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Original Scientific Article

Ascertaining the Effectiveness of Strength-Aerobic Combined Exercise in Improving Body Composition among Obese Women: A Randomized Controlled Trial

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Abstract

Background. The novelty of this study is a combination of strength and aerobic exercise, thereby enhancing the benefits of improving body composition. Aerobic exercise is effective for burning calories, which helps to lose fat, while strength exercise facilitates maintaining and building muscle mass.

Objectives. This study aimed to demonstrate that a combination of strength-aerobic exercise can significantly improve the body composition of obese women.

Materials and methods. This study was an experimental randomized controlled trial (RCT) involving 20 participants consisting of obese women who were given the intervention for eight weeks with a frequency of 4x/week. The data collected included a body composition, measured using the TANITA Body Composition Analyzer DC-360 (TANITA Corporation, Inc., IL 60005, USA). The data analysis techniques used were the paired sample t-test, with a significance level of 95 %.

Results. The results obtained indicate that this combined exercise program significantly reduces body weight, body mass index (BMI), fat mass, and body fat percentage ($p < 0.05$). In addition, the program also significantly increases fat-free mass and muscle mass ($p < 0.05$).

Conclusions. The findings showed that a combination of aerobic exercise and endurance led to substantial improvements in body composition in obese women. These results confirm previous studies and provide scientific evidence for including a combination exercise program as part of an obesity management strategy.

Keywords: combined exercise, body composition, healthy lifestyle, obese women.

Introduction

Obesity in women is a growing global health problem. According to a report from the World Health Organization (WHO), in 2020, about 15% of adult women worldwide were obese (BMI ≥30) (Li & Chen, 2021). Women who are obese have up to 10 times higher risk of developing diabetes compared to women with normal weight. Obesity in women is not only related to appearance but also poses a significant danger to physical and mental health (Bakaloudi et al., 2020). The increasing rate of obesity worldwide highlights the urgent need for effective interventions, such as physical activity, a good diet, and psychological support, to mitigate the negative effects (Wang et al., 2022).

Body composition, which shows the ratio of body fat to lean mass (such as muscle, bone, water, and other tissues), is an important indicator of an individual's health (Rejeki et al., 2023). Improving body composition means reducing excess body fat and increasing or maintaining muscle mass, both of which provide significant benefits for physical and mental health (Pekas et al., 2020). Amid rising global obesity rates, especially among women, the development of effective strategies to improve body composition is becoming increasingly important (Mpampoulis et al., 2024).

Aerobic exercise, consisting of sustained moderate to high-intensity activities such as running, cycling, or swimming, offers various benefits to the body (Ashadi et al., 2024). Aerobic exercise can enhance calorie burning, which contributes to weight loss, and improve cardiovascular capacity by increasing the heart and lungs' efficiency in delivering oxygen to muscles, supporting heart health (Jones et al., 2020). This exercise modality is also effective in reducing body fat percentage, including visceral fat, which is strongly associated with metabolic disease risks. Additionally, aerobic exercise improves insulin sensitivity and regulates stress hormones such as cortisol, reducing fat accumulation (Youssef et al., 2022). However, aerobic exercise alone has limitations—it does not significantly increase muscle mass, a critical factor in boosting basal metabolism (Kysel et al., 2023). Weight loss due to aerobic exercise without incorporating strength training may risk muscle mass loss (Zhang et al., 2023).

Strength exercises, such as weightlifting or bodyweight training, aim to strengthen and increase muscle mass (Valenzuela et al., 2021). These exercises enhance muscle mass and basal metabolic rate, allowing for higher calorie expenditure even at rest through the excess post-exercise oxygen consumption (EPOC) effect (Versic et al., 2021). Strength training also improves posture and physical function by strengthening supporting muscles that help prevent injury (Atakan et al., 2021). Furthermore, it improves glucose regulation by increasing insulin sensitivity, as muscle mass serves as the primary reservoir for glucose storage (Domingues et al., 2024). Despite these benefits, strength training burns fewer calories during exercise compared to aerobic activities and is less effective in improving cardiovascular health (Oh & Lee, 2023).

Given the complementary benefits of aerobic and strength exercises, integrating these modalities has emerged as a highly effective approach for improving body composition. Aerobic exercise facilitates fat loss by increasing calorie burn, while strength training preserves and builds muscle mass, ensuring weight loss comes from fat rather than lean tissue (Jamka et al., 2021). Strength training further enhances basal metabolism, allowing for sustained calorie burning even after an aerobic session (Park et al., 2020). The combined approach is not only effective for heart health but also strengthens the body for daily physical activities (Pippi et al., 2022).

This integrated method has a superior long-term effect, enabling more sustainable weight loss compared to relying on a single exercise type. Studies that focus solely on one type of exercise often overlook the synergistic benefits of combining both aerobic and strength exercises, which have been proven to be more effective in improving overall body composition (Manojlović et al., 2021). Therefore, a dual approach should be emphasized in fitness strategies, especially for populations with obesity, such as women (Coelho-Júnior et al., 2020).

The aim of this study is to demonstrate that the combination of aerobic and strength exercise can significantly improve the body composition of obese women. This research offers an important contribution to the global community by presenting a practical, evidence-based approach to managing obesity. Furthermore, the findings underscore the importance of incorporating both aerobic and strength training into exercise programs, benefiting not only individuals but also contributing to public health efforts worldwide.

Materials and Methods

Study Design

This study was an experimental randomized controlled trial (RCT). The purpose of this study was to compare combination of strength and aerobic exercise in the experimental group that received the intervention and the control group that did not receive the intervention. A total of 20 people were divided into two groups: a control group (Control) consisting of 10 people without intervention and 10 other participants who were given combination of strength and aerobic exercise interventions (Exercise). The study began by disseminating information about open recruitment for research samples through social media. The sample was selected based on predetermined criteria, namely: young adult women aged 20-30 years, inactive in exercise, with a BMI above 28 kg/m^2, and willing to participate in an exercise program for 8 weeks. The training was carried out on a scheduled basis with the guidance of the research team and instructors every Monday, Tuesday, Wednesday, Thursday, and Saturday. Details of the training program are presented in Table 1.

Data Collection Techniques

Body fat measurements will be carried out using TANITA Body Composition Analyzer DC-360 (TANITA Corporation, Inc., IL 60005, USA) twice, before and one day after the four-week intervention period. The height of the subjects will be measured using a portable stadiometer Seca 213 (Seca 213, Hammer Steindamm 3-25 22089, Hamburg Germany).

Data Analysis Techniques

The data analysis in this study will used Shapiro-Wilk to test normality. The paired sample t-test was applied to evaluate the differences in each group, while the independent sample t-test was to analyze the differences between groups. The applied significance level was a 95%, and the data will be presented as an mean ± standard deviation (SDs). Effect size was assessed using Cohen's D analysis.

Results

The results of the analysis of participant characteristics are presented in Table 2. Table 2 shows no significant differences in age, body mass index, body composition, resting heart rate, and blood pressure, and oxygen saturation observed all analysis results show $p \geq 0.05$ (Table 2). Meanwhile, the results of body composition assessments between pre and post exercise are presented in Figure 1.

Based on Figure 1, it shows that there are significant differences between baseline (pre) and weeks 8 (post) in weight ($p = 0.001$; ES = 1.337), BMI ($p = 0.001$; ES = 0.651), PBF ($p = 0.001$; ES = 0.896), FM ($p = 0.001$; ES = 0.423), FFM ($p = 0.001$; ES = 0.524), and MM ($p = 0.001$; ES = 0.494) in the exercise group. Meanwhile, in the control group no significant differences were observed ($p > 0.05$). The results of the analysis of differences between groups are presented in Table 3.

Table 1. The training program of strength aerobic combined exercise

Weeks	Strength-aerobic combined exercise group	Control group
Week – 1	Moderate-intensity continuous training The intensity was done at 60 % of maximum heart rate for 30 minutes Total body strength training The intensity was done at 60 % of 1 repetition maximum (1RM) with a 4 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention
Week – 2	Moderate-intensity continuous training The intensity was done at 60 % of maximum heart rate for 30 minutes Total body strength training The intensity was done at 60 % of 1 repetition maximum (1RM) with a 4 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention
Week – 3	Moderate-intensity continuous training The intensity was done at 65 % of maximum heart rate for 30 minutes Total body strength training The intensity was done at 65 % of 1 repetition maximum (1RM) with a 4 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention
Week – 4	Moderate-intensity continuous training The intensity was done at 65 % of maximum heart rate for 30 minutes Total body strength training The intensity was done at 65 % of 1 repetition maximum (1RM) with a 5 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention
Week – 5	Moderate-intensity continuous training The intensity was done at 65 % of maximum heart rate for 35 minutes Total body strength training The intensity was done at 65 % of 1 repetition maximum (1RM) with a 5 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention
Week – 6	Moderate-intensity continuous training The intensity was done at 65 % of maximum heart rate for 35 minutes Total body strength training The intensity was done at 65 % of 1 repetition maximum (1RM) with a 5 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention
Week - 7	Moderate-intensity continuous training The intensity was done at 70 % of maximum heart rate for 35 minutes Total body strength training The intensity was done at 70 % of 1 repetition maximum (1RM) with a 5 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention
Week – 8	Moderate-intensity continuous training The intensity was done at 70 % of maximum heart rate for 40 minutes Total body strength training The intensity was done at 70 % of 1 repetition maximum (1RM) with a 6 sets of 12-15 repetitions Warming up and cooling down are each done for 5 minutes at an intensity of 50 % HRmax.	Without exercise intervention

Table 2. Baseline characteristics of study participants

Variable	Control (n = 10)	Exercise (n = 10)	p-value Independent sample t-test
Age (years)	23.30 ± 1.34	23.20 ± 1.48	0.876
Resting heart rate (beats/min)	74.20 ± 4.35	75.55 ± 7.61	0.632
Systolic blood pressure (mmHg)	115.06 ± 3.43	116.05 ± 2.89	0.494
Diastolic blood pressure (mmHg)	75.20 ± 2.87	75.05 ± 4.38	0.929
Oxygen saturation (%)	99.00 ± 0.82	99.10 ± 0.88	0.795
Height (m)	1.56 ± 0.05	1.55 ± 0.04	0.756
Weight (kg)	74.46 ± 6.79	74.05 ± 7.03	0.896
Body mass index (kg/m^2)	30.43 ± 1.39	30.54 ± 2.26	0.891
Percentage of body fat (%)	34.70 ± 3.11	34.79 ± 1.91	0.939
Fat mass (kg)	26.45 ± 5.21	25.15 ± 3.82	0.533
Free fat mass (kg)	35.43 ± 5.96	33.89 ± 3.12	0.479
Muscle mass (kg)	25.93 ± 2.05	24.71 ± 2.45	0.243

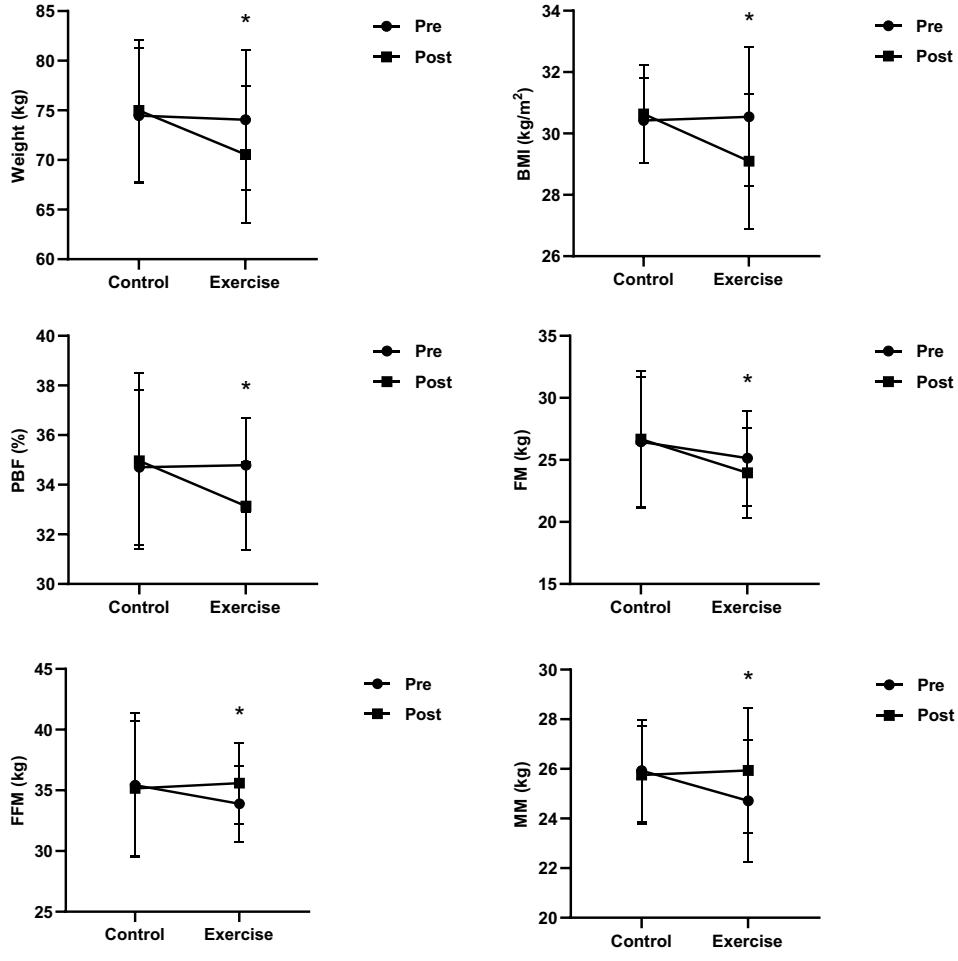

Fig. 1. Assessment of weight, body mass index (BMI), percentage of body fat (PBF), fat mass (FM), fat-free mass (FFM), and muscle mass (MM) baseline (pre) and weeks 8 (post) in each group. The data was presented as mean ± standard deviation (SDs). *Significantly different from pre in exercise group $p < 0.001$. ES: Effect size. p-value was obtained by paired sample t-test

Table 3. Assessment of weight, BMI, PBF, FM, FFM, and MM baseline (pre) and weeks 8 (post) between groups

Variable	Control (n = 10)	Exercise (n = 10)	p-value	Effect size
Post-Weight (kg)	74.98 ± 7.15	70.55 ± 6.86	0.175	0.632
Post-BMI (kg/m2)	30.64 ± 1.59	29.09 ± 2.19	0.089	0.804
Post-PBF (%)	34.97 ± 3.55	33.14 ± 1.77	0.163	0.651
Post-FM (kg)	26.67 ± 5.52	23.95 ± 3.64	0.211	0.581
Post-FFM (kg)	35.15 ± 5.52	35.59 ± 3.34	0.832	0.096
Post-MM (kg)	25.76 ± 1.99	25.94 ± 2.52	0.861	0.079
Δ-Weight (kg)	0.52 ± 1.44	-3.50 ± 0.48[a]	0.000	3.732
Δ-BMI (kg/m^2)	0.21 ± 0.59	-1.45 ± 0.21[a]	0.000	3.727
Δ-PBF (%)	0.27 ± 0.67	-1.65 ± 0.26[a]	0.000	3.767
Δ-FM (kg)	0.22 ± 0.52	-1.19 ± 0.24[a]	0.000	3.513
Δ-FFM (kg)	-0.28 ± 0.71	1.69 ± 0.32[a]	0.000	3.623
Δ-MM (kg)	-0.17 ± 0.51	1.23 ± 0.18[a]	0.000	3.634

The data was presented as mean ± standard deviation (SDs). [a]Significantly different from control group $p < 0.001$. p-value was obtained by paired sample t-test

Discussion

The study demonstrated the significant impact of combined strength and aerobic exercise on body composition in obese women. The results indicate that this combined exercise program significantly reduces body weight, body mass index (BMI), fat mass, and body fat percentage while increasing muscle mass and fat-free mass (FFM). These findings underline the effectiveness of combination exercise programs in achieving a healthier body composition.

The results align with and extend prior research on the effects of combined aerobic and strength exercises on body composition. For instance, Oh and Lee (2023) found that an 8-week combined exercise program significantly reduced body fat percentage, triglyceride levels, and leptin levels in middle-aged women with obesity. They also observed that moderate-intensity aerobic exercise during combination training yielded slightly better outcomes for lipid profiles than vigorous-intensity aerobic exercise. Similarly, Cicek and Singin (2023) showed that 10 weeks of either aerobic or strength exercise significantly improved BMI, fat mass, and quality of life (QoL) sub-dimensions such as physical and psychological health. These findings reinforce the results of the present study, emphasizing the holistic benefits of combined exercise programs, particularly their ability to enhance body composition and overall well-being.

Aerobic and strength exercises, especially when combined, have long been recognized as effective strategies for addressing obesity (Pojednic et al., 2022). The dual approach is superior to performing either exercise alone in reducing fat mass (Jamka et al., 2021). The primary mechanism involves increased energy expenditure and metabolic efficiency, with aerobic exercise directly contributing to calorie burning and strength training promoting muscle mass maintenance or growth (Makiel et al., 2023). Notably, an increase in FFM, as observed in this study, is associated with a higher basal metabolic rate, which facilitates more effective weight management (Ahn & Kim, 2022).

This study's findings are consistent with evidence that adding strength training to an aerobic exercise program enhances fat reduction and increases FFM. Strength training stimulates muscle protein synthesis, which aids in improving body composition by increasing muscle mass and reducing fat (Despeghel et al., 2021). Furthermore, the decrease in fat mass observed in this study aligns with metabolic adaptations supported by hormones such as leptin and adiponectin, which are influenced by consistent physical activity (Garcia-Roca et al., 2024). The increase in FFM observed in this study highlights the role of strength training in promoting muscle growth, contributing to improved metabolic health and overall physical strength.

Combination exercises impact body composition through multiple mechanisms. Aerobic exercise increases fat oxidation and insulin sensitivity, which reduces fat accumulation, while strength training enhances muscle hypertrophy and metabolic activity (Lee et al., 2024). These complementary effects underscore the importance of combining aerobic and strength exercises to achieve optimal results. This approach not only reduces fat mass but also increases FFM, which has profound implications for long-term metabolic health and physical functionality.

The results have important implications for obesity management, particularly in women. Considering that obesity in women is often linked to hormonal and metabolic changes, combined exercise programs provide an effective strategy for achieving weight loss and improving overall health (Masouleh et al., 2021; Tan et al., 2023). To maximize benefits, the duration, intensity, and frequency of exercise programs must be tailored to individual conditions (Białkowski et al., 2024). For instance, Bagheri et al. (2023) recommend exercising three times per week for 60 minutes per session over 12 weeks to achieve significant results. This regimen aligns with the current study's findings, which support moderate-intensity aerobic exercise combined with strength training targeting major muscle groups for optimal outcomes (Bakaloudi et al., 2020; Oh & Lee, 2023).

However, this study has certain limitations. The sample size was relatively small and included only young adult women with sedentary lifestyles, limiting the generalizability of the findings. Previous research suggests that older women and other demographic groups may exhibit different responses to combination exercise programs due to variations in hormonal, metabolic, and lifestyle factors (Méndez-Hernández et al., 2022). Additionally, the short duration of the intervention may not capture the long-term effects of combined exercise programs. Future research should explore the sustainability of benefits over extended periods and assess the effects of different exercise intensities and frequencies to refine individualized exercise prescriptions (Garcia-Roca et al., 2024).

Studies on the combination of aerobic and strength exercise are essential as a preventive measure against global obesity. They offer practical, scalable solutions with broad health benefits, including improved metabolic health, enhanced physical strength, and better quality of life. Furthermore, the integration of these findings into public health policies could contribute to addressing the global obesity epidemic. Future research should also consider including quality-of-life assessments and additional health metrics to capture the comprehensive benefits of combined exercise programs.

Conclusion

The study highlighted that combining aerobic and strength exercises effectively enhances body composition in obese women. These findings support earlier studies and offer scientific backing for including combination exercise programs in strategies for managing obesity. Therefore, the development of programs tailored to individual needs is essential to improve the success of interventions and long-term health.

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Conflict of Interest

The authors declare that they have no competing interests in this study.

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З'ясування ефективності поєднання силових та аеробних вправ щодо покращення композиції тіла у жінок з ожирінням: Рандомізоване контрольоване дослідження

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

Реферат. Стаття: 6 с., 2 табл., 2 рис., 22 джерел.

Історія питання. Наукова новизна цього дослідження полягає у вивченні поєднання силових та аеробних вправ, застосування яких посилює позитивний вплив на поліпшення компонентного складу тіла. Виконання аеробних вправ є ефективним з точки зору спалювання калорій, що допомагає позбутися жирових відкладень, тоді як силові вправи сприяють підтримці та нарощуванню м'язової маси.

Мета дослідження. Це дослідження мало на меті продемонструвати, що поєднання силових та аеробних вправ може суттєво покращити композицію тіла жінок з ожирінням.

Матеріали та методи. Проведено експериментальне рандомізоване контрольоване дослідження (РКД) за участю 20 жінок з ожирінням, які проходили інтервенцію протягом восьми тижнів із частотою 4 рази на тиждень. Збір даних включав визначення складу тіла за допомогою аналізатора складу тіла TANITA DC-360 (TANITA Corporation, Inc., IL 60005, США). Методи аналізу даних передбачали застосування t-критерію для парних вибірок з рівнем значущості 95%.

Результати. Отримані результати вказують на значне зниження маси тіла, індексу маси тіла (ІМТ), жирової маси та відсоткового вмісту жиру в організмі ($p < 0,05$) завдяки застосуванню комбінованої програми тренувань ($p < 0,05$). Крім того, застосування зазначеної програми забезпечує достовірне підвищення показників безжирової маси та м'язової маси ($p < 0,05$).

Висновки. Результати дослідження показали, що поєднання аеробних вправ і витривалості призводить до суттєвого поліпшення композиції тіла у жінок з ожирінням. Вказані результати підтверджують дані попередніх досліджень і надають наукові докази щодо включення комбінованої програми тренувань як частини стратегії боротьби з ожирінням.

Ключові слова: комбіновані фізичні вправи, композиція тіла, здоровий спосіб життя, жінки з ожирінням.

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