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Original Scientific Article

Using Different Types of Exercise Can Have Varied Effects on Fat Mass and Muscle Mass in Obese Females

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Objectives. This study aimed to compare the effects of aerobic and resistance training on improving body composition in obese women.

Materials and methods. This study used a true-experimental pretest-posttest control group design. A total of 33 obese women aged 23.21 ± 1.36 years, with a body mass index of 29.11 ± 3.35 kg/m^2, and a body fat percentage of 33.99 ± 2.55 %, were selected from female students in Malang City to be given an aerobic training (Aerobic) and resistance training (Resistance) intervention program for 8 weeks. Baseline (pre) and week 8 (post) body composition assessments were performed using the Body composition analyzer LN-GS6.5C. Statistical analysis was applied using the Two-Way Repeated Measures ANOVA, followed by LSD post-hoc test, with a significance level of 5 %.

Results. The results showed that delta (Δ) body weight, body mass index, body fat, and body fat percentage were found to have experienced a significant reduction, while skeletal muscle mass increased substantially after undergoing aerobic training and resistance training intervention programs compared to baseline (pre) ($p < 0.05$). Aerobic training was found to be more effective in reducing body fat, while resistance training was effective in increasing skeletal muscle mass ($p < 0.05$).

Conclusions. These findings indicate that both training models have different effects on reducing body fat and increasing skeletal muscle mass in obese women.

Keywords: aerobic training, body composition, healthy lifestyle, obesity, resistance training.

Introduction

Beyond its effects on metabolism, obesity significantly impacts muscle function (Valenzuela et al., 2020). In some individuals, a condition known as sarcopenic obesity, characterized by excessive fat mass combined with low muscle mass, is observed (Donini et al., 2022). This condition raises serious concerns as it exacerbates the risks of physical disability, reduced mobility, and diminished quality of life (Petroni et al., 2019). Numerous studies have explored the relationship between obesity and muscle quality (Tomlinson et al., 2016; Tallis et al., 2018; da Costa Teixeira et al., 2024). Consistent findings indicate that in obese individuals, muscle quality tends to decline, negatively affecting the contractile capacity of skeletal muscles (Lafortuna et al., 2014; Choi et al., 2016). For instance, Lafortuna et al. (2014) reported that high adiposity negatively correlates with muscle lipid levels, ultimately impairing contractile ability in both men and women. Similarly, Choi et al. (2016) demonstrated that myofibers in obese individuals exhibit decreased functionality, leading to reduced muscle strength. These findings are further supported by studies showing that muscle strength in obese populations is significantly lower than in individuals with normal body weight (Bollinger, 2017). The decline in muscle quality and strength not only worsens metabolic disorders but also reduces functional capacity in daily activities.

Physical exercise has long been recommended as a primary approach to addressing obesity (Johnson et al., 2021; Strain et al., 2024). Aerobic exercise, which involves rhythmic activities using large muscle groups continuously, is often regarded as an effective method for reducing body fat mass and improving metabolic health (Liu et al., 2022). Several studies support the effectiveness of aerobic exercise in weight reduction, primarily through significant calorie burning and the utilization of fat reserves as the main energy source (Oppert et al., 2024; Güzel et al., 2024). A recent meta-analysis revealed that aerobic exercise results in greater fat mass reduction compared to other types of exercise, making it a popular choice among obese individuals (Ismail et al., 2011). However, a significant drawback of this exercise modality is often overlooked. Some studies indicate that aerobic exercise not only reduces fat mass but may also decrease muscle mass if not accompanied by adequate nutrition or complementary exercises (Villareal et al., 2017). This loss of muscle mass is a particular concern for obese populations, given the crucial role of muscles in maintaining basal metabolism and supporting physical function (Mengeste et al., 2021).

As an alternative, resistance training has gained increasing attention in the context of obesity management (Liu et al., 2022). This type of exercise involves the use of weights or resistance to stimulate muscle contraction, aiming to increase muscle mass and physical strength (Semlitsch et al., 2019). Resistance training is considered an anabolic approach as it stimulates muscle protein synthesis and prevents muscle mass loss during weight reduction (Carneiro et al., 2024). Previous research has demonstrated that resistance training positively impacts muscle mass, strength, and physical function (Paluch et al., 2023). Additionally, resistance training has been shown to improve insulin sensitivity, which is crucial in managing obesity and related metabolic disorders (Boyer et al., 2023). Therefore, this type of exercise is not only effective in enhancing muscle mass but also provides broader health benefits for obese individuals.

While resistance training provides various health benefits, the broader question of how different exercise types affect specific components of body composition in obese females remains underexplored. Several meta-analyses and randomized controlled trials have examined the effects of aerobic, resistance, and combined exercise training on fat mass in overweight and obese populations (Ho et al., 2012; Schroeder et al., 2019; Amare et al., 2024; Lafontant et al., 2025; Liu et al., 2024; Lee et al., 2024). Although these studies consistently report that exercise, particularly combined training, improves fat loss and metabolic outcomes, they typically focus on fat mass alone and often involve mixed-gender or heterogeneous samples. Furthermore, only a limited number of studies have directly compared the isolated effects of aerobic versus resistance training on both fat mass and muscle mass in obese women, using standardized protocols and validated body composition measures. Therefore, there remains a critical gap in the literature concerning how different exercise modalities uniquely affect fat and muscle mass in this specific population. Addressing this gap is essential for developing evidence-based, gender-specific exercise recommendations for obesity management.

This study aims to evaluate and compare the effects of aerobic and resistance training on body composition changes in obese females. Specifically, it focuses on how aerobic training can help reduce body fat mass, while resistance training is hypothesized to increase muscle mass significantly. Based on the existing literature, we hypothesize that fat mass reduction will be significant in the aerobic training group. In contrast, muscle mass increase will be more pronounced in the resistance training group. The findings of this study are expected to provide evidence-based guidelines for obesity management in women, emphasizing the importance of selecting exercise types that align with desired body composition goals.

Materials and Methods

Study Design

This study was a true-experimental research with a pretest-posttest control group design. The study involved 33 female university students from the Malang region as participants. Obesity was defined based on the international diagnostic criteria for clinical obesity by The Lancet Diabetes & Endocrinology, using a BMI cut-off of ≥27 kg/m² and body fat percentage ≥30% for Asian populations (Rubino et al., 2025). Inclusion criteria included: age 20–25 years, BMI ≥27 kg/m², BFP ≥30%, absence of chronic diseases, non-smoker, no alcohol use in the past five years, and willingness to participate for 8 weeks. Participants were randomly divided into three groups: Control (n = 11; control group), Aerobic (n = 11; aerobic training group), and Resistance (n = 11; resistance training group). Before participation, all participants were provided with detailed information about the study's objectives, benefits, and risks. Those who voluntarily agreed to participate were required to complete and sign an informed consent form. This study adhered to the principles outlined in the World Medical Association's Declaration of Helsinki (1975) and received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Airlangga, on June 19, 2024 (Approval No: 32/EC/KEPK/FKUA/2024).

Training Program Protocol

The training program was conducted at Atlas Sports Club Malang (Indonesia) every morning from 07:00 to 09:00 AM, three times per week over eight weeks. Each session was supervised by certified fitness instructors and research staff. Before each session, participants completed a 5-minute warm-up (stretching and light aerobic movements), and ended with a 5-minute cooldown on a treadmill at a low pace. Aerobic training was performed at 60–70% of estimated maximal heart rate (HRmax), calculated using the formula 220-age. Each session lasted 40–60 minutes and was conducted continuously on a treadmill (Life Fitness™). Resistance training was performed using Cybex machines (pull-down, chest press, shoulder press, leg press, leg curl, leg extension). The intensity was set at 60–70% of 1-repetition maximum (1-RM). 1-RM was estimated using submaximal testing and calculated with the Brzycki formula (Brzycki, 1993). Each session consisted of 4–6 sets of 12–15 repetitions, performed in intervals. The control group did not receive any intervention. All sessions were carried out in a controlled room with an ambient temperature of 25 ±

Table 1. Detailed training program protocol

Training Model	Frequency	Intensity	Type	Time	Tools
Aerobic training	3x/week during 8 weeks	60-70% HRmax	Continuous	40-60 minutes/session	Life fitness treadmill 95T
Resistance training	3x/week during 8 weeks	60-70% 1-RM	Interval	4-6 sets with 12-15 reps/session	Cybex: Pull down Shoulder press Chest press Leg press Leg extension Leg curls
Control group	Did not receive any intervention for 8 weeks				

1°C and a humidity level of 50–60%. Details of the training program are presented in Table 1.

Data Collection

Data collection involved the assessment of body weight (BW), body mass index (BMI), body fat (BF), body fat percentage (BFP), and skeletal muscle mass (SMM) at baseline (pre) and the 8th week (post) using a Body Composition Analyzer LN-GS6.5C.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows version 21.0. Paired sample t-tests were applied to evaluate within-group differences between pre-intervention and post-intervention for data with a normal distribution. Additionally, Two-Way Repeated Measures ANOVA and the Least Significant Difference (LSD) post-hoc test were used to assess between-group differences for data with a normal distribution and homogeneous variances. All data were presented as mean ± standard deviation (SDs).

Results

The results of the baseline assessment of the characteristics of the participants are presented in detail in Table 2. No significant differences were found in all parameters of the participants' characteristics (all $p > 0.05$). Meanwhile, the results of the analysis of body weight (BW), body mass index (BMI), body fat (BF), body fat percentage (BFP), and skeletal muscle mass (SMM) between baseline (pre) and week 8 (post) are presented in Figures 1-5 and Table 3.

As shown in Table 3, statistically significant changes were observed in body composition parameters following the 8-week intervention. In the aerobic group, BMI de-

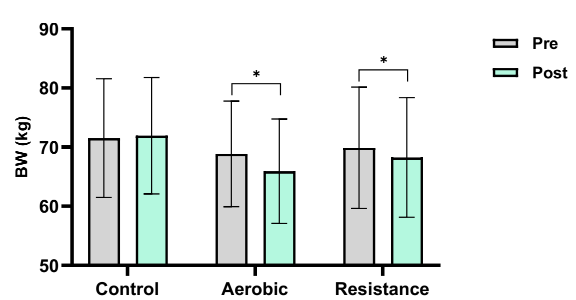

Fig. 1. Body weight (BW) assessment at baseline (pre) and week 8 (post). Data are presented as mean ± SDs. p-value was obtained by using paired sample t-test. *Significant at pre ($p < 0.05$)

Table 2. Characteristics of the participants of the study

Characteristics	Control (n = 11)	Aerobic (n = 11)	Resistance (n = 11)	p
Age, yrs	23.09 ± 1.44	23.18 ± 1.41	23.36 ± 1.36	0.898
SBP, mmHg	115.54 ± 3.15	115.81 ± 3.41	116.04 ± 3.09	0.936
DBP, mmHg	72.59 ± 5.91	73.54 ± 4.66	72.90 ± 4.72	0.906
RHR, bpm	73.86 ± 4.21	73.45 ± 6.84	75.63 ± 5.78	0.640
SpO_2, %	97.72 ± 1.11	97.90 ± 1.04	97.91 ± 1.13	0.904
BT, °C	36.29 ± 0.44	36.45 ± 0.26	36.33 ± 0.29	0.524
FBG, mg/dL	90.63 ± 5.85	89.72 ± 7.01	91.00 ± 4.81	0.876
Hb, g/dL	14.75 ± 1.14	15.07 ± 1.17	14.73 ± 1.25	0.759
Height, m	1.56 ± 0.05	1.54 ± 0.04	1.55 ± 0.04	0.385
Pre-BW, kg	71.51 ± 10.02	68.85 ± 8.93	69.89 ± 10.26	0.813
Pre-BMI, kg/m^2	29.03 ± 4.06	29.05 ± 2.70	29.25 ± 3.47	0.986
Pre-BF, kg	24.71 ± 5.01	23.93 ± 7.64	23.10 ± 4.57	0.814
Pre-BFP, %	34.17 ± 2.46	34.29 ± 3.25	33.52 ± 1.93	0.763
Pre-SMM, kg	23.85 ± 3.81	24.67 ± 3.07	24.71 ± 3.14	0.798

Description: SBP: Systolic blood pressure; DBP: Diastolic blood pressure; RHR: Resting heart rate; SpO2: Oxygen saturation; BT: Body temperature; FBG: Fasting blood glucose; Hb: Hemoglobin. Data are presented as mean ± standard deviation (SDs). p-value was obtained by using Two-Way Repeated Measures ANOVA.

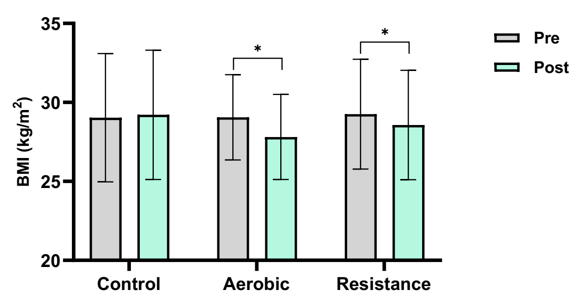

Fig. 2. Body mass index (BMI) assessment at baseline (pre) and week 8 (post). Data are presented as mean ± SDs. p-value was obtained by using paired sample t-test. *Significant at pre ($p < 0.05$)

creased from 29.21 ± 4.09 to 27.81 ± 2.69, while in the resistance group it decreased from 28.57 ± 3.45 to 28.57 ± 3.45, with no significant change in the control group. Although the BMI reduction observed in the aerobic group was sta-

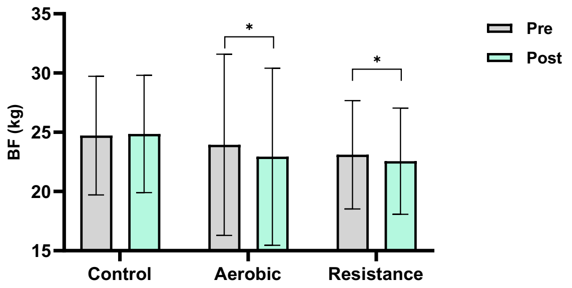

Fig. 3. Body fat (BF) assessment at baseline (pre) and week 8 (post). Data are presented as mean ± SDs. p-value was obtained by using paired sample t-test. *Significant at pre ($p < 0.05$)

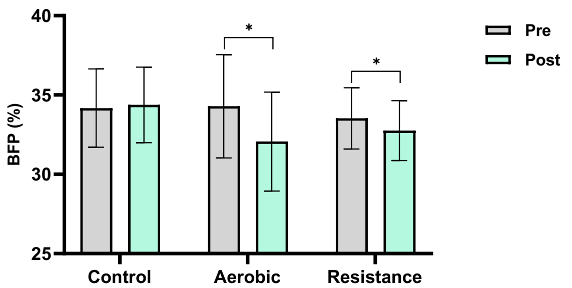

Fig. 4. Body fat percentage (BFP) assessment at baseline (pre) and week 8 (post). Data are presented as mean ± SDs. p-value was obtained by using paired sample t-test. *Significant at pre ($p < 0.05$)

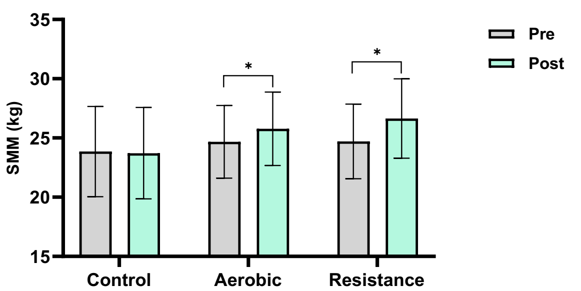

Fig. 5. Skeletal muscle mass (SMM) assessment at baseline (pre) and week 8 (post). Data are presented as mean ± SDs. p-value was obtained by using paired sample t-test. *Significant at pre ($p < 0.05$)

tistically significant ($p < 0.001$), participants remained in the overweight category (BMI > 25). From a clinical standpoint, this level of change may appear modest. However, growing evidence suggests that improvements in body composition—such as reduced body fat percentage and increased skeletal muscle mass—are more indicative of health risk reduction than BMI alone. Therefore, the observed reductions in body fat percentage (Δ-BFP: –2.22%) and increases in muscle mass (Δ-SMM: +1.11 kg in the aerobic group, +1.93 kg in the resistance group) highlight the clinical value of these interventions despite minimal categorical shifts in BMI classification.

Table 3. Body composition assessment at baseline (pre) and week 8 (post) between group

Parameters	Control (n = 11)	Aerobic (n = 11)	Resistance (n = 11)	p
Post-BW, kg	71.93 ± 9.85	65.91 ± 8.83	68.25 ± 10.11	0.347
Post-BMI, kg/m^2	29.21 ± 4.09	27.81 ± 2.69	28.57 ± 3.46	0.639
Post-BF, kg	24.85 ± 4.95	22.94 ± 7.47	22.55 ± 4.48	0.613
Post-BFP, %	34.37 ± 2.38	32.06 ± 3.11	32.75 ± 1.88	0.102
Post-SMM, kg	23.71 ± 3.86	25.77 ± 3.11	26.63 ± 3.34	0.142
Δ-BW, kg	0.41 ± 0.82	-2.93 ± 0.67^{ac}	-1.63 ± 0.37^{a}	0.000
Δ-BMI, kg/m^2	0.18 ± 0.33	-1.24 ± 0.29^{ac}	-0.68 ± 0.12^{a}	0.000
Δ-BF, kg	0.13 ± 0.27	-0.99 ± 0.26^{ac}	-0.54 ± 0.14^{a}	0.000
Δ-BFP, %	0.21 ± 0.39	-2.22 ± 0.86^{ac}	-0.77 ± 0.16^{a}	0.000
Δ-SMM, kg	-0.13 ± 0.28	1.11 ± 0.26^{a}	1.93 ± 0.61^{ab}	0.000

Description: Data are presented as mean ± standard deviation (SDs). p-value was obtained by using Two-Way Repeated Measures ANOVA and following by LSD post-hoc test. aIndicates a significant difference with the control group ($p < 0.001$). bIndicates a significant difference with the aerobic group ($p < 0.001$). cIndicates a significant difference with the resistance group ($p < 0.001$).

Discussion

This study aimed to evaluate the effects of aerobic and resistance training on changes in body fat and muscle mass in obese females. The results demonstrated that aerobic training was effective in significantly reducing body fat, while resistance training resulted in greater muscle mass gain. These findings support the understanding of evidence-based exercise effectiveness for improving body composition in obese females. Although the changes in fat and muscle mass observed in this study were statistically significant, their clinical relevance is equally important. Improvements in body composition, even when not accompanied by large reductions in total body weight, have been associated with better metabolic health, increased functional capacity, and reduced risk of chronic conditions in individuals with obesity. For obese females in particular, decreasing fat mass while increasing muscle mass contributes to improved mobility, hormonal balance, and long-term weight maintenance. These outcomes highlight that exercise interventions yielding statistically significant changes in fat or muscle mass can have meaningful implications for clinical practice, especially in designing targeted, sustainable obesity management programs.

Our results are consistent with previous studies that found aerobic training to be superior to resistance training in reducing body fat (Willis et al., 2012). Additionally, a meta-analysis comparing the effects of aerobic and resistance training on body fat concluded that greater body fat reduction occurred in the aerobic training group compared to the resistance training group (Ismail et al., 2011). These findings are consistent with prior studies demonstrating the effectiveness of aerobic training in reducing body fat. For example, Keating et al. (2017) reported that aerobic exercise could reduce body fat by up to 1.26%, while Wewege et al. (2022) observed reductions of 1.4% in body fat percentage. Schwingshackl et al. (2013) also showed an average fat mass reduction of approximately 1 kg following aerobic programs. Such evidence reinforces the role of aerobic training as a reliable modality for fat mass reduction in obese individuals.

In addition to reducing body fat, aerobic training has been consistently associated with broader health benefits. Previous studies have reported that aerobic exercise contributes to improved cardiovascular health, lower metabolic risk, and better functional capacity among individuals with obesity (Lopez et al., 2022). Moreover, aerobic programs have been shown to positively influence bone mineral density and support the preservation of lean body mass (Stonehouse et al., 2016). These findings reinforce the role of aerobic training as a foundational component of comprehensive obesity management.

Our findings also highlight that resistance training was more effective than aerobic training in increasing muscle mass. This aligns with several studies, including Schoenfeld et al. (2016), which demonstrated significant hypertrophy following an 8-week high-intensity program. Increases in muscle strength have also been reported among obese women engaged in resistance training, as evidenced by 1-RM testing results (Zemková et al., 2017; Sarsan et al., 2006). Systematic reviews have emphasized that muscle hypertrophy is especially pronounced when exercises are performed to voluntary fatigue, particularly in untrained individuals (Toth et al., 2012; Lopez et al., 2020). These outcomes underscore the importance of resistance training in enhancing muscle mass and physical performance as part of obesity intervention programs.

Although this study examined aerobic and resistance training separately, evidence suggests that combining the two may produce synergistic effects. For instance, Willis et al. (2012) demonstrated that combined training not only accelerates fat loss but also promotes muscle gain, resulting in more holistic improvements in body composition. This integrated approach may be particularly beneficial for obese women, who often require strategies targeting both fat reduction and muscle preservation. Future studies are needed to determine the optimal structure, duration, and intensity of combined training interventions for this population.

The physiological mechanisms underlying the effects of aerobic and resistance training on body composition are distinct and complementary. Aerobic training enhances mitochondrial density within skeletal muscle, promoting the efficient breakdown of triglycerides into free fatty acids to meet increased energy demands (Brooks, 2020; Hargreaves & Spriet, 2020). This type of exercise also activates AMP-activated protein kinase (AMPK) and intracellular calcium pathways, which upregulate GLUT-4 expression and facilitate greater glucose and fatty acid uptake during muscle contraction (Richter & Hargreaves, 2013). Additionally, aerobic training increases fatty acid oxidation capacity, reduces reliance on glycogen, and lowers lactate production, thereby improving metabolic efficiency during prolonged activity (El-Zayat et al., 2019; Brooks, 2020). In contrast, resistance training induces muscle hypertrophy and enhances neuromuscular adaptations through the stimulation of muscle protein synthesis. This process is supported by the activation of GLUT-4 via the transcriptional coactivator PGC-1α, which also plays a role in mitochondrial biogenesis, particularly in type I muscle fibers (Kido et al., 2016). Furthermore, the increase in lean muscle mass contributes to a higher basal metabolic rate, which is critical for long-term energy balance and obesity management (Mitchell et al., 2012). These mechanisms explain the differential effects observed in this study and reinforce the value of exercise specificity in targeting fat loss or muscle gain.

This study has several limitations. First, the relatively short intervention duration (8 weeks) may not be sufficient to evaluate the long-term effects of both exercise types on body composition. Previous studies have shown that combining exercises requires more than 12 weeks to yield significant results (Willis et al., 2012). Second, the sample size, which was limited to obese females, restricts the generalization of findings to other populations, such as obese males or individuals with other comorbidities. Third, this study did not measure additional physiological variables, such as hormone levels or other metabolic parameters, which could provide deeper insights into the body's response to exercise.

Future research directions should include long-term evaluations of combined aerobic and resistance training in obese females, particularly to assess sustained changes in body composition and metabolic health. Given that the average age of participants in this study was relatively young (23 years), these findings can be seen as a form of early preventive intervention. Since obesity-related complications such as type 2 diabetes, hypertension, and cardiovascular disease are more prevalent in older adults, it is important to ensure that early improvements observed in younger populations can be maintained or enhanced in older age groups. Investigating these interventions across different life stages may help inform comprehensive, age-appropriate strategies for obesity management. Additionally, future studies should explore psychological and behavioral aspects, such as motivation and adherence, to support more effective and sustainable exercise interventions.

This study demonstrates that aerobic training is effective in reducing body fat, while resistance training excels in increasing muscle mass in obese females. These complementary effects highlight the potential value of combining both exercise types for a more comprehensive approach to body composition improvement. By understanding the strengths and limitations of each exercise modality, these findings can support the development of evidence-based, individualized obesity management programs.

Conclusions

These findings suggest that the two training models have different effects in reducing body fat and increasing skeletal muscle mass in obese women. Body fat reduction was greater in the aerobic training group, while skeletal muscle mass increase was more pronounced in the resistance training group.

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Conflict of Interest

The authors declare that they have no conflicts interests.

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Використання різних видів фізичних вправ може чинити різноманітний вплив на жирову та м'язову маси у жінок з ожирінням

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 3 табл., 5 рис., 46 джерел.

Мета дослідження. Мета цього дослідження полягала в порівнянні впливу аеробних та силових тренувань на покращення композиції тіла жінок з ожирінням.

Матеріали та методи. У цьому дослідженні використовувався справжній експериментальний претест-посттест дизайн із контрольною групою. Загалом 33 жінки з ожирінням віком 23.21 ± 1.36 років, з індексом маси тіла 29.11 ± 3.35 кг/м^2 і відсотком жирової маси тіла 33.99±2.55 %, було відібрано з числа студенток міста Маланг для участі в програмі аеробних тренувань (Аеробні) та силових тренувань (Силові) тривалістю 8 тижнів. Оцінювання показників композиції тіла на початковому етапі дослідження (переддослідницький) та на завершальному етапі — 8-му тижні (постдослідницький) проводилося із використанням аналізатора складу тіла LN-GS6.5C. Статистичний аналіз застосовувався за допомогою двофакторного дисперсійного аналізу із повторними вимірами, після чого проводився post-hoc тест LSD (найменша значуща різниця) з рівнем значущості 5 %.

Результати. Результати показали, що дельта (Δ) маса тіла, індекс маси тіла, жирова маса тіла та відсоток жирової маси тіла зазнали значного зниження, тоді як після виконання інтервенційних програм з аеробних та силових тренувань спостерігалося суттєве збільшення маси скелетних м'язів порівняно з вихідним рівнем (переддослідницький етап) ($p < 0.05$). Аеробні тренування виявилися ефективнішими у зменшенні жирової маси тіла, тоді як силові тренування були ефективними у збільшенні скелетної м'язової маси ($p < 0.05$).

Висновки. Отримані результати свідчать про те, що обидві моделі тренувань мають різний вплив на зниження рівня жиру в організмі та збільшення маси скелетних м'язів у жінок з ожирінням.

Ключові слова: аеробні тренування, композиція тіла, здоровий спосіб життя, ожиріння, силові тренування.

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