Comparative effects of 8-week exercise programs on fat reduction in female college students

Efectos comparativos de programas de ejercicio de ocho semanas sobre la reducción de grasa en estudiantes universitarias

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Abstract

Introduction: The number of overweight college students is increasing. Moderate aerobic exercise is commonly recommended to reduce obesity and improve body composition.
Objective: To compare the effects of two 8-week exercise programs on body fat reduction in female college students.
Methodology: Twenty-eight female students were randomly assigned to a resistance-plus-aerobic group (ST, n=14) or an aerobic-only group (AT, n=14). Both groups trained three times per week for 60 minutes at moderate intensity (heart rate 110 – 130 bpm). ST performed 30 minutes of resistance band training and 30 minutes of aerobic exercise; AT did 60 minutes of running.
Results: Both groups significantly reduced body weight, fat mass, fat percentage, and WHR ($p<0.001$), with the ST group showing better results. Lean body mass, TC, and HDL did not change significantly ($p>0.05$). LDL slightly decreased ($p=0.088$), while TG increased ($p<0.05$). Leptin levels dropped significantly in both groups ($p<0.05$), with no difference between them.
Conclusions: Both programs effectively reduced body fat and serum leptin. However, the ST program was more effective than the AT program in improving overall body composition, except for leptin reduction.

Keywords

Elastic bands; obesity; body fat; female college students.

Resumen

Introducción: El número de estudiantes universitarios con sobrepeso está aumentando. El ejercicio aeróbico moderado se recomienda comúnmente para reducir la obesidad y mejorar la composición corporal.
Objetivo: Comparar los efectos de dos programas de ejercicio de 8 semanas sobre la reducción de grasa corporal en estudiantes universitarias.
Metodología: Veintiocho estudiantes mujeres fueron asignadas aleatoriamente a un grupo de resistencia más ejercicios aeróbicos (ST, n=14) o a un grupo de solo ejercicios aeróbicos (AT, n=14). Ambos grupos entrenaron tres veces por semana durante 60 minutos a intensidad moderada (frecuencia cardíaca 110-130 lpm). ST realizó 30 minutos de entrenamiento con bandas de resistencia y 30 minutos de ejercicio aeróbico; AT hizo 60 minutos de carrera.
Resultados: Ambos grupos redujeron significativamente el peso corporal, la masa grasa, el porcentaje de grasa y el RCC ($p < 0,001$), siendo el grupo ST el que mostró mejores resultados. La masa corporal magra, el CT y el HDL no cambiaron significativamente ($p>0,05$). El LDL disminuyó levemente ($p=0,088$), mientras que el TG aumentó ($p<0,05$). Los niveles de leptina disminuyeron significativamente en ambos grupos ($p<0,05$), sin diferencias entre ellos.
Conclusiones: Ambos programas redujeron eficazmente la grasa corporal y la leptina sérica. Sin embargo, el programa ST fue más eficaz que el programa AT para mejorar la composición corporal general, excepto en la reducción de leptina.

Palabras clave

Bandas elásticas; obesidad; grasa corporal; estudiantes universitarias.

Introduction

Obesity, a critical global health issue, greatly raises the risk of cardiovascular disease (CVD) (Powell-Wiley et al., 2021), the primary cause of death and illness among obese individuals. Dyslipidemia plays a central role in the pathogenesis of obesity-related CVD (Hedayatnia et al., 2020). Reduced insulin sensitivity and high insulin levels, combined with increased pro-inflammatory adipokines and decreased anti-inflammatory adipokines, lead to chronic low-grade inflammation. This inflammation is a typical metabolic issue in obesity, potentially resulting in dyslipidemia (Vekic et al., 2019; Zatterale et al., 2020). Obesity is closely linked to leptin resistance, a concept well-documented since 2000 (Aizawa-Abe et al., 2000). Leptin levels, which correlate with fat mass, play a key role in signaling energy balance (Elias & Purohit, 2013). Obese individuals typically exhibit high leptin levels (hyperleptinemia) while maintaining a normal resting energy expenditure (REE). In contrast, individuals with a normal weight have normal REE but lower leptin levels (Lustig et al., 2004). When leptin levels decrease, it signals an energy deficiency, triggering counter-regulatory responses such as a reduction in REE (Elias & Purohit, 2013). Therefore, obesity is acknowledged as a persistent medical condition, highlighting the pivotal role of dyslipidemia management as a fundamental aspect of treatment, and leptin plays an important role in fat metabolism and body weight regulation.

Lifestyle interventions aimed at facilitating body fat loss encompass exercise programs, dietary changes, or a combination of both, constituting primary modalities for addressing obesity and its associated comorbidities (Khalafi et al., 2023). Some scholars suggest that, at the same exercise intensity, combining resistance training with aerobic exercise burns more energy and reduces more fat compared to aerobic exercise alone, effectively preventing and treating dyslipidemia (Pranoto et al., 2024; Oh & Lee, 2023). Resistance training typically takes place in fitness centers with machines and free weights. However, there is a need for approaches that can be easily integrated into daily life, as access to traditional training facilities may be restricted due to availability, experience, and cost issues, especially for younger individuals (Aerenhouts & D'Hondt, 2020). One viable option is to offer strength training regimens that use affordable, readily available equipment like elastic bands (EBs). EBs are versatile tools for both strength and multicomponent training, capable of providing similar resistance as conventional gym equipment (Babiloni-Lopez et al., 2022). Training with EBs has demonstrated beneficial effects on anthropometry measurements, physical fitness, body composition, and general health in diverse populations (Flandez et al., 2020). Nevertheless, research on such training programs has mostly targeted older adults, examining aspects like body composition, physical performance, and muscular strength, with inconsistent results (Bårdstu et al., 2020; Campa et al., 2021). There is a notable lack of studies investigating the effects of EBs and dietary interventions on body fat reduction in female college students. Furthermore, there is no clear consensus on the most effective approach for reducing body fat at a similar intensity level, which represents a significant research gap.

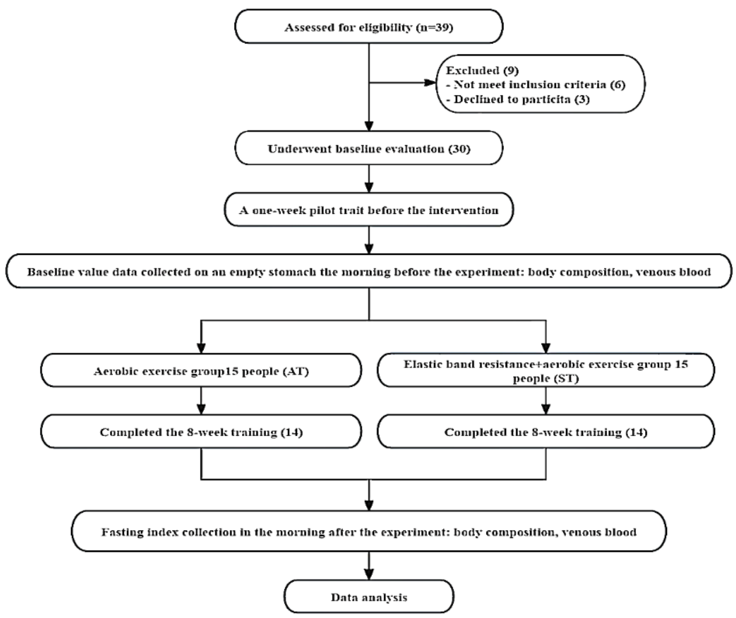
Research on exercise physiology has traditionally focused on male participants, often overlooking sex differences. Although females remain underrepresented in this field, studies have highlighted distinct physiological and molecular adaptations to exercise between sexes (Hagstrom et al., 2021; Bhargava et al., 2021). These variations encompass musculoskeletal, cardiovascular, metabolic, and molecular characteristics, influenced by factors such as sex chromosomes, hormones, and the epigenome (Landen et al., 2019). Generally, males possess greater lean mass, lower fat mass, and a higher proportion of fast-twitch muscle fibers in certain muscle groups (Carter et al., 2001). They also tend to rely more on carbohydrates and proteins for energy during exercise, whereas females predominantly utilize fats (Tarnopolsky, 2008). Given these differences, future studies should incorporate female participants to provide a more comprehensive understanding of sex-specific exercise responses (Arnegard et al., 2020). Thus, this research comprised the divided 28 female college students into two groups. One group engaged in a EBs resistance combined with the aerobic exercise group (ST) while the other participated in an aerobic exercise group (AT). Both groups underwent an 8-week exercise intervention. This study focused on comparing the outcomes of two distinct exercise programs in terms of body fat reduction among female college students. This study aimed to highlight the strengths and weaknesses of each exercise regimen, with the objective of determining the most suitable program and providing evidence-based guidance for future fat reduction interventions.

Method

Participants

The sample size was calculated with the use of G-power3.1 software (Version 3.1 for Windows, Franz Faul, Germany). The test power was set as 0.80 (β = 0.20), and the alpha error rate was set as 0.05. The reduction of body fat percentage was a main research indicator of this study. Based on the meta-analysis of the effect of exercise intervention on body fat percentage in previous study (Batacan et al., 2017), the correlation between before and after intervention was 0.80, and the effect size was 0.32. It was calculated that the required sample size for each group should be 12. To account for sample attrition, this was expanded to about 15 individuals per group. A total of 39 female college students were initially recruited. Nine participants were excluded because they did not meet the experimental requirements, and 2 participants dropped out before completing the study, resulting in a final sample of 28 participants divided equally into two groups of 14 participants each. Written informed consent was obtained from each subject. Inclusion criteria: (1) Age of 18-25 years old, female college students; (2) Willing to participate in the study and provided written informed consent. Exclusion criteria: (1) patients with serious organic diseases such as heart, brain, lung, kidney and motor system; (2) patients with chronic diseases and taking medication; (3) those with a history of mental illness; (4) unable to complete follow-up or poor compliance; (5) those unwilling to sign the informed consent form. Those who meet the eligibility criteria will participate in a one-week pilot test. Individuals who meet the stipulated conditions will proceed to have their body composition assessed and venous blood drawn, while those who do not meet the criteria will be excluded from the study. The study was approved by the Human Research Ethics Committee of Central China Normal University.

Fig. 1. Schematic representation of the experimental procedure



Study design

This study followed a randomized parallel-group trial with a single-blind design. Randomization was conducted using opaque, sealed envelopes (A for AT; B for ST), prepared by independent staff uninvolved in recruitment. Each participant drew an envelope, and their identification was recorded accordingly. While participants were blinded to their assignment, all outcome measurements were conducted by the same investigator. Before the intervention, participants underwent initial screening, blood sample collection, and body composition assessments. They then completed their assigned 8-week training protocol (AT or ST), exercising three times per week. After the intervention, all pre-exercise tests were repeated in the same order (Figure 1).

The daily energy intake was around 1200-1500 kcal/day, as indicated in the study by ElSayed et al. (2023). This intake was distributed across approximately three meals. At the beginning of the experiment, all participants will be explained the principle of dietary nutrition, the proportion of meals, and the calorie calculation method of each food. In addition, all employees are required to report their daily food intake in the We Chat group, encouraging adherence to healthy eating habits, and make regular checks and inquiries. Basic sports knowledge will be explained before exercise, and all subjects will be guaranteed not to participate in other sports activities except daily class activities during the experiment, to ensure the effectiveness of energy consumption.

Exercise intervention

The intervention lasted 70 minutes per session for both groups. This included a 10-minute warm-up and cool-down and 60 minutes of main exercise. These sessions were conducted three times a week, at the same time for both groups but in separate locations, over a span of 8 weeks. The exercise intensity was maintained at a moderate level, with heart rates controlled between 110 and 130 beats per minute using Bluetooth heart rate monitors. The exercise program was developed based on American College of Sports Medicine [ACSM] (ACSM, 2018). In the ST group, participants engaged in 30 minutes of elastic band resistance training, targeting major muscle groups across the body. This involved five different exercises, each performed in four sets of 10-15 repetitions, with a 1 minute rest between sets (Table 1). Following the EBs training, participants completed 30 minutes of continuous running on a track. The AT group performed 60 minutes of continuous running on a track. After each exercise session, both groups participated in 5 minutes of passive stretching and relaxation exercises with partners, using tools like foam rollers to assist in muscle relaxation. The study was conducted in a gymnasium.

The initial intensity level was determined by assessing each participant's perceived exertion (RPE) score during the EBs. This assessment identified their moderate intensity level, as all participants reported an RPE between 10 and 15 when using the red elastic band. Therefore, the red elastic band was designated as the starting level of moderate strength. During the 8-week period, the intensity of exercise was performed in the following manner: during the first 2 weeks, 10 repetitions were performed per session using a red EB; Over the next 3 weeks, the number of repetitions was increased to 15 per session, still using the red EB; During the last 3 weeks, participants performed 15 repetitions per session using a green EB, which represents higher intensity (Choi et al., 2020). During each session, an instructor demonstrated the exercises while two assistants helped ensure proper technique. Participants were encouraged to memorize the movements. The elastic band (KDDST, Zhejiang, China) was 30 cm long and had a resistance of 5 kg for the red band and 7 kg for the green band when fully stretched.

Experimental observation indexes and methods

Before the test, the subjects did not exercise for 48 hours and were fasted for 12 hours. Following the 8-week exercise training program, participants completed the same assessments as they did prior to the intervention, following the same procedures. To avoid the acute effects of exercise impacting the post-training results, these assessments were carried out 72 hours after the last training session.

Body composition was measured using the portable InBody 270 Body Composition Analyzer. This bioelectrical impedance device uses a low electrical current (50 kHz) and operates like a bathroom scale, making it easy to use and battery-powered. It is a reliable and valid method for assessing body composition.

Blood index detection: Total triglyceride (TG), Total cholesterol (TC), High-density lipoprotein cholesterol (HDL-C), Low-density lipoprotein cholesterol (LDL-C) and Serum leptin. Detection methods: TG was measured using the acetylacetone micro method, TC was determined by enzymatic reaction, LDL-C was assessed using the polyvinyl sulfate precipitation method, HDL-C was measured using the phosphotungstic acid magnesium method, and Serum leptin concentrations were determined by enzyme-linked immunosorbent assay (ELISA).

Table 1. Exercise programs with EBs

Day	Exercises	Sets, Repetitions, and Rest
Monday	The workout consists of Push-ups, Kneeling Push-ups, Horizontal Press, Front Raise, Lateral Raise, Overhead Press, and V-ups, focusing on the chest, shoulders, and rectus abdominis.	3-4 sets, 65%-75% 1RM (10-15 reps), 60s rest for large

Wednesday	The workout consists of Bodyweight Squats, Lunge Squats, Prone Leg Curl, Standing Calf Raise, Side-Lying Oblique Crunch, and Supine Diagonal Crunch, focusing on the quadriceps, calves, and core.	muscle groups, 40s rest for small muscle groups
Friday	The workout consists of Seated/Bent-over Rows, Overhead Triceps Extension, Narrow-Grip Push-ups, Standing Bicep Curl, and Crunches, focusing on the back, arms, and abdominals.	

Data analysis

The data were subjected to analysis using the statistical software package SPSS version 25. The Shapiro-Wilk test was employed to assess the normality of the data. A two-way repeated measures ANOVA was employed to assess the differences between the groups over time, with time designated as the within-subject factor and training type as the between-subject factor. Post hoc comparisons were conducted using the Bonferroni test. Pearson correlation coefficients were calculated in order to investigate the relationships between different body composition measures. The threshold for statistical significance was set at $p < 0.05$, and the results are presented as mean ± standard deviation.

Results

To compare the differences between the ST and AT in the pre and post-test indexes, the pretest indexes and post-test indexes of the subjects were taken as the intra-group variables, and the group as the grouping variables, repeated measurement analysis of variance was conducted. The results found that:

Table 2. Mean ± SD values of body composition, lipid profile, and leptin for two groups

Characteristic	AT(n=14)		ST (N=14)		Group X Time Interaction
	Pre	Post	Pre	Post	
Body weight (kg)	53.74±4.87	53.30±4.53	56.45±7.94	54.55±7.19[a]	7.64 <0.01
WHR (cm)	0.80±0.06	0.79±0.05	0.84±0.09	0.79±0.08[a]	18.06 <0.001
Body fat (%)	27.69±2.82	27.36±2.47	28.80±3.91	26.53±4.49[a]	14.70 <0.001
Body fat (kg)	14.94±2.53	14.64±2.29	16.46±4.23	14.64±3.99[a]	18.63 <0.001
Lean body mass (kg)	21.03±3.62	21.49±4.45	21.36±2.50	22.12±2.30	0.14 0.71
TC (mmol/L)	4.18±0.62	4.23±0.47	4.41±0.88	4.68±0.93	0.98 0.33
TG (mmol/L)	0.74±0.21	0.90±0.30	0.76±0.29	0.83±0.29	0.88 0.36
HDL-C (mmol/L)	1.77±0.30	1.72±0.28	1.67±0.49	1.75±0.55	0.53 0.47
LDL-C (mmol/L)	2.11±0.46	1.96±0.32	2.38±0.59	2.32±0.48	0.67 0.42
Leptin (mmol/L)	5.64±3.00	4.29±3.42	5.89±2.35	5.24±2.94	0.80 0.38

AT, aerobic exercise; ST, EBs resistance combined with the aerobic exercise.
a Indicates significant differences compared to the Pre-values ($p<0.001$).

In this study, significant effects of time were observed across various metrics. Body fat showed a notable reduction from pretest to post-test ($F = 36.12$, $p < 0.001$), with a significant interaction between time and group ($F = 18.63$, $p < 0.001$); specifically, the ST group exhibited a significant decrease ($F = 53.32$, $p < 0.001$) while the AT group did not. Body fat percentage similarly decreased over time ($F = 26.31$, $p < 0.001$), with a significant interaction ($F = 14.70$, $p < 0.001$), and a significant reduction in the ST group ($F = 40.17$, $p < 0.001$) but not in the AT group. WHR also showed a significant time effect ($F = 40.64$, $p < 0.001$) and interaction ($F = 18.06$, $p < 0.001$), with a significant decrease in the ST group ($F = 56.45$, $p < 0.001$) but not in the AT group. Finally, weight decreased significantly over time ($F = 19.43$, $p < 0.001$) with a significant interaction ($F = 7.64$, $p < 0.01$), with a significant reduction in the ST group ($F = 25.71$, $p < 0.001$) but not in the AT group.

Lean body mass showed no significant changes over time ($F = 2.34$, $p = 0.14$), by group ($F = 0.16$, $p = 0.69$), or in the interaction between time and group ($F = 0.14$, $p = 0.71$). TC similarly showed no significant effects over time ($F = 2.30$, $p = 0.14$), by group ($F = 1.72$, $p = 0.20$), or in the interaction ($F = 0.98$, $p = 0.33$). However, TG did show a significant time effect ($F = 4.69$, $p = 0.04$), with levels increasing post-training ($M = 0.86$, $SD = 0.29$). HDL-C and LDL-C levels exhibited no significant changes over time, by group, or in their interactions. Leptin levels showed a significant decrease over time ($F = 6.43$, $p < 0.05$), but there were no significant group effects or interactions.

Discussion

The primary objective of this experiment is to compare the effect of ST and AT on fat reduction in female college students at the same intensity. The main finding of this research was that after 8 weeks of intervention, both the ST and AT exercise programs significantly reduced in body weight, WHR, body fat, body fat percentage and serum leptin in female college students. However, the ST program was more effective than the AT program in reducing these measures, except for serum leptin. These results were aligned with our expectations.

The importance of optimizing training interventions to maximize the positive outcomes of regular exercise is underlined by the many health benefits of regular exercise. Exercise intensity and duration are key to exercise compliance in young adults. This study evaluated two training modalities of identical duration and intensity. Both groups showed full compliance with the programs, suggesting that resistance training is as well tolerated as aerobic training. Notably, the subjects were young and highly motivated. Another observation suggests that older adults who trained for longer periods had higher retention rates in combined exercise programs compared to those who trained at lower intensities for longer periods (Moro et al., 2017).

Both AT and ST demonstrated a notable impact on body composition. However, ST was observed to be more effective. This phenomenon may be attributed to the distinctive structural characteristics of EBs, which exhibit a nonlinear relationship between tensile force and elongation. This unique property enables the implementation of relatively low-intensity training regimens that rely on aerobic oxidation of glucose and fat, effectively promoting fat loss. Additionally, EBs allow for variable resistance direction, enabling comprehensive muscle group training in various positions, which supports efficient fat-burning (Lopes et al., 2020; Liu et al., 2022). It is of particular significance that these improvements in body composition and anthropometric measures occurred, as an increased WHR is associated with an elevated risk of diabetes and other diseases (Ross et al., 2020). The findings of this research align with those of previous research that has demonstrated comparable outcomes (Yoon et al., 2017; Baptista et al., 2017; Liao et al., 2018). Unlike Roberson et al. (2018), who had participants engage in shorter rest intervals, our protocol, which included sessions three times a week with active rest periods, likely resulted in higher energy expenditure, thereby contributing to the observed improvements in body composition and anthropometric measures.

Research has consistently demonstrated that exercise can positively impact lipid abnormalities in obese individuals, likely due to reductions in fat mass. Exercise enhances the activity of enzymes such as lipoprotein lipase, which facilitates TG breakdown (Noland, 2015). Regular exercise and lifestyle changes have been shown to impact blood lipid levels, thereby reducing the risk of cardiovascular disease in overweight individuals (Salas-Salvadó et al., 2019). LDL-C is the primary atherogenic factor, penetrating vascular endothelium and contributing to atherosclerosis by increasing TC levels. In this research, lipid profiles (TC, HDL-C, LDL-C) did not show significant improvement in either training group, which is consistent with Roberson et al. (2018), who found no lipid profile changes following power training in older adults, possibly due to insufficient training duration. Studies suggest that long-term aerobic exercise must exceed 75% HRmax for over 12 weeks to affect lipid levels (Doewes et al., 2023). Salas-Salvadó et al. (2019) reported that lifestyle control improved HDL-C, TC over a year. A meta-analysis involving 170,000 participants revealed that regular physical activity leads to an increase in HDL-c levels without affecting LDL-C and TG levels. The study suggests that physical activity might theoretically offset any increases in LDL-C and TG (Mann et al., 2014). However, our study demonstrated significant enhancements in TG levels. This is consistent with Yoo et al. (2013) who reported an increase in TG in elderly women with insulin resistance syndrome, although other studies have not observed similar changes. Similarly, our study found no significant changes in LDL levels, aligning with previous findings (Liao et al., 2018; Carvalho et al., 2010). Conflicting results regarding HDL were noted in previous studies examining various exercise intensities and durations (Mann et al., 2014). In our study, neither AT nor ST resulted in significant changes in HDL-C levels. The existing literature on multicomponent exercise interventions is sparse and presents conflicting results (Mann et al., 2014). These inconsistencies among studies may be due to variations in exercise protocols, such as differences in intensity, duration, and types of exercises performed. It can be observed that an overall improvement in the lipid profile can result from an increase in lipoprotein lipase activity in muscle tissue, an enhancement of microvascular density, and an optimization of lipid acid uptake. These physiological changes promote more efficient lipid metabolism and contribute to cardiovascular health benefits (Seip & Semenkovich, 1998).

Leptin, an adipokine predominantly produced by adipose tissue, is vital for managing energy balance, appetite, and metabolism (Jafarinasabian, 2017). It influences the hypothalamus to reduce food consumption and enhance energy usage. Elevated leptin levels correlate with increased body fat, while its concentration typically diminishes with weight loss and enhanced physical activity (Obradovic et al., 2021; Pandit et al., 2017). In this study, 28 female college students showed a significant reduction in serum leptin levels after the 8-week training period. Specifically, the ST group showed a decrease from 5.89±2.35 mmol/L to 5.24±2.94 mmol/L, while the AT group exhibited a reduction from 5.64±3.00 mmol/L to 4.29±3.42 mmol/L. These findings are consistent with previous studies demonstrating a decrease in leptin levels following resistance and aerobic exercise, suggesting increased leptin sensitivity and potential benefits for metabolic health (Botero et al., 2013; Prestes et al., 2018). Multiple studies have investigated the connection between physical exercise and leptin levels. For instance, Senkus et al. (2022) found that increased physical activity can reduce circulating leptin levels in healthy adults, likely due to improved body composition and enhanced leptin sensitivity (Senkus et al., 2022). Similarly, Botero et al. (2013) observed a substantial reduction in leptin levels in postmenopausal women following a year-long resistance training program. The current study's findings of reduced leptin levels after 8 weeks of exercise further support the hypothesis that regular physical activity can positively affect leptin regulation and metabolic health. Conflicting results in the research regarding the effects of traditional strengthen training on leptin levels may be due to differences in study design, participant characteristics, and exercise protocols. For example, Lau et al. (2010) and Prestes et al. (2009) reported no significant alterations in leptin levels following resistance training, highlighting the need for standardized methodologies in future research. Differences in training intensity, duration, and participant demographics (e.g., gender, age, baseline fitness level) could all influence leptin responses to exercise. Exercise alleviates obesity and related diseases by reducing body fat, and improving insulin resistance and glycolipid metabolism. These benefits are closely related to improved leptin resistance, which is achieved by lowering serum leptin levels and increasing leptin sensitivity (Bharath et al., 2018; Peng et al., 2021). Apart from exercise, leptin levels can be influenced by diet, sleep, and stress levels. For instance, insufficient sleep has been linked to higher leptin levels and greater appetite, potentially counteracting the positive effects of physical exercise (Chaput et al., 2023). For optimal leptin function and metabolic health, stress management and a diet high in nutrients are vital.

Elerian et al. (2020) investigated the effect of gender differences on total leptin levels in obese participants after a resistance training program combined with calorie restriction. The study included 12 participants divided into two groups of six each based on gender. Both groups followed 14 weeks of resistance training while maintaining a calorie intake of 1200 to 1800 kcal per day. A key finding was a significant sex difference in the leptin response to exercise. While leptin levels decreased substantially in men, leptin concentrations were four times higher in women than in men. This result is consistent with the findings of Geer and Shen (2009), and the difference is mainly attributed to the role of estrogen in regulating leptin secretion and the higher percentage of fat mass in women. As the present study focused only on female participants, sex-specific leptin modulation may play a dominant role, thus potentially masking the effects of different exercise modalities. This may explain why both resistance and aerobic training resulted in a significant reduction in leptin, but no significant differences were observed between the two exercise groups.

The characteristics of the experimental subjects and the limitations of the research equipment precluded the implementation of closed management, training, and daily activity monitoring for the participants. Consequently, certain factors that could potentially influence the results were present during the experiment. Furthermore, the intervention lasted for 8 weeks, which may not have been sufficient to capture long-term changes in leptin levels and body composition. Future studies should consider extending the intervention period to assess sustained effects.

Conclusions

An 8-week program of either ST or AT exercise resulted in significant reductions in body weight, WHR, body fat, body fat percentage, and serum leptin in female college students. However, the ST program was more effective than the AT program in reducing these measures, except for serum leptin. This suggests that ST is an appropriate option for reducing body fat in female college students.

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