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EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING ON BODY COMPOSITION AND PHYSICAL FITNESS IN UNIVERSITY STUDENTS LIVING WITH OBESITY

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Abstract: This present study explored the effects of a twelve-week body-weight-based high-intensity interval training (HIIT) program on body composition and physical fitness in obese university students. Methods: Sixty-one participants completed a total of 36 sessions of weight management classes over twelve weeks. Each intervention session included 40 seconds of 14 sets of high-intensity exercises at 85%-90% of Hrmax (such as burpees, mountain climbers, etc.), with 20 seconds of recovery in between. Body composition, Cooper 12-minute run , 50-meter sprint, and standing long jump were measured before and after the intervention. Results: Participants showed significant reductions in weight, BMI, and TBF% after the intervention, with statistical significance ($p < 0.05$). Besides, participants showed significant improvements in the Cooper 12-minute run and 50-meter sprint. However, there was no significant change in the standing long jump performance ($p > 0.05$), suggesting that the impact of HIIT on lower body power may be limited. Conclusion: High-intensity interval training (HIIT) shows positive effects on body composition and physical fitness in obese university students, demonstrating its potential application as a university physical education program.
Keywords: Body-weight based HIIT; Intervention; Obesity; Physical fitness; Young adult

1 INTRODUCTION

Obesity is a growing global issue, particularly among young people, and has become a significant factor affecting health and quality of life. University students are in the early stages of adulthood, and lifestyle changes during this period have important implications for long-term health [1]. Hence, effective interventions for obese university students, especially in weight management and physical fitness improvement, are crucial. In recent years, high-intensity interval training (HIIT) has gained considerable attention as an effective strategy for weight management, largely due to its time efficiency and its benefits in improving metabolic health [2].

HIIT combines short bouts of high-intensity exercise with intervals of recovery and can achieve high energy expenditure in a short period, showing significant effects in weight control and cardiovascular health improvement. Previous studies have shown that HIIT can not only effectively reduce body fat but also enhance cardiorespiratory fitness and improve metabolic health, particularly in obese and overweight populations [3]. Also, HIIT can further enhance its weight management effects by increasing insulin sensitivity and basal metabolic rate [4].

Body-weight-based HIIT, in particular, is suitable for promotion in university physical education programs as it does not rely on special equipment and is more flexible and adaptable to different settings and student fitness levels. This training format not only has all the advantages of HIIT but also reduces psychological stress during training and lowers the risk of injury [5].

Further studies are necessary to explore the long-term application of HIIT as an intervention for obese university students in university physical education courses, despite extensive research on its effects on weight management. Furthermore, personalized HIIT program designs tailored to different fitness levels and individual differences are also urgently needed. Therefore, this study aims to evaluate the effects of a twelve-week body-weight-based HIIT program on body composition and physical fitness in obese university students, providing scientific evidence for obesity management in university physical education.

2 MATERIALS AND METHODS

2.1 Participants

Participants of this study who volunteered to attend the weight management course were recruited from a local university. Inclusion criteria were as follows: 1) Age 18-23 years old; 2) Body fat percentage $\geqslant$ 30%; 3) A sedentary lifestyle: no regular exercise and a sedentary time of more than 8 hours a day; 4) Self-reported weight has been stable within ±2kg for the past 3 months; 5) All questions on the physical activity readiness questionnaire are answered negatively. After fully understanding the purpose and requirements of this study, the participants signed a written informed consent.

2.2 Study Procedure

After screening, 61 eligible participants were included in this weight management course. Each participant completed a twelve-week exercise intervention course and received testing before and after the training intervention, including height, weight, body fat percentage, and physical fitness testing; All assessments, except for body composition, are scheduled for the afternoon. Participants are required to complete three times a week for a total of 36 training sessions during the twelve-week intervention program.

2.3 Testing Protocol

Before pre-intervention assessments, the subjects were invited to the laboratory to familiarize themselves with all testing and training procedures and to sign the written informed consent. The baseline assessments were completed in three days, with a minimum interval of 24 hours between each test. All tests are completed at least 72 hours before the training course begins. The test contents are as follows.

2.3.1 Measurement of body composition

On the day of body composition measurement, subjects were required to come to the laboratory in the early morning and ensure that they had fasted for at least 12 hours before the test and did not engage in strenuous exercise for 48 hours. When measuring height and weight, the subjects wore light clothes with no footwear and were measured using a standard method with a stadiometer (accurate to 0.1 cm) and an electronic scale (accurate to 0.1 kg). The calculation of body mass index is to divide the weight in kilograms by the square of the height in meters. The same operator used bioelectrical impedance analysis technology (Tanita MC-980 PLUS MA, Tokyo, Japan)to measure the body fat percentage of the subjects. Before the measurement, the palms and soles of the feet were kept dry, and the torso was kept upright during the measurement, with an angle of 15 degrees between the upper limbs and the torso.

2.3.2 Physical fitness test

Standing Long Jump In the standing long jump, participants should begin with their feet naturally shoulder-width apart, knees bent, and arms swinging to generate momentum. During take-off, both feet must push off the ground simultaneously to maximize horizontal distance. The jump distance is measured from the take-off line to the heel of the farthest landing point. Each participant is allowed two attempts, with the best result recorded to the nearest 0.1 cm.

50-meter sprint The 50-meter sprint is conducted on the straight segment of a standard 400-meter track. Participants begin from a stationary position behind the starting line and sprint towards the finish line at maximum effort when they hear the starting signal. Timing is recorded from the start signal until the moment the participant crosses the finish line. Each participant is allowed two attempts, with the best result recorded to the nearest 0.1 second.

Cooper test: The Cooper 12-minute run test is conducted on a 400-meter standard track. During the test, the subject tried to cover as much distance as possible within the specified time. At the end of 12 minutes, the tester immediately recorded the total distance meters the subject had run. Based on the recorded distance, evaluate their aerobic endurance level.

2.3.3 Exercise training

HIIT sessions utilized body-weight-based exercises, accompanied by music rhythms. Each training session consisted of two cycles, each containing seven movements. Each exercise was performed at 85%–90% HRmax for 40 seconds at high intensity, followed by a 20-second recovery period. After completing a full cycle, repeat the cycle. During the training process, the Polar HR (Polar Team Pro, Finland) was used to monitor the heart rate to ensure the safety and effectiveness of the training. The training course standardized the warmup and cooldown, with a 10-minute warmup and a 5-minute cooldown. Throughout the course, participants are free to drink water if they need to.

2.4 Statistical Analysis

The data were presented as mean ± standard deviation and analyzed using SPSS 26.0 (Chicago, IL, USA). The normality of the data was assessed using the Shapiro-Wilk test. Paired *t*-tests were used to compare the results before and after the intervention. The level of significance for all statistical tests was set at $p < 0.05$.

3 RESULTS

3.1 Participants

In this study there were a total of 61 participants, including 27 females and 34 males. Baseline data prior to the intervention showed that the average weight for females was 81.0 ± 12.2 kg and for males was 96.1 ± 19.1 kg, with corresponding body mass index (BMI) of 28.4 ± 4.8 kg/m² and 33.9 ± 7.1 kg/m2, respectively. The overall TBF (%) was 40.2 ± 9.6 for females and was 35.6 ± 9.1 for males (Table 1).

Table 1 Characteristics of the participants

	Females(n = 27)	Males(n = 34)
Age(years)	19.5±0.9	19.4±0.7
Height(cm)	169.2±8.8	168.6±8.3

Body mass(kg)	81.0±12.2	96.1±19.1
BMI(kg/m^2)	28.4±4.8	33.9±7.1
TBF(%)	40.2±9.6	35.6±9.1

Observed values are expressed as means ± standard deviation. BMI: body mass index, TBF(%): total body fat percentage.

3.2 Body Composition and Physical Fitness

Throughout the intervention period, HR and RPE were continuously monitored during each training session. All participants completed 14 sets of 40-second bodyweight-based HIIT exercises at 85%-90% HRmax, with 20 seconds of recovery between sets. The outcomes for body mass, BMI, TBF%, standing long jump, 50-meter sprint, and the Cooper 12-minute run, both before and after the intervention, are presented in Table 2.

After twelve weeks of high-intensity interval training (HIIT), participants showed improvement in body composition and physical fitness. Overall, there was a significant decrease in body mass ($p < 0.05$), and BMI also significantly decreased ($p < 0.05$). Although the reduction in TBF% was small, it still showed significant changes ($p < 0.05$).

The physical fitness tests revealed significant improvements in some fitness indicators. Particularly, the Cooper 12-minute run and 50-meter sprint were improved significantly ($p < 0.001$). However, there was no significant change in the standing long jump ($p > 0.05$). The specific percentage of change is displayed in Table 2.

Table 2 Outcomes before and after twelve weeks of HIIT

	Pre	Post	*p*
Body composition			
Body mass(kg)	89.4±17.9	87.2±16.9	0.002
BMI(kg/m^2)	31.5±6.7	30.6±6.1	0.002
TBF(%)	37.6±9.5	37.1±9.1	0.018
Physical fitness			
Standing long jump(cm)	174.3±30.9	175.4±30.1	0.560
50 m sprint(s)	11.1±1.7	9.1±1.4	<0.001
Cooper 12-minute run(m)	1523.8±242.2	1615.2±321.3	<0.001

Observed values are expressed as means ± standard deviation. BMI: body mass index, TBF(%): total body fat percentage.

4 DISCUSSION

The results of this study indicate that obese young adults achieved significant improvements in weight, BMI, TBF%, and certain physical fitness tests (such as the 50-meter sprint and Cooper 12-minute run) after a twelve-week body-weight-based HIIT intervention. The implementation of body-weight-based HIIT in university physical education programs, particularly for obese populations, demonstrates multiple advantages, including clear positive effects on weight management and significant importance for fitness improvement.

Firstly, the significant decrease in body mass and BMI is consistent with the conclusions of existing studies. Some studies in recent years have shown that HIIT has obvious advantages in weight control, especially in obese and overweight people. This may be related to the high-intensity nature of HIIT, which can significantly increase energy expenditure in a short period of time and also continuously increase metabolic rate after training [6]. In addition, HIIT can further support effective weight management by improving insulin sensitivity and increasing basal metabolic rate [7]. Although the reduction in total body fat in this study was relatively small, this change was statistically significant, suggesting that HIIT may affect TBF% by adjusting body fat distribution or increasing lean body mass. Previous studies have also shown that HIIT can help reduce visceral fat and thereby reduce cardiovascular risk.

Secondly, in terms of physical fitness improvement, the significant improvements in the 50-meter sprint and Cooper 12-minute run results further demonstrate the effectiveness of body-weight-based HIIT. Not only does the improvement in physical fitness show up in aerobic capacity, but it also significantly enhances anaerobic exercise performance, a crucial factor in the daily activity capacity of obese students [5]. As a high-intensity interval training mode, HIIT can comprehensively exercise various major muscle groups of the body through diverse self-weight movements such as jumping jacks, high-stepping, and burpees, thereby improving power and speed. In this study, the significant improvement in the 50-meter sprint performance reflects the enhancement of speed and agility of obese individuals; moreover, the improvement in the Cooper 12-minute run demonstrates the enhancement of aerobic capacity [5, 8].

However, the intervention did not significantly increase the standing long jump performance, possibly because body-weight-based HIIT training primarily focuses on improving overall aerobic and anaerobic endurance, with less direct impact on lower extremity muscular strength. Nevertheless, body-weight-based HIIT still has significant

advantages in university physical education courses, as it does not require special equipment, making it simple to implement in various settings and suitable for students of different physical abilities. For obese students, this equipment-free training method not only reduces psychological stress but also reduces the risk of injury during the training session. Body-weight-based HIIT, based on a combination of music and rhythm, further enhances the fun and interactivity of training, increasing students' adherence and enjoyment of regular exercise.

5 LIMITATION

The results of this study further verify the effectiveness of body-weight-based HIIT as a weight management and physical fitness improvement strategy for obese university students. However, there are still some limitations. Firstly, the sample size of this study is relatively small, and the research subjects are limited to a specific group of university students. Hence, it should be cautious when promoting and applying this to a broader population. Furthermore, the intervention period in this study was twelve weeks, and the long-term effects of body-weight-based HIIT could not be assessed. Future research should expand the sample size and include participants of different ages, genders, and health statuses to improve the universality and extrapolation of research results. Meanwhile, future research should also focus on changes in other physical fitness indicators, such as muscular strength and flexibility, and explore how to optimize this training regimen in the curriculum so that body-weight-based HIIT can better meet the needs of different groups, ensuring that they can obtain the best benefits from training.

6 CONCLUSION

In conclusion, young obese adults showed significant improvements in weight, BMI, body fat percentage, and certain physical fitness indicators after a twelve-week body-weight-based HIIT intervention program, demonstrating this program's positive impact on improving the physical fitness of obese university students and its potential as a type of physical education course in universities.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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