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Impact of 8-week combined training on anthropometric and body composition parameters in young women with obesity

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Abstract

Introduction. **Obesity has become a global health issue with a continually increasing prevalence. Developing strategies for managing obesity remains a key concern to mitigate the adverse effects associated with it.** Aim of Study. **This study aims to demonstrate the effectiveness of a combined resistance-endurance training program in improving anthropometry and body composition among women with obesity.** Material and Methods. **A total of 30 obese women with a mean age of 22.60 ± 1.48 years and body mass index (BMI) 29.08 ± 2.82 kg/m^2 were randomly selected to participate in this study and divided into two groups: control group (CTL, n = 15) and combined training group (CTR, n = 15). The combined training was applied at a moderate intensity with a frequency of 3 sessions per week for 8 weeks. Anthropometric and body composition assessments were conducted before and after the intervention program. Statistical analysis was performed using parametric tests, specifically the paired samples t-test and independent samples t-test, with a significance level of 95%.** Results. **The results indicated significant reductions in weight, BMI, waist-to-hip ratio (WHR), body fat (BF), and body fat percentage (BFP), along with an increase in skeletal muscle (SM) mass after the combined training intervention ($p \leq 0.05$). We also observed delta (Δ) and changes (%) in weight reduction, BMI, WHR, BF, BFP, and SM mass increase between groups ($p \leq 0.05$).** Conclusions. **These findings demonstrate that an 8-week combined training intervention effectively improves anthropometry and body composition in women with obesity, as evidenced by reductions in body weight, BMI, WHR, BF, BFP, and increases in SM mass.**

KEYWORDS: obesity, anthropometry, combined training, body composition, metabolic health.

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Introduction

Obesity has emerged as a global health problem with an increasing prevalence, particularly among women [1]. In 2022, the World Health Organization (WHO) reported that a total of 2.5 billion adults over the age of 18 had excess body weight, with more than 890 million living with obesity [2]. This statistic indicates that 43% of adults (43% men and 44% women) carry excess body weight, an increase from 25% in 1990 [2]. Obesity is a well-known risk factor for various chronic diseases, including type 2 diabetes, cardiovascular disease, and hypertension [3]. The incidence of obesity in adult women in Indonesia has also been increasing every year, mainly because of physical inactivity, consumption of unhealthy food, as well as genetic and hormonal factors [4].

Obesity is characterized by an abnormal or excessive accumulation of body fat (BF), which may be directly determined by BF and body fat percentage (BFP) [5]. It is not just a physical health-induced condition, but it also disrupts mental health and, ultimately, the quality of life [6]. A gradual loss of BF is an essential objective in weight loss programs for individuals with obesity [7]. Maintaining metabolic health is necessary, not only for reducing total body mass but also for improving body composition through an increased proportion of lean mass [8].

Physical exercise is one of the common approaches used to reduce BF [9]. The American College of Sports Medicine recommends structured physical training, including resistance and endurance training, as effective in reducing BF and improving body composition [10]. Resistance training increases skeletal muscle (SM) mass and metabolic rate [11], while endurance training enhances cardiovascular capacity and facilitates greater caloric expenditure [7]. Combining these two types of exercise in weight loss programs is generally believed to yield better outcomes than either modality alone. Although several studies support the superior benefits of combined training for adults with obesity [10], other research has reported inconsistent or minimal effects [9, 12-13], suggesting that its effectiveness may vary depending on individual characteristics or program design.

Resistance training induces activation of the mechanistic target of rapamycin pathway, leading to muscle protein synthesis while endurance training activates peroxisome proliferator-activated receptor gamma coactivator-1 alpha (PGC-1α) and adenosine monophosphate-activated protein kinase (AMPK), which in turn increases fat oxidation [14-15]. Endurance training increases mitochondrial mass and function to promote fat oxidation [16]. Through these biological adaptations, combined training programs are anticipated to accelerate BF reduction more efficiently than other training methods [17].

Aim of Study

This study emphasizes the effects of exercise on reducing BF and provides concrete evidence of improvements in anthropometry and body composition in individuals with obesity. Therefore, the focus of this study is to investigate the impact of combined resistance-endurance training on anthropometry and body composition, specifically in terms of weight reduction, body mass index (BMI), waist-to-hip ratio (WHR), BF, BFP, and SM mass increase among women with obesity. The objective of this study is to validate the effectiveness of a combined resistance-endurance training program in improving anthropometry and body composition in women with obesity.

Material and Methods

Study design and participants' characteristics

This study employed a true experimental, pretest–posttest control group (CTL) design. The study involved female university students with obesity residing in Malang. Recruitment was conducted via social media platforms, including Instagram, Facebook, Twitter, and WhatsApp, by distributing flyers from June 1, 2024 to June 30, 2024. A total of 45 participants registered and underwent initial anthropometric and body composition assessments. Fifteen participants did not meet the inclusion criteria. A total of 30 women with obesity met the inclusion criteria, with the following characteristics (mean ± SD): age 22.60 ± 1.48 years, BMI 29.08 ± 2.82 kg/m², body fat percentage 33.29 ± 3.18%, systolic/diastolic blood pressure 112.60 ± 5.01 / 73.27 ± 5.08 mmHg, resting heart rate 74.80 ± 5.61 bpm, oxygen saturation 97.80 ± 1.09%, fasting blood glucose 90.30 ± 5.59 mg/dL, and hemoglobin 15.65 ± 1.82 g/dL and they were randomly allocated into two equal (n = 15) groups: CTL and combined training group (CTR). The above parameters were measured using validated digital instruments: Omron HEM-7130 (blood pressure and heart rate), Yonker YK-82C fingertip oximeter (oxygen saturation), a digital thermometer (body temperature), Accu-Chek Performa (fasting blood glucose), and Mission Plus Hb meter (hemoglobin). Physical activity and diet outside the intervention were not strictly controlled, but all participants were instructed to maintain their usual routines and dietary patterns throughout the study period. This study was not registered as a clinical trial in a national or international database due to resource limitations and the pilot-scale nature of the research; however, ethical clearance was obtained. All procedures applied in this study have complied with the World Medical Association Declaration of Helsinki and were approved by the Ethics Committee of Universitas Negeri Malang, Indonesia, on June 20, 2024 (20.06.9/UN32.14.2.8/LT/2024).

Combined training protocol

Participants in the CTR group engaged in exercise sessions three times a week for 8 weeks, on Tuesdays, Thursdays, and Saturdays at Atlas Sports Club Malang, East Java (Indonesia). Each session comprised a combination of resistance training (Cybex – Life Fitness: lat pulldown, chest press, shoulder press, leg extension, leg press, hip abduction) and endurance training (treadmill) (Table 1). In the first week, each endurance training session lasted 40 minutes and gradually increased to 60 minutes. Resistance training was performed with 4–6 sets of 12-15 repetitions. The overall training intensity was moderate (60-70% of one-repetition maximum [1RM] for resistance and 60-70% of maximum heart rate [HRmax] for endurance). Each participant was accompanied by a personal trainer to assist and monitor exercise movements throughout the session. Attendance was recorded in a logbook, and participants were considered compliant if they attended at least 85% of the sessions (i.e., minimum 20 out of 24 sessions). Those who missed more than four sessions without valid reasons were excluded from the analysis. Participants in the CTL group were asked to continue with their usual activities and were not provided with any specific exercise intervention.

Body composition and anthropometry measurements

Body composition measurements, including BF, BFP, and SM, were obtained using the TANITA DC-360 body composition analyzer (TANITA Corporation of America, Inc., IL 60005, USA). Anthropometric measurements, including height, weight, and BMI, were assessed using the TANITA WB 380 H (TANITA Corporation, Tokyo, Japan). The WHR was calculated by dividing the waist circumference by the hip circumference using the same unit of measurement for both. Anthropometric and body composition assessments were conducted at baseline (pre) and at week 8 (post) in both groups.

Statistical analysis

All statistical analyses were performed using SPSS for Windows, version 21 (SPSS Inc., Chicago, IL, USA). Data normality was evaluated using the Shapiro–Wilk test. Parametric tests, specifically the paired samples

Table 1. Combined training program details

Group	Frequency	Intensity	Type	Time	Warm-up	Cooldown
Combined training	Week 1-2 Three times a week for 8 weeks	60% 1RM	Resistance training [lat pulldown, chest press, shoulder press, leg extension, leg press, hip abduction]	4 sets of 12-15 repetitions	Dynamic stretching for 5 min	Running at low intensity for 5 min
		60% HRmax	Endurance training (treadmill)	40 min		
	Week 3-4 Three times a week for 8 weeks	65% 1RM	Resistance training [lat pulldown, chest press, shoulder press, leg extension, leg press, hip abduction]	5 sets of 12-15 repetitions	Dynamic stretching for 5 min	Running at low intensity for 5 min
		65% HRmax	Endurance training (treadmill)	45 min		
	Week 5-6 Three times a week for 8 weeks	65% 1RM	Resistance training [lat pulldown, chest press, shoulder press, leg extension, leg press, hip abduction]	6 sets of 12 repetitions	Dynamic stretching for 5 min	Running at low intensity for 5 min
		65% HRmax	Endurance training (treadmill)	50 min		
	Week 7-8 Three times a week for 8 weeks	70% 1RM	Resistance training [lat pulldown, chest press, shoulder press, leg extension, leg press, hip abduction]	6 sets of 15 repetitions	Dynamic stretching for 5 min	Running at low intensity for 5 min
		70% HRmax	Endurance training (treadmill)	60 min		
Control	Without training intervention for 8 weeks					

Note: 1RM – one-repetition maximum, HRmax – maximum heart rate t-test, were used to assess changes in anthropometry and body composition from baseline (pre) to week 8 (post) within each group, while independent samples t-tests were applied to evaluate differences in anthropometry and body composition between groups (CTL vs CTR) at a 95% significance level. Effect sizes (ES) were calculated using Cohen's d, which classifies ES as small (d = 0.2), medium (d = 0.5), and large (d ≥ 0.8) [18].

Results

In this study, the attendance rate was 100%, and the dropout rate was 0%. Participant characteristics are presented in Table 2. Table 2 shows no significant differences in age, BMI, resting heart rate, blood pressure, oxygen saturation, body temperature, fasting blood glucose, and hemoglobin levels, with all analyses yielding $p \geq 0.05$ (Table 2). Meanwhile, anthropometric and body composition assessments before and after training are presented in Table 3 and Figure 1.

There were significant differences between pre and post for the CTR in body weight (ES: 0.165), BMI (ES: 0.212), WHR (ES: 0.392), BF (ES: 0.313), BFP (ES: 0.581), and SM mass (ES: 0.509) ($p \leq 0.05$) (Figure 1). Meanwhile, in the CTL no differences were observed in

Table 2. General characteristics of participants

Parameters	CTL (n = 15)	CTR (n = 15)	p-value Independent samples t-test
Age, yrs	22.20 ± 1.52	23.00 ± 1.36	0.141
Height, m	1.54 ± 0.06	1.55 ± 0.04	0.750
Body weight, kg	69.61 ± 9.69	69.76 ± 8.21	0.965
BMI, kg/m2	29.09 ± 2.65	29.08 ± 3.07	0.991
Resting heart rate, beats/min	74.50 ± 3.75	75.10 ± 7.15	0.776
Systolic blood pressure, mmHg	111.90 ± 5.19	113.30 ± 4.89	0.454
Diastolic blood pressure, mmHg	72.53 ± 5.34	74.00 ± 4.88	0.439
SpO_2, %	97.73 ± 1.16	97.87 ± 1.06	0.745
BT, °C	35.24 ± 1.28	35.39 ± 1.24	0.742
FBG, mg/dL	89.13 ± 6.12	91.47 ± 4.96	0.261
Hb, g/dL	15.99 ± 2.04	15.31 ± 1.57	0.311

Note: BMI – body mass index, SpO_2 – oxygen saturation, BT – body temperature, FBG – fasting blood glucose, Hb 2 – hemoglobin, CTL – control group, CTR – combined training group
All data are presented as mean ± SD.

Table 3. Anthropometry and body composition assessments at CTL and CTR

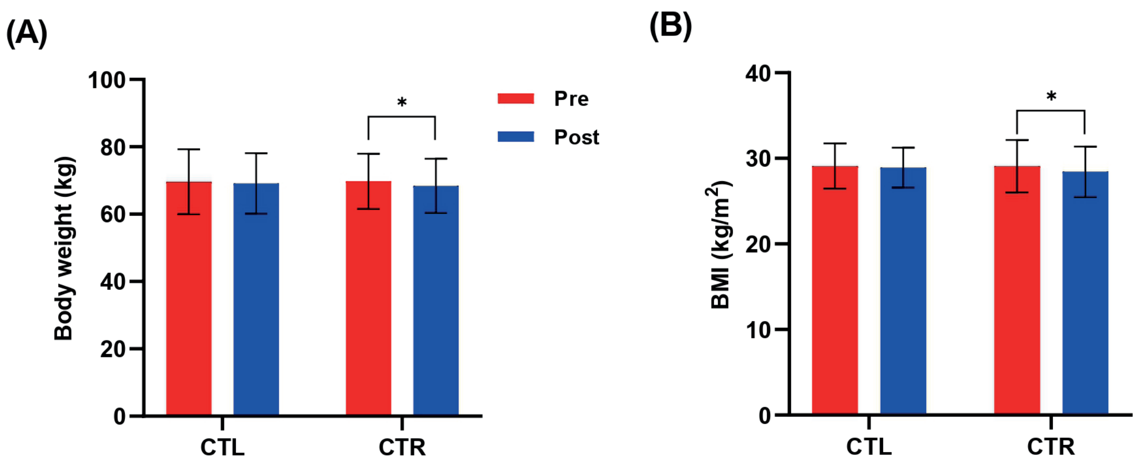
Parameters	CTL (n = 15)	CTR (n = 15)	Mean difference	95% CI		p-value	ES
				lower	upper		
Pre-BW, kg	69.61 (9.69)	69.76 (8.21)	−0.15 (3.28)	−6.87	6.57	0.965	0.016
Pre-BMI, kg/m^2	29.09 (2.65)	29.08 (3.07)	0.01 (1.05)	−2.13	2.16	0.991	0.004
Pre-BF, kg	24.09 (7.02)	23.33 (3.57)	0.75 (2.03)	−3.41	4.92	0.714	0.135
Pre-BFP, %	33.29 (4.17)	33.30 (1.89)	0.00 (1.18)	−2.42	2.42	0.999	0.003
Pre-WHR	0.82 (0.07)	0.79 (0.05)	0.03 (0.02)	−0.02	0.08	0.285	0.398
Pre-SM, kg	24.11 (3.85)	24.51 (2.63)	−0.39 (1.21)	−2.86	2.07	0.746	0.119
Post-BW, kg	69.16 (8.99)	68.41 (8.08)	0.75 (3.12)	−5.65	7.14	0.813	0.087

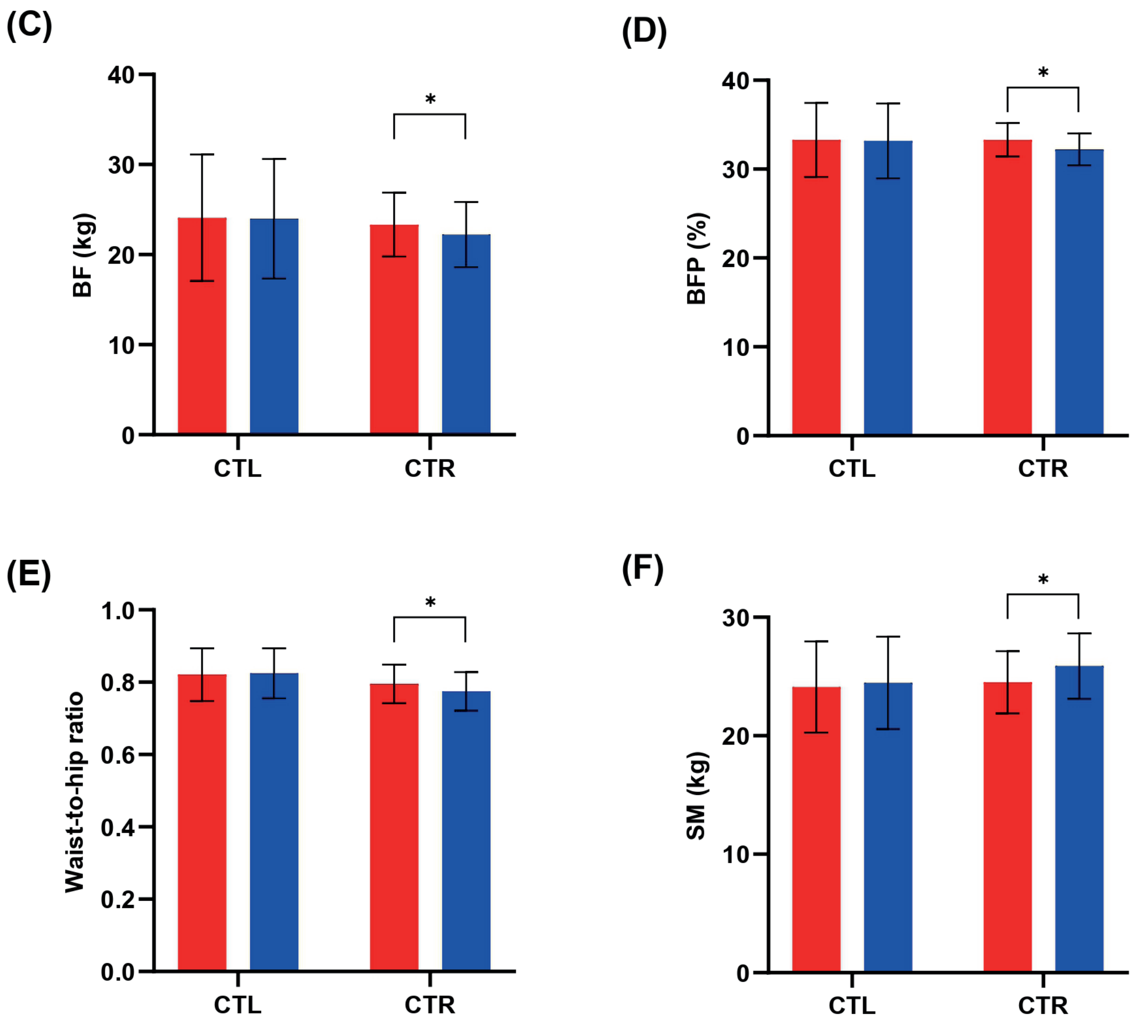
Post-BMI, kg/m²	28.92 (2.33)	28.44 (2.96)	0.49 (0.97)	−1.51	2.47	0.625	0.181
Post-BF, kg	23.97 (6.64)	22.21 (3.63)	1.77 (1.95)	−2.23	5.77	0.373	0.331
Post-BFP, %	33.17 (4.23)	32.22 (1.82)	0.95 (1.19)	−1.48	3.39	0.429	0.293
Post-WHR	0.83 (0.07)	0.78 (0.05)*	0.05 (0.02)	0.01	0.09	0.035	0.811
Post-SM, kg	24.45 (3.89)	25.88 (2.76)	−1.43 (1.23)	−3.95	1.09	0.257	0.422
Δ-BW, kg	−0.45 (1.33)	−1.35 (0.87)*	0.89 (0.41)	0.05	1.73	0.039	0.795
Δ-BMI, kg/m²	−0.17 (0.73)	−0.64 (0.43)*	0.47 (0.22)	0.02	0.92	0.042	0.787
Δ-BF, kg	−0.11 (1.06)	−1.13 (0.52)*	1.01 (0.31)	0.39	1.64	0.002	1.215
Δ-BFP, %	−0.12 (1.04)	−1.07 (0.43)*	0.95 (0.29)	−1.48	3.38	0.003	1.204
Δ-WHR	0.01 (0.01)	−0.02 (0.01)*	0.03 (0.01)	0.02	0.03	0.000	2.255
Δ-SM, kg	0.34 (0.69)	1.37 (0.59)*	−1.03 (0.23)	−1.51	−0.55	0.000	1.615
Change-BW, %	−0.51 (2.01)	−1.93 (1.26)*	1.42 (0.61)	0.17	2.67	0.029	0.847
Change-BMI, %	−0.48 (2.53)	−2.18 (1.46)*	1.70 (0.75)	0.16	3.25	0.032	0.824
Change-BF, %	0.07 (4.74)	−4.93 (2.32)*	5.01 (1.36)	2.22	7.79	0.001	1.342
Change-BFP, %	−0.37 (3.15)	−3.21 (1.25)*	2.84 (0.87)	1.06	4.64	0.003	1.188
Change-WHR	0.51 (0.45)	−2.64 (0.91)*	3.15 (0.51)	2.11	4.19	0.000	4.396
Change-SM, %	1.42 (2.91)	5.63 (2.35)*	−4.22 (0.97)	−6.19	−2.24	0.000	1.594

Note: BW – body weight, BMI – body mass index, BF – body fat, BFP – body fat percentage, WHR – waist-to-hip ratio, SM – skeletal muscle mass, CTL – control group, CTR – combining training group, 95%, CI – 95% confidence interval, ES – effect size
All data are presented as mean ± SD.
* significantly different from the CTL at $p \leq 0.05$
Δ (post – pre)

body weight, BMI, WHR, BF, and BFP, and SM mass between pre and post (all $p \geq 0.05$) (Figure 1).

No differences were observed in body weight, BMI, WHR, BF, and BFP, and SM mass between CTR and CTL in pre and post (all $p \geq 0.05$) (Table 3). However, we observed there were significant differences between the groups (CTR vs CTL) in (Δ) body weight (ES: 0.795), BMI (ES: 0.787), WHR (ES: 2.255), BF (ES: 1.215), BFP (ES: 1.204), and SM mass (ES: 1.615) ($p \leq 0.05$) (Table 3). We also observed significant differences between groups (CTR vs CTL) in change (%) of body weight (ES: 0.847), BMI (ES: 0.824), WHR (ES: 4.396), BF (ES: 1.342), BFP (ES: 1.188), and SM mass (ES: 1.594) ($p \leq 0.05$) (Table 3).





CTL – control group, CTR – combined training group, (A) body weight assessment, (B) BMI – body mass index assessment, (C) BF – body fat assessment, (D) BFP – body fat percentage assessment, (E) waist-to-hip ratio assessment, (F) SM – skeletal muscle mass assessment
All data are presented as mean ± standard deviation (SD).
* significantly different from the CTL at $p \leq 0.05$

Figure 1. Anthropometry and body composition assessment at baseline (pre) and week 8 (post) in each groups

Discussion

This study aims to analyze the impact of 8-week combination training on anthropometric parameters and body composition in young women with obesity. Our main finding is that combined resistance-endurance training can significantly improve anthropometry and body composition in young women with obesity. It improved anthropometry and body composition, including weight loss, BMI, WHR, BF, and BFP, and increased SM mass compared to the CTL. Our findings are in accordance with earlier investigations [12, 19-20], which have shown that supervised exercises, both aerobic and resistance, reduce BF mass in patients with obesity. Likewise, the recent study by Pranoto et al. found that combined training significantly improved body composition, characterized by decreased BF and increased SM mass in women with obesity [21]. Sugiharto et al. additionally reported reductions in BFP, total BF, BMI, and increased SM mass after 8 weeks of combined training among subjects with obesity [22].

The changes in anthropometry and body composition reported in our study may have resulted from the 8-week combined resistance-endurance training program. Through the mTOR pathway activation, resistance training increases SM mass by promoting muscle protein synthesis [11]. This increase in SM mass can increase basal metabolic rate, allowing the body to burn more calories at rest [14]. On the other hand, endurance training enhances fat oxidation by activating the PGC-1α and AMPK pathways, making the body more efficient in utilizing fat as an energy source [15]. The combination of these two training types achieves a more optimal reduction in BF than aerobic or resistance training alone.

The reduction in BFP in this study also suggests substantial improvements in anthropometry and body composition. BFP reflects the proportion of fat relative to total body weight, and a decrease in BFP indicates that this training program not only reduced overall body weight but also effectively targeted BF specifically [13]. Endurance training burns calories during exercise, while resistance training increases metabolism after exercise (afterburn effect), providing additional benefits in BF reduction [7].

The observed increase in lean mass is another significant finding. Lean mass includes muscle, bone, and body fluids, and the increase in lean mass is closely related to muscle growth from resistance training [8]. Skeletal muscle mass, which substantially contributes to basal metabolic rate, plays a crucial role in sustaining long-term weight control [23]. Thus, the combined resistance-endurance training not only reduces BF but also helps maintain and improve lean body components, which are vital for overall metabolic health. The significant weight loss observed in this study underscores the effectiveness of combined resistance-endurance training in creating a caloric deficit. Endurance training directly burns calories, while resistance training contributes to an increased metabolism that lasts beyond the exercise session [24]. This synergistic effect is ideal for sustainable and healthy body mass reduction through fat mass loss and maintaining and possibly even increasing your muscle mass [25].

This program included a mix of endurance and moderate-intensity resistance training, engaging major muscle groups. Although the program was neither lengthy nor overly intense, it led to valuable physiological changes, such as increased calorie burning, muscle protein synthesis, and efficient fat metabolism. Additionally, factors beyond exercise, like diet and daily activity levels, also influence outcomes. While reps and sets weren't tightly controlled, the benefits of pairing training with a healthy diet can't be overlooked [26]. Hence, it is suggested that this training program should be accompanied by nutritional guidance to support weight loss and body composition improvement.

While the combined resistance-endurance training program could provide long-term effects that are sustainable, especially for basal metabolism and cardiovascular capacity [27], significant adaptations in exercise duration and intensity are required to avoid overtraining and to maintain a proper balance between exercise and recovery. Regular monitoring and individualized program adjustments are essential for both sustaining achieved results and preventing maladaptive responses, such as non-functional overreaching or overtraining [28-29]. To ensure long-term sustainability, it is advisable that the program be continued beyond the initial 8-week period through structured periodization, including alternating phases of progressive overload, active recovery, and maintenance. This strategy can prevent plateaus and overtraining while encouraging consistent progress. In real-world settings, regular re-assessments and individualized modifications based on participants' fitness levels and goals are essential to maintain engagement and maximize outcomes. Moreover, alternative training formats – such as high-intensity interval training, circuit training, bodyweight resistance training, or home-based routines – may be employed in situations where access to gym equipment is limited. These formats offer similar benefits in improving body composition and may increase adherence due to their accessibility and time efficiency. Although the program offers promising implications for obesity management, its interpretation must be tempered by several limitations. Notably, the lack of stringent dietary control among participants introduces a potential confounding variable, warranting the implementation of standardized nutritional guidelines in future research. The brevity of the intervention period further restricts conclusions regarding long-term efficacy; thus, extended trials are necessary to confirm lasting effects. The homogeneity of teh sample – composed solely of young women with obesity – limits the applicability of findings to broader populations, including males, older adults, and individuals with chronic metabolic conditions. Consequently, more inclusive studies are recommended. Additionally, careful monitoring of adverse outcomes, such as injury or psychological distress, should be prioritized in future iterations to ensure safety and feasibility of the intervention over time.

Conclusions

This study demonstrates that an 8-week combined resistance and endurance training program, conducted three times per week, effectively improves anthropometric and body composition parameters in young women with obesity. The intervention led to significant reductions in body weight, BMI, WHR, total BF, and BFP, along with an increase in SM mass. These findings offer practical implications for the development of time-efficient and accessible exercise strategies for obesity management in women. The combined training model can serve as a foundational framework for health professionals and fitness practitioners designing targeted interventions for this population. Future research should explore the long-term sustainability of the observed changes, the effects of varying training intensities and durations, and potential benefits in diverse populations, including different age groups and individuals with obesity-related comorbidities. Additionally, integrating dietary control or psychological well-being assessments could provide a more holistic understanding of the effectiveness of the intervention.

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Conflict of Interest
The authors declare no conflict of interest.

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