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The role of long-term combination training in reducing and maintaining of body fat in obese young adult women

El papel del entrenamiento combinado a largo plazo en la reducción y el mantenimiento de la grasa corporal en mujeres adultas jóvenes obesas

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Abstract. Reducing body weight and body fat is the primary goal for overcoming obesity. Lifestyle modifications with a non-pharmacological approach based on programmed physical exercise are recommended for increasing energy expenditure and reducing body weight and body fat. This study aims to analyze different types of exercise in reducing and maintaining body fat in obese young adult women. This study was a randomized controlled trial (RCT) with a true experimental design. A group of 28 sedentary overweight women were enlisted and provided with aerobic, strength, and mixed exercise regimens. Aerobic, resistance, and combined training programs were conducted with an intensity of 60-70% HRmax for aerobic, and 60-70% 1-RM for resistance. These sessions were performed 3x/week for 4 weeks. Measurement of body fat before-intervention and 24 hours after-intervention for 4 weeks using Seca mBCA 554. The one-way ANOVA test was utilized for statistical analysis, with a significance level of 5%. The findings demonstrated a significant reduction in body fat through all three forms of exercise, evident in the decrease in changes in body mass index, body weight, fat mass, and free fat mass ($p \leq 0.05$). Additionally, all three exercise modalities led to a significant increase in changes in skeletal muscle mass in comparison to the control group ($p \leq 0.05$). Our study results concluded that the combination type of exercise performed 3x/week for 4 weeks was more beneficial in lowering body fat and increasing muscle mass compared to aerobic exercise and resistance type exercise in obese young adult women.
Keyword: Body fat, combined training, obesity, sedentary, healthy lifestyle

Abstracto. Reducir el peso corporal y la grasa corporal es el objetivo principal para superar la obesidad. Se recomiendan modificaciones del estilo de vida con un enfoque no farmacológico basado en ejercicio físico programado para aumentar el gasto energético y reducir el peso y la grasa corporal. Este estudio tiene como objetivo analizar diferentes tipos de ejercicios para reducir y mantener la grasa corporal en mujeres adultas jóvenes con obesidad. Este estudio fue un ensayo controlado aleatorio (ECA) con un diseño experimental validado científicamente. Se reclutó a un grupo de 28 mujeres sedentarias con sobrepeso y se les proporcionaron regímenes de ejercicio aeróbico, de fuerza y mixto. Los programas de entrenamiento aeróbico, de resistencia y combinado se realizaron con una intensidad de 60-70% FCmáx para aeróbico y 60-70% de 1RM para resistencia. Estas sesiones se realizaron 3 veces por semana durante 4 semanas. Medición de la grasa corporal antes de la intervención y 24 horas después de la intervención durante 4 semanas utilizando Seca mBCA 554. Para el análisis estadístico se utilizó la prueba ANOVA unidireccional, con un nivel de significancia del 5%. Los hallazgos demostraron una reducción significativa de la grasa corporal mediante las tres formas de ejercicio, evidente en la disminución de los cambios en el índice de masa corporal, el peso corporal, la masa grasa y la masa grasa libre ($p \leq 0,05$). Además, las tres modalidades de ejercicio condujeron a un aumento significativo en los cambios en la masa del músculo esquelético en comparación con el grupo de control ($p \leq 0,05$). Los resultados de nuestro estudio concluyeron que el tipo combinado de ejercicio realizado 3 veces por semana durante 4 semanas fue más beneficioso para reducir la grasa corporal y aumentar la masa muscular en comparación con el ejercicio aeróbico y el ejercicio de resistencia en mujeres adultas jóvenes obesas.
Palabra clave: Grasa corporal, entrenamiento combinado, obesidad, sedentarismo, estilo de vida saludable

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Introduction

Obesity is a global health issue that must be addressed because it poses a risk for various diseases (Okati-Aliabad et al., 2022), such as cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), non-alcoholic fatty liver disease (NAFLD), coronavirus disease 2019 (COVID-19), polycystic ovarian syndrome (PCOS), and certain types of cancer(Kopelman et al., 2000; Stefan et al., 2021; Kolnes et al., 2021). Obesity-related health problems are primarily caused by an excess of body fat and low-grade chronic inflammation (Dai et al., 2022). As a result, special strategies that lead to the regulation of body fat deposits through a non-pharmacological approach based on programmed physical exercise are required to overcome obesity-related problems (Pranoto et al., 2023; Sugiharto et al., 2023). High body fat deposits have been correlated to a higher risk of death (Jayedi et al., 2022). This is due to the fact that obesity is linked to an increase in body fat, oxidative stress, and inflammatory markers (Soujanya & Jayadeep, 2022). Conversely, obesity is closely linked to atherogenic dyslipidemia, a phenotype characterized by lipid abnormalities that promote atherosclerosis, and it serves as a risk factor for cardiovascular disease on its own (Yudin et al., 2022). CVD refers to heart and blood vascular disorders. This includes coronary artery disorders such as angina and myocardial infarction, and also cardiovascular conditions such as hypertensive heart disease, stroke, ischemic heart disease, rheumatic heart disease, myocarditis, and cardiomyopathy (Li et al., 2021; Olvera Lopez et al., 2021). Therefore, reducing body weight and body fat is the primary goal for overcoming obesity (Butryn et al., 2022).

Lifestyle modifications with a non-pharmacological approach based on programmed physical exercise are recommended for increasing energy expenditure and reducing body weight and body fat (Rejeki et al., 2023; Kolnes et al., 2021; Pojednic et al., 2022; Susanto et al., 2023). This is due to the fact that exercise can trigger the Peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC-1α) pathway, which induces browning of white adipose tissue (WAT) by promoting the release of myokine derived from muscles, such as irisin (Boström et al., 2012; Lee et al., 2014; Merawati et al., 2023). Irisin is produced by the enzymatic cleavage of fibronectin type III domain-containing protein 5 (FNDC5). It serves to stimulates the expression of uncoupling protein 1 (UCP1) in white adipose tissue (WAT) while also inhibiting the differentiation of adipocytes (Boström et al., 2012; Zhang et al., 2016).

Various research have presented diverse findings concerning weight loss and body fat reduction in obese individuals. Previous study by Li et al. (2022), engaging in 8 weeks of aerobic exercise and resistance training has been shown to be an effective strategy for encouraging weight loss and subsequently reducing body fat mass. Another study carried out by Said et al. (2018), it was reported that aerobic exercise was more efficient in decreasing body fat, while resistance training was more efficient in enhancing muscle mass. According to the findings by Waters et al. (2022), it was discovered that a combination of aerobic and resistance training was beneficial in enhancing the physical and metabolic fitness levels of older adults with obesity, while also leading to a decrease in ectopic fat deposits. Based on this, our hypothesis is that diverse forms of exercise can elicit varying adaptations in reducing both body weight and body fat among individuals with obesity. The primary focus of this study is to investigate which exercise modality, conducted over a four-week period, is most effective in reducing body fat and enhancing muscle mass in obese young adult women. The research seeks to ascertain whether a combination type of exercise outperforms both aerobic exercise and resistance training in achieving these desired outcomes.

Material and Methods

Study participants

This research was carried out as a randomized controlled trial (RCT) with a true experimental design. A total of 28 sedentary obese women were recruited from several Universities in Malang City, Indonesia using leaflets and social media. The Helsinki Declaration principles were followed in this investigation, which was authorized by the Health Research Ethics Committee of the Faculty of Medicine at Universitas Airlangga with No: 283/EC/KEPK/FKUA/2021. A total of 56 respondents were invited to visit the research center at the Atlas Sports Club Malang Fitness Center, Indonesia. Before collecting data, the researcher thoroughly explained the purpose and research protocol. Participants signed a written informed consent form prior to registration. Six respondents declined to participate in this study, while 50 completed the initial examination, which included demographic, anthropometric, body composition, physical, and physiological tests. Twenty-two participants did not meet the inclusion criteria for sedentary obesity, so a total of 28 were invited to participate in this study. The procedure of research is displayed in Figure 1.

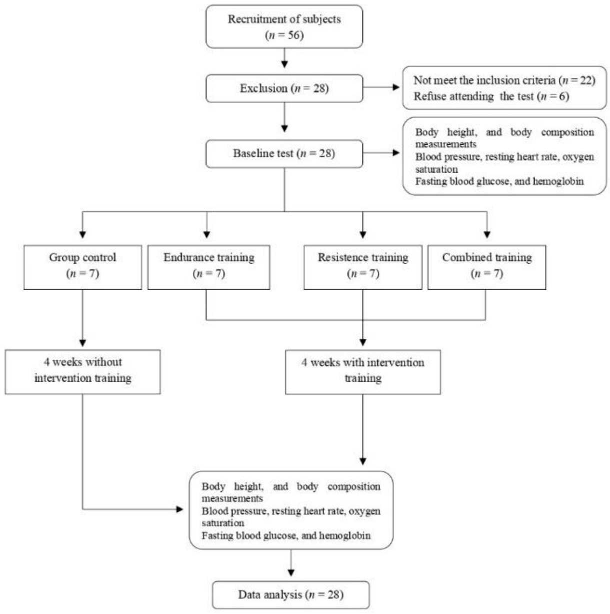

Figure 1. The flow chart of the experiment.

Body fat measurement

Body fat measurement were conducted using a Seca mBCA 554 (Body Composition Analyzer, Hammer Steindamm, Hamburg Germany) was carried out twice, once before-intervention and 1x24 hours after-intervention for 4 weeks. Seca mBCA is a multifrequency bioelectrical impedance analysis (BIA) device. This advanced instrument accurately measures various body composition parameters, including body weight, by employing multiple frequencies to analyze the impedance of different tissues. The use of the Seca mBCA ensured precise and reliable measurements of body weight throughout the study period (Lahav et al., 2021). Height measurements were taken using a portable stadiometer known as the Seca 213 (Seca 213, Hammer Steindamm, Hamburg Germany).

Statistic analysis

The Shapiro-Wilk test is used to determine the normality of the data distribution, while the Lavene' test. Was used to determine the homogeneity. The Paired Samples t-Test and One-way ANOVA parametric test was applied to see differences in all groups, while LSD post-hoc test was utilized to determine differences between groups. All statistical analyzes used the 5% significance level, and data are displayed by mean ± SD.

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Results

The findings of the baseline characteristics analysis (demographic, anthropometric, and physiological data) did not show a significant difference between groups (Table 1). Figure 2 depicts the findings of the analysis of body fat before and after intervention in each research group. Meanwhile, the findings of the body fat analysis between groups are shown in Table 2, and the examination of the relationship between skeletal muscle mass and body fat is shown in Table 3.

Table 1.
Baseline characteristics in all subjects before intervention

Parameters	CG (*n* = 7)	ATG (*n* = 7)	RTG (*n* = 7)	CTG (*n* = 7)	p-value
Age (yrs)	22.29±1.70	21.71±1.79	21.72±1.38	22.14±1.07	0.850
BW (kg)	73.14±8.47	73.73±9.73	73.66±8.67	74.81±12.20	0.991
BH (m)	1.56±0.06	1.55±0.07	1.54±0.06	1.57±0.05	0.892
BMI (kg/m^2)	29.30±3.17	30.26±3.42	30.73±3.58	30.65±3.40	0.853
SBP (mmHg)	113.43±7.76	111.00±8.93	113.42±10.82	114.57±6.75	0.889
DBP (mmHg)	77.57±8.36	78.57±8.62	81.72±8.90	82.57±4.79	0.584
RHR (bpm)	77.14±10.78	79.00±4.97	82.57±8.44	82.71±6.02	0.480
SpO_2 (%)	98.28±0.49	97.57±0.98	97.86±1.07	98.00±1.41	0.639
BT (°C)	36.04±0.23	36.29±0.22	36.26±0.24	36.11±0.17	0.148
FBG (mg/dL)	89.57±6.24	92.57±5.09	90.14±6.84	93.00±5.51	0.634
Hb (g/dL)	15.84±1.32	15.09±1.22	15.70±1.51	16.36±2.08	0.517

Description: BH: Body height; BMI: Body mass index; BT: Body temperature; BW: Body weight; DBP: Diastolic blood pressure; FBG: Fasting of blood glucose; Hb: Hemoglobin; RHR: Resting heart rate; SBP: Systolic blood pressure; SpO_2: Oxygen saturation. CG: Control group; ATG: Aerobic training group; RTG: Resistance training group; CTG: Combined training groups. Data are presented by mean ± SD. *p*-value obtained by one-way ANOVA.

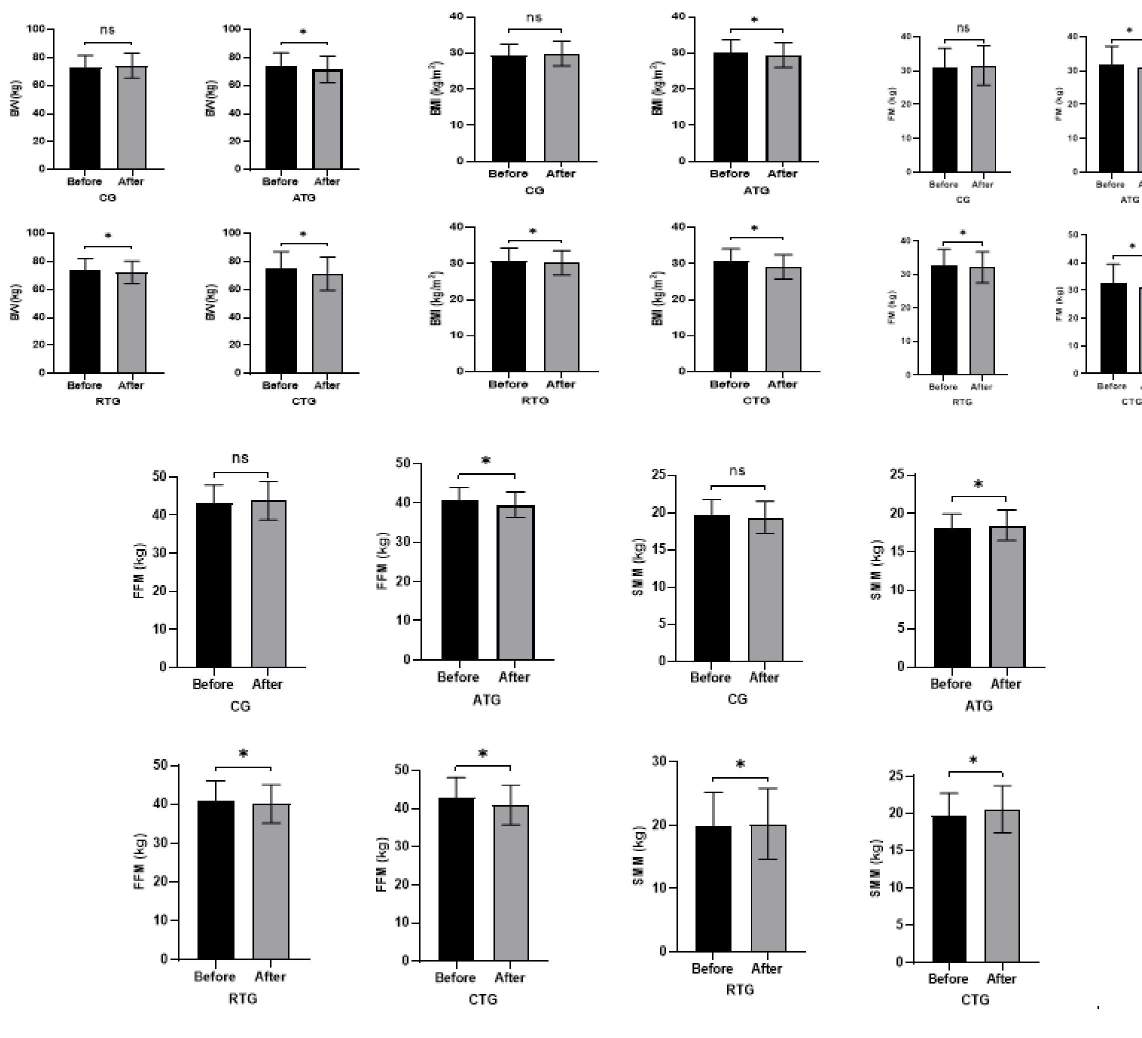

Figure 2. The analysis of body fat between before- and after-intervention in each study group
Description: *p*-value obtained by Paired Samples t-Test. (ns) Not significant ($p \geq 0.05$). (*) Significant at before ($p \leq 0.001$).

Table 2.
The results of the analysis of body fat between groups

Parameters	CG (*n* = 7)	ATG (*n* = 7)	RTG (*n* = 7)	CTG (*n* = 7)	p-value
Before-BW (kg)	73.14±8.47	73.73±9.73	73.66±8.67	74.81±12.20	0.991
After-BW (kg)	74.22±8.87	71.62±9.61	72.24±8.21	71.41±11.92	0.947
Delta-BW (kg)	1.09±1.73	-2.11±0.35^	-1.42±0.58^	-3.40±0.50^†$	0.000
Before-BMI (kg/m²)	29.30±3.17	30.26±3.42	30.73±3.58	30.65±3.40	0.853
After-BMI (kg/m²)	29.91±3.39	29.52±3.44	30.17±3.40	29.05±3.42	0.932
Delta-BMI (kg/m²)	0.61±0.88	-0.74±0.29^	-0.56±0.26^	-1.61±0.71^†$	0.000
Before-FM (kg)	31.04±5.61	31.79±5.40	32.74±4.86	32.47±7.01	0.947
After-FM (kg)	31.52±5.88	30.88±5.32	32.11±4.66	30.99±6.78	0.976
Delta-FM (kg)	0.48±0.73	-0.91±0.17^	-0.63±0.26^	-1.48±0.31^†$	0.000
Before-FFM (kg)	43.19±4.79	40.69±3.26	40.92±5.16	42.92±5.29	0.659
After-FFM (kg)	43.83±5.02	39.53±3.23	40.14±4.94	40.96±5.22	0.344
Delta-FFM (kg)	0.64±1.03	-1.17±0.19^	-0.79±0.32^	-1.95±0.24^†$	0.000
Before-SMM (kg)	19.63±2.15	17.98±1.96	19.79±5.38	19.67±3.07	0.722
After-SMM (kg)	19.36±2.16	18.51±1.99	20.19±5.60	20.61±3.14	0.694
Delta-SMM (kg)	-0.28±0.46	0.53±0.09^	0.40±0.24^	0.94±0.13^†$	0.000

Description: *p*-value obtained by One-way ANOVA and LSD post-hoc test. Data are presented by mean ± SD. (^) Significant at CG ($p \leq 0.001$). (†) Significant at ATG ($p \leq 0.001$). ($) Significant at RTG ($p \leq 0.001$).

Table 3.
The analysis of the relationship between skeletal muscle mass and body fat

Δ Body Fat	Δ SMM (kg)	
	r	*p*-value
Δ BW (kg)	-0.993**	$p \leq 0.001$
Δ BMI (kg/m²)	-0.911**	$p \leq 0.001$
Δ FM (kg)	-0.989**	$p \leq 0.001$
Δ FFM (kg)	-0.994**	$p \leq 0.001$

(**) Significant with $p \leq 0.001$.

Discussion

According to the study's findings, aerobic and resistance exercise combination was more effective in lowering body fat and enhancing skeletal muscle mass in obese young adult women than aerobic and resistance training. These results align with the study of Wang et al. (2022), which reported that the most effective modality for increasing the quality of body composition and lowering inflammation in overweight and obese people is a combination of exercise. In contrast, Lopez et al. (2022) discovered that therapies that combined both resistance training and calorie restriction were the most effective in lowering the percentage of body fat and total body fat mass when compared to the control group. Zhu et al. (2022) reported that the implementation of various exercise types, including aerobic, resistance, and combined training, has been linked to noteworthy reductions in body weight, waist circumference, and total fat. However, several other studies agree that combined exercise is an effective exercise intervention in reducing body weight and body fat (Li et al., 2022; Waters et al., 2022).

Overcoming the problem of obesity and the risk of complications can be accomplished through lifestyle modification such as reducing calorie intake from one's diet while simultaneously increasing calorie expenditure through higher levels of physical activity (Pojednic et al., 2022; Sugiharto et al., 2023). The management of health concerns such as obesity, inflammation, and metabolic disorders is heavily influenced by dietary choices (Álvarez-Herrero et al., 2022). Carbohydrate and lipid oxidation considerably adds to energy requirements during physical activity (Sharma & Agarwal, 2022). Muscle contractions during exercise play a crucial role in reducing body fat by boosting glucose uptake and enhancing blood flow (Cohen et al., 2022). Exercise increases the activation of AMP-activated protein kinase (AMPK) (Spaulding & Yan, 2022). AMPK is involved in cellular activities such as autophagy and cell polarity, as well as regulating growth and reprogramming metabolism (Mihaylova & Shaw, 2011). Through signaling activated by Fibroblast growth factor 21 (FGF-21), irisin, and PGC-1α, the body can increase energy consumption during exercise by increasing mitochondrial energy producers in muscles (Alizadeh Pahlavani, 2022).

Resistance training has been associated with muscle hypertrophy (Bernárdez-Vázquez et al., 2022). In regular resistance training, two primary principles for encouraging ongoing muscle adaptation are progressive overload and variation (Kassiano et al., 2022). Progressive overload is defined as a constant rise in the stress on the body, whereas variety is defined as the systematic adjustment of one or more factors in a resistance training program, such as intensity and volume. Participating in a suitable level of exercise intensity holds the potential to yield health advantages with considerable effects (Donate et al., 2023). While variations in intensity and volume have been extensively researched as variables for systematic adjustments, it is crucial to remember that variety in resistance training can also be reached by modifying other aspects such as exercise selection (Evans, 2019; Fisher et al., 2018). Using diverse exercise, such as exercise variants, as a way to target several locations within a muscle group, including separate muscle heads or even distinct section with a single muscle, has been proposed. This method may maximize the potential for muscle growth. Furthermore, variation of exercise can optimize nerve impulses to active muscles, resulting in greater strength gains (Carvalho et al., 2021; Stone et al., 2000).

Overweight or obese individuals often choose to participate in aerobic exercise as a means to reduce fat mass and, consequently, enhance their overall body composition. Nevertheless, it is s important to note that aerobic exercise often results in the reduction of fat mass, but it may also lead to notable decreases in muscle strength and muscle mass (Villareal et al., 2017). Resistance training, being an anaerobic form of exercise, can boost muscle strength by enhancing muscle performance. Furthermore, it not only eliminates fat mass but also boosts lean body mass, which has the ability to increase an individual's absolute strength (Shaibi et al., 2006; McGuigan et al., 2009). Therefore, combining the two types of exercise is effective for reducing body fat and increasing muscle mass. We also identified changes in muscle mass. The results indicate that combination exercises are more effective than either resistance exercise or aerobic training alone when it comes to increasing skeletal muscle mass in obese women. This suggests that such combined exercises may offer valuable solutions for addressing musculoskeletal issues associated with obesity (Ghiotto et al., 2022). Several limitations should be acknowledged in interpreting the findings of this study. The relatively small sample size of 28 sedentary overweight women may impact the generalizability of the results to broader populations. Additionally, the short intervention period of four weeks may have limitations in capturing long-term effects of the exercise modalities. Longer-term studies with larger and more diverse participant groups would be beneficial for a more comprehensive understanding of the sustained impact of these exercise programs on body composition. Despite these limitations, the study provides valuable insights into the immediate effects of aerobic, resistance, and combined training on body fat and muscle mass in obese young adult women.

Conclusion

According to the study's findings, the type of combination exercise performed 3x/week for 4 weeks was more effective in reducing body fat and increasing skeletal muscle mass in obese young adult women than aerobic and resistance training. As a result, combined exercise can be used to reduce and maintain body fat in obese young adult women.

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Declaration of competing interest

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

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