, and used the experimental method to divide 40 sophomore girls from Qingdao No. 2 Middle School into the AIT group (n=20) and the MICT group (n=20). They conducted an 8-week exercise intervention and tested the aerobic endurance index, cardiopulmonary function index, blood index and renal function index of the AIT group and MICT group before and after the intervention to compare the exercise effects of the two different exercise programs. The results are as follows: (1) Both aerobic interval exercise and moderate-intensity continuous exercise can improve the aerobic exercise capacity and pulmonary ventilation function of high school girls, and aerobic interval exercise has a greater effect on endurance running performance, maximum oxygen uptake, and lung function. good. (2) Compared with moderate-intensity continuous exercise, aerobic interval exercise can reduce the cardiac repolarization process in high school girls, provide cardiac protection and improve cardiac function, and these changes do not depend on the organic changes of the heart, reducing exercise risks. (3) Both aerobic interval exercise and moderate-intensity continuous exercise can reduce the incidence of inflammation in high school girls, thereby reducing the risk of infectious diseases, and both types of exercise have a certain degree of safety. (4) By comparing the PACES scales of the two forms of exercise, it is believed that high school girls have higher compliance with aerobic interval exercise.

Liu Jun (2022). Study two different programs of HIIT and MICT to intervene in overweight young women. Comparatively analyze the health-promoting effects of the

two exercise methods from cardiopulmonary function, body composition, and blood lipid metabolism, and recruit overweight young women. 50 people, and 30 effective experimental subjects were finally determined through set screening. After screening, they were randomly divided into 2 groups, namely the high-intensity interval training group (HIIT) and the moderate-intensity continuous training group (MICT), with 15 people in each group. The results show that a 10-week training intervention of 10 weeks of high-intensity interval training can reduce the abdominal visceral fat content and abdominal subcutaneous fat content in young overweight women, causing changes in body shape. Compared with the MICT group, under the same exercise duration, HIIT It is more effective in controlling body fat and reducing body circumference. HIIT and MICT training can reduce resting heart rate and blood pressure levels, increase the body's basal metabolic rate, and improve cardiopulmonary function. Both HIIT and MICT training can optimize blood lipid profiles. Under the same exercise time , high-intensity exercise may have more positive effects

Lu Qing (2022) conducted an experiment on the effects of high-intensity interval training (HIIT) and moderate-intensity continuous training (MCT) on the endurance of junior high school students. 32 people were divided into a high-intensity interval training group and a continuous training group, and were randomly divided into 16 people in each group. , research has found that both training methods can reduce body fat rate, among which HIIT has a more obvious effect. Compared with MCT, HIIT can also significantly enhance cardiopulmonary function and aerobic exercise capacity, as evidenced by improvements in maximum oxygen uptake (VO2max) and 1000-meter running performance. While MCT is effective in increasing lung volume, among middle school students, HIIT overall provides more substantial benefits in terms of fat loss, cardiorespiratory function, and aerobic capacity and physical performance.

Meng, C.,et al.(2022) To study Effects of school-based high-intensity interval training on body composition, cardiorespiratory fitness and cardiometabolic markers

in adolescent boys with obesity。 Forty-five adolescent boys with obesity (age = 11.2 ± 0.7 years, BMI = 24.2 ± 1.0 kg/m2), were randomized to high-intensity interval training group (HIIT, n = 15), moderate-intensity continuous training group (MICT, n = 15), or a control group (CON, n = 15). The intervention groups performed three weekly exercise sessions over 12 weeks. HIIT group performed two sets of eight bouts of 15 s run at high-intensity [90 ~ 100% maximal aerobic speed (MAS)] separated by eight bouts of 15 s recovery run at low-intensity (50% MAS), MICT group performed 30 min run at moderate intensity (60 ~ 70% MAS) and CON group were instructed to continue their normal behaviors. All participants had indices of body composition, cardiorespiratory fitness (CRF) and cardiometabolic markers measured at baseline and post-intervention. Statistical differences between and within groups were determined by use of two-way analysis of variance (ANOVA) with repeated measures.Following the school-based training program, BMI and body fat mass decreased in HIIT and MICT group, but there was no significant difference between the two interventions; a significant decrease in body fat percentage (-3.1 ± 1.0 kg, $P < 0.01$), but there were no significant difference between the two interventions. Low-density lipoprotein cholesterol decreased only in HIIT group (-17.2%, $P < 0.05$). Significant decrease in the usual index of insulin resistance (HOMA-IR) occurred in HIIT and MICT groups (-27.3 and -28.6%, respectively; $P < 0.05$).

Wang Changlu (2022) Study the effect of high-intensity intermittent step training on the health and fitness of secondary vocational boys. A total of 76 boys from Grade 2020 (Grade 2) of Wuhan Instrument and Electronics School were randomly selected, including 38 in the experimental group and 38 in the control group. The experimental group performed high-intensity intermittent step training, while the control group performed physical exercises according to the physical education plan. The experimental group and the control group went through the same preparation part, skills part and ending part. After the intervention, participants in the experimental group and the control group were tested on relevant indicators, and the collected data were statistically analyzed. The conclusion shows that the step HIIT group has a very significant difference in the growth of vital capacity and 1000

meters; the conventional physical training group has a significant difference in the growth of vital capacity, but there is no significant difference in the growth of 1000 meters. Therefore, step HIIT training can significantly improve the cardiorespiratory fitness of secondary vocational boys. The step HIIT group has a very significant difference in the standing long jump index, and the conventional physical training group has a significant difference; the step HIIT group has a significant difference in the pull-up index, but the conventional physical training group has no significant difference. Therefore, step HIIT training can significantly improve the performance of standing long jump and pull-ups, and enhance the strength of upper and lower limb muscles. Step HIIT training can reduce the weight of secondary vocational students and bring their BMI index closer to the normal range. It can effectively promote the cardiorespiratory fitness, lower limb muscle strength and upper limb muscle strength of secondary vocational school boys. Step HIIT can be used as a daily exercise training method for boys in secondary vocational schools. At the same time, it can significantly improve healthy physical fitness. Based on its short time-consuming and high efficiency characteristics, it can be used as a form of physical exercise in physical education classes in secondary vocational schools.

Ying Le (2022) studied the effect of using TABATA training in middle school physical education classes to develop students' healthy physical fitness, introduced modified HIIT-TABATA training based on functional movement forms into the teaching of middle school physical education classes, and studied the effect of TABATA training on the health of middle school students. The impact of physical fitness (body composition, cardiorespiratory fitness, muscle fitness, flexibility fitness, etc.) provides a basis for the effectiveness of using TABATA training in middle school physical education classes to develop students' healthy physical fitness. A total of 56 middle school students (all boys) from two first-grade ordinary classes in Guanshan Middle School in Wuhan City were selected, with approximately 30 students in each class. One class performed HILT training three times a week according to the original physical education class plan, and the other class performed TABATA training during the same time period. The intervention lasted for 10 weeks. Before and after the intervention, students in the two classes were tested on health and

fitness-related indicators. The conclusion shows that the use of TABATA training in middle school physical education classes can effectively improve the health and fitness level of middle school students. TABATA training can develop the health and fitness of middle school students more comprehensively than HILT. It can improve the growth of skeletal muscles, muscle fitness and flexibility fitness. The improvement effect is better than HILT. In addition, TABATA training can more effectively increase students' lower limb explosive power, speed, and agility.

Zhang Siqi (2022) To study: A comparative study on the effects of high-intensity interval training and moderate-intensity continuous training on the aerobic capacity of adolescent female rowing athletes. This article studies the impact of high-intensity interval training and moderate-intensity continuous training on the body's aerobic capacity, and compares the differences in the effects of the two training methods on athletes' aerobic capacity, in order to provide scientific guidance for the correct selection of training methods and improvement of training effects in the future. in accordance with. Research method: This article uses the literature method to study and organize related concepts, summarizes and studies the mature knowledge of "high-intensity interval" and the accumulation of literature on rowing aerobic capacity training; uses the expert consultation method to gain an in-depth understanding of the experiment The selection of indicators and the formulation of training programs were carried out, and high-intensity interval training and moderate-intensity continuous training programs were formulated three times a week, 40 minutes each time, for a total of 8 weeks. During the experiment, testing methods were used to test hemoglobin, red blood cells, hematocrit, exercise heart rate, morning pulse, dynamometer 2000m, 5000m, 30min results, and blood lactate value immediately after exercise. Finally, the mathematical statistics method was used, and SPSS 27.0 mathematical statistics software was used for processing and analysis. The independent sample T test was used before the experimental intervention, and the paired T test was used after the experimental intervention to perform statistical analysis on the relevant indicators before and after training. The two training methods were analyzed on the impact of youth rowing. Effects on aerobic capacity of athletes. The results show that (1) 8-week experimental intervention, high-intensity interval

training and moderate-intensity continuous training can both improve the aerobic capacity of young rowing athletes. Among them, high-intensity interval training has a more obvious effect than medium-intensity continuous training, and the aerobic capacity The improvement is even greater. (2) Compared with medium-intensity continuous training, high-intensity interval training is more obvious in improving hemoglobin, red blood cells and other blood physiological indicators of young rowing athletes; at the same time, it has a better effect on improving the heart pumping function. (3) Compared with medium-intensity continuous training, high-intensity interval training can significantly improve the specific aerobic capacity of young rowing athletes. This is mainly reflected in the significant improvement in the ergometer 30min, 5000m, and 2000m scores. The specific aerobic capacity is theoretically quantified. The numerical value has improved significantly.

Cai Rui et al. (2023) studied the impact of HIIT training in land and shallow water environments on the health and fitness of college students (men). This article used the literature method to conduct a literature review of HIIT and health fitness training. An integrated review was conducted using the experimental method to select Anhui. 42 male college students in Anqing City, Shandong Province were used as experimental subjects. They underwent HIIT training intervention three times a week for 6 weeks. The expert interview method was used for screening and authoritative identification in selecting training movements and evaluation indicators. At the same time, combined with pre-test Based on the actual situation of the experiment, a set of training programs approved by experts and equally applicable to two different environments was determined. Training time, intensity control, movement standards, etc. were strictly controlled; after the pre-test of the experiment, all The subjects were randomly divided into three groups, including 14 people in the no-intervention group, 14 people in the shallow water group, and 14 people in the land group. The non-intervention group only maintained normal daily activities without other requirements and intervention. The shallow water group and the land group were respectively The same program of bodyweight HIIT training was conducted in a 125-130cm deep shallow water environment and a land environment with a plastic floor. After 6 weeks, the body composition, cardiorespiratory fitness, and muscle fitness of the three

groups were compared before and after the training within and between groups. , the data changes of flexibility and fitness are discussed and analyzed. The conclusion shows that training in a shallow water environment can achieve a more efficient fat loss and slimming effect compared to a land environment; the improvement and promotion of cardiopulmonary fitness of male college students in a water environment is better than that in a land environment; HIIT training in a land environment can achieve better results. It can better improve the waist and abdominal muscle strength and endurance levels of male college students; training intervention in the water environment can better improve the flexibility and fitness of male college students and enhance their body flexibility.

Cao et al. (2023) studied the impact of high-intensity interval training (HIIT) on body composition and cardiorespiratory fitness of obese primary school students, providing theoretical basis and practical reference for the application of HIIT exercise prescriptions in schools. 25 obese primary school students [age (11.0±0.4) years old, body mass index (BMI): (23.3±0.8)kg/m~2]] from a primary school in Shenzhen City will be recruited and randomly divided into an exercise group (13 students) and a control group (12 people). After 12 weeks of exercise intervention [the load period and interval period are both 15 s, the exercise intensity of the load period is 100% of the maximum aerobic speed (MAS), and the exercise intensity of the interval period is 50% MAS, 2 groups × 8 rounds each time, There was a 2-minute rest between groups, a total of 10 minutes, and a 20-m round-trip running test (20-m-SRT) was performed every 4 weeks to adjust and update the MAS] to compare the changes in body composition and cardiorespiratory fitness indexes of obese primary school students before and after the intervention. The results showed that the weight, BMI, body fat content, body fat rate and visceral fat area of the obese primary school students in the exercise group were significantly reduced. Skeletal muscle mass, 20 m-SRT and maximum oxygen uptake (VO_2max) were increased. The conclusion shows that HIIT exercise prescription effectively improves the body composition and cardiorespiratory fitness of obese primary school students. Schools with conditions can use it as an intervention measure for obese students to lose weight and improve cardiorespiratory fitness.

Cao Cheng (2023) To study: Study on the impact of high-intensity interval training method on some sports qualities of tennis-specific college students. This study mainly explores the impact of high-intensity interval training on some sports qualities of tennis-specific college students. Through literature analysis, experimental research, mathematical statistics analysis and logical analysis and other research methods, 60 tennis college students from Hunan University of Science and Technology were used as experimental subjects, with 30 people in the control group and 30 people in the experimental group. Investigation, design of high-intensity interval training training methods and selection of some sports quality test indicators were conducted, and a 12-week teaching experimental study was conducted. The data of the two groups before and after the experiment were recorded and statistically analyzed to provide the basis for current tennis. Provide an effective reference for the training of sports quality of special college students. The results of the study show: 1. The experimental group's strength and quality indicators, grip strength, overhead throw of a medicine ball, and standing long jump, are more significantly improved than those of the control group. The experimental group has statistically significant improvements in grip strength, overhead throw of a medicine ball, and standing long jump. sexual differences. It shows that high-intensity interval training method is better than traditional teaching training method in improving the strength quality of tennis-specific college students. 2. The experimental group's endurance quality indicators of 12-minute running and YOYO running improved more significantly than the control group. There was a statistically significant difference in the experimental group's 12-minute running and YOYO running. It shows that high-intensity interval training method is better than traditional teaching training method in improving the endurance quality of tennis-specific college students. 3. The experimental group’s speed quality index 10m sprint, 20m sprint, and 50m sprint performance improved more significantly than the control group. There were statistically significant differences in the experimental group’s 10m sprint, 20m sprint, and 50m sprint, indicating that High-intensity interval training method is superior to traditional teaching training method in improving the speed quality of tennis-specific college students. 4. The experimental group's agility quality index spider run, T test, and Illinois motor agility

test scores improved more significantly than the control group. The experimental group's spider run, T test, and Illinois motor agility test had statistically significant differences. .

Cao Chenyu (2023) explored the impact of an 8-week high-intensity interval training (HIIT) program on the body shape, body composition, and cardiorespiratory function of non-athletic college students at Tianjin Sport University. The study involved 40 students, evenly split by gender, randomized into HIIT and traditional moderate-intensity continuous training groups. The results indicated that the HIIT regimen improved physical attributes and cardiorespiratory function, with some inconsistencies in body composition improvements between genders, suggesting potential gender differences in response to HIIT compared to traditional training methods.

Gao Qisheng et al. (2023). study was conducted on the impact of high-intensity interval training on body composition, form, and function of male college students. Male college students from the School of Physical Education of Wuhan Institute of Physical Education were selected as the experimental subjects for a total of 16 weeks, with 2 classes per week. Each class is 90 minutes; before the experiment, the subjects are tested one by one using the selected indicators to obtain the pre-experiment data.The test includes: height and body mass index, waist height, body fat percentage, vital capacity, maximum oxygen uptake, and resting heart rate. The results show that high-intensity interval training has significant significance in improving the body composition of male college students: the reduction of body fat and the increase in lean body mass can increase our basal metabolic rate, and high-intensity interval training can effectively improve the body composition of male college students. High-intensity intermittent training can effectively improve the body shape of male college students: the waist circumference of the subjects dropped significantly, the bust, hip, thigh and upper arm circumferences of the subjects also changed to varying degrees, and the vital capacity and maximum oxygen uptake of the subjects also changed to varying degrees. The volume also increased significantly before and after training, indicating that high-intensity interval training also has a good stimulating effect on

cardiopulmonary function. It can be seen that high-intensity interval training has a positive impact on improving the physical function of male college students.

Chen Tengfei (2023) To study: Comparative analysis of the impact of high-intensity interval training and continuous training on the physical health of junior high school students under different organizational forms. This article aims to use the effects of high-intensity interval training combined with continuous training to compare the impact of these two different teaching organization methods on students' physical health, and analyze the advantages and disadvantages of the two teaching organization methods' impact on students' physical health. . Taking the effect of physical training of junior high school students in Ganzhou No. 3 Middle School under different teaching organization forms as the experimental object, experimental groups and control groups were set up respectively. Among them, the experimental group (Qingnian Road Campus) uses inter-class sports activities (physical training exercises created by Ganzhou No. 3 Middle School), and the control group (Zanxian Road Campus) uses after-school sports extended services (college social practice course "Physical Training") conduct. Before and after the experiment, five aspects of body shape, body function, physical fitness, functional movement test and physical exercise interest level were investigated and tested to verify the effects of different aspects. The specific conclusions are: 1. After eight weeks of training, the boys in the experimental group had the greatest changes in BMI and weight. Compared with the control group, the vital capacity of the male and female students in the experimental group was more significantly improved after physical training during inter-class sports activities. 2. Changes in physical fitness before and after the experiment. In the experimental group, boys' pull-ups had the greatest impact, and girls' seated forward bends and sit-ups had the greatest impact, indicating that physical training during breaks can better improve students' flexibility and strength. Compared with the former, boys in the control group have the greatest impact on 50-meter running, standing long jump and pull-ups, while girls' endurance running has the greatest impact, indicating that after-school physical training with delayed services can better improve students' speed and endurance qualities. . 3. Physical training in the form of teaching and organizing sports activities between classes can better increase students'

interest in physical exercise, and also has a good effect on improving students' sports participation and enhancing their active learning motivation.

Guo Linxuan et al. (2023) To study the impact of high-intensity interval training on the health and fitness of adolescents, 88 students aged 15-17 were randomly selected as the subjects of this study, and one class was randomly selected as the experimental group (HIIT group) , one class is the control group (CON group). The number of subjects included in both groups was 44. The entire intervention process for the experimental group and the control group included three parts: warm-up, training, and relaxation. The exercise intensity is set at 85%-90% of the maximum heart rate (HRmax). The training process is divided into two phases, namely a 4-week basic adaptation phase (the exercise-to-rest ratio is 1:1) and a 4-week enhancement and improvement phase. (The exercise to rest ratio is 2:1). The training process of the control group was taught in accordance with the school physical education teaching requirements. The final finishing and relaxation process lasts 5 minutes. The results show that 8 weeks of high-intensity interval training can significantly improve the body composition, muscle endurance and cardiorespiratory fitness of adolescents, and the effect is better than traditional physical education classes, but the improvement effect on muscle strength and flexibility fitness of adolescents is not obvious. High-intensity interval training based on the school environment can better improve the physical activity volume and physical activity level of adolescents.

Huo Xiaojuan. (2023). To study the impact of high-intensity interval training on the body composition, form, and function of male college students, this article selected 40 male college students in the non-sports major of Guangzhou Institute of Technology and HIIT optional courses to conduct high-intensity interval training for 16 weeks. training, through the comparison of body data before and after training, to explore the scientific and effective method of high-intensity interval training for male college students. This experiment used the Inbody 720 body composition analyzer, vital capacity tester, height and weight tester, and tape measure to conduct physical tests on the subjects. Analysis and recording of composition, vital capacity, heart rate, height and weight, and body circumference. The research results show that high-

intensity interval training has significant significance in improving the body composition of male college students. High-intensity interval training can effectively improve the body shape of male college students. High-intensity interval training has a positive impact on improving physical function in male college students.

Jiang Chaopeng (2023) To study: Research on the effect of HIIT on promoting the physical fitness level of ordinary college students. This article aims to explore a new physical exercise method that can more efficiently improve physical fitness, cultivate sports interests, improve the national students' physical health compliance rate, and enrich the effective theories and methods of college students' physical training. This article adopts research methods such as literature method, experimental method, expert interview method, mathematical statistics method, etc., and takes the general physical education class (mainly physical training) of 2022 ordinary college students in Saihan Campus of Inner Mongolia Normal University as the research object. First, the subjects Participants were tested on body shape, physical function and physical fitness, and then classes with similar pre-test data were divided into experimental classes and control classes using equidistant sampling, excluding those with hypertension, systemic lupus erythematosus and other diseases, or those who were unable to After engaging in strenuous exercise and students with professional training experience, 50 students (including 40 girls and 10 boys) were selected from each class. Girls in the control group: age 19±0.52 years old, BMI 19.76±1.63, girls in the experimental group: age 19±0.61, BMI 19.85±1.82. Boys in the control group: age 19±0.2, BMI 22.83±1.20, boys in the experimental group: age 19±0.3, BMI 23.14±2.09, a total of 100 students were studied. The subjects were tested for body shape (BMI, waist circumference, hip circumference, large and small leg circumference, arm circumference, chest circumference), physical function (heart rate, vital capacity) and physical fitness (sit-ups, pull-ups, 800m, 1000m, 50m). , 20m return run) test, based on the "National Student Physical Health Standards" as the test standard. After obtaining the pretest data, the experimental group was subjected to high-intensity interval training (HIIT), and the control group was subjected to long-term, moderate-intensity continuous aerobic training (MICT). The experimental period is 10 weeks, and physical training is conducted twice a week, with each

training time lasting 70 minutes. The same test was conducted after the 10-week training. The independent sample T test was used to compare data between the two groups before and after training, and the paired sample T test was used within the group before and after training. The results show that both high-intensity interval training and long-term, medium-intensity continuous aerobic training can significantly improve the physical fitness of ordinary college students. However, in terms of improving the strength and speed quality of ordinary college students, high-intensity interval training has a better training effect. . And high-intensity interval training can not only improve the physical fitness of ordinary college students, but also cultivate their interest in sports and develop a lifelong sports awareness.

Jiang Kaiyuan et al. (2023) studied the effect of high-intensity interval training on the body composition and blood pressure of male college students. They used 20 male college students from Hunan University who were not majoring in physical education as experimental subjects, and used literature methods, experimental methods and mathematical statistics methods to study high-intensity Effects of interval training on body composition and blood pressure in overweight male college students. The experimental subjects were randomly divided into an interval training group and a continuous training group, and the two groups were asked to perform high-intensity interval training and moderate-intensity continuous training respectively. A 10-week exercise intervention program was designed for the two groups respectively. The weight of the subjects before and after the experiment was , BMI index, body fat percentage and blood pressure were tested, and SPSS 17.0 software was used to process and analyze the data. Experimental results show that high-intensity interval training can significantly improve the weight, BMI index, body fat rate and blood pressure of male college students, and is especially effective in reducing body fat rate.

Lai Weixing (2023) conducted a meta-analysis and empirical research on the effects of High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) on the physical health of Chinese college students. The study, involving 60 students randomly assigned to HIIT or MICT groups, found both

training methods effective in reducing BMI and improving lung capacity. HIIT showed greater benefits in enhancing speed, endurance, and strength, while MICT was also effective in improving endurance and strength. Overall, HIIT was superior in enhancing physical health after an 8-week intervention.

Li Ling (2023). To study the impact of 8 weeks of high-intensity interval training on the physical health and special sports quality of students taking optional badminton courses in colleges and universities. The purpose is to explore the impact of high-intensity interval training on the physical health level of students taking optional badminton courses in colleges and universities, and to examine the impact of this training method on The positive significance of college students' badminton-specific sports qualities. Therefore, 42 students from the 2021 badminton optional course of Changzhou Engineering Vocational and Technical College were selected as the experimental subjects, and they were randomly divided into the experimental group and the control group. The experimental group used high-intensity interval training, and the control group performed regular training, and conducted an 8-week training intervention. . After that, the changes in the test item values of the two groups before and after the experiment were compared and analyzed. The experimental results showed that in terms of body shape, there was no difference in height indicators between the experimental group and the control group, and there was a very significant difference in weight indicators. Sexual differences, the control group had significant differences in weight indicators. In terms of physical function, there is a very significant difference in the vital capacity index. There is a difference in the vital capacity index in the control group. In terms of physical fitness, the experimental group has very significant differences in the 50 meters, standing long jump, men's 1000 meters and women's sit-ups. There are differences in the women's 800 meters, and there are differences in the seated forward bend and men's pull-ups. There is no differentiation on the upward indicators. The control group has a very significant difference in the men's 1000-meter index, a significant difference in the women's 800-meter index, and a significant difference in the 50-meter, standing long jump, seated forward bend, women's sit-ups, and men's pull-ups. There is no difference

Li Shuhui et al. (2023). Study the effect of 12 weeks of high-intensity interval training on the health and fitness of college students. Through 12 weeks of HIIT exercise intervention, explore the intervention effect of HIIT on the health and fitness of college students, in order to improve the physical fitness and health level of college students. Provide reference basis. 74 healthy students aged 18-24 years old with no history of regular exercise at Jiangxi Normal University were selected as the research subjects. Following the voluntary principle, they conducted HIIT intervention training three times a week. Before and after the exercise intervention, the students' health and fitness related indicators (weight, body Components, vital capacity, 800/1000, seated forward flexion, pull-ups, grip strength, standing long jump, sit-ups) were used to test the resting heart rate and heart rate change rate of college students' cardiorespiratory fitness. The conclusion showed that the overall subject heart rate and 800 /1000 meters decreased by 8.24% and 11.95% respectively, and vital capacity and vital capacity index increased by 8.65% and 0.1% respectively. Among them, HIIT has a significant impact on the resting heart rate, 1000 meters, vital capacity, vital capacity index of boys and girls, and 800 meters of girls. There were significant differences in vital capacity, vital capacity index, and resting heart rate after intervention between male and female students before and after intervention. Before and after the intervention, there were very significant differences in the grip strength index of muscle fitness of college students and girls' sit-ups, which increased by 0.08% and 18.30% respectively. Among them, HIIT had a very significant impact on the standing long jump of boys and the grip strength index of girls. The grip strength index of boys and girls before and after the intervention , standing long jump has a very significant impact. : 12 weeks of high-intensity interval training has a good effect on improving the body composition of college students, has a positive effect on improving cardiorespiratory fitness, and can have a good promotion effect on muscle fitness.

Liu Jing et al. (2023) studied the effects of different exercise methods on the cardiorespiratory fitness and body composition of overweight male youths. From May to August 2022, 64 overweight male youths with irregular exercise habits in a community in Beijing were selected and divided into groups according to the random

number table method. For the HIIT group, MICT group and control group (Group C), the maximum oxygen uptake (VO_(2max)) was measured by incremental load test before and after the 12-week intervention, and body composition was measured by dual-energy X-ray absorptiometry. Results After the test, VO_(2max) increased in both the HIIT group and the MICT group (P less than 0.05). In the MICT group, the whole body fat content, body fat percentage, android region fat content and percentage decreased (P less than 0.05), and the lean body mass increased (P less than 0.05), while there was no statistical difference in changes in body composition in the HIIT group (P greater than 0.05); there were no statistical differences in changes in all parameters in group C. Conclusion When overweight male youths engage in physical activities using different exercise methods, HIIT is time-effective in improving cardiorespiratory fitness, while MICT is the main means to improve body composition.

Liu Lei (2023) To study: An experimental study on the impact of HIIT combined with MICT training on obese students aged 12-16. This article aims to develop a set of MICT combined with HIIT training methods that are simple and convenient to carry out in schools to promote the physical and mental health development of students of this age, cultivate good exercise habits, stimulate students' enthusiasm for physical exercise, and then help them establish lifelong Sports Thoughts. Research methods: Use literature data method, mathematical statistics method and experimental method to conduct research. This study divided 60 obese students aged 12-16 into HIIT+MICT group, MICT group and control group to explore the effect of high-intensity interval training combined with moderate-intensity continuous training on obese students. The HIIT group performed high-intensity interval training, the MICT group performed moderate-intensity continuous training, and the control group participated in normal courses according to the semester physical education course plan. There is no other physical exercise activity, each training time is 60 minutes, 3 times/week, a total of 12 weeks. Statistical analysis was conducted on the body shape, body function and physical fitness of the students before and after the experiment. The results show that 1. HIIT+MICT and MICT can reduce the weight, BMI, waist circumference, hip circumference and waist-to-hip ratio of obese students, but

HIIT+MICT is more effective in reducing weight and BMI; the MICT group is more effective in reducing waist circumference and hip circumference. And the waist-to-hip ratio is more obvious. 2. HIIT+MICT also has a great effect on improving the physical function of obese students aged 12-16 years old; HIIT+MICT has a greater improvement in the heart rate of obese students; MICT is more obvious in improving the vital capacity of obese students. 3. HIIT+MICT has greatly improved the physical fitness of obese students aged 12-16. HIIT+MICT has greatly improved the obese students' 50m, standing long jump, seated forward bend, and men's 1000m/women's 800m results. ; The MICT group only has a more obvious effect in improving the performance of men's 1000m/women's 800m.

Li Haonan (2023) studied the impact of HIIT on the physical health level of vocational students in the Corps, explored the impact of two different training models of HIIT exercise intervention and conventional running intervention on the physical health level of vocational students in the Corps, and compared and analyzed different training methods The resulting physical health results are intended to seek appropriate training methods and training models to promote the physical health of secondary vocational students in the Corps and to effectively improve the physical health of secondary vocational students. 80 secondary vocational students were randomly divided into the HIIT group and the conventional group, and the impact of 12 weeks of different modes of exercise intervention on physical fitness test scores was experimentally verified. The data generated by the HIIT group and the conventional group before and after the experiment were analyzed for differences. By sorting out the experimental data and comparing the changes in physical health test indicators between the HIIT group and the conventional group before and after the experiment, the research results show that the HIIT intervention has a very significant effect on reducing the BMI of vocational students in the Corps, while the conventional running exercise in the conventional group has Reducing the BMI of vocational students in the Corps did not significantly change. HIIT intervention has a significant effect on improving students' body shape, which is better than conventional running intervention. HIIT intervention significantly improved the vital capacity level of the vocational students in the Corps, while conventional running exercise had no

significant effect on the boys in the conventional group, but had a significant effect on improving the vital capacity of the girls in the conventional group.

Li Zhilong (2023) To study: Study on the effect of continuous/intermittent high-intensity interval training with different amounts of exercise on weight loss in young obese women. This article studies the weight loss effect of low-intensity intermittent HIIT on young obese women and compares it with high-intensity continuous HIIT. Research method: 75 subjects were randomly divided into 5 groups: high-exercise continuous HIIT group, high-exercise intermittent HIIT group, low-exercise continuous HIIT group, low-exercise intermittent HIIT group and no-exercise control group (CON) group, each group was 15 people. The high-intensity HIIT group overcame 200 kilojoules (KJ) of mechanical work with each exercise, and the low-intensity HIIT group overcame 100 KJ of mechanical work with each exercise; the continuous group exercised continuously for 8 weeks, and the intermittent group trained every 2 weeks with an interval of 1 week until the completion of 8 weeks. Exercise intervention. The exercise program was all conducted at an intensity of 90% of maximum oxygen uptake (VO_(2max)) for 4 minutes, with a 3-minute interval, and repeated until 200KJ or 100KJ mechanical work was completed, 4 times/week. The subjects' height, weight, body mass index (BMI), total fat mass, body fat percentage (Fat%), abdominal visceral fat mass and abdominal subcutaneous fat mass were tested before and after the intervention. Test the energy consumption, sugar and fat oxidation during the 1st, 17th and 32nd exercise and the half-hour post-exercise recovery period. The results show that 1. The effect of low-intensity HIIT on reducing the weight and BMI of young obese women is the same as that of high-intensity HIIT. Whether training is interrupted or not has no effect on its weight loss effect. 2. Low-intensity HIIT can reduce Fat%, total fat mass, abdominal visceral fat, and abdominal subcutaneous fat in young obese women, but the effect is lower than high-intensity HIIT. Whether training is interrupted or not has no effect on its effect.

Li Ziyan et al. (2023) studied the application of HIIT training method in the physical education and health courses of No. 16 Middle School in Yinchuan, Ningxia, and explored the application effect of HIIT training method in the physical education

and health courses of No. 16 Middle School in Yinchuan, Ningxia. This study selected Yinchuan, Ningxia Hui Autonomous Region The third-grade students of the No. 16 Middle School in the city were used as the experimental subjects. Before the experiment, the class teachers and parents were asked to understand the students' participation in sports activities. The number was initially determined to be 87. After the pre-experiment, the number was finally determined to be 80 junior-grade students, 45 boys and 45 girls. 35 people. By conducting HIIT training for students for 12 weeks, the impact on students' physical fitness and athletic ability was analyzed. Research results show that HIIT training method can significantly improve students' cardiopulmonary function, muscle strength and endurance, and also has a positive impact on students' body fat rate and body shape. At the same time, the HIIT training method can also help students stimulate their enthusiasm for physical exercise, and at the same time independently formulate their own HIIT training method, promote the formation of students' lifelong sports awareness, and help their families have a healthy lifestyle.

Qin Hao (2023) studied the effect of abata training on the cardiorespiratory endurance, body composition and blood lipid metabolism of overweight female college students. This study aimed to find ways to improve the cardiorespiratory endurance of overweight female college students and explore its preliminary mechanism. We selected 40 non-sports major female college students from Guangxi Normal University whose BMI was overweight (BMI≧24kg/m~2) and 10 who had normal BMI as the research subjects. The subjects were randomly divided into exercise groups (E group), 20 people in the control group (Control group, C group), and 10 people in the blank control group (Blank group, B group). Subjects in the exercise group were subjected to Tabata aerobics intervention for 10 weeks (3 days/week). Except for no exercise intervention, the subjects in the two control groups behaved the same as the exercise group. The exercise plan for the exercise group includes three parts: 10 minutes of warm-up activity, 40 minutes of Tabata training, and 10 minutes of stretching and relaxation. Tabata training is divided into 3 training phases based on the principle of incremental overload: 1-2 weeks is the adaptation phase (exercise at 70%-80% of the maximum heart rate), 3-6 weeks is the basic phase

(exercise at 75%-85% of the maximum heart rate) Exercise at a heart rate), and 7-10 weeks is the strengthening phase (exercise at 85%-95% of the maximum heart rate). The body composition index, cardiorespiratory endurance index and blood lipid metabolism index data of the three groups of subjects before and after were recorded respectively, and the results were statistically analyzed. The results showed that the weight, BMI, waist circumference, hip circumference and body fat percentage indexes of body composition were significantly reduced, and the changes were statistically significant. The waist-to-hip ratio and muscle mass decreased.

Qu Kaiyuan (2023) studied the impact of high-intensity interval training on the physical fitness level of naval personnel, and explored the impact of HIIT on the physical fitness level of naval personnel. 26 naval ship personnel were selected and randomly divided into an experimental group of 13 and a control group of 13 through SPSS. The experimental group received a 6-week HIIT intervention, while the control group received regular naval military fitness training. Healthy fitness indicators (body fat, plank support, 300-yard return run, seated forward flexion, grip strength, standing long jump, deep jump) and competitive physical fitness indicators (body fat, plank support, 300-yard return run, seated forward flexion, grip strength, standing long jump, deep jump) and competitive fitness indicators (40-yard dash, T-run, forward medicine ball throw, back throw, Y balance). The research results show that there are significant differences in the body fat rate, plank support, 300-yard return run, seated forward flexion, right hand grip strength, and T-shaped running in the experimental group after the intervention; while in the control group, there are only plank support and standing long jump. Significant difference, and the control group's plank support performance showed a significant downward trend.

Sun Xuao et al. (2023) studied the impact of 6 weeks of HIIT training on the physical fitness of non-sports male high school students. Thirty healthy male high school students who had not undergone systematic training were selected as experimental subjects, and were randomly divided into an experimental group (HIIT group) and a control group (continuous training group) with 15 people in each group. Choose from: jumping jacks, sit-ups, push-ups, squats, and pull-ups. Each movement

lasts 45 seconds, rests for 20 seconds, and rests for 3 minutes between groups, for a total of 3 groups. Training monitoring means: Polar heart rate monitor, exercise heart rate is 180-190 beats/min, inter-group heart rate is 140-150 beats/min, and inter-group heart rate is 110-120 beats/min. The control group used the same exercise movements, using medium and low intensity continuous training, with no intermission within 30 seconds of each movement, and a 2-minute rest between groups, a total of 3 groups, and the exercise heart rate was maintained at 140-150 beats/min. Before and after the experiment, the subjects' body shape (height, weight, body measurements), strength quality (pull-ups, standing long jump), speed quality (100m), and cardiopulmonary function (vital capacity) were tested. All experimental data are expressed as mean ± standard deviation, and Spss25.0 is used for data statistics, and paired sample t test is used within the group. The results showed that the physical fitness of both the experimental group and the control group improved to varying degrees after the 6-week experiment. In the upper limb strength, the experimental group increased from 7±2 to 12±3, the difference was very significant; the control group increased from 6±2 to 8±2, the difference was not significant; there was a significant difference between the two groups. In the lower limb strength, the experimental group increased from 2.32±0.35m to 2.45±0.35m, the difference was very significant; the control group increased from 2.35±0.34 to 2.40±0.33, the difference was significant; there was a significant difference between the two groups. In the speed quality, the experimental group increased from 13.03±0.55s to 12.77±0.45s, the difference was very significant; the control group increased from 13.15±0.56 to 13.05±0.42, the difference was significant; the difference between the two groups was significant. In the cardiopulmonary function, the experimental group increased from 3500±1500ml to 4000±2000ml, and the difference was very significant; the control group increased from 3550±1500ml to 3700±1000ml, the difference was significant; the difference between the two groups was significant. Six weeks of HIIT training can effectively improve the physical fitness of non-sports male high school students, and its effect is more obvious than ordinary low-intensity continuous exercise.

Wang Chenxu et al. (2023) studied the effects of 8 weeks of high-intensity interval training on food reward and body composition in overweight female college

students. Overweight female college students aged 18 to 25 were recruited and screened from Liaoning Normal University. Finally, 60 overweight female college students were selected as experimental subjects, and 60 subjects with body fat rates in the 25% to 30% range were randomly divided into experimental groups (n= 30) and control group (n=30). The experiment adopts a 2×3 mixed design. The independent variable is the exercise group (experimental group, control group) as the between-group variable, the intervention time is the within-group variable (before intervention, 4 weeks, and 8 weeks after intervention), and the dependent variable is body composition. Relative preference, implicit craving, explicit liking, and explicit craving scores for four categories of food pictures. The experimental group did a high-intensity interval training intervention experiment three times a week for 8 weeks, while the control group maintained their original living habits. After the experiment, food reward and body composition were tested via the Leeds Food Preference Questionnaire and Body Composition Analyzer, respectively. The conclusion shows that 8 weeks of HIIT-TABATA exercise can optimize the body composition of overweight female college students, mainly by reducing body weight, body fat content, body fat rate and waist-to-hip ratio; 8 weeks of HIIT-TABATA exercise can improve the food reward function of overweight female college students , inhibit the preference and eating motivation for high-fat sweet and high-fat salty foods, increase the preference for low-fat sweet foods, and improve self-control of high-fat foods. In summary, this study used this experimental paradigm to measure the effects of HIIT-TABATA exercise on food reward and body composition in overweight female college students and found long-term high Intense interval exercise can improve the food reward and body composition of overweight female college students. This exercise model can provide a scientific exercise program for overweight female college students to lose weight and promote health.

Wang Hui (2023) Study the effect of high-intensity interval training on body composition, cardiorespiratory fitness and arterial stiffness of obese male college students, explore the impact of intervention on arterial stiffness, and compare the changes in arterial stiffness with body weight, BMI, body fat rate, Correlation analysis of changes in blood pressure and maximum oxygen uptake indicators

provides a theoretical reference for obese male college students to reduce fat and weight, improve cardiorespiratory fitness, reduce arterial hardness, and improve cardiovascular health. Twenty obese male college students from Jinan Campus of Shandong Institute of Physical Education were selected as subjects. Randomly divided into an experimental group of 10 people and a control group of 10 people. The experimental group, as the exercise group, underwent high-intensity interval training for 8 weeks, and other activities remained the same as before the intervention; the control group, as the no-training group, did not undergo exercise intervention. The experimental conclusion showed that the weight, BMI, body fat percentage, and The waist-to-hip ratio decreased significantly; in the control group, there were no significant changes in weight, BMI, body fat percentage, and waist-to-hip ratio. : The maximum oxygen uptake index of the experimental group increased significantly; the maximum oxygen uptake index of the control group showed no significant change.

Wang Xiaoxiao et al. (2023) studied the gender characteristics of the impact of high-intensity interval training on the cardiorespiratory endurance of college students, and explored the impact of 12 weeks of high-intensity interval training on the cardiorespiratory endurance of male and female college students to clarify whether there is a gender difference in the improvement of cardiorespiratory endurance levels with the same amount of exercise. difference. Recruited 67 non-athlete students (27 males, 40 females), used a power cycling submaximal intensity exercise program to calculate their maximum oxygen uptake (VO_(2max)), and conducted 12 weeks of high-intensity running (80-90% of maximum Heart rate), walking (50-55% of maximum heart rate) interval training, monitor heart rate during training to maintain exercise intensity. Paired sample T test was used to compare the VO_(2max) of male and female college students before and after training, and independent sample T test was used to test the gender difference in the increased value of VO_(2max). Research results: The VO_(2max) of male and female college students after training were significantly higher than the pre-training level, but there was no significant difference in the increased value of VO_(2max) between male and female students after training. The increased value of VO_(2max) of female students was 0.33 L. /min; boys' VO_(2max) increase value is 0.25 L/min). Research conclusion: 12 weeks of high-

intensity interval training can improve the cardiorespiratory endurance of male and female college students to the same extent, and there is no gender difference.

Wang Yaping et al. (2023) studied the impact of high-intensity interval training on the physical health of college students. Taking the impact of high-intensity interval training on the physical health of college students as the research object, 40 students from Zhu College of Tianjin University of Finance and Economics were selected as experimental subjects. The experimental group was the conventional training group, and the experimental group was the high-intensity interval training group, with a total of 8 weeks of training intervention. Compare the changes in the test item values of the two groups before and after the experiment and analyze them. The results show that in terms of body shape, high-intensity interval training can effectively control body shape and reduce students' risk of diseases caused by obesity. In terms of physical performance, 8 weeks of high-intensity interval training can significantly improve students' lung capacity, which in turn improves students' physical performance. High-intensity interval training can effectively improve students' physical fitness. Promote the physical health of college students, and can be used as an effective intervention program for student sports. The author recommends that high-intensity interval training methods should be widely promoted in colleges and universities. In order to more effectively improve students' physical fitness levels, it is recommended that it be introduced into college physical education classes. It is recommended that when carrying out high-intensity interval training, teachers can use various forms of exercise programs and design targeted exercise programs at different levels to effectively improve students' physical fitness.

Wen Donglin (2023) To study the impact of high-intensity interval training on the health and fitness of adolescents, 120 students in the second grade of a middle school in Xi'an were selected as subjects and randomly divided into four groups: 10s sprint group (HIIT1 group), no Equipment fitness group (HIIT2 group), combination group (HIIT3 group), control group (Control, CON group). The control group received normal teaching according to the original physical education plan, while the intervention group conducted HIIT training in different ways. Each group was given

the same load arrangement (load time 10s, recovery time 30s, inter-group interval 60s, 3 times a week). The conclusion shows that in terms of weight, the three high-intensity interval training groups and the control group did not significantly change the weight of men, while only the HIIT2 group significantly reduced the weight of women. In terms of body mass index (BMI), men only had a significant decrease in the HIIT1 group, while women had a significant decrease in all three HIIT groups. There was no significant difference in training effects between men and women in the same group, and there was no significant difference between groups. Regarding body fat percentage (BF%), only men in the HIIT1 group had a significant decrease, while there was no significant decrease in any female group. Regarding muscle mass, there was no significant increase in either male or female group. Comparison between groups showed that the training effect of men was higher than that of women in terms of muscle mass. In specific sports events, the male CON group and HIIT1 group significantly improved in push-ups, while the female HIIT2 and HIIT3 groups significantly improved in crunches. For 50-meter running and seated forward bending, only men in the HIIT1 group and women in the HIIT3 group had significant improvements respectively. In the standing long jump event, the male CON group, HIIT1 group and HIIT2 group all showed significant improvements, while no significant improvement was observed in any female group.

Xu Mengyao's (2023) study on the impact of different high-intensity interval training (HIIT) on the physical health of high school students selected 90 students as experimental subjects, and randomly divided the 90 students into 3 groups, namely experimental group 1, experimental group 2 and control group , with 30 people in each group, the study found that sprint interval training and high-intensity aerobic interval training were more effective than moderate-intensity continuous training in improving the shape, physical function and physical fitness of teenagers. Furthermore, the popularity of high-intensity aerobic interval training compared to other modalities suggests that it is a more suitable training method for adolescents and can improve physical and mental health, thus promoting better physical health through enjoyable physical activity.

Yang Yong et al. (2023) studied the effect of multiple combination training on the cardiorespiratory fitness and muscular fitness of male college students. 20 college students aged 18 to 21 were selected as the research subjects and randomly divided into a control group and an experimental group, with 10 people in each group. The control group normally participated in physical education classes twice a week; the experimental group performed multiple combination training in physical education classes. . An extra multi-combination training will be conducted on Sunday afternoon, including session 1: performing 6 movements such as high leg raises, jumping jacks, mark exercises, alternating lunges, bent knee jumps, and burpees; session 2: performing a line segment of 20 m Graphic running exercise, a total of 4 types of graphics are designed; session three: 12 weeks of volleyball game dragon and pearl training. The conclusion shows that compared with the control group, the muscle strength, maximum vital capacity and cardiorespiratory fitness of the students in the experimental group have been improved to a greater extent. Among them, the maximum heart rate, heart rate 3 minutes after exercise, maximum vital capacity, 1500 m and standing long jump running scores have been significantly improved. , with statistical difference. Multi-combination training is a safe and efficient training program that can increase maximum vital capacity, enhance and improve cardiorespiratory fitness and muscle fitness, and reduce maximum heart rate within an effective period of time.

Yu Zhendong (2023) studied the effect of 8-week HIIT and MICT swimming training intervention on the body shape and vascular function of adult overweight/obese people, and explored the impact and feasible mechanism of intervention on the improvement of body shape and cardiovascular function of overweight/obese people. Provide exercise programs and scientific advice for overweight/obese people and the general public to promote good body shape development and cardiovascular health through swimming. 41 overweight/obese people (body mass index BMI≥25kg/m2) were recruited from Guangzhou Institute of Physical Education. The average age of the subjects was 23±4 years old, including 9 women and 32 men. The average BMI was 27.3±2.0kg/m2. . They were randomly divided into 2 groups, 21 people in the high-intensity interval training group (HIIT

group) and 20 people in the moderate-intensity continuous training group (MICT group). The HIIT group and the MICT group simultaneously carried out swimming training intervention three times a week for 8 weeks. Training plan: The HIIT group performed 30s*12 groups of sprint swimming, with a 60s interval between groups, and the exercise intensity was 90%-95% HRmax. The MICT group performed 30 minutes of non-stop swimming, and the exercise intensity was 70%-75%HRmax. The results showed that the weight, BMI, body fat content, body fat percentage, waist-to-hip ratio, chest circumference, waist circumference, arm circumference, and leg circumference of the HIIT group were significantly reduced, and the muscle mass was significantly increased. The weight, BMI, body fat content, body fat percentage, waist-to-hip ratio, arm circumference, hip circumference, and leg circumference of the MICT group were significantly reduced.

Zhang Mengmeng (2023) studied the impact of high-intensity interval training in college physical education classes on the physical fitness of college students. In recent years, the physical fitness of college students has declined year by year; at the same time, affected by the epidemic, this phenomenon has intensified. In order to solve the problem of declining physical fitness of college students, we should start from the most basic physical education classes. In order to improve the training effect of physical education classes on college students' physical fitness, this article introduces high-intensity interval training, which is more professional, shorter-time-consuming, and more effective, into compulsory college physical education courses; and explores the application effect of high-intensity interval training in physical education classes. . The 21st grade students of Fuyang Normal University were selected as the experimental subjects, and two classes with similar male-to-female ratios were selected. After the students gave their informed consent, a random method (random drawing within the class) was used to select 20 boys and 10 girls from each of the two classes; they were divided into an experimental group of high-intensity interval training and a control group of traditional physical fitness exercise. . The physical fitness training of students in the experimental group used high-intensity interval training in the classroom, while the physical fitness training of students in the control group used traditional physical fitness training. The training duration of both groups

was 30 minutes. The experimental group exercised at an intensity of 90% HRmax, and the control group exercised at an intensity of 50% to 70% HRmax. The experimental contents are all conducted in physical education class, once per week, for a total of 12 weeks. Before and after the experiment, the cardiopulmonary capacity, speed, strength, endurance, flexibility, BMI and other related indicators of the two groups of students were tested. Through the difference significance test, compare the differences between the experimental group and the control group before and after the experiment. The conclusion shows that before the experiment, the heart rate, vital capacity, boys' 1000 meters/girls' 800 meters, standing long jump, 50 meters, boys' pull-ups, girls' one-minute sit-ups, seated forward flexion, and BMI index indicators of the control group and the experimental group were all the same. There are no significant differences. There is no significant difference between the resting heart rate of boys and girls between the experimental group and the control group. The average vital capacity of boys in the experimental group is significantly higher than that of the control group. The average vital capacity of girls in the experimental group is also significantly higher than that of the control group. The average scores of the experimental group in the boys' 1000 meters and the girls' 800 meters were significantly improved compared to the control group. The average scores of male and female students in the standing long jump were significantly increased in the experimental group compared with the control group.

Zhou Lijia et al. (2023) studied the effect of 12 weeks of kickboxing exercise in HIIT mode on the body composition of obese male college students, and explored the effect of kickboxing exercise in high-intensity interval training (HIIT) mode and the same dose of running in moderate-intensity continuous training (MICT) mode. Comparative analysis of the impact of exercise on body composition of obese male college students, and evaluation of the effectiveness of kickboxing exercise as a HIIT model on body composition of obese male college students. Thirty obese male college students were used as experimental subjects. They were divided into 2 groups, MICT group and HIIT group, using weight as the matching variable, and underwent 12 weeks of exercise intervention. The MICT group performed 32 minutes of running exercise 6 days a week, with an exercise intensity of 60-75% HRpeak. The HIIT

group performed 4-minute kickboxing exercises 6 days a week, 4 times a day, with an intermittent period of 2 minutes of complete rest, and a daily exercise time of 16 minutes. Exercise intensity is 85-95%HRpeak. Study indicators include body weight, BMI, WHR, fat mass, FMI, BF%, muscle mass and LMI. The results showed that compared with before the intervention, the weight, BMI, WHR, fat mass, and body weight of obese male college students in the MICT group and HIIT group were significantly reduced after the intervention. The muscle mass of obese male college students in the MICT group and HIIT group was significantly increased after the intervention. The HIIT group The degree of reduction in body weight, fat mass and FMI after intervention was better than that in the MICT group, and the degree of increase in muscle mass and LMI in the HIIT group after intervention was better than that in the MICT group. The author believes that the HIIT mode of kickboxing exercise has a good impact on the body composition of obese male college students, and the effect is better than the MICT mode of running exercise.

Yang Baiquan et al. (2024) studied the improvement effect of 8 weeks of Tabata training on body composition and muscle fitness of obese college students. Methods: 24 obese college students were recruited and randomly divided into Tabata training group (T group, n=12) and no training control group (C group, n=12). Group T underwent Tabata training three times a week for 8 weeks, while group C maintained its original lifestyle. Research results: The body composition indicators and muscle fitness indicators of the two groups were compared before and after the experiment. After the 8-week experiment, the body fat of the subjects in the T group decreased significantly, the skeletal muscle content increased significantly, and the grip strength and back strength increased significantly. Compared with group C, group T had significant improvements in both body composition and muscle fitness. Research conclusion: 8 weeks of Tabata training can effectively reduce the body fat rate of obese college students, increase skeletal muscle content, and improve muscle strength.

Zhou Yuchuan et al. (2024) studied the effects of HIIT combined with MICT on body composition, blood pressure, and blood lipids in obese college students. 30 obese college students were selected for 10 weeks of HIIT combined with MICT intervention, 3 times a week, 10 sets of MICT each time, the high intensity was 75% to 80% heart rate reserve (HRR) for 1 minute, and the interval intensity was 50% to 60% The HRR lasts for 1 minute, and the HIIT intensity is 60% HRR for 5 minutes without intermission; blood pressure, blood lipids and body composition indicators were tested before and after the intervention. Comparing the 30 subjects who completed the HIIT intervention program with those before the intervention, the subjects' BMI, body fat %, waist-to-hip ratio, diastolic blood pressure (DBP), systolic blood pressure (SBP), and low-density lipoprotein (LDL) after the intervention , total triglyceride (TG), and total cholesterol (TC) values were significantly reduced, and body skeletal muscle mass and high-density lipoprotein (HDL) were significantly increased. The results show that 10 weeks of HIIT combined with HIIT intervention can significantly improve the body composition, blood pressure, and blood lipids of obese college students, and effectively improve the health level of the subjects.

These studies focused on the effects of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) on the physical health of different groups of people. Research results generally show that HIIT has significant effects on improving body shape, body composition, cardiopulmonary function, lower limb muscle endurance and strength, and is usually better than MICT. Especially in terms of improving aerobic exercise capacity, reducing body fat, increasing lean mass, and improving sports performance, HIIT has shown better training effects. In addition, some studies have also found that HIIT can improve the fun of exercise and may be more suitable for teenagers and college students. Although both HIIT and MICT can improve physical health indicators, HIIT usually performs better in terms of time efficiency and degree of improvement, providing a new reference for school physical education and personal health management.

8.2 International research

KAZEMZADEH, Y.,et al(2016)TO study The effect of high intensity interval training HIIT on body composition, lipid profile and insulin sensitivity in overweight young men。 HIGH INTENSITY INTERVAL TRAINING (HIIT) is a kind of exercise training that suggested for individuals with any sufficient time for regular training. The purpose of this study was to determine the effects of 8 weeks of HIIT on BODY COMPOSITION and some indexes of relative to metabolic diseases in young men with overweight. Methods: For this aim thirty young men participants with age of 19-25 y and 25-29 (kg/m2) were randomly assigned to HIIT and control groups (n=15). HIIT groups exercised three times per week, 10-20 min per session for 8 weeks and control group. Baseline and after 8 weeks intervention blood samples and BODY COMPOSITION analyze were assessed. Results: from independent t test showed that INSULIN SENSITIVITY and total triglyceride in HIIT group increased ($p<0.05$). No changes in variables include total plasma cholesterol, cholesterol), LDL-C (low density lipoprotein-cholesterol), HDL-C (high density lipoprotein-cholesterol), fat percentage and body mass index occurred. Conclusions: These findings suggested that HIIT with low volume and time in comparison with traditional continues training, promoted INSULIN SENSITIVITY of muscle cells.

Ouerghi, N. et al. (2017) Study Effects of high-intensity interval training on body composition, aerobic and anaerobic performance, and lipids in overweight/obese and normal-weight young men.the effects of short high-intensity interval training (HIIT) on body composition, physical performance and plasma lipids in overweight/obese compared to normal-weight young men. Nine overweight/ obese and nine normal-weight men (control group) aged 17 to 20 years underwent a HIIT programme three times per week for eight weeks. Body composition, indices of aerobic [maximal aerobic velocity (MAV) and maximal oxygen uptake (VO2max)] and anaerobic [squat jump (SJ), counter-movement jump (CMJ), five-jump test (FJT), 10-m and 30-m sprint] performances, as well as fasting plasma lipids, were assessed in the two groups at PRE and POST HIIT. The HIIT programme resulted in significant

reductions in body mass and fat mass in obese, but not in normal-weight subjects. MAV , VO2max , FJT , SJ and CMJ significantly increased in overweight/obese and normal-weight groups, respectively.30-m sprint time significantly decreased in both groups . Plasma total cholesterol , LDL cholesterol and triglycerides significantly decreased in the obese group, but not in the normalweight group. The eight-week HIIT programme resulted in a slight improvement in physical fitness and a significant decrease in plasma lipids in the obese. Short duration HIIT may contribute to an improved cardiometabolic profile in the obese.

Khammassi, M. et al .(2018) studied the effects of 12 weeks of HIIT without caloric restriction on body composition and blood lipids in sedentary healthy overweight youth, and investigated the effects of a 12-week HIIT program without caloric restriction on body composition and blood lipids in young overweight/obese men. Effects of blood lipids. 20 healthy obese young people were randomly divided into two groups; experimental group (HIIT) and control group. The HIIT program consists of three workouts per week (30 seconds at 100% maximum aerobic velocity [MAV]), interspersed with 30 seconds of active recovery at 50% MAV, starting with 15 repetitions and reaching 27 by the end of the program. Aerobic capacity (MAV and maximum oxygen uptake [VO2max]), body composition (body mass index [Body Mass Index], waist circumference [WC] and fat mass percentage) and lipid status (triglycerides [TG] and total cholesterol, high Density lipoprotein [HDL] and low-density lipoprotein [LDL] cholesterol) were measured before and after the HIIT program. This pilot study demonstrates that a 12-week HIIT intervention can produce clinically significant improvements in body composition, fitness, and lipid profile in young obese individuals. Although our results also suggest that initial adiposity level may influence the effectiveness of such interventions, further research in this area is needed to improve our weight loss strategies.

Boukabous I et al. (2019)To compare the effect of low-volume high-intensity interval training (HIIT) with moderate-intensity continuous training (MICT) on fat mass, cardiometabolic profile, and physical capacity, and confirm its feasibility in older women. Methods: Inactive older women (60–75 years) were randomly assigned

to 8 weeks of either HIIT (75 min/week; n = 9) or MICT (150 min/week; n = 9). Body composition, fasting metabolic profile, cardiovascular risk (Framingham score), and physical capacity (senior fitness test, peak oxygen uptake) were assessed before and after the intervention. Feasibility was evaluated with completion rate (training compliance; dropout rate) and affective response (Feeling Scale; pre- and postexercise). Results: Total cholesterol level, non-high-density lipoprotein cholesterol level, and the Framingham risk score decreased in both groups (ps ≤ .03). Although peak oxygen uptake remained unchanged, the 6-min walk test distance increased ($p < .0001$), irrespective of the group. Completion rate and affective responses were not different between groups (ps ≥ .38). Conclusion: A short-term HIIT program is feasible and provides as much benefits as MICT in older women.

Bryant R et al. (2019) conducted a study on combining personalized moderate-intensity exercise training with high-intensity interval training to enhance training response ability, recruiting 54 people aged 21 to 55 from local universities and communities. among non-smoking adults to examine the effects of personalized moderate-intensity continuous training (MICT) combined with high-intensity interval training (HIIT) versus MICT alone on overall training responses. The study found that the personalized MICT+HIIT approach resulted in more significant improvements in maximal oxygen uptake (VO2max) and metabolic syndrome z-score compared to standardized MICT, showing reduced inter-individual variability in training responses.

Falz R et al. (2019) studied the acute cardiorespiratory response to strength training, high-intensity interval training and moderate-intensity continuous training, selecting 12 young male subjects (age 23.4±2.6 years old; BMI (23.7±1.5 kg/m2) perform incremental exercise testing, randomized into HIIT (4 reps of 4-minute intervals), MCT (continuous cycling), and ST (5 reps of bodyweight exercise), matched to training time. Monitor cardiopulmonary (impedance electrocardiography, human spirometry) and metabolic response. Results The peak blood lactate response after HIIT and ST was similar (8.5±2.6 and 8.1±1.2 mmol/l, respectively; p = 0.83). The impact of training on HIIT time was 90.7±8.5% and on MCT time was

68.2±8.5% ($p < 0.0001$). The average cardiac output of the HIIT group was significantly higher than that of the MCT group and ST group (23.2±4.1 l/min vs. 20.9±2.9 l/min vs. 12.9±2.9 l/min, respectively; Pis less than 0.0001). VO2max during HIIT was twice as high as during ST (2529±310 vs 1290±156 ml); $p = 0.0004$). Among ST components, squats produced different heart rates (111 ± 13.5 vs. 125 ± 15.7 bpm, respectively; $P < 0.05$) and stroke volumes (125 ± 23.3 vs. 104 ± 19.8 ml, respectively) compared with push-ups. difference. ;104±19.8 ml; $P < 0.05$). $P < 0.05$). Conclusion Although the training time is the same and the acute metabolic response is similar, there are obvious differences in the timing of training effects and the cardiorespiratory response. HIIT and MCT (but less ST) induce adequate cardiorespiratory responses that are important for the preventive effects of training; however, the intensity of ST differs significantly.

Cuddy, T. F.,et al.(2019)Research shows that high-intensity interval training with reduced exercise is more effective than traditional moderate-intensity continuous training in improving cardiorespiratory fitness and cardiometabolic health.This study sought to determine the effectiveness of an 8 wk reduced-exertion high-intensity interval training (REHIT) at improving cardiorespiratory fitness (CRF) and positively modifying cardiometabolic health in the workplace environment. Participants ($n = 32$) were randomized to two groups: (1) One group ($n = 16$) was prescribed an 8 wk REHIT program, and (2) one group ($n = 16$) was prescribed moderate-intensity continuous training (MICT). Cardiometabolic risk factors and CRF were measured at baseline and 8 wks. After 8 wks, changes in CRF (REHIT, 12%; MICT, 7%), systolic blood pressure (REHIT, −5%; MICT, −2%), waist circumference (REHIT, −1.4%; MICT, −0.3%), and metabolic syndrome (MetS) severity (MetS z-score: REHIT, −62%; MICT, 27%) were more favorable ($p < 0.05$) in the REHIT group relative to the MICT group. Interestingly, there was a significantly greater proportion of participants in the REHIT group (75%, 9/12) who had a favorable change in the MetS z-score ($\Delta > -0.60$) relative to the MICT group (47%, 7/15). The main finding of the present study is that 8 wks REHIT elicited more potent and time-efficient improvements in CRF and cardiometabolic health when compared to traditional MICT. This study provides critical evidence for implementation of the sprint interval

training (SIT) paradigm from the scientific literature into a real-world workplace setting.

Mentz V et al. (2019). Study the effects of functional training and running low-volume high-intensity interval training on VO2 max and muscular endurance.To evaluate whether high-intensity interval training (HIIT) using functional exercises is as effective as traditional running HIIT in improving maximum oxygen uptake (VO2max) and muscular endurance. Fifteen healthy, moderately trained female (n = 11) and male (n= 4) participants (age 25.6 ± 2.6 years) were assigned to either running HIIT (HIIT-R; n = 8, 6 females, 2 males) or functional HIIT (HIIT-F; n = 7, 5 females, 2 males). Over a four-week period, both groups performed 14 exercise sessions of either HIIT-R or, HIIT-F consisting of 3-4 sets of low-volume HIIT (8x 20 s, 10 s rest; set rest: 5 min). Training heart rate (HR) data were collected throughout all training sessions. Mean and peak HR during the training sessions were significantly different (p = 0.018 and p = 0.022, respectively) between training groups, with HIIT-F eliciting lower HR responses than the HIIT-R. However, despite these differences in exercise HR, VO2max improved similarly (~13% for the HIIT-R versus ~11% for the HIIT-F, p=0.300). Muscular endurance (burpees and toes to bar) significantly improved (p =0.004 and p = 0.001, respectively) independent of training modality. These findings suggest that classic running HIIT and functional HIIT both improve VO2max and affect muscular endurance to the same extent despite a lower cardiovascular strain in the functional protocol.

Tom F Cuddy et al. (2019) conducted a study comparing the effects of an 8-week Reduced-Exertion High-Intensity Interval Training (REHIT) with Moderate-Intensity Continuous Training (MICT) on cardiorespiratory and cardiometabolic health in a workplace setting. Faculty/staff from a local university and hospital were divided into two groups, with the REHIT group showing more significant improvements in cardiorespiratory health, blood pressure, waist circumference, and metabolic syndrome severity, highlighting the potential application of sprint interval training concepts in real.

Fang, B. et al.(2020)This study analyzed the impact of short-term high intensity interval training (HIIT) training and traditional moderate intensity continuous training (MICT) on adolescent soccer players. Participants included 56 adolescent soccer players who were divided into HIIT and MICT groups. The training program was conducted 3 times a week for 4 weeks using cycle ergometer. Each session included the same resistance training program, and the characteristics of HIIT and MICT were applied to improve cardiorespiratory fitness and anaerobic power. Body composition analysis, graded exercise test for peak oxygen uptake (VO2 peak), Wingate anaerobic power test, and isokinetic knee strength test were performed. VO2 peak was improved in HIIT and MICT, but anaerobic threshold and heart rate recovery significantly improved in the HIIT group. Wingate anaerobic peak power had increased significantly in sets 1, 2, and 3 in the HIIT group, but showed significant improvement only in set 1 in the MICT group. The isokinetic strength improved significantly in the HIIT group at 60°/s and in the MICT group at 240°/s. There was no significant change in body composition in either group. In conclusion, short-term HIIT administered to adolescent soccer players effectively improved cardiorespiratory fitness in HIIT and MICT groups. While HIIT increased anaerobic threshold and power, MICT effectively improved muscle endurance. Short-term intensive training can be considered a time-efficient training strategy.

Miguet M et al. (2020) Studying the effects of HIIT versus MICT on body composition and energy intake in obese adolescents with and without dietary restrictions. High-intensity interval training (HIIT) has been suggested as an effective alternative to traditional moderate-intensity continuous training (MICT) that can yield improvements in a variety of health outcomes. Yet, despite the urgent need to find effective strategies for the treatment of pediatric obesity, only a few studies have addressed the impact of HIIT on eating behaviors and body composition in this population. This study aimed to compare the effect of HIIT versus MICT on eating behaviors in adolescents with obesity and to assess if the participants' baseline dietary status is associated with the success of the intervention. The study is comparing the effects of HIIT versus MICT on eating behaviors in obese adolescents and assessing

whether participants' baseline dietary status is associated with intervention success. Restrained eating, emotional eating, and external eating were assessed using the Dutch Eating Behavior Questionnaire at baseline. Both interventions led to significant weight, body mass index (BMI), and fat mass percentage (FM%) reductions, with better improvements in FM% in the HIIT group; whereas 24-h ad libitum energy intake increased to a similar extent in both groups. HIIT provides better body composition improvements over MICT, despite a similar increase in energy intake. Restrained eaters experienced less weight loss and smaller BMI reduction compared with unrestrained eaters; higher baseline cognitively restrained adolescents showed a greater increase of their ad libitum energy intake.

Ram A et al. (2020) studied the effects of high-intensity interval training and moderate-intensity continuous training on aerobic fitness and body composition in overweight or obese men. This study evaluated the effects of 6 weeks of high-intensity interval training (HIIT) or moderate-intensity continuous training (MICT) on aerobic fitness and body composition in overweight or obese men. Twenty-eight participants (18-45 years old; BMI: 25-35 kg/m2) performed stationary cycling three times per week for 6 weeks. Participants were randomly assigned to a job-matched HIIT group (N = 16) (10 × 1 min intervals, 90% peak heart rate) or a MICT group (N = 12) (30 min, 65-75% peak heart rate). Maximal aerobic capacity (VO2peak) and body composition were assessed before and after 6 weeks of training. Both HIIT and MICT induced modest increases in aerobic fitness (Δ% VO2peak: HIIT 9±8%, ES equal to 0.42; MICT: 7±13%, ES equal to 0.32) and work capacity (Δ% peak workload: HIIT: 13 ±10%, ES = 0.69; MICT: 17±15%, ES = 0.76), but these changes were not significantly different between groups (all p greater than 0.16). HIIT or MICT had negligible effects on body composition outcomes across the whole body and all region-specific sites (all effect sizes ES = -0.19 to 0.38), with no significant differences between the two groups. Short-term (6 weeks) cycling training does not improve body composition in overweight or obese men. Improvements in aerobic fitness were comparable between work-matched HIIT and MICT.

Russomando, L.,et al.(2020)To study the effects of individualized short-term high-intensity interval training (HIIT) versus standard moderate-intensity continuous training (MICT) on body fat percentage, abdominal circumference, BMI, and maximum oxygen uptake (VO2max) in overweight volunteers.abdominal circumference, BMI and maximal oxygen uptake (VO2max) in overweight volunteers. Twenty overweight sedentary volunteers (24.9 ± 2.9y; BMI: 26.1 ± 1 kgm−2) were randomly assigned to 2 groups, HIIT or MICT. HIIT trained 6 weeks (3-days/week), 40-min sessions as follows: 6-min warm-up, 20-min resistance training (RT) at 70% 1-RM, 8-min HIIT up to 90% of the predicted Maximal Heart Rate (HRmax), 6-min cool-down. MICT trained 6 weeks (3-days/week) 60-min sessions as follows: 6-min warm-up, 20-min RT at 70% 1-RM, 30-min MICT at 60–70% of the predicted HRmax, 4-min cool-down. Two-way ANOVA was performed in order to compare the efficacy of HIIT and MICT protocols, and no significant interaction between training x time was evidenced ($p > 0.05$), indicating similar effects of both protocols on all parameters analyzed. Interestingly, the comparison of Δ mean percentage revealed an improvement in VO2max ($p = 0.05$) together with a positive trend in the reduction of fat mass percentage ($p = 0.06$) in HIIT compared to MICT protocol. In conclusion, 6 weeks of personalized HIIT, with reduced training time (40 vs. 60 min)/session and volume of training/week, improved VO2max and reduced fat mass percentage more effectively compared to MICT. These positive results encourage us to test this training in a larger population.

Marterer, N et al. (2020) studied 6 weeks of lower-limb high-intensity interval training (HIIT) to increase upper-limb VO2max.High intensity interval training (HIIT) is widely used to improve VO2max. The purpose of this study was to examine if lower extremity HIIT resulted in improved maximal oxygen uptake (VO2max) and peak power output (PPO) of the upper extremities. Twenty healthy and trained participants (11 female and 9 male, VO2max 3160±1175 ml/min) underwent a 6-week HIIT program of the lower extremities on a cycle ergometer. Before and after the training period a maximal cycle ergometry (CE) and a maximal hand crank ergometry (HCE) were conducted to determine VO2max and PPO. Additionally, hematological parameters were determined. Increases in VO2max of the lower

extremities (3160±1175 to 3449±1231 ml/min, p<0.001, η2p=0.779) as well as of the upper extremities (2255±938 to 2377±1015 ml/min, p=0.010, η2p=0.356) from pre- to post-test were found. PPO of the lower extremities increased (243±95 to 257±93 W, p<0.001, η2p=0.491), whereas it remained unchanged for the upper extremities (103±50 to 108±54 W, p=0.209, η2p=0.150). All hematological parameters increased. The results demonstrate that VO2max of the upper extremities increased after 6-weeks of cycling HIIT. However, upper body PPO was unchanged.

Russomando L et al. (2020) This study aimed to compare the effects of a personalized short-term high-intensity interval training (HIIT) vs. standard moderate intensity continuous training (MICT) on body fat percentage, abdominal circumference, BMI and maximal oxygen uptake (VO2max) in overweight volunteers. Twenty overweight sedentary volunteers (24.9 ± 2.9y; BMI: 26.1 ± 1 kgm−2) were randomly assigned to 2 groups, HIIT or MICT. HIIT trained 6 weeks (3-days/week), 40-min sessions as follows: 6-min warm-up, 20-min resistance training (RT) at 70% 1-RM, 8-min HIIT up to 90% of the predicted Maximal Heart Rate (HRmax), 6-min cool-down. MICT trained 6 weeks (3-days/week) 60-min sessions as follows: 6-min warm-up, 20-min RT at 70% 1-RM, 30-min MICT at 60–70% of the predicted HRmax, 4-min cool-down. Two-way ANOVA was performed in order to compare the efficacy of HIIT and MICT protocols, and no significant interaction between training x time was evidenced ($p > 0.05$), indicating similar effects of both protocols on all parameters analyzed. Interestingly, the comparison of Δ mean percentage revealed an improvement in VO2max ($p = 0.05$) together with a positive trend in the reduction of fat mass percentage ($p = 0.06$) in HIIT compared to MICT protocol. In conclusion, 6 weeks of personalized HIIT, with reduced training time (40 vs. 60 min)/session and volume of training/week, improved VO2max and reduced fat mass percentage more effectively compared to MICT. These positive results encourage us to test this training in a larger population.

Aristizabal J C et al. (2021) The aim of this study was to compare the effects of low-volume, high-intensity interval training (HIIT) or moderate-intensity continuous training (MICT) on body composition in adults with metabolic syndrome (MS).This is a post hoc analysis of the randomized clinical trial Intraining-MET. Sixty adults (40–

60 years old) were randomized to an MICT (n = 31) or HIIT (n = 29) supervised programme 3 days/week for 12 weeks. MICT sessions were conducted for 36 min at 60% of peak oxygen consumption (VO2peak). HIIT sessions included 6 intervals at 90% VO2peak for 1 min, followed by 2 min at 50% VO2peak. Body composition was assessed with dual energy X-ray absorptiometry. Both MICT and HIIT reduced FM without changing body weight in adults with MS. MICT had additional benefits by reducing the android FM, whereas HIIT seemed to increase LM. Given the characteristics of the post hoc analysis, further research is required to confirm these results.

Soylu Y et al.(2021)This study aimed to compare the effects of 8-week self-paced high-intensity interval training (HIIT) vs. self-paced moderate-intensity continuous training (MICT) on the physical performance and psychophysiological responses of young adults. Twenty-eight recreationally active young adults (age: 21.1 ± 1.6 years) were randomly assigned to either the self-paced HIIT (n = 14) or the MICT (n = 14) group training protocol. The HIIT consisted of two 12–24 x 30 seconds of high-intensity runs interspersed by 30 seconds of recovery. The MICT completed 24–48 minutes of continuous running. Before and after the 8-week interventions the following tests were completed: maximum oxygen consumption (V̇ O2max) estimated from the Yo-Yo Intermittent Recovery Test level 1 (YYIRTL-1), repeated sprint ability (RSA), 10–30-m sprint test, change of direction test (T-drill), countermovement jump (CMJ) and squat jump (SJ), and triple hop distance test (THD). Training rating of perceived exertion (RPE) and physical activity enjoyment scale (PACES) were assessed during the training programme. The HIIT resulted in greater improvement in YYIRTL-1, V̇ O2max, RSA and T-drill performances compared to the MICT. Furthermore, RPE and PACES values were higher in the HIIT than the MICT. This study suggested that self-paced HIIT may be a more effective training regime to improve aerobic fitness with greater physical enjoyment in recreationally active young adults.

Domaradzki Jarosław et al.(2022)This study aimed to evaluate the role of biological age in the relationship between preintervention fat mass and

cardiorespiratory fitness effects (CRF) after High-Intensity Interval Training (HIIT) intervention in adolescents. Methods: A total of 141 boys and girls (16 years) were examined as control (CG) and experimental (EG) groups that conducted a 10-week HIIT implemented in physical education. Measurements: body height, body weight, fat mass index (FMI), CRF (Harvard Step Test).Conclusion: HIIT is an effective way of exerting positive changes in CRF in adolescents, which is greater in boys than girls. APHV plays a role only in girls. The HIIT should be tailored to girls depending on their maturity status.

De Lima N et al. (2022) This study showed that moderate-intensity continuous training and high-intensity interval training can improve cognition and BDNF levels in middle-aged overweight men. A quasi-experimental randomized controlled trial was used, with 54 participants (age = 67.8±6.2 years). Participants were randomly assigned to the HIICT group (n = 18), MICT group (n = 18), or non-exercise control group (CG; N = 18). Participants in the HIICT or MICT group trained twice a week (1 hour each session) for 18 weeks. Forty-one subjects were analyzed (HIICT; n = 17, MICT; n = 12, CG; N = 12). Five subjects experienced adverse events during the study. Strength, gait, cardiorespiratory fitness, balance and body mass index were measured. A significant training x group interaction was found in the arm flexion test, where HIICT was statistically superior to MICT and CG. Likewise, HIICT was statistically superior to CG in terms of BMI interaction. HIICT and MICT were statistically superior to CG in terms of lower limb strength, gait/dynamic balance, and cardiorespiratory fitness. In summary, HIICT produced better adaptations in upper limb strength than MICT. Likewise, HIICT produced better adaptation in terms of body mass index compared with CG. Finally, HIICT and MICT have similar effects on strength, cardiorespiratory fitness, and gait/dynamic balance.

Kauser S et al. (2022) The aims of the study were to analyze the effect of the moderate intensity training sessions on body composition and aerobic fitness of the female students.An experimental Pre-test Post-test study Design was used. A sample of fourteen female students aged 17-20 years were selected to participate (n-14) through simple random sampling from the Govt degree colleges for Women Alipur

Chattha, Gujranwal. A moderate continuous intensity level training of 8 weeks were given to the participants. SPSS version 23 was used for data analysis.It is concluded that 8 weeks moderate intensity level of continuous training has significant effect on body composition and aerobic fitness of the female students.

Nasiri Masoud et al. (2022)The study focused on evaluating the impact of high-intensity intermittent training (HIIT) and combined training (COM) on various anthropometric measures and aerobic performance in females with polycystic ovary syndrome (PCOS). It was structured as a randomized controlled clinical trial involving 45 women with PCOS, who were divided into three groups: HIIT, COM, and a control group, each consisting of 15 participants. The interventions lasted for eight weeks. Key anthropometric indices such as weight, body mass index (BMI), waist-to-hip ratio (WHR), body fat percentage (FP), and visceral adipose tissue (VAT), along with aerobic capacity measured by VO2max, were assessed at the beginning and end of the study period. The data analysis was performed using a one-way ANOVA test, with Tukey post hoc tests applied for pairwise comparisons. The results indicated significant reductions in weight, BMI, WHR, FP, and VAT in both the HIIT and COM groups after the eight-week intervention, with no significant changes observed in the control group. Additionally, VO2max significantly increased in both the HIIT and COM groups compared to the control group, with HIIT showing a statistically greater improvement in aerobic performance than COM.

Fatma Rhibi et al. (2022) studied the effects of different training intensities in high-intensity interval training (HIIT) on maximum aerobic speed, hematology and muscle damage markers in healthy young people, aiming to study two types of high-intensity interval training (HIIT) Effects of program on maximum aerobic velocity (MAV), hematological changes, and markers of muscle damage in young healthy adults. The study involved 29 male physical education students for 8 weeks, divided into a control group and two intervention groups. The results of the study showed that the group trained at 110% MAV had significantly higher MAV and lower liver enzyme and C-reactive protein levels compared to the 100% MAV group. In addition, lymphocytes were significantly reduced in the 110% MAV group. The study also

found that MAV was positively correlated with liver enzymes, creatine kinase and lactate dehydrogenase levels, providing a theoretical basis for exercise practice and health intervention.

Sarfraz M et al. (2022) In this study the effects of high intensity interval training (HIIT) and moderate intensity continuous training (MICT) were compared to see the reduction in body fat percentage in young university girls age between 20 to 25 years.Thirty subjects were recruited in HIIT (n=15) and MICT group (n=15) for 8 weeks. Pre and post fat percentage was assessed to see the changes before and after work out of two different exercise regimens.Eight weeks of HIIT and MICT resulted in improvements in anthropometric measures along with changes in dietary habit intake. HIIT appears to be the predominant strategy for controlling weight because of its adherence and time efficiency.

Westmacott Ailsa et al. (2022)This study aimed to determine the effect of high intensity interval training (HIIT) in hypoxia on maximal oxygen uptake (VO2max) compared with HIIT in normoxia with a Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)-accordant meta-analysis and meta-regression. Studies which measured VO2max following a minimum of 2 weeks intervention featuring HIIT in hypoxia versus HIIT in normoxia were included. From 119 originally identified titles, nine studies were included (n = 194 participants). Meta-analysis was conducted on change in VO2max using standardised mean difference (SMD) and a random effects model. Meta-regression examined the relationship between the extent of environmental hypoxia (fractional inspired oxygen) and VO2max and intervention duration and ΔVO2max. The overall SMD for ΔVO2max following HIIT in hypoxia was 1.14 (95% CI equal to 0.56–1.72; p less than 0.001). Meta-regressions identified no significant relationship between FiO2 (coefficient estimateequal to 0.074, p equal to 0.852) or intervention duration (coefficient estimate equal to 0.071, p equal to 0.423) and VO2max. In conclusion, HIIT in hypoxia improved VO2max compared to HIIT in normoxia. Neither extent of hypoxia, nor

training duration modified this effect, however the range in FiO2 was small, which limits interpretation of this meta-regression. Moreover, training duration is not the only training variable known to influence VO2max, and does not appropriately capture total training stress or load. This meta-analysis provides pooled evidence that HIIT in hypoxia may be more efficacious at improving VO2max than HIIT in normoxia. The application of these data suggest adding a hypoxic stimuli to a period of HIIT may be more effective at improving VO2max than HIIT alone. Therefore, coaches and athletes with access to altitude (either natural or simulated) should consider implementing HIIT in hypoxia, rather than HIIT in normoxia where possible, assuming no negative side effects.

Gonçalves Catarina et al. (2023) Studying short-term high-intensity interval training and moderate-intensity continuous training regimens to improve health outcomes in patients with coronary heart disease. This study aimed to evaluate the impact of two community-based exercise programs, HIIT and MICT, on physical health and activity levels in patients with coronary artery disease (CAD). Sixty-nine CAD patients were randomly assigned to HIIT, MICT, or a control group for a 6-week treadmill intervention. Results indicate that community exercise programs, particularly HIIT, have more positive effects on physical fitness and activity levels than controls, highlighting HIIT as a potentially effective alternative training method in community exercise programs for CAD patients. High-intensity interval training (HIIT) has been shown to be more effective than moderate-intensity continuous training (MICT) in improving aerobic capacity in people with heart disease.

D'Alleva(2023)This study aimed to investigate the effects of combined training (COMB, a combination of moderate-intensity continuous training-MICT and high-intensity interval training-HIIT) vs. continuous MICT administered during a 3-week in-hospital body weight reduction program (BWRP) on body composition, physical capacities, and substrate oxidation in adolescents with obesity. The 3-week in-hospital BWRP entailed moderate energy restriction, nutritional education, psychological counseling, and two different protocols of physical exercise. Twenty-one male adolescents with obesity (mean age: 16.1 ± 1.5 years; mean body mass index [BMI] 37.8 ± 4.5 kg m−2) participated in this randomized control trial study (n:10 for

COMB, n:11 MICT), attending ~ 30 training sessions. The COMB group performed 3 repetitions of 2 min at 95% of peak oxygen uptake (V′O2 peak) (e.g., HIIT less than or equal to 20%), followed by 30 min at 60% of V′O2 peak (e.g., MICT greater or equal to80%). Body composition, V′O2 peak, basal metabolic rate (BMR), energy expenditure, and substrate oxidation rate were measured during the first week (W0) and at the end of three weeks of training (W3). The two training programs were equivalent in caloric expenditure. At W3, body mass (BM) and fat mass (FM) decreased significantly in both groups, although the decrease in BM was significantly greater in the MICT group than in the COMB group (BM: − 5.0 ± 1.2 vs. − 8.4 ± 1.5, P less than 0.05; FM: − 4.3 ± 3.0 vs. − 4.2 ± 1.9 kg, Pless than 0.05). V′O2 peak increased only in the COMB by a mean of 0.28 ± 0.22 L min−1 (P less than 0.05). The maximal fat oxidation rate (MFO) increased only in the COMB group by 0.04 ± 0.03 g min−1 (P less than 0.05). COMB training represents a viable alternative to MICT for improving anthropometric characteristics, physical capacities, and MFO in adolescents with obesity during a 3-week in-hospital BWRP.

Miguet, M.,et al(2023)To study Effect of HIIT versus MICT on body composition and energy intake in dietary restrained and unrestrained adolescents with obesity This study aimed to compare the effect of HIIT versus MICT on eating behaviors in adolescents with obesity and to assess if the participants' baseline dietary status is associated with the success of the intervention. Forty-three adolescents with obesity were randomly assigned to a 16-week MICT or HIIT intervention. Body composition and 24-h ad libitum energy intake were assessed at baseline and at the end of the program. Restrained eating, emotional eating, and external eating were assessed using the Dutch Eating Behavior Questionnaire at baseline. Both interventions led to significant weight, body mass index (BMI), and fat mass percentage (FM%) reductions, with better improvements in FM% in the HIIT group; whereas 24-h ad libitum energy intake increased to a similar extent in both groups. HIIT provides better body composition improvements over MICT, despite a similar increase in energy intake. Restrained eaters experienced less weight loss and smaller BMI reduction compared with unrestrained eaters; higher baseline cognitively restrained adolescents showed a greater increase of their ad libitum energy intake.

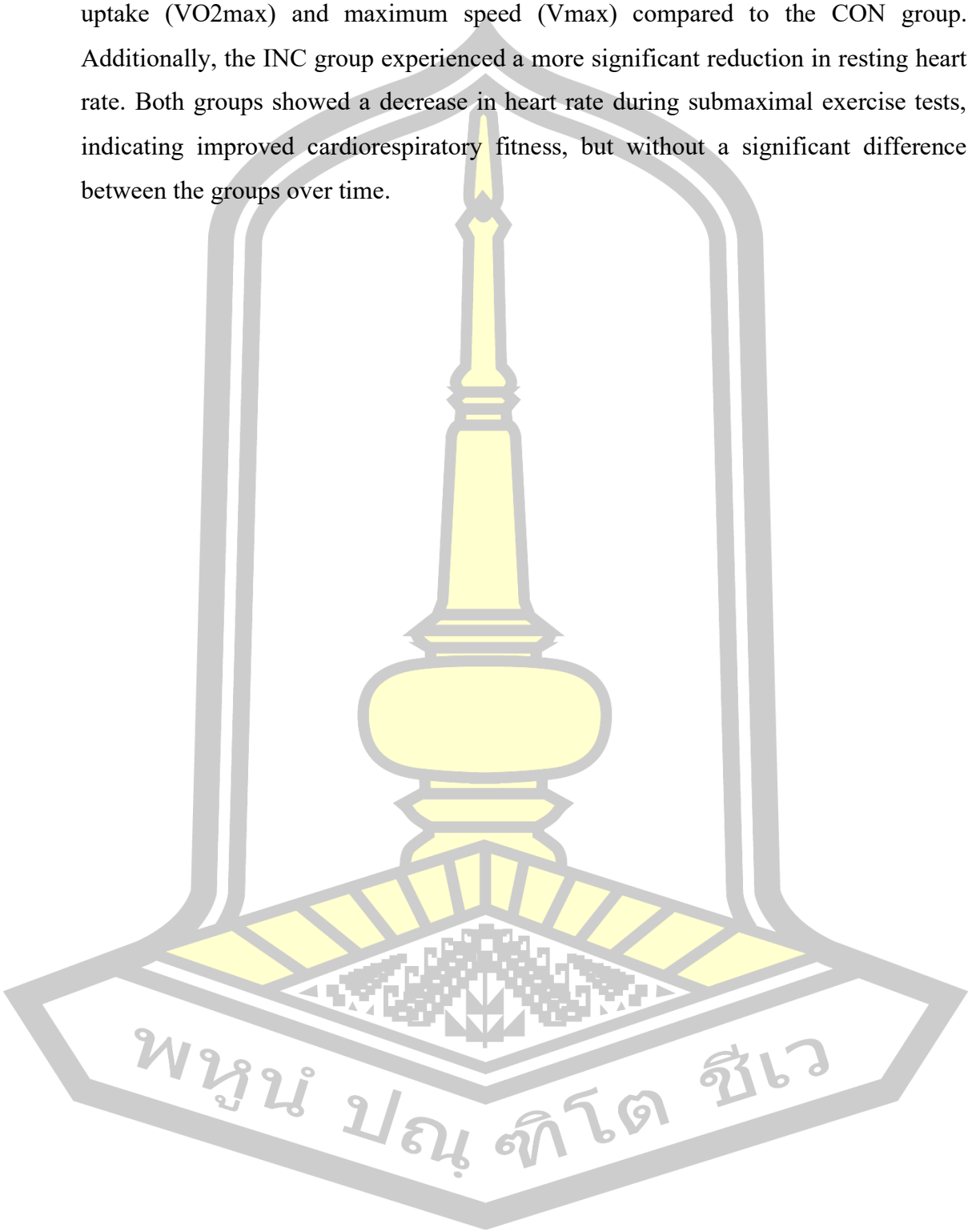
Nur Azis Rohmansyah et al. (2023) aimed to explore the impact of High-Intensity Interval Training (HIIT) on health-related outcomes in elderly women. The study involved 24 inactive older women who underwent 16 weeks of HIIT and Moderate-Intensity Continuous Training (MICT) interventions. Measurements before and after the intervention included body composition, insulin resistance, blood lipids, functional capacity, cardiorespiratory health, and quality of life. Results indicated significant improvements in both groups, with HIIT showing greater enhancements in fasting plasma glucose, cardiorespiratory fitness, lipid profile, and functional ability, suggesting HIIT as an effective exercise modality for improving the physical health of elderly women.

Nduduzo Msizi Shandu et al. (2023) This study examined the effects of high-intensity interval training and continuous aerobic training on health, health-related quality of life (HRQOL), and psychometric measures in college-age smokers. Outcomes included HRQOL, hemodynamics, anthropometry, lung function and cardiorespiratory endurance. Sixty inactive college-age male smokers (18-30 years old) were randomly divided into three groups: high-intensity interval training (HIIT), continuous aerobic training (CAT), and a control group (CON). The HIIT group and the CAT group completed 8 weeks of non-consecutive cycling three times a week. The CON group did not receive exercise intervention. 60 participants met inclusion criteria. Of these, 48 participants (HIIT: n = 18, CAT: n = 16, CON: n = 14) completed the study and were included in the final analysis. Compared with the CON group, the HIIT group significantly (p equal to 0.01) improved forced expiratory flow (FEF_75%) compared with the CAT group (p equal to 0.29). HIIT provided a significant improvement in FEF_75% compared to CAT (p equals 0.04). Compared with the con group, the recovery heart rate (RHR) of the HIIT group and the CAT group was significantly increased (p equal to 0.00). The RHR of the HIIT group was significantly different from that of the CAT group. Research results show that both HIIT and CAT exercise intervention can significantly improve lung function and cardiorespiratory endurance indicators. However, the findings suggest that HIIT should be the preferred form of exercise for college-age smokers because of its greater health benefits.

Rohmansyah, N.et al(2023)To study High-intensity interval training versus moderate-intensity continuous training for improving physical health in elderly women. INQUIRY，In elderly women, a lack of regular physical exercise may result in faster decreases in general health and functional performance. Although high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) have been effectively applied in young and clinical groups, there is no evidence to support their use in elderly women to achieve health benefits. Thus, the major goal of this study was to investigate how HIIT affected health-related outcomes in elderly women. Twenty-four inactive elderly women agreed to participate in the 16-week HIIT and MICT intervention. Body composition, insulin resistance, blood lipids, functional capacity, cardiorespiratory fitness, and quality of life were all measured before and after the intervention. The number of differences between groups was determined using Cohen's effect sizes, and the pre-post intra-group changes were compared using paired t-tests. Using 2 × 2 ANOVA, the time × group interaction effects between HIIT and MICT were evaluated. Body fat percentage, sagittal abdominal diameter, waist circumference, and hip circumference all were improved significantly in the 2 groups. HIIT substantially improved fasting plasma glucose and cardiorespiratory fitness as compared to the MICT. HIIT improved the lipid profile and functional ability more significantly compared to the MICT group. These findings show that HIIT is a useful exercise for improving elderly women's physical health.

Marcel Reuter et al. (2024) conducted a study titled "Effects on cardiorespiratory fitness of moderate-intensity training vs. energy-matched training with increasing intensity." The research aimed to investigate whether beginners would benefit from an increase in training intensity after an initial moderate-intensity training phase, without altering the overall energy expenditure. The study involved 31 healthy, untrained individuals who underwent 10 weeks of moderate-intensity training, followed by allocation to either a control group (CON) that continued moderate training or an intervention group (INC) that shifted to high-intensity interval training (HIIT) with constant energy expenditure, maintained through indirect calorimetry.After 26 weeks,

the INC group demonstrated significantly greater improvements in maximum oxygen uptake (VO2max) and maximum speed (Vmax) compared to the CON group. Additionally, the INC group experienced a more significant reduction in resting heart rate. Both groups showed a decrease in heart rate during submaximal exercise tests, indicating improved cardiorespiratory fitness, but without a significant difference between the groups over time.



CHAPTER III
RESEARCH METHODS

These are Effects of High intensity interval training (HIIT) and Moderate intensity continuous training (MICT) on body composition, cardiorespiratory fitness and muscle fitness of college students

1. Research participants
    - 1.1 Population
    - 1.2 Target Group
    - 1.3 Sample selection criteria
2. Research tools and equipment
    - 2.1 Material and equipment
    - 2.2 Experimental testing tools
    - 2.3 Tools for collecting data
    - 2.4 Steps to create a research tool
3. Research methods and data collection
    - 3.1 Research process
    - 3.2 Data collection process
4. Experimental site
5. Data analysis
6. Research statistics
    - 6.1 Basic Statistics
    - 6.2 Statistical data used in hypothesis testing

1. Research participants

1.1 Population

Among the 6,538 non-sports major students of Sichuan Health and Rehabilitation Vocational College, 1,167 are overweight students. Among these overweight students, there are 369 male college students and 798 female college students. There are 667 freshmen and 500 sophomores who are overweight. Therefore, I selected 66 overweight and obese freshmen as the experimental subjects. Sixty-six subjects were randomly divided into three groups. Fourteen overweight and obese students served as volunteers before the experiment. Group A of the experiment was the high-intensity interval training group, Group B of the experiment was the moderate-intensity continuous training group, and the control group C was the daily training group without HIIT and MICET. The randomization operation is as follows: Firstly, 66 subjects were divided into two groups: 33 males and 33 females. Then the boys and girls were randomly grouped according to the cardboard singles and doubles. Experiment Group A and Experiment Group B each consist of 22 subjects. There were 22 people in Group C of the control group. Experiment A was the high-intensity interval training group (11 boys and 11 girls). Experiment B was a moderate-intensity continuous training group (11 men and 11 women). The control group used subjects who participated in regular physical education classes (11 males and 11 females). The research subjects are college students aged 18 to 20.

1.2. Target Group

1.2.1 The sample size calculation based on the formula: (Z_alpha/2 + Z_beta)^2 / d^2. The values used for the calculation are as follows:

Z_alpha/2 = 1.96 (for a significance level alpha = 0.05 in a two-tailed test

Z_beta = 0.842 (for a statistical power of 0.80)

Effect size (d) = 0.4

Substituting the values into the formula:

(Z_alpha/2 + Z_beta)^2 / d^2 = (1.96 + 0.842)^2 / 0.4^2

= (2.802)^2 / 0.16

= 7.85 / 0.16

= 65.5

Considering a 20% dropout rate:

n_final = 49.06 * (1 + 0.20)

= 66 * 1.20

= 79.2, rounded to 80.

Thus, the sample size per group is 66 participants, and the total sample size for the study with three groups is 22 participants.

1.2.2 In order to allow more students to understand and participate in the research, first of all, on-campus publicity is carried out through posters, and the student union of the college assists in transmitting information. Meanwhile, the student management department further expands its influence to ensure that the information is conveyed to students of all grades in the entire school. Next, the official online platform of the college has released recruitment information for the HIIT, MICT, and control group test research. The recruitment content details the specific details and processes of the research, including test items, test methods, time arrangements, etc., and emphasizes the benefits of participating in this project. Finally, contact information and the person in charge are also provided to facilitate students' inquiries and suggestions.

1.2.3 The experiment randomly sampled 66 research samples and divided them into 3 groups by gender, with 22 people in each group. Experimental group A is the HIIT group, consisting of 11 overweight male college students and 11 overweight female college students, with an equal number. The second experimental group is group B, which undergoes moderate-intensity continuous training. This group consists of 11 overweight male college students and 11 overweight female college students. Group C is the control group, consisting of 11 overweight male college students and 11 overweight female college students, who participated in the daily physical education teaching plan. The changes in body composition, cardiopulmonary function, muscle function, and test indicators of the three groups of subjects before and after the experiment are compared.

1.3 Sample selection criteria

1.3.1 Inclusion criteria

1) Overweight male and female college students aged between 18 and 20 are freshmen at Sichuan Health and Rehabilitation Vocational College.

2) Overweight male and female college students with a BMI ranging from 24 to BMI<27.9 were selected according to the body mass index standard of the "Chinese Physical Fitness Test Standard.

3) Volunteers confirm their own physical health status through the Physical Activity Readiness Questionnaire (PAR-Q). There are no congenital or pathological heart diseases, vascular diseases, etc.

4) The differences in body composition, muscle function, and cardiopulmonary function among volunteers are relatively small.

5) In good health and with good physical condition, able to withstand and complete the corresponding load required by the physical fitness test.

6) Voluntarily participate in the research and are willing to sign the consent form.

1.3.2 Conditions for exiting midway

1) In the past three months, the volunteers were injured and had not fully recovered.

2) The volunteers are taking medication for other diseases.

3) During the experiment, if one gets sick or injured and cannot complete all the experimental procedures,

4) for other reasons, one does not want to continue to participate in the experimental test.

5) One is unable to participate in the 8-week experiment.

Table 3 This study was an experimental study, with tests conducted before training and 8 weeks after training

Experimental inggroup	60 minutes Exercise time	Interval time	dependent variables	Test Methods
HIIT group	Train at anintensity greater than80% HRmax for 30 minutes	30seconds per set for weeks 1-6, 20 seconds per set for weeks 7-8	bodycomposition cardiorespiratory fitness muscle fitness	1. BMI 2. WHR 3. Striated muscle 4. Spirometry 5. 1,000-meter run (men) 6. 800-meter run (female) 7. Standing long jump 8. 1min push-ups 9. 1min sit-ups
MICT group	Train for 6 0 minutes at an intensity of 60% to 70% HRmax	No gap		
Control subjects	No training	No gap		

2. Research tools and equipment

2.1 Material and equipment

1) Body composition tester

2) lung capacity tester

3) Cardiopulmonary endurance tester

4) Muscle strength tester

5) Muscle endurance tester

2.2 Experimental testing tools

1) Body composition tester

2) HIIT Training Plan (See the appendix for details)

HIIT (Each group lasts for 60 minutes, including 10 minutes of warm-up, 30 minutes of HIIT, 10 minutes of stretching, and 10 minutes of relaxation). The exercise intensity is required to be ≥ 80% HRmax. In the basic adaptation period (the first 6 weeks), the interval between each movement is 20-30 seconds. In the strengthening period (the last 2 weeks), the interval between two combinations in each group is 20

seconds. Three combinations form one group, and a total of two groups are completed.

3) MICT Training Plan (See the appendix for details)

Each group lasts for 60 minutes, including 10 minutes of warm-up, followed by 30 minutes of moderate-intensity continuous training, and finally 10 minutes of stretching and 10 minutes of relaxation). The training movements are the same as those in the experimental group, but the intervention methods are different. After the end of each combination training in the group, the next combination training starts immediately without any interval. The intensity of the entire 30-minute training is maintained at 60%-70% HRmax.2.2.4 Spirometry tester: The subject stands facing the instrument, holding the blowing mouth; standing facing the spirometer, inhale deeply (avoid shrugging, inhale slowly, like a fancy inhalation style; after inhalation , hold your breath, then aim and blow with your mouth; you are not allowed to inhale or blow twice during the test, and slowly exhale into your mouth until you can no longer exhale; after blowing, the final score displayed on the LCD screen It is the lifetime capacity in milliliters.

2.3 Tools for Data Collection (See the appendix for details)

1) Record sheet before and after the HIIT group experiment

2) Record sheet before and after the MICT group experiment

3) Record sheet before and after the control group experiment

2.4 Steps to create a research tool

1) Health Assessment Record Form

2) Physical Activity Readiness Questionnaire (PAR-Q)

3) By referring to the literature and combining the actual situation of our school, it is found that the failure rate and obesity rate of students nationwide are on the rise. Based on the research literature, theoretical research on the test methods is carried out from two aspects: overweight and obesity, and training methods (HIIT and MICT). Taking the body composition, cardiopulmonary health, and muscle strength of overweight college students as the entry points, a HIIT, a MICT, and a daily physical education teaching control group are set up to conduct exercise interventions

for overweight college students. Experimental research is carried out based on literature materials, theoretical support, and practical training to compare and analyze the changes in various indicators of body composition, cardiopulmonary function, and muscle function of overweight college students before and after training.

4) Prepare experimental data collection tools. These include the Muscle Strength Test Record Form, Muscle Endurance Test Record Form, Cardiopulmonary Endurance Record Form, Vital Capacity Test Form, Body Composition Analyzer, and Body Composition Analysis Report Form.

5) Submit the HIIT and moderate-intensity continuous training programs of this study to the Thesis Management Committee for review and make modifications according to the committee's decisions. Through the number (1843410df57e488ba781f46d7af05f16).

6) Submit the training plan to 3 experts for review. The experts will check the rationality and effectiveness of the training plan, evaluate whether it is appropriate, and give an objective consistency score (IOC).

Rating +1, considered appropriate.

Rating 0, inappropriate.

Rating -1, inappropriate.

7) The training plan was revised based on expert opinions to ensure the IOC score was qualified.

8) A preliminary experiment was conducted on 14 overweight college students aged between 18 and 20 years in the non-experimental group for 4 weeks. Data was collected, and the training plan was revised. (See Appendix for details)

3. Research methods and data collection

3.1 Research process

3.1.1 Using "overweight college students, moderate-intensity exercise, MICT, body composition, muscle strength, and cardiopulmonary function" as keywords, various Chinese and foreign literatures were searched in the Chinese National Knowledge Infrastructure, including the China Academic Literature Full-text Database, China Journal Network, PubMed, and other databases. According to the

needs of this study, the relevant works and literature were deeply analyzed to provide a theoretical basis for this study.

3.1.2 Determine the detection methods and tools according to the research variables.

3.1.3 Create a record sheet to record the test data and training completion.

3.1.5 Expert suggestions:

3.1.5.1 It is recommended to change the total time of HIIT training from 30 minutes to 60 minutes and extend the stretching and cooling time.

3.1.5.2 It is also recommended to provide standardized instructions for each test item and to demonstrate on-site to ensure that all testers understand and correctly perform the test movements, reduce errors caused by non-standard movements, and improve the consistency of test results.

3.1.6 The training plan has been modified according to the experts' suggestions.

3.1.7 Before the experiment was carried out, an experimental study was conducted on 14 non-experimental overweight college students, and the training plan and experimental tools were revised based on the experimental results. According to the preliminary experimental results and expert opinions, the total training time was changed from 30 minutes to 60 minutes.

3.2 Data collection process

3.2.1 Sixty-six volunteers with little difference in BMI and weight were selected from 80 non-sports volunteers.

3.2.2 Explain the experimental method to the volunteers, including distributing the experimental process and introducing the experimental procedures to the volunteers.

3.2.3 The study by Paulo Gentil et al. (2017) showed that HIIT requires at least 2 to 8 weeks of intervention to produce a positive effect. In addition, after reviewing a large number of literature, it was found that a large proportion of HIIT intervention periods were 8 to 12 weeks. The study by Deng Jianwei et al. (2019)

showed that the frequency of HIIT was mostly 2 to 3 times a week. Therefore, this study determined that 8 weeks of training, 3 times a week.

3.2.4 HIIT was scheduled to be carried out from 5:30 to 6:30 pm on Tuesdays, Thursdays, and Saturdays, and moderate-intensity continuous training was scheduled to be carried out from 6:40 to 7:40 pm on Tuesdays, Thursdays, and Saturdays.

3.2.5 Data were collected again after the 8th week of training.

3.2.6 Summarize the research results and follow-up research recommendations.

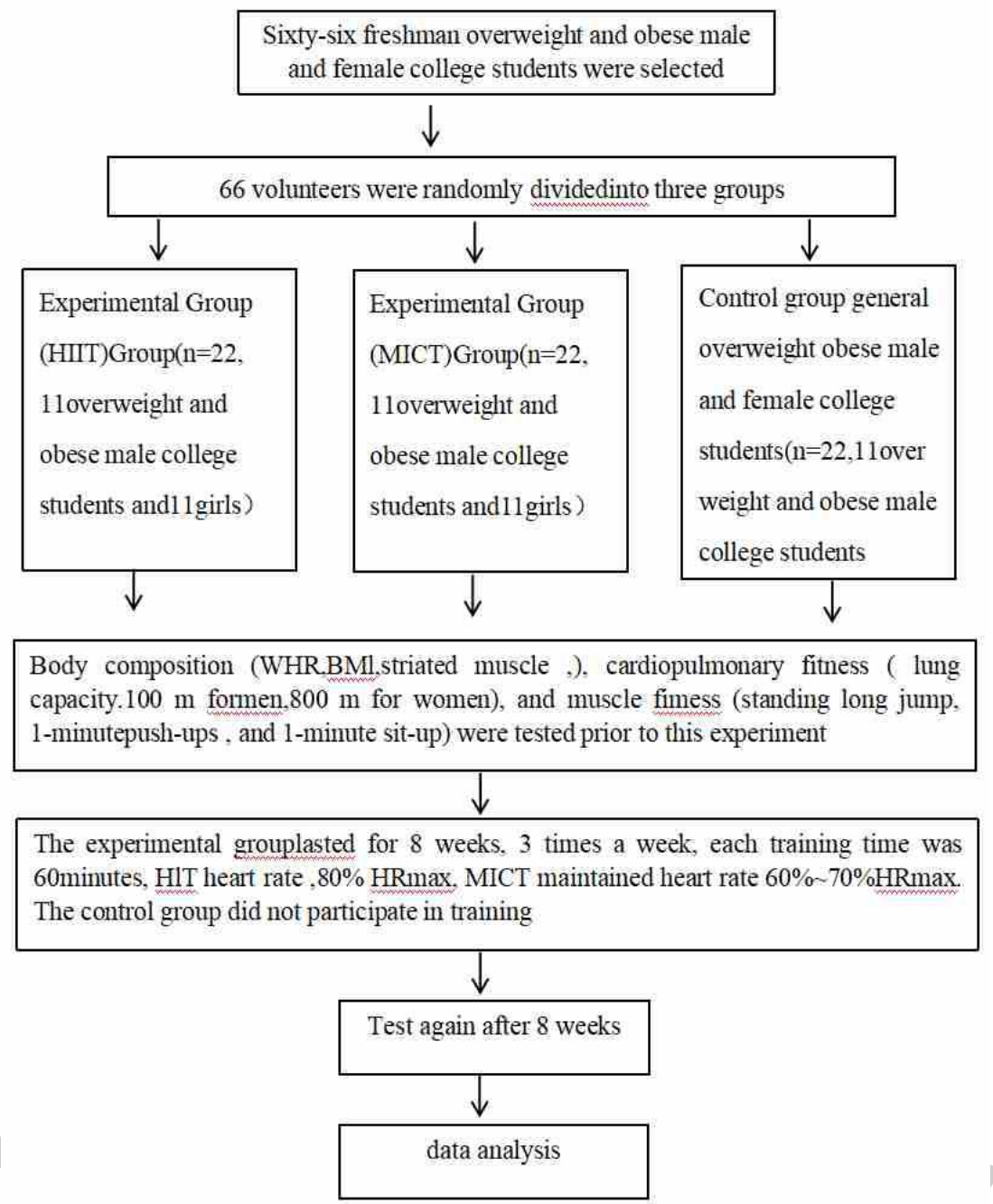


Figure 1 Experimental process framework

4. Experimental site

4.1 Sichuan Health and Rehabilitation Vocational College Gymnasium

5. Data analysis

5.1 The BCA-1D Body Composition Analyzer was used to measure skeletal muscle, BMI, and waist-to-hip ratio of volunteers using the Direct Segmented Multi-Frequency Bioelectrical Impedance DSM (DSM-BIA) test method.

5.2 The standing long jump tester, 800-meter running tester, 1000-meter running tester, sit-up tester and lung capacity tester produced by the Physical Fitness Test Instrument for College Students were used to test the subjects.

5.3 BMI, striated muscle, waist-to-hip ratio, lung capacity, Cardiorespiratory endurance, Muscular strength, Muscular endurance, power mean and standard deviation before and after the experiment were calculated.

5.4 The F-test will be used to compare the differences in the mean values of the three groups of experiments

5.5 One-way ANOVA was used to compare the differences between the HIIT group, the medium-intensity continuous training group, and the daily physical training control group. When a statistically significant difference of 0.05 was found, paired comparisons were made.

5.6 The data obtained from the experiment were statistically analyzed using EXCEL and SPSS 22.

6. Research statistics

6.1 Basic Statistics

$$P = \frac{f \times 100}{N}$$

P represents the percentage, N represents the total number of data, and frepresents the number of data to calculate the percentage.

Average formula:

$$X=(A1+A2+A3+....)\div N$$

X represents the average value, A represents each data, and N represents the total number of data.

Standard deviation (SD) formula:

$$S = \frac{\sqrt{(A-X)^2}}{N-1}$$

S represents the standard deviation, A represents each data, and X represents the mean.

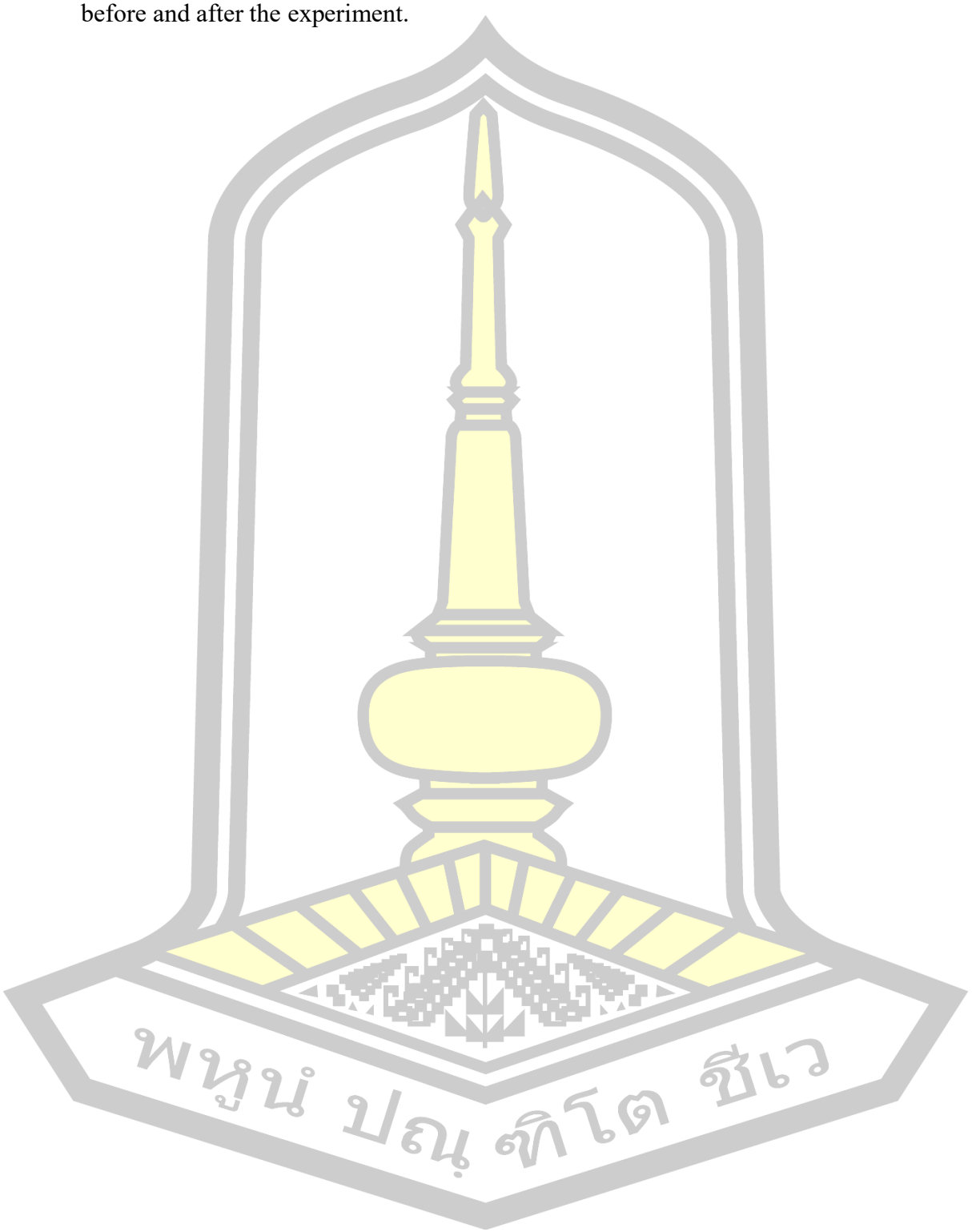
6.2 Statistical data used in hypothesis testing

6.2.1 College student tester test (lung capacity, 800 meters, 1000 meters, sit-ups, standing long jump)

6.2.2 Skeletal muscle, BMI, and waist-to-hip ratio were detected using the BCA-1D Body Composition Analyzer.

6.2.3 Detection of 1-minute push-ups with stopwatch YS-810

6.2.4 One-way ANOVA F test was used to compare the three groups of data before and after the experiment.



CHAPTER IV
DATA ANALYSIS RESULTS

In this study, researchers used HIIT, MICT and daily training methods for the control group to train overweight college students for 8 weeks and collected data before and after the experiment. The body composition, cardiorespiratory fitness and muscular fitness data before and after the experiment and between the three experimental groups were statistically analyzed. In terms of body composition, BMI (kg/m 2), waist-to-hip ratio WHR (%) and skeletal muscle weight (kg) were selected as evaluation indicators; in terms of cardiorespiratory fitness, vital capacity and women's 800 meters (s) and men's 1000 meters (s) were selected as evaluation indicators. In terms of muscular fitness, standing long jump (cm), 1-minute push-ups (reps) and 1-minute sit-ups (reps) were selected as evaluation indicators.

1. Symbols used to represent the results of data analysis

$\bar{x}$ Stands for mean

S.D. Stands for standard deviation

t Stands for paired samples t-test

f Represents statistical values used for F-distribution analysis for significance testing.

p Denotes the probability calculated by the program, compared with the value calculated by the tester specified in the T and F tests.

2. Data analysis

1. Statistically significant levels of the HICT group, the MICT group, and the control group were compared within groups before and after the 8-week intervention training by means of a paired-samples t-test.

2. A one-way ANOVA was used to compare whether there was a significant difference between the HICT group, the moderate-intensity continuous training group, and the control group before and after the experiment.

3. Results

Table 4 Shows the normality analysis of eight experimental variables for three groups of male subjects. (n =33)

Variable	HIIT ($\bar{x}$±S.D.)	MICT ($\bar{x}$±S.D.)	Control groups ($\bar{x}$±S.D.)	p
Body composition				
BMI (kg/m2)	26.18±1.63	26.52±1.88	26.29±1.83	0.057
WHR	0.91±0.03	0.93±0.05	0.91±0.05	0.105
Skeletal muscle weight(kg)	25.42±3.01	25.77±3.11	26.22±2.96	0.348
Cardiorespiratory fitness				
Lung capacity(ml)	3910.27±581.79	3991.09±545.16	4008.00±466.81	0.265
Cardiorespiratory endurance(s)	268.18±22.80	263.18±26.67	261.18±23.18	0.781
Muscular fitness				
Power (cm.)	202.73±23.01	201.55±18.97	204.00±11.01	0.063
Muscular strength (rep)	20.82±3.55	19.09±3.33	19.70±3.71	0.408
Muscular endurance (rep)	28.55±3.96	27.55±4.82	26.73±8.11	0.282

From table 4 it is found that, p≥ 0.05, which satisfies the normal distribution, and the assumption holds.

Table 5 Shows the normality analysis of eight experimental variables for three groups of female subjects. (n =33)

Variable	HIIT ($\bar{x}$±S.D.)	MICT ($\bar{x}$±S.D.)	Control groups ($\bar{x}$±S.D.)	p
Body composition				
BMI (kg/m2)	24.85±1.65	25.13±1.41	24.49±1.54	0.063
WHR	0.85±0.03	0.86±0.02	0.86±0.03	0.070
Skeletal muscle weight(kg)	20.97±3.01	22.02±2.54	20.52±1.63	0.353
Cardiorespiratory fitness				
Lung capacity(ml)	3100.18±727.26	3107.00±718.89	2722.36±602.62	0.060
Cardiorespiratory endurance(s)	257.91±24.63	276.09±35.94	287.00±32.26	0.257
Muscular fitness				
Power (cm.)	162.91±12.52	167.73±16.94	159.45±15.84	0.512
Muscular strength (rep)	19.36±4.99	20.36±4.08	20.18±5.06	0.565
Muscular endurance (rep)	27.00±5.51	28.36±5.24	26.55±5.96	0.578

From the table 5 it is found that, p≥0.05, which satisfies the normal distribution, and the assumption holds.

Table 6 Shows a comparison of the data for the HITT, MICT, and Control groups' body composition before and after eight weeks of male overweight. (n=33)

Variable	$\bar{x}$	S.D.	t	p
HITT				
Body composition				
BMI (kg/m2)	26.18	1.63	9.952	0.000**
	24.82	1.44		
WHR	0.91	0.03	14.685	0.000**
	0.86	0.03		
Skeletal muscle weight(kg)	25.42	3.01	-3.724	0.004**
	26.23	2.36		
MICT				
Body composition				
BMI (kg/m2)	26.52	1.88	2.590	0.027*
	26.31	1.68		
WHR (No unit)	0.93	0.05	0.803	0.441
	0.93	0.05		
Skeletal muscle weight(kg)	25.77	3.11	-1.196	0.259
	25.90	2.81		
Control group				
Body composition				
BMI (kg/m2)	24.49	1.54	1 762	0.171
	24.55	1.56		
WHR (No unit)	0.86	0.03	1.838	0.138
	0.86	0.03		
Skeletal muscle weight(kg)	20.52	1.63	-0.643	0.063
	20.75	1.48		

From Table 6, it can be seen that after the experiment, the BMI (kg/m²) p≤0.000, WHR p≤0.000, and skeletal muscle weight (kg) p≤0.004 of the overweight boys in the HIIT group; after the experiment, the BMI (kg/m²) p≤0.027, WHR p≤0.441, and skeletal muscle weight (kg) p≤0.259 of the overweight boys in the MICT group; there was no significant improvement in the control group before and after the experiment.

Table 7 Shows the comparison of data on cardiorespiratory fitness in the HITT group, MICT group and control group before and after 8 weeks of overweight in male. (n=33

Variable	$\bar{x}$	S.D.	t	p
HITT				
cardiorespiratory fitness				
lung capacity(ml)	3910.27	581.79	-16.122	0.000**
	4210.00	540.33		
cardiorespiratory endurance(s)	268.18	22.80	5.086	0.000**
	247.27	20.67		
MICT				
cardiorespiratory fitness				
lung capacity(ml)	3991.09	545.16	-2.397	0.038*
	4067.82	454.60		
cardiorespiratory endurance(s)	263.18	26.67	3.125	0.011*
	260.91	25.48		
Control group				
cardiorespiratory fitness				
lung capacity(ml)	4008.00	466.81	-0.389	0.705
	4021.55	388.22		
cardiorespiratory endurance(s)	261.18	23.18	1.969	0.077
	257.73	26.29		

From Table 7, it can be seen that after the experiment, the lung capacity (ml) $p \leq 0.000$, cardiorespiratory endurance (s) $p \leq 0.000$ of the overweight boys in the HIIT group; after the experiment, the lung capacity (ml) $p \leq 0.038$, cardiorespiratory endurance (s) $p \leq 0.011$ of the overweight boys in the MICT group; there was no significant improvement in the control group before and after the experiment.

Table 8 Shows a comparison of data on muscle fitness in the HITT group, MICT group and control group before and after 8 weeks of overweight in male. (n=33)

Variable	$\bar{x}$	S.D.	t	p
HITT				
Muscular fitness				
Power (cm.)	202.73	23.01	-9.872	0.000**
	210.18	21.37		
Muscular strength (rep)	20.82	3.55	-4.847	0.001**
	23.45	3.29		
Muscular endurance (rep)	28.55	3.96	-14.330	0.000**
	33.45	3.91		
MICT				
Muscular fitness				
Power (cm.)	201.55	18.97	-1.973	0.077
	202.91	17.67		
Muscular strength (rep)	19.09	3.33	-4.183	0.032*
	19.82	3.25		
Muscular endurance (rep)	27.55	4.82	-2.803	0.019*
	28.55	4.29		
Control group				
Muscular fitness				
Power (cm.)	204.00	11.01	-2.015	0.072
	205.55	11.44		
Muscular strength (rep)	19.70	3.71	-1.641	0.132
	19.82	3.60		
Muscular endurance (rep)	26.73	8.11	0.289	0.779
	26.55	6.71		

From Table 8, it can be seen that after the experiment, the Power (cm.) p≤0.000, Muscular strength (rep) p≤0.001, Muscular endurance (rep) p≤0.004 of the overweight boys in the HIIT group; after the experiment, the Power (cm.) p≤0.077,

Muscular strength (rep) p≤0.032, Muscular endurance (rep) p≤0.019 of the overweight boys in the MICT group; there was no significant improvement in the control group before and after the experiment.

Table 9 Shows the comparison of data on body composition in the HITT group, MICT group and control group before and after 8 weeks of overweight in female. (n=33)

Variable	$\bar{x}$	S.D.	t	p
HITT				
Body composition				
BMI (kg/m2)	24.85	1.65	7.860	0.000**
	23.70	1.67		
WHR (No unit)	0.85	0.03	13.836	0.000**
	0.78	0.03		
Skeletal muscle weight(kg)	20.97	3.01	-8.089	0.000**
	22.61	2.44		
MICT				
Body composition				
BMI (kg/m2)	25.13	1.41	2.706	0.022*
	25.02	1.36		
WHR (No unit)	0.86	0.02	-0.820	0.432
	0.86	0.02		
Skeletal muscle weight(kg)	22.02	2.54	-1.836	0.096
	22.24	2.37		
Control group				
Body composition				
BMI (kg/m2)	24.49	1.54	-1.477	0.171
	24.55	1.56		
WHR (No unit)	0.86	0.03	-1.614	0.138
	0.86	0.03		
Skeletal muscle weight(kg)	20.52	1.63	-2.093	0.063
	20.75	1.48		

From Table 9, it can be seen that after the experiment, the BMI(kg/m²)p≤0.000,WHR p≤0.000,and skeletal muscle weight (kg)p≤0.000 of the overweight female in the HIIT group; after the experiment, the BMI(kg/m²)p≤0.022,WHR p≤0.432,and skeletal muscle weight (kg)p≤0.096 of the

overweight female in the MICT group; there was no significant improvement in the control group before and after the experiment.

Table 10 Shows the comparison of cardiorespiratory fitness in the HITT, MICT and control groups before and after 8 weeks of overweight in female. (n=33)

Variable	$\bar{x}$	S.D.	t	p
HITT				
cardiorespiratory fitness				
lung capacity(ml)	3100.18	727.2	-6.255	0.000**
	3242.64	687.31		
cardiorespiratory endurance(s)	257.91	24.63	10.611	0.000**
	239.64	23.00		
MICT				
cardiorespiratory fitness				
lung capacity(ml)	3107.00	718.89	-2.780	0.019*
	3159.91	691.36		
cardiorespiratory endurance(s)	276.09	35.94	2.324	0.043*
	272.09	33.27		
Control group				
cardiorespiratory fitness				
lung capacity(ml)	2722.36	602.62	-1.508	0.162
	2763.73	552.37		
cardiorespiratory endurance(s)	287.00	32.26	0.713	0.492
	285.45	36.29		

From Table 10, it can be seen that after the experiment, the lung capacity (ml) $p \leq 0.000$, cardiorespiratory endurance (s) $p \leq 0.000$ of the overweight females in the HIIT group; after the experiment, the lung capacity (ml) $p \leq 0.019$, cardiorespiratory endurance (s) $p \leq 0.043$ of the overweight females in the MICT group; there was no significant improvement in the control group before and after the experiment.

Table 11 Shows a comparison of muscle fitness data between the HITT, MICT and control groups in female before and after 8 weeks of overweight (n=33)

Variable	$\bar{x}$	S.D.	t	p
HITT				
Muscular fitness				
Power (cm.)	162.91	12.52	-10.202	0.000**
	170.36	10.76		
Muscular strength (rep)	19.36	4.99	-8.724	0.000**
	24.64	3.85		
Muscular endurance (rep)	27.00	5.51	-19.688	0.000**
	32.55	5.37		
MICT				
Muscular fitness				
Power (cm.)	167.73	16.94	-1.110	0.293
	169.18	16.61		
Muscular strength (rep)	20.36	4.08	-2.390	0.038*
	21.09	3.56		
Muscular endurance (rep)	28.36	5.24	-2.803	0.019*
	29.36	5.39		
Control group				
Muscular fitness				
Power (cm.)	159.45	15.84	-1.750	0.111
	160.73	13.88		
Muscular strength (rep)	20.18	5.06	-0.191	0.852
	20.27	3.87		
Muscular endurance (rep)	26.55	5.96	0.235	0.819
	26.36	5.06		

From Table 11, it can be seen that after the experiment, the Power (cm.) $p \leq 0.000$, Muscular strength (rep) $p \leq 0.000$, Muscular endurance (rep) $p \leq 0.000$ of the overweight females in the HIIT group; after the experiment, the Power (cm.)

p≤0.293, Muscular strength (rep) p≤0.038, Muscular endurance (rep) p≤0.019 of the overweight females in the MICT group; there was no significant improvement in the control group before and after the experiment.

Comparison and analysis of three groups of overweight students in each index after the experiment.

Table 12 Shows a comparison between HITT, MICT, and Control groups on male overweight student. (n=33)

Variable		Sum of Squares	df	Mean Square	F	p
BMI (kg/m2)	Between Groups	15.064	2	7.532	2.896	0.071
	Within Groups	78.020	30	2.601		
	Total	93.085	32			
WHR	Between Groups	0.026	2	0.013	6.062	0.006**
	Within Groups	0.063	30	0.002		
	Total	0.089	32			
Skeletal muscle weight(kg)	Between Groups	1.047	2	0.524	0.069	0.933
	Within Groups	227.478	30	7.583		
	Total	228.525	32			
Lung capacity(ml)	Between Groups	212197.152	2	106098.576	0.490	0.617
	Within Groups	6493374.364	30	216445.812		
	Total	6705571.515	32			

Cardiorespiratory endurance(s)	Between Groups	1119.697	2	559.848	0.950	0.398
	Within Groups	17673.273	30	589.109		
	Total	18792.970	32			
Power (cm.)	Between Groups	298.242	2	149.121	0.497	0.613
	Within Groups	8997.273	30	299.909		
	Total	9295.515	32			
Muscular strength (rep)	Between Groups	96.970	2	48.485	4.228	0.024**
	Within Groups	344.000	30	11.467		
	Total	440.970	32			
Muscular endurance (rep)	Between Groups	278.061	2	139.030	5.332	0.010**
	Within Groups	782182	30	26.073		
	Total	1060.242	32			

Table 12 shows the results of one-way ANOVA for body composition, cardiorespiratory endurance and muscular endurance of overweight male students in the three groups after the experiment, and the sig value of the test of variance of each item (LEVENE)≥0.05, indicating that the assumption of variance of the data in each group is valid. The results of the F-test show that the p-values of the five indicators, namely, BMI, skeletal muscle content, lung capacity, cardiorespiratory endurance and Power,≥0.05, while the P-values of the three indicators of WHR, muscle strength and muscular endurance≤0.05, indicating that the difference in the overall genus of the multiple groups was statistically significant and that multiple comparisons (two-by-

two comparisons) were needed to explore whether there was a significant difference between the groups.

Table 13 Compare pairs show the variable of the three groups of overweight male student. (n=33)

Variable	Groups	($\bar{x}$±S.D.)	HIIT	MICT	Control groups
WHR	HIIT	0.86±0.03	-	0.002**	0.018*
	MICT	0.93±0.05	0.002**	-	0.410
	control subjects	0.91±0.05	0.018*	0.410	-
Muscular strength (rep)	HIIT	23.45±3.29	-	0.017*	0.017*
	MICT	19.82±3.25	0.017*	-	1.000
	control subjects	19.82±3.60	0.017*	1.000	-
Muscular endurance (rep)	HIIT	33.45±3.91	-	0.032*	0.003**
	MICT	28.55±4.29	0.032*	-	0.366
	control subjects	26.55±6.71	0.003**	0.366	-

Multiple comparisons in Table 13 revealed that after 8 weeks of exercise intervention, the HICT group was better than the moderate-intensity continuous training group and the control group, and the moderate-intensity continuous training group was better than the control group.

Table 14 Shows a comparison between HITT, MICT, and Control groups on female overweight student.

Variable		Sum of Squares	df	Mean Square	F	p
BMI (kg/m2)	Between Groups	9.843	2	4.922	2.087	0.142
	Within Groups	70.758	30	2.359		
	Total	80.602	32			
WHR	Between Groups	0.048	2	0.024	27.563	0.000**
	Within Groups	0.026	30	0.001		
	Total	0.073	32			
Skeletal muscle weight(kg)	Between Groups	21.313	2	10.657	2.318	0.116
	Within Groups	137.904	30	4.597		
	Total	159.217	32			
Lung capacity(ml)	Between Groups	1441578.424	2	720789.212	1.722	0.196
	Within Groups	12554941.64	30	418498.055		
	Total	13996520.06	32			
cardiorespiratory endurance(s)	Between Groups	12214.364	2	6107.182	6.205	0.006**
	Within Groups	29528.182	30	984.273		
	Total	41742.545	32			
Power (cm.)	Between Groups	607.697	2	303.848	1.846	0.175

	Within Groups	4938.364	30	164.612		
	Total	5546.061	32			
Muscular strength (rep)	Between Groups	118.364	2	59.182	4.171	0.025*
	Within Groups	425.636	30	14.188		
	Total	544.000	32			
Muscular endurance (rep)	Between Groups	210.242	2	105.121	3.791	0.034*
	Within Groups	831.818	30	27.727		
	Total	1042.061	32			

Table 14 shows the results of one-way ANOVA for body composition, cardiorespiratory fitness and muscular fitness of three groups of overweight female students after the experiment. The sig value of the test of equality of variance (LEVENE) for each item was≥0.05, which likewise indicates that the assumption of equality of variance of the data in each group is valid. This equality of variance is sufficient for further parametric tests to be carried out. The results of the F-test showed that the p-values of four indicators, BMI, skeletal muscle content, lung capacity and Power, were≥0.05, whereas the p-values of three indicators, WHR, cardiorespiratory endurance, muscular strength and muscular endurance, were≤0.05. This suggests that there were statistically significant differences in the overall characteristics of the multiple groups, and that multiple comparisons (two-by-two) need to be carried out to explore whether there are any significant differences between the groups.

Table 15 Compare pairs show the variable of the three groups of overweight female student. (n=33)

Variable	Groups	($\bar{x}$±S.D.)	HIIT	MICT	Control groups
WHR (No unit)	HIIT	0.78±0.03	-	0.000**	0.000**
	MICT	0.86±0.02	0.000**	-	0.829
	control subjects	0.86±0.03	0.000**	0.829	-
Cardiorespiratory endurance(s)	HIIT	239.64±23.00	-	0.021*	0.002**
	MICT	272.09±33.27	0.021*	-	0.326
	control subjects	285.45±36.29	0.002**	0.326	-
Muscular strength (rep)	HIIT	24.64±3.85	-	0.035	0.011*
	MICT	21.09±3.56	0.035	-	0.614
	control subjects	20.27±3.87	0.011*	0.614	-
Muscular endurance (rep)	HIIT	32.55±5.37	-	0.617	0.010*
	MICT	29.36±5.39	0.617	-	0.192
	control subjects	26.36±5.06	0.010*	0.192	-

Multiple comparisons in Table 15 show that after 8 weeks of exercise intervention, the HICT group was better than the moderate-intensity continuous training group and the control group in improving various indicators of overweight girls, while the moderate-intensity continuous training group was better than the control group.

CHAPTER V
CONCLUSION, DISCUSSION, AND SUGGESTIONS

In this study on the effects of HIIT and MICT on body composition, cardiorespiratory fitness, and muscle fitness of overweight college students, the researchers summarized the following themes:

1. Conclusion
2. Discussion
3. Suggestions

1. Conclusion

1.1 HIIT can significantly improve the body composition, cardiorespiratory fitness, and muscular fitness of male and female college students.

1.2 After 8 weeks of HIIT and MICT, overweight college students showed improvements in body composition, cardiorespiratory health, and muscular health. High-intensity interval training (HIIT) showed the best improvement, while moderate-intensity continuous training was better than the control group.

1.3 Group 1: HIIT showed very significant differences in body composition, cardiorespiratory fitness, and muscular fitness before and after the experiment of overweight male and female college students ($P<0.01$).

1.4 Group 2: MICT showed significant differences in BMI, lung capacity, 1000-meter push-ups, and 1-minute sit-ups before and after the experiment of overweight male and female college students ($P<0.05$), while there were no significant differences in WHR, skeletal muscle content, and standing long jump ($P>0.05$), which was similar to the control group.

1.5 In the control group of Group 3, there were no significant differences in body composition, cardiopulmonary fitness, and muscular fitness between overweight male and female college students before and after the experiment ($P>0.05$).

2. Discussion

This study aimed to evaluate the effects of HIIT, MICT, and a control group on body composition, cardiorespiratory fitness, and muscular fitness in overweight college students. The three groups were trained for 8 weeks. The results showed that HIIT could significantly improve the body composition, cardiorespiratory fitness, and muscular fitness of overweight male and female college students. There were significant differences in body composition, cardiorespiratory fitness, and muscular fitness among the groups, among which the improvement in the first group, HIIT, was the most significant, followed by the second group, MICT.

2.1 The study found that HIIT can significantly improve body composition, cardiorespiratory fitness, and muscular fitness in male and female college students.

2.1.1Qi Yugang et al. (2013) conducted HIIT and continuous aerobic training on junior high school students and pointed out that both training methods can significantly improve the subjects' weight, BMI, and waist-to-hip ratio, but HIIT has a better improvement effect. Wang Jing (2019) pointed out the analysis of the reasons why HIIT is more effective than MICT training, and HIIT can develop fast muscle fibers. Li Xiaochen (2018) showed that HIIT can improve the explosive power and strength endurance of the subjects' upper limbs. Eight weeks of HIIT and MICT intervention have a significant promoting effect on the improvement of master's students' hand grip strength, 1 min sit-ups, and push-ups. Among them, the HIIT intervention had a significantly better effect on the performance of sit-ups and push-ups than the MICT intervention. The HIIT intervention had a very significant effect on the reduction of BMI and weight of postgraduate students but had no effect on the reduction of WHR. The 8-week MICT intervention had a very significant effect on the reduction of WHR, BMI, and weight. Among them, the HIIT intervention was significantly better than the MICT group in reducing the BMI of postgraduate students.

2.2 The study found that after overweight college students performed HIIT and MICT for 8 weeks, their body composition, cardiopulmonary health, and muscle

health improved. HIIT showed the best improvement, while MICT was better than that of the control group.

2.2.1 In Liu Jun's (2022) study, HIIT and MICT training can reduce resting heart rate and blood pressure levels, increase the body's basal metabolic rate, and improve cardiopulmonary function. Both HIIT and MICT training can optimize blood lipids. In Yu Ping's (2021) article, high-intensity exercise may produce more positive effects under the same exercise time. HIIT can improve the cardiopulmonary fitness and muscle strength of normal-weight adolescents, and the effect is better than traditional physical education classes. In Lu Mengyi's (2021) study, 12 weeks of high-intensity interval training can significantly improve college students' lung capacity and physical function level. In terms of physical fitness, 12 weeks of high-intensity interval training can effectively improve college students' strength, endurance, flexibility, speed, agility, and balance. Miguet, M. et al. (2023) studied obese adolescents and found that HIIT provided better improvements in body composition compared with MICT. Zhou Lijia et al. (2023) found that the increase in muscle mass and LMI in the HIIT group after intervention was better than that in the MICT group. The author believes that the HIIT mode of Taekwondo has a good effect on the body composition of obese male college students, and the effect is better than the MICT mode of running. Xu Pengfei (2020) showed that both HIIT and MICT training can significantly reduce weight and improve BMI index, among which HIIT has a better effect, but there is no significant improvement. Both training can significantly improve the level of vital capacity, among which HIIT has a better effect. Both HIIT and MICT can significantly improve the endurance level of college students, and HIIT has a better effect. Speed and agility: MICT has a poor effect on 50-meter running training, and HIIT is significantly better than the former.

3. Suggestions

3.1 Application of research results

3.1.1 Application of HIIT program

HIIT is short in duration and high in intensity, suitable for college students who have little time but like challenges. It can be adopted according to physical fitness to promote health.

3.1.2 Application of MICT program

MICT is long in duration and medium in intensity, suitable for most people, especially for beginners to gradually adapt to exercise.

3.1.3 Progressive nature of training program

HIIT should be gradual. MICT transition can be selected in the early stage. Pay attention to stretching and relaxation after training and ensure a reasonable diet and nutritional intake.

3.1.4 Application in physical education

Increase the reform of students' physical education courses. The training effect of the experimental group in this study is good, and the feedback from the subjects is positive. It is hoped that HIIT can be added to the university physical education classroom in the future to increase the choice of exercise methods for college students, thereby improving the physical health level of college students.

3.1.5 Optimization of experimental conditions

This study did not control diet and work and rest, and the test indicators did not involve physiological and biochemical levels. Future research can further optimize the experimental conditions.

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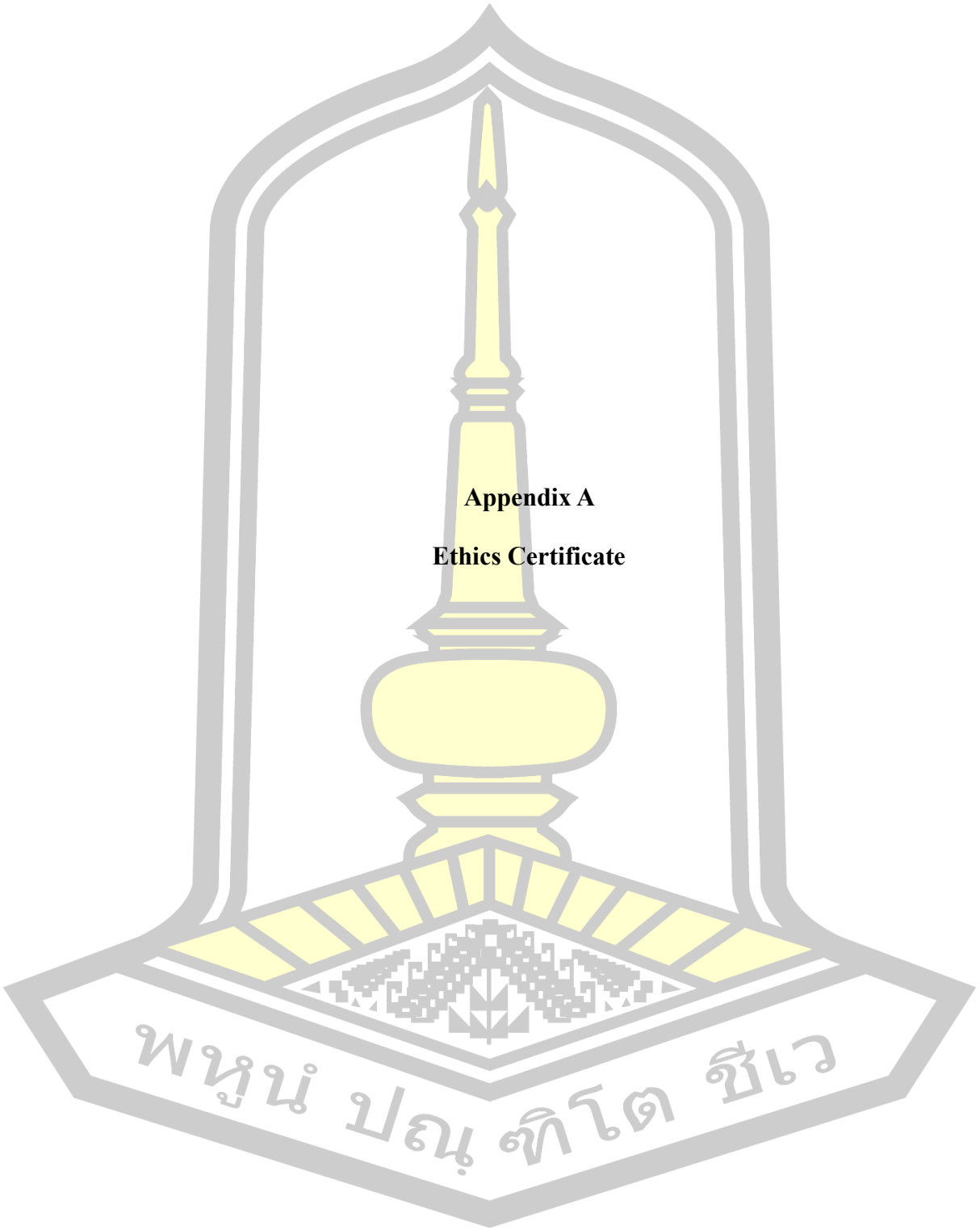
Zhu, L., Liu, J., Yu, Y., & Liu, W. (2020). The effect of high-intensity interval training on fat reduction in overweight and obese adolescents: A meta-analysis. *Journal of Guangzhou Sport University*, 40(01), 96-101.

Zouhal, H., Zare-Kookandeh, N., Haghighi, M. M., et al. (2021). Physical activity and adipokine levels in individuals with type 2 diabetes: A literature review and practical applications. *Reviews in Endocrine and Metabolic Disorders,* Advance online publication. https://doi.org/10.1007/s11154-021-09607-7

APPENDIX



Appendix A

Ethics Certificate

MAHASARAKHAM UNIVERSITY ETHICS COMMITTEE FOR
RESEARCH INVOLVING HUMAN SUBJECTS

Certificate of Approval

Approval number: 656-559/2024

Title : Effects of HIIT and MICT on body composition, cardiorespiratory fitness and muscle fitness of college students.

Principal Investigator : Li Xuan
Responsible Department : Faculty of Education
Research site : Zigong City, Sichuan Province, China

Review Method : Expedited Review

Date of Manufacture : 31 October 2024 **Expire :** 30 October 2025

This research application has been reviewed and approved by the Ethics Committee for Research Involving Human Subjects, Mahasarakham University, Thailand. Approval is dependent on local ethical approval having been received. Any subsequent changes to the consent form must be re-submitted to the Committee.

Ratree S.
.....

(Assistant Professor Ratree Sawangjit)
Chairman

Approval is granted subject to the following conditions: (see back of this Certificate)

Appendix B

Clarification documents for the experts who answered the questionnaires

(answering questionnaires must be over 18 years old)

67/559

ECMSU01-10.13 (English)

Clarification documents for the volunteers (For Interview)

(Respondents must be above 18 years of age to participate in answering the interview)

To All respondents

I am (Li Xuan, Master student, Health and Sport Science. Faculty of Education, Mahasarakham University) The ongoing study is titled "The Effects of HIIT and MICT on body composition, cardiopulmonary function and muscle health in overweight and obese college students". Through the study of experimental training and observation of overweight and obese college students, the impact of two training methods on the body composition, muscle fitness, and cardiorespiratory fitness of overweight and obese effects of HIIT and MICT on Body Composition, Cardiorespiratory Fitness and Muscular Fitness of College Students was compared, with the purpose of finding a training method that is more suitable for the development of healthy physical fitness of college students, and for Self-exercise for college students provides a better choice and provides a method reference for promoting the improvement of college students' physical health. What are the differences between high-intensity interval training and moderate-intensity continuous training? Which method is more efficient in reducing fat, which method is more effective, etc.

If you decide to participate in the research, The researchers will ask you to answer a general questionnaire about the HIIT, MICT exercise study. The questionnaire consists of 11 questions. The researchers will ask you to answer a general questionnaire about the HIIT, MICT exercise study. The questionnaire consists of 11 questions. answer the question is taking about 4 minutes. By requesting an interview at Sichuan Vocational College of Health and Rehabilitation gym.

information obtained from the interview. The researcher will request permission (audio recording, photographing and video recording). The researcher is requested to identify the record of data consistent with the researcher's research and will proceed to destroy the data after the completion of the study.

If you feel uncomfortable or feel uncomfortable with some questions You have the right to not answer those questions. You have the right to withdraw from this project at any time without prior notice. The refuse of participating in the research or withdrawing from this research project Will not have any effect to does not affect your studies.

The information in your questionnaire will be kept. Not disclosed to the public on an individual basis, only the overall research results will be reported. Researcher will destroy relevant information after the research is completed. In this research, you will not receive any compensation or any fees.

If you have questions about the research, please contact us at (Xuan Li- Health and Sport Science. Educational Faculty, Mahasarakham University, Phone: +8613568321581)

ECMSU01-10.13 (English)

If you have not performed as stated or want to know your rights while participating in this research, please contact "Committee on Ethics for Research in Humans Mahasarakham University Division of Research" Tel. 043-754416, 1758

Sincerely

.....

(Xuan Li)

Researcher

Appendix C

Informed consent form for research from volunteers

(For volunteers over 18 years old)

ECMSU01-07.10 English 2023

Informed consent form for research from volunteers

(For volunteers over 18 years old)

I (Mr.) .....Surname .....Age.....Year.

House number ..... Village No. .....

Sub-district ..... District ..... province.....

Convenient phone .....Email address .....

I read the explanation / listen to the explanation from Mr. Li Xuan about volunteering in the research project on " Effects of High intensity interval training (HIIT) and Moderate intensity continuous training (MICT) on body composition, cardiorespiratory fitness and muscle fitness of college students", the explanatory text consists of Full details about the purpose of the research, details of the research. That I have to do and be treated, the benefits that I may gain from the research and the risks that may arise from participating in the study. Including guidelines for questions that may arise throughout. It has also received an explanation and an answer to any questions from the research project leader.

As well as the testimony from the researcher that will keep my information confidential. In addition, not anonymously or private information individually to the public. The results of the research will be presented in the form of an overview that is a summary of the research results for academic purposes only.

"In participating as a volunteer of this research project I join voluntarily." And I can withdraw from this study at any time. If I wish which will not have any effect and will not lose any rights in study or work that I will receive in the future.

sign.....Volunteers (.....)

Date.....

sign..... ...witness (.....)

Date.....

sign.....researcher (Mr. Li Xuan)

Date.....

Appendix D

Research tools

1. Pre-exercise screening questionnaire (PAR-Q)
2. HIIT group before and after record table
3. MICT group before and after record table
4. Control group before and after record table
5. Dynamic Warm-Up and Static Cool-Down Training Methods
6. Experimental process photos

PAR-Q Questionnaire

Name: _____Age: _____Date filled: _____

For most people, physical activity is not a problem or a crisis. The PAR-Q is designed to identify those few people who are not suitable for physical activity or who need a doctor's advice to participate in physical activity. Please read the following questions carefully and select "yes" or "no" before the question number.

Yes No

□ □ 1. Has your doctor told you that you have heart problems and that you can only do physical activities recommended by your doctor?

□ □ 2. Do you feel chest pain when you do physical activities?

□ □ 3. Since the last month, have you had chest pain when you were not physically active?

□ □ 4. Have you fallen or lost consciousness because of dizziness?

□ □ 5. Have you had bone or joint problems aggravated by changes in physical activities?

□ □ 6. Has your doctor recently prescribed blood pressure or heart medication for you?

□ □ 7. Is there any other reason why you cannot do physical activities?

Pre-exercise screening questionnaire

<table>
<tr><td colspan="2">Evaluate your health by answering the following questions truthfully:</td></tr>
<tr><td>Medical History
Have you ever had:
----One heart attack
----Heart surgery
----Cardiac catheterization
----Percutaneous transluminal coronary angioplasty (PTCA)
----Pacemaker/insertable defibrillator/cardioverter
----Heart failure
----Heart transplant
----Congenital heart disease</td><td rowspan="2">If you have any of the conditions described in this section, please consult a doctor or health care professional before exercising. You may need to exercise under the supervision of a certified medical professional.</td></tr>
<tr><td>Symptoms
----Experienced chest discomfort when exerting oneself
----Experienced unexplained breathing difficulties
----Experienced dizziness, fainting, or vertigo
----Experienced swollen ankles
----Experienced discomfort due to a fast and strong heartbeat
----Take heart medications
----Muscle or bone problems that limit physical activity</td></tr>
<tr><td>Other health problems
----Having diabetes
----Having asthma or other lung disease
----Your calves feel warm or cramp when walking short distances
----Concerned about the safety of exercise
----Taking prescription medications
----Pregnant</td><td></td></tr>
</table>

Cardiovascular risk factors ----Smoking or quitting smoking for less than 6 months ----Blood pressure ≥ 140/90 mm Hg ----Taking antihypertensive medications ----Plasma cholesterol ≤ 200 mg/dl ----Don't know your plasma cholesterol level ----A close relative with a weak heart or heart surgery, where the father or brother is ≤ 55 years old, the mother or sister is ≤ 65 years old ----Prediabetes ----Don't know if you are in prediabetes	If you have two or more of these conditions, you need to consult a physician or other health care professional to develop your exercise program as part of your medical management. "You will benefit more from your exercise program under the guidance of a qualified professional exercise instructor."
None of the above items were selected	You can safely start exercising without consulting a physician or other health care provider, and you can exercise in almost any setting that meets your exercise program needs.

Name: Time：

Table 16 HIIT group before and after record

HIIT group before and after record table (body composition, cardiorespiratory fitness muscle fitness)												
Student ID Number		A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11
BMI (kg/m2)	8 weeks ago											
	8 weeks later											
WHR	8 weeks ago											
	8 weeks later											
Skeletal muscle weight (kg)	8 weeks ago											
	8 weeks later											
lung capacity (ml)	8 weeks ago											
	8 weeks later											
Cardiorespiratory endurance (s) Men's 1000m, Women's 800m	8 weeks ago											
	8 weeks later											
Power (cm.) Standing long jump	8 weeks ago											
	8 weeks later											

Muscular strength 1-minute push-ups	8 weeks ago											
	8 weeks later											
Muscular endurance 1-minute sit-ups	8 weeks ago											
	8 weeks later											

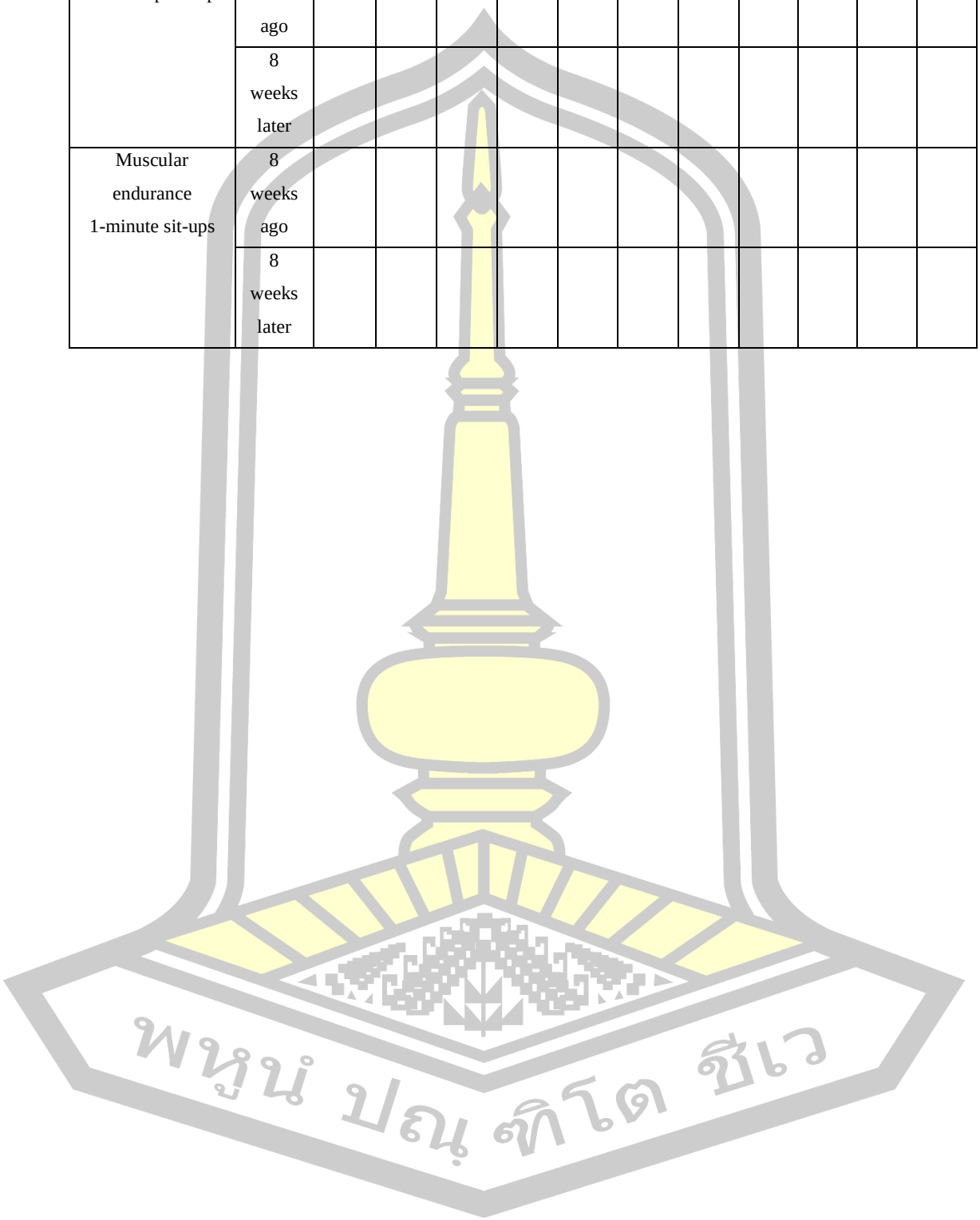


Table 17 MICT group before and after record

MICT group before and after record table (body composition, cardiorespiratory fitness muscle fitness)												
Student ID Number		A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11
BMI (kg/m2)	8 weeks ago											
	8 weeks later											
WHR	8 weeks ago											
	8 weeks later											
Skeletal muscle weight (kg)	8 weeks ago											
	8 weeks later											
lung capacity (ml)	8 weeks ago											
	8 weeks later											
Cardiorespiratory endurance (s) Men's 1000m, Women's 800m	8 weeks ago											
	8 weeks later											
Power (cm.) Standing long jump	8 weeks ago											
	8 weeks later											

Muscular strength 1-minute push-ups	8 weeks ago											
	8 weeks later											
Muscular endurance 1-minute sit-ups	8 weeks ago											
	8 weeks later											

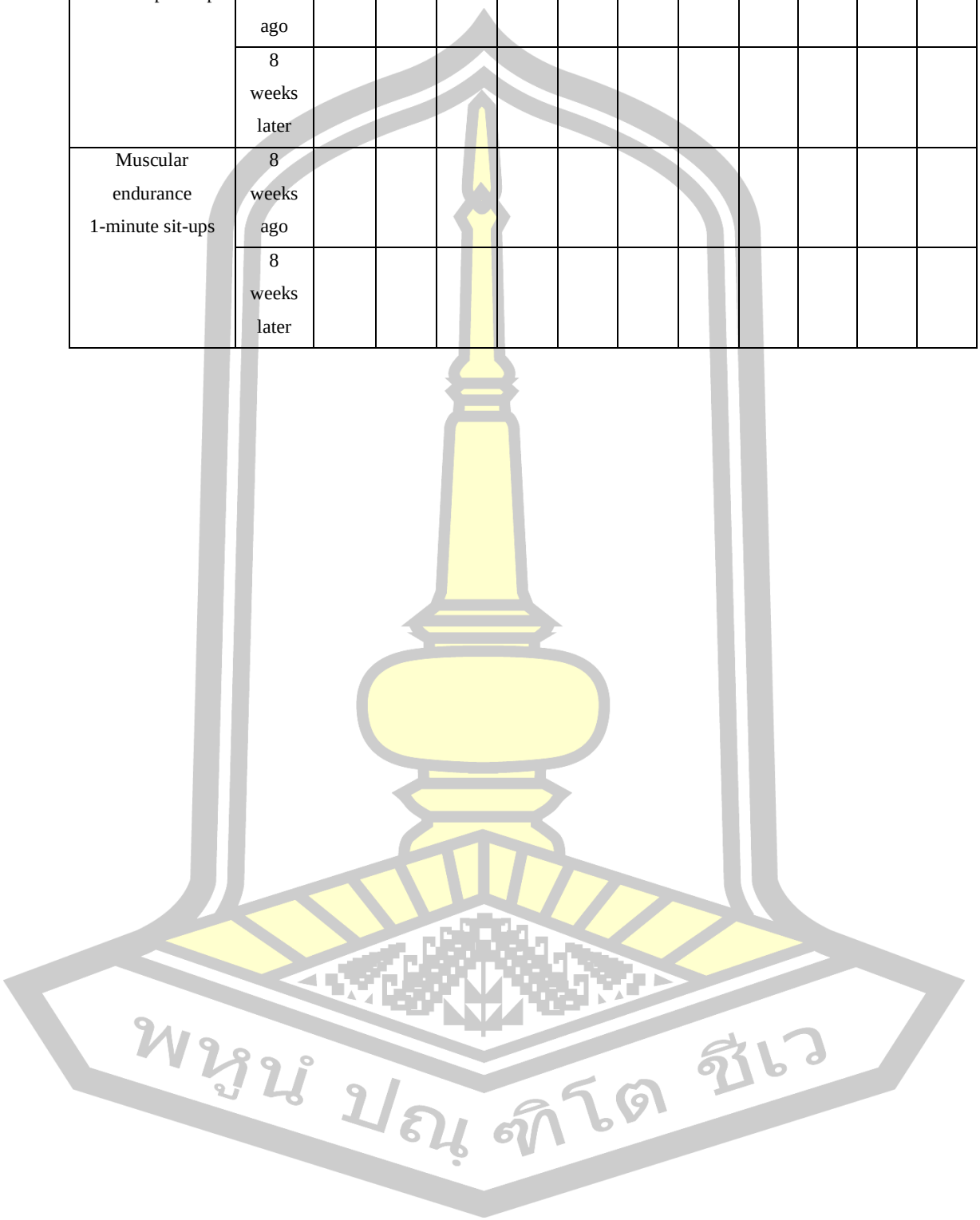


Table 18 Control group before and after record

Control group before and after record table (body composition, cardiorespiratory fitness muscle fitness)												
Student ID Number		A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11
BMI (kg/m2)	8 weeks ago											
	8 weeks later											
WHR	8 weeks ago											
	8 weeks later											
Skeletal muscle weight (kg)	8 weeks ago											
	8 weeks later											
lung capacity (ml)	8 weeks ago											
	8 weeks later											
Cardiorespiratory endurance (s) Men's 1000m, Women's 800m	8 weeks ago											
	8 weeks later											
Power (cm.) Standing long jump	8 weeks ago											
	8 weeks later											

Muscular strength 1-minute push-ups	8 weeks ago											
	8 weeks later											
Muscular endurance 1-minute sit-ups	8 weeks ago											
	8 weeks later											

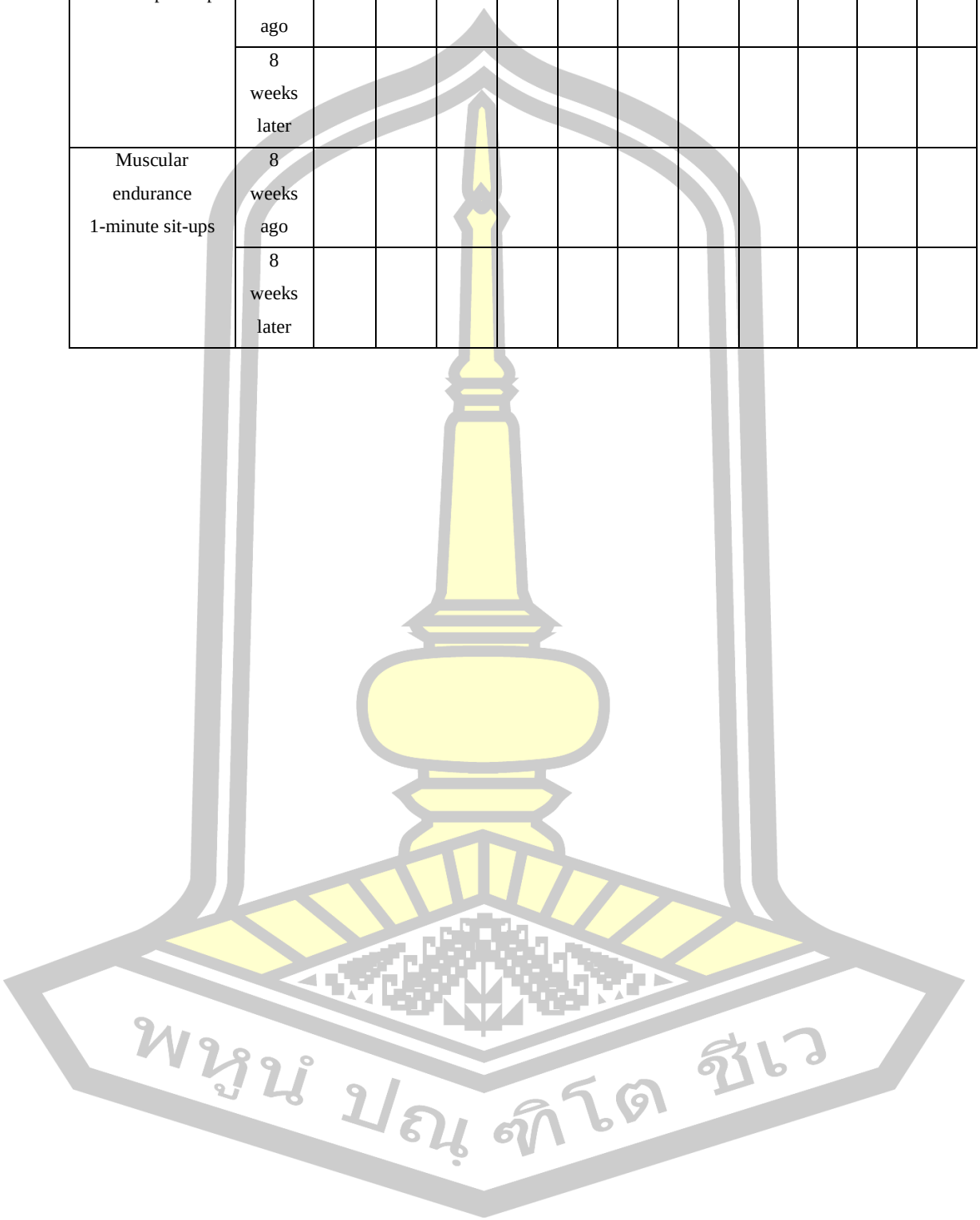


Table 19 Dynamic Warm-Up and Static Cool-Down Training Methods

1-2 weeks of training content Experimental group A high-intensity interval training plan

	Training content＋action illustration	Number of groups	training intensity	training interval
warm up part	Ten-minute Nine-grid warm-up exercise：（Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step）	×	×	×
basic part	Combination 1: Jumping jacks (45 seconds) + small lunges (30 seconds) + abdominal crunches (20 seconds) + hand-to-the-ground jumps (30 seconds) + quick trots on the spot (10 seconds) Combination 1ction illustration：  Jumping jacks (45 seconds)＋small lunges (30 seconds) 	Complete each training movement for 30 seconds, with seven movements forming one set, and complete four sets in total.	Greater than and equal to 80%HRmax	every two groups Complete between closing full interval 90/60 seconds

abdominal crunches (20 seconds)＋hand-to-the-ground jumps (30 seconds)

quick trots on the spot (10 seconds)

Combination 2: High leg raise (30 seconds) + left and right front raise (20 seconds) + Russian twist (30 seconds) + burpee (20 seconds)

Combination 2 ction illustration：

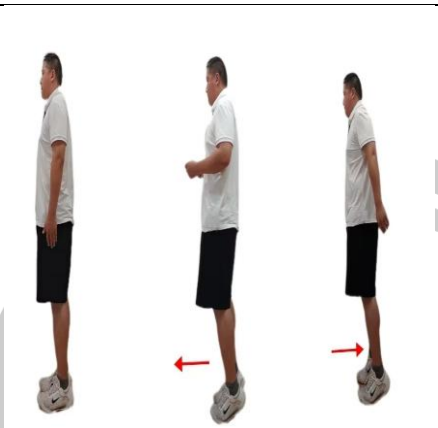
High leg raise (30 seconds) + left and right front raise (20 seconds)

Russian twist (30 seconds) + burpee (20 seconds)

Combination three: Gassho jump (30 seconds) + plank support (60 seconds) + squat jump (20 seconds) + front and back small jumps (20 seconds)

Combination 3 ction illustration：

	  Gassho jump (30 seconds) + plank support (60 seconds) 			

	 squat jump (20 seconds) + front and back small jumps (20 seconds)			
Stretch part	Ten-minute cool-down stretch：Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

1-2 weeks medium continuous training schedule for experimental group B

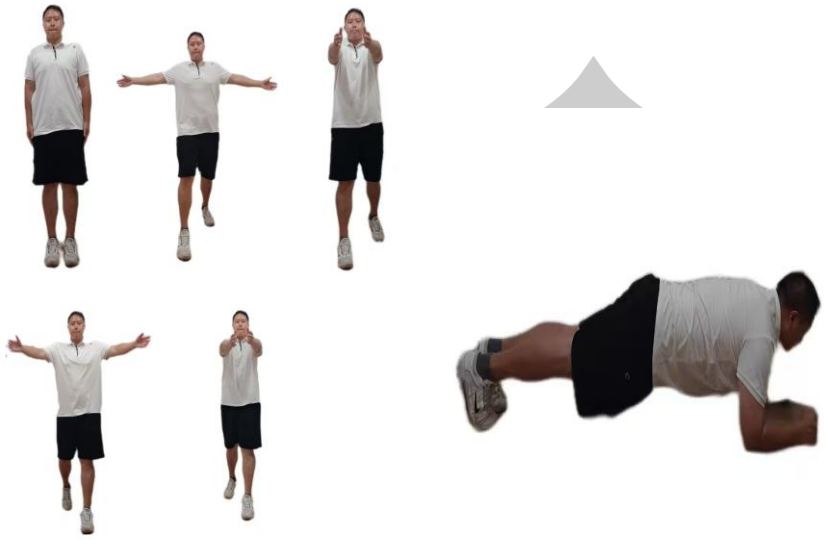
	Training content	Number of groups	training intensity	training interval
warm up part	Ten-minute Nine-grid warm-up exercise：(Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step)		60%～70%HRmax	
basic part	Combination 1: Jumping jacks (30 seconds) + small lunges (20 seconds) + abdominal crunches (10 seconds) + hand-to-the-ground jumps (20 seconds) Combination 1ction illustration：  Jumping jacks (30seconds) ＋small lunges (20 seconds)  abdominal crunches (10 seconds)＋hand-to-the-ground jumps (20 seconds) Combination 2: High leg raise (10 seconds) + left and right front raise (20 seconds) + Russian twist (20 seconds) + burpee (10 seconds) Combination 2 ction illustration：	Complete each training movement for 30 seconds, with seven movements forming one set, and complete five sets in total.		No gap

High leg raise (10 seconds) + left and right front raise (20 seconds)

Russian twist (20 seconds) + burpee (10 seconds)

Combination three: Gassho jump (20 seconds) + plank support (40 seconds) + squat jump (10 seconds) + front and back small jumps (10 seconds)

Combination 3 ction illustration：

	 Gassho jump (20 seconds) + plank support (40 seconds)  squat jump (10 seconds) + front and back small jumps (10 seconds)			
Stretch part	Ten-minute cool-down stretch：Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

3-4 weeks training content Experimental group A high-intensity interval training plan

	Training content	Number of groups	training intensity	training interval
warm up part	Ten-minute Nine-grid warm-up exercise：(Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step)	×	×	×
basic part	Combination 1: Jumping jacks (45 seconds) + jumping lunges (30 seconds) + high-knee high-five jumps (20 seconds) + back cross jumps (30 seconds) + quick trots on the spot (10 seconds) Combination 1ction illustration：  umping jacks (45 seconds) + jumping lunges (30 seconds)  high-knee high-five jumps (20 seconds) + back cross jumps (30 seconds)	complete each training movement for 30 seconds, with seven movements forming one set, and complete four sets in total.	Greater than and equal to 80%HRmax	every two groups Complete between closing full interval 90/60 seconds

quick trots on the spot (10 seconds)

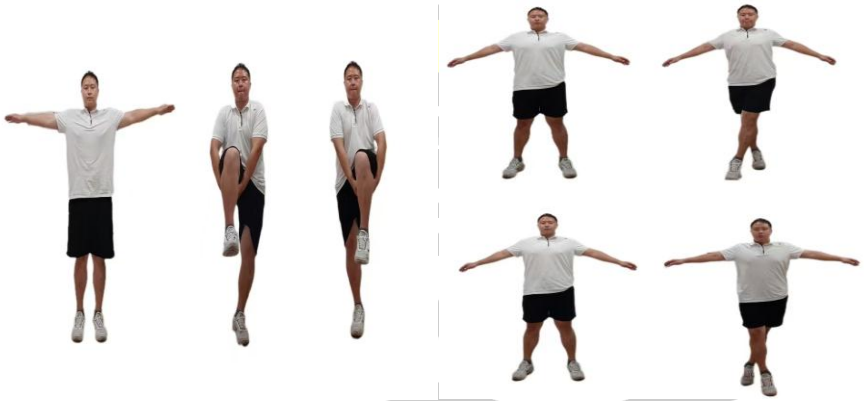
Combination 2: High leg raise (30 seconds) + shuttlecock kicking (20 seconds) + front raise and left and right jumps (30 seconds) + burpee (20 seconds)

Combination 2 ction illustration：

High leg raise (30 seconds) + shuttlecock kicking (20 seconds)

	front raise and left and right jumps (30 seconds) + burpee (20 seconds) Combination 3: Push-ups (30 seconds) + Plank (60 seconds) + Quick mountain climbing (20 seconds) + Small jumps back and forth (20 seconds) Combination 3 ction illustration：  Push-ups (30 seconds) + Plank (60 seconds)  Quick mountain climbing (20 seconds) + Small jumps back and forth (20 seconds)			
Stretch part	Ten-minute cool-down stretch： Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

3-4 weeks training content Experimental group B moderate intensity continuous training plan

<table>
<tr><th></th><th>Training content</th><th>Number of groups</th><th>training intensity</th><th>training interval</th></tr>
<tr><td>warm up part</td><td>Ten-minute Nine-grid warm-up exercise：(Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step)</td><td rowspan="2">Complete each training movement for 30 seconds, with seven movements forming one set, and complete four sets in total.</td><td rowspan="2">60%～70%HR max</td><td rowspan="2">No gap</td></tr>
<tr><td>basic part</td><td>Combination 1: Jumping jacks (30 seconds) + jumping lunges (20 seconds) + high-knee high-five jumps (10 seconds) + back cross jumps (20 seconds) + quick trots on the spot (10 seconds)
Combination 1ction illustration：
 
umping jacks (30seconds) + jumping lunges (20 seconds)
 
high-knee high-five jumps (10 seconds) + back cross jumps (20 seconds)</td></tr>
</table>

quick trots on the spot (10 seconds)

Combination 2: High leg raise (10 seconds) + shuttlecock kicking (20 seconds) + front raise and left and right jumps (20 seconds) + burpee (10 seconds)

Combination 2 ction illustration：

High leg raise (10 seconds) + shuttlecock kicking (20 seconds)

front raise and left and right jumps (20 seconds) + burpee (10 seconds)

	Combination 3: Push-ups (20 seconds) + Plank (40 seconds) + Quick mountain climbing (10 seconds) + Small jumps back and forth (10 seconds) Combination 3 ction illustration：  Push-ups (20 seconds) + Plank (40 seconds)  Quick mountain climbing (10 seconds) + Small jumps back and forth (10 seconds)			
Stretch part	Ten-minute cool-down stretch：Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

High-intensity interval training plan for experimental group A in 5-6 weeks of training

	Training content	Number of groups	training intensity	training interval
warm up part	Ten-minute Nine-grid warm-up exercise：(Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step)	×	×	×

basic part	Combination 1: Knee-raising high-five jump (45 seconds) + squat jump (30 seconds) + jumping jacks (20 seconds) + simplified burpee (30 seconds) + fast trot in place (10 seconds) Combination 1 ction illustration：  Knee-raising high-five jump (45 seconds) + squat jump (30 seconds)  jumping jacks (20 seconds) + simplified burpee (30 seconds)	Complete each training movement for 30 seconds, with seven movements forming one set, and complete four sets in total.	Greater than and equal to 80%HRmax	every two groups Complete between closing full interval 90/60 seconds

fast trot in place (10 seconds)

Combination 2: Jump back and forth, left and right (30 seconds) + jump with body extension for 20 seconds) + jog on the spot (30 seconds) + raise your legs high (20 seconds)

Combination 2 ction illustration：

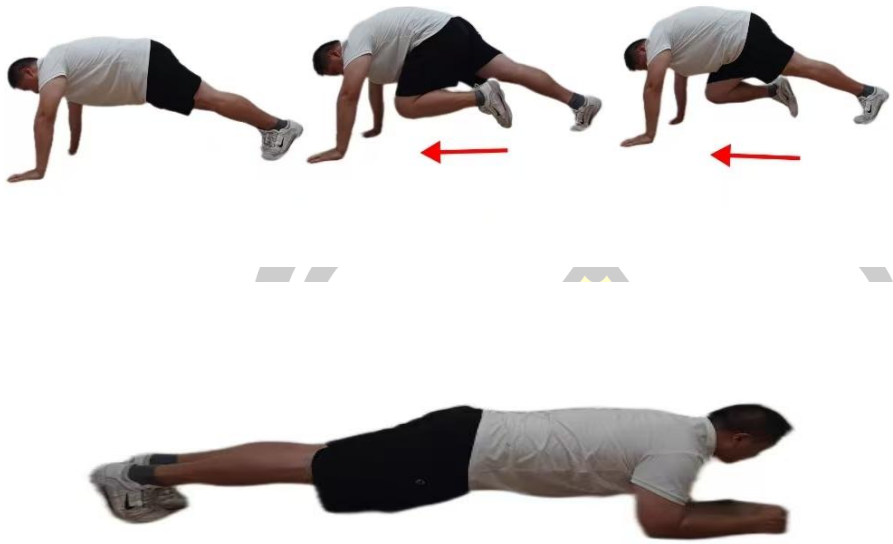
Jump back and forth, left and right (30 seconds) + jump with body extension for 20 seconds)

jog on the spot (30 seconds) + raise your legs high (20 seconds)

Combination 3: Lie on your back and switch legs (30 seconds) + support abdominal jump (60 seconds) + fast mountain climbing (20 seconds) + plank support (20 seconds)

Combination 3 ction illustration：

Lie on your back and switch legs (30 seconds) + support abdominal jump (60 seconds)

	 fast mountain climbing (20 seconds) + plank support (20 seconds)			
Stretch part	Ten-minute cool-down stretch： Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

5-6 weeks training content Experimental group B moderate intensity continuous training plan

<table>
<tr><th></th><th>Training content</th><th>Number of groups</th><th>training intensity</th><th>training interval</th></tr>
<tr><td>warm up part</td><td>Ten-minute Nine-grid warm-up exercise：(Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step)</td><td rowspan="2">Complete each training movement for 30 seconds, with seven movements forming one set, and complete four sets in total.</td><td rowspan="2">60%～70%HRmax</td><td rowspan="2">No gap</td></tr>
<tr><td>basic part</td><td>Combination 1: Knee-raising high-five jump (30 seconds) + squat jump (20 seconds) + jumping jacks (10 seconds) + simplified burpee (20 seconds) + fast trot in place (10 seconds)
Combination 1 ction illustration：
 
Knee-raising high-five jump (30 seconds) + squat jump (20 seconds)</td></tr>
</table>

jumping jacks (10 seconds) + simplified burpee (20 seconds)

fast trot in place (10 seconds)

Combination 2: Jump back and forth, left and right (10 seconds) + jump with body extension for 20 seconds) + jog on the spot (20 seconds) + raise your legs high (10 seconds)

Combination 2 action illustration：

Jump back and forth, left and right (10 seconds) + jump with body extension for 20 seconds)

jog on the spot (20 seconds) + raise your legs high (10 seconds)

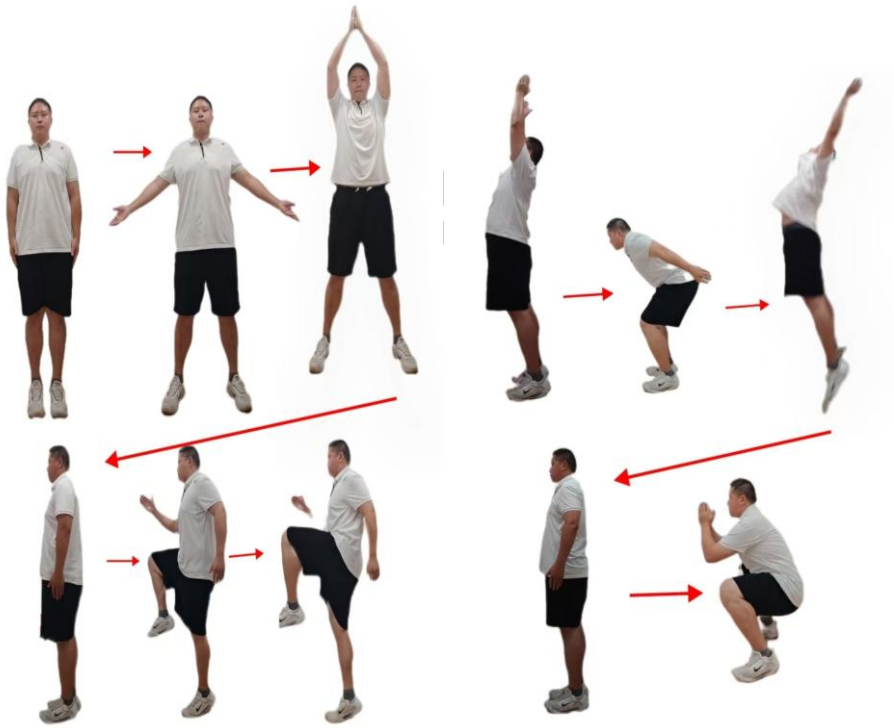
Combination 3: Lie on your back and switch legs (20 seconds) + support abdominal jump (40 seconds) + fast mountain climbing (10 seconds) + plank support (10 seconds)

Combination 3 action illustration：

	      Lie on your back and switch legs (30 seconds) + support abdominal jump (60 seconds)     fast mountain climbing (20 seconds) + plank support (20 seconds)			
Stretch part	Ten-minute cool-down stretch：Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

High-intensity interval training plan for experimental group A in 7-8 weeks of training

	Training content	Number of groups	training intensity	training interval
warm up part	Ten-minute Nine-grid warm-up exercise：(Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step)	×	×	×
basic part	Combination 1: Knee-lift high-five jump (45 seconds) + squat jump (30 seconds) + four jumping jumps and eight high leg raises (60 seconds) + two body extension jumps and squats (20 seconds) + in place Quick trot (10 seconds) Combination 1 ction illustration：  Knee-lift high-five jump (45 seconds) + squat jump (30 seconds)	All three groups are combined into one group, each action is done for 30 seconds, and a total of 2 groups are done	Greater than and equal to 80%HRmax	every two groups Complete between closing full interval 90/60 seconds



four jumping jumps and eight high leg raises (60 seconds) + two body extension jumps and squats (20 seconds)

in place Quick trot (10 seconds)

Combination 2: Combination 2: Squat jump (30 seconds) + Knee push palm jump (20 seconds) + Jogging in place (30 seconds) + high leg raise (20 seconds)

Combination 2 action illustration :

Squat jump (30 seconds) + Knee push palm jump (20 seconds)

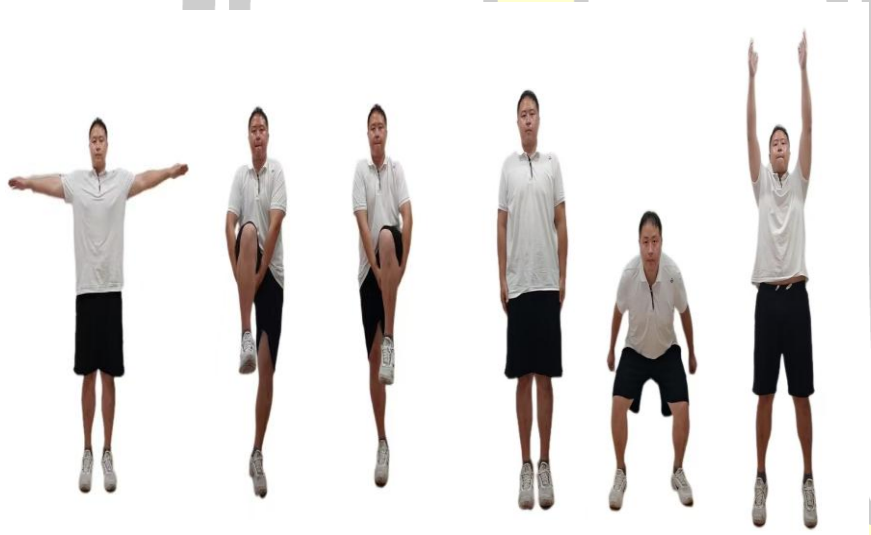
Jogging in place (30 seconds) + high leg raise (20 seconds)

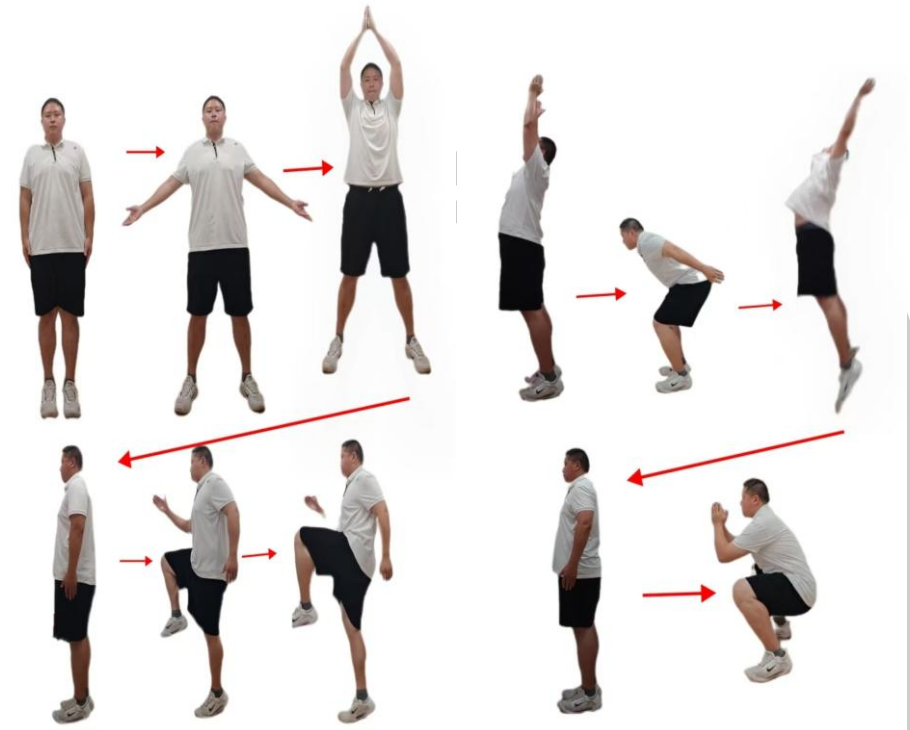
Combination 3: Lie on your back and switch legs (30 seconds) + support abdominal jump (60 seconds) + fast mountain climbing (20 seconds) + plank support (20 seconds)

Combination 3 action illustration :

	  Lie on your back and switch legs (30 seconds) + support abdominal jump (60 seconds)   fast mountain climbing (20 seconds) + plank support (20 seconds)			
Stretch part	Ten-minute cool-down stretch：Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

7-8 weeks training content experiment group B moderate intensity continuous training plan

	Training content	Number of groups	training intensity	training interval
warm up part	Ten-minute Nine-grid warm-up exercise：（Step side by side, shoulder adduction and abduction, Nine-grid left and right points, shoulders adducted and abducted, Left and right point shoulder lift, Nine-grid V-shaped step, Nine-grid left and right turn punch, Nine-grid left and right diagonal step 4 times + jump and kick 4 times, Nine-grid left and right cross step）	All three groups are combined into one group, each action is done for 30 seconds, and a total of 3 groups are done	60%～70%HRmax	No gap
basic part	Combination 1: Knee-lift high-five jump (30 seconds) + squat jump 20seconds) + four jumping jumps and eight high leg raises (30 seconds) + two body extension jumps and squats (30 seconds) + in place Quick trot (20 seconds) Combination 1 ction illustration：  Knee-lift high-five jump (30 seconds) + squat jump (20 seconds)			



four jumping jumps and eight high leg raises (30 seconds) + two body extension jumps and squats (30 seconds)

in place Quick trot (20 seconds)

Combination 2: Combination 2: Squat jump (30 seconds) + Knee push palm jump (20 seconds) + Jogging in place (30 seconds) + high leg raise (20 seconds)

Combination 2 action illustration :

Squat jump (30 seconds) + Knee push palm jump (20 seconds)

Jogging in place (30 seconds) + high leg raise (20 seconds)

Combination 3: Lie on your back and switch legs (30 seconds) + support abdominal jump (60 seconds) + fast mountain climbing (20 seconds) + plank support (20 seconds)

Combination 3 action illustration :

	  Lie on your back and switch legs (30 seconds) + support abdominal jump (60 seconds)   fast mountain climbing (20 seconds) + plank support (20 seconds)			
Stretch part	Ten-minute cool-down stretch：Rear deltoid stretch＋Single-arm triceps stretch＋Stretch your waist with your hands＋Piriformis standing stretch＋Standing stretch for the front of the thigh＋Standing hamstring stretch Allow for a 10-minute cooling down period			

Appendix D

Experimental process photos

Figure 2 Experimental process photos 1

Figure 3 Experimental process photos 2

Figure 4 Experimental process photos 3

Figure 5 Experimental process photos 4

Figure 6 Experimental process photos 5

Figure 7 Experimental process photos 6

BIOGRAPHY

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DATE OF BIRTH	25 February, 1991
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ADDRESS	No. 1 Douyawan, Ziliujing District, Zigong City, China
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