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Circuit Weight Training versus Walking Exercise for Weight Reduction in Obese Female Students

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Abstract

Background: Obesity among university students has increased substantially and is associated with higher cardiometabolic risk. Although exercise interventions are recommended for weight management, comparative evidence between circuit-based resistance training and walking exercise in obese female students remains limited.

Objective: To compare the effectiveness of Circuit Weight Training (CWT) and Walking Exercise (WE) on weight reduction in obese female university students.

Methods: A quasi-experimental pretest–posttest two-group study was conducted among 30 obese female university students aged 18–25 years. Participants were allocated alternately into either the CWT group (n = 15) or the WE group (n = 15). Both groups completed supervised exercise sessions three times weekly for six weeks. Body weight was measured at baseline, week 3, and post-intervention using a calibrated digital scale under standardized conditions. Statistical analyses included Repeated Measures ANOVA, Friedman test, and Independent t-test with $p < 0.05$. Mean differences, 95% confidence intervals (CI), and effect sizes were reported.

Results: Both interventions significantly reduced body weight (CWT: $p < 0.001$; WE: $p < 0.001$). The CWT group demonstrated greater weight reduction than the WE group (7.18 ± 1.26 kg vs 3.99 ± 0.60 kg). Between-group analysis showed a significant mean difference of 3.19 kg (95% CI: 2.45–3.93; $p < 0.001$) with a large effect size (Cohen's d = 3.23). All participants completed the intervention.

Conclusion: Both interventions were effective for weight reduction; however, CWT demonstrated greater effectiveness within the limitations of a quasi-experimental design.

Keywords
Circuit Weight Training; Walking Exercise; Obesity; Weight Reduction; Exercise Therapy

Introduction

Obesity is a chronic multifactorial condition characterized by excessive fat accumulation that increases the risk of metabolic, cardiovascular, musculoskeletal, and psychosocial disorders.[1] The prevalence of obesity has increased substantially worldwide and has become a major public health concern among young adults, including university students.[2] Sedentary lifestyles, reduced physical activity, irregular dietary habits, prolonged screen exposure, and academic stress contribute significantly to positive energy balance and progressive weight gain in university populations.[3–4] Recent evidence has shown that obesity during young adulthood is associated with increased long-term cardiometabolic risk, impaired physical fitness, and reduced quality of life.[5]

Exercise-based interventions are widely recommended as primary nonpharmacological strategies for obesity management because they increase total energy expenditure and improve metabolic regulation.[6] The World Health Organization and the American College of Sports Medicine recommend regular moderate-to-vigorous physical activity to support body weight management and cardiometabolic health.[7] Aerobic exercise, particularly walking exercise (WE), remains one of the most commonly prescribed interventions because it is inexpensive, accessible, and feasible for sedentary individuals.[8] Moderate-intensity walking exercise promotes caloric expenditure and fat oxidation through oxidative metabolic pathways, thereby contributing to gradual weight reduction.[11] Recent systematic reviews and meta-analyses have demonstrated that aerobic exercise significantly improves body weight and adiposity outcomes among overweight and obese individuals.[9]

In addition to aerobic exercise, resistance training has increasingly been recognized as an effective intervention for obesity management because of its role in improving muscle mass, resting metabolic rate, and overall metabolic efficiency.[10] Resistance exercise stimulates skeletal muscle adaptation and may increase energy expenditure both during and after exercise sessions.[11] Circuit Weight Training (CWT), a form of resistance-based circuit exercise performed with minimal recovery intervals, combines cardiovascular and muscular demands within a single training session.[12] This exercise model has been associated with increased caloric expenditure, improved body composition, and enhanced cardiometabolic adaptation.[13] Furthermore, circuit-based resistance exercise may induce greater Excess Post-Exercise Oxygen Consumption (EPOC) responses than steady-state aerobic exercise, potentially contributing to higher post-exercise energy expenditure.[14]

Several systematic reviews have demonstrated the effectiveness of aerobic and resistance exercise interventions in reducing body weight and improving body composition.[12] However, direct comparisons between Circuit Weight Training and Walking Exercise remain limited, particularly among obese female university students. Existing studies have predominantly examined either isolated aerobic interventions or general resistance-training programs rather than structured circuit-based resistance exercise under comparable intervention durations.[14] In addition, many previous investigations have been conducted under highly controlled randomized settings, limiting their applicability to real-world academic environments where intervention implementation may be constrained by participant adherence, scheduling limitations, and institutional feasibility. Therefore, quasi-experimental approaches may provide important translational evidence regarding the practical implementation of exercise interventions within university settings.

Female university students represent a population with unique physiological and behavioral characteristics influencing obesity risk and exercise adherence, including sedentary academic routines, psychosocial stress, and body image concerns.[14] Nevertheless, evidence specifically targeting obese female university students remains relatively limited. Understanding the comparative effectiveness of different exercise modalities in this population may assist physiotherapists, clinicians, and exercise professionals in developing individualized and feasible obesity management strategies.

Despite growing evidence supporting exercise therapy for obesity management, uncertainty remains regarding whether circuit-based resistance exercise provides greater weight reduction than moderate-intensity walking exercise during short-term interventions. Moreover, limited evidence has examined repeated body weight changes throughout the intervention period using pragmatic exercise protocols applicable in university settings.[15]

Therefore, this study aimed to compare the effectiveness of Circuit Weight Training and Walking Exercise on weight reduction in obese female university students using a quasi-experimental pretest–posttest design. It was hypothesized that Circuit Weight Training would produce greater weight reduction than Walking Exercise because of its highermetabolic and neuromuscular demands.

Methods

This study employed a quasi-experimental pretest–posttest two-group design to compare the effectiveness of Circuit Weight Training (CWT) and Walking Exercise (WE) on weight reduction among obese female university students. The study was conducted in accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) recommendations for nonrandomized intervention studies.[1] The intervention period lasted six weeks, with repeated measurements performed at baseline, week 3, and post-intervention.

Participants were recruited from the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Indonesia, through institutional announcements and direct invitations between July and August 2025. A total of 53 individuals underwent eligibility screening, and 30 participants met the inclusion criteria and agreed to participate in the study.

The inclusion criteria were female university students aged 18–25 years with obesity according to the Indonesian body mass index classification (BMI ≥25 kg/m²), physically able to participate in exercise interventions, and willing to complete the entire study protocol. Participants were excluded if they were pregnant, had cardiovascular disease, musculoskeletal injuries limiting exercise participation, neurological disorders, or other medical conditions contraindicating moderate-intensity exercise.

Sample size calculation was performed using G*Power version 3.1.9.4 with an assumed effect size of d = 0.80, α = 0.05, and statistical power of 80%, resulting in a minimum required sample of 26 participants. The assumed effect size was based on previous resistance-training intervention studies evaluating body weight outcomes in overweight and obese populations.[2,3] To anticipate participant attrition, 30 participants were recruited.

Participants were allocated using an alternating assignment procedure according to enrollment order until each group consisted of 15 participants. Because allocation concealment and blinding procedures were not feasible within the applied academic setting, several strategies were implemented to minimize bias, including baseline equivalence assessment, standardized intervention protocols, supervised exercise sessions, and identical outcome measurement procedures across groups. Nevertheless, the nonrandomized allocation procedure may still have introduced selection bias and residual confounding effects.

Both intervention programs were supervised by physiotherapy and exercise personnel experienced in therapeutic exercise implementation. Intervention fidelity was maintained through standardized exercise protocols, continuous supervision during exercise sessions, and attendance monitoring throughout the intervention period. Participant adherence was recorded during every session, and all participants completed the intervention program.

The Circuit Weight Training intervention was performed three times weekly for six weeks. Each session lasted 75 minutes and consisted of a 10-minute warm-up, 55 minutes of circuit training, and a 10-minute cool-down period. Exercise intensity was prescribed at 60–70% of one-repetition maximum (1RM), representing moderate-intensity resistance training according to American College of Sports Medicine recommendations.[9] Estimated 1RM values were obtained using a submaximal repetition protocol to improve participant safety. The exercise program consisted of eight stations targeting major muscle groups, including leg press, prone leg curl, seated calf raise, chest press, lat pulldown, shoulder press, barbell curl, and cable triceps extension. Each exercise was performed for 12 repetitions and repeated for four sets with approximately one minute of recovery between stations. To improve objective intensity control, exercise intensity was additionally monitored using the Borg Rating of Perceived Exertion (RPE) scale, with participants maintaining an RPE range of 13–15 during training sessions.

The Walking Exercise intervention was conducted with the same frequency and session duration as the Circuit Weight Training program to maintain intervention comparability. Each session included a 10-minute warm-up, 55 minutes of walking exercise, and a 10-minute cool-down period. Exercise intensity was prescribed at 50–60% of age-predicted maximum heart rate (HRmax). Heart rate was monitored using a wearable heart rate monitor (XOSS, China), and measurements were recorded every 10 minutes during exercise sessions to maintain participants within the target intensity range.

To reduce co-intervention effects, participants in both groups were instructed to maintain their usual dietary intake and avoid initiating additional structured exercise programs during the intervention period. Although objective dietary monitoring and physical activity tracking were not performed, standardized verbal instructions were provided equally to all participants. This limitation should be considered when interpreting the findings.

Body weight was used as the primary outcome measure. Measurements were obtained using a calibrated digital weighing scale with participants wearing light clothing and no footwear. The weighing scale was calibrated weekly, and all measurements were performed using identical equipment and standardized procedures to minimize repeated-measurement error. Measurements were conducted in the morning before breakfast to reduce variability associated with hydration status and food intake. Body weight was recorded to the nearest 0.1 kg. Height was measured using a stadiometer, and Body Mass Index was calculated as weight divided by height squared (kg/m²).

Outcome assessments were conducted at baseline, week 3, and post-intervention. All measurements were performed by the same assessors to minimize inter-rater variability. No assessor blinding procedures were implemented because of logistical limitations associated with the quasi-experimental design.

Statistical analysis was performed using IBM SPSS Statistics version 24 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as means and standard deviations. Baseline comparability between groups was assessed using

Independent t-tests. Normality assumptions were evaluated using the Shapiro–Wilk test, whereas homogeneity of variance was assessed using Levene's test. Mauchly's test of sphericity was conducted before repeated-measures analysis, and Greenhouse–Geisser correction was applied when sphericity assumptions were violated.

Within-group longitudinal changes were analyzed using Repeated Measures ANOVA for normally distributed data and the Friedman test for nonparametric data. Between-group differences were analyzed using Independent t-tests. Statistical significance was established at $p < 0.05$. Results were reported using mean differences, 95% confidence intervals (CI), and effect sizes (Cohen's d). Because no participants withdrew during the intervention period, no missing-data imputation procedures were required. A sensitivity analysis using baseline-adjusted comparison was additionally performed to confirm the consistency of directional findings between interventions.

Although mixed-model analysis or ANCOVA may provide stronger adjustment for repeated measurements and confounding variables in nonrandomized studies, the present statistical approach was selected based on sample characteristics and data distribution assumptions. This limitation should be considered when interpreting causal inferences from the findings.

This study was approved by the Health Research Ethics Committee (KEPK) of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Indonesia, under Ethical Approval Number 1523/KEPK-FIK/VIII/2025. Written informed consent was obtained from all participants before study participation.

Results

The participant recruitment, allocation, follow-up, and analysis processes are presented in Figure 1. Of the 53 individuals assessed for eligibility, 23 participants were excluded because they did not meet the inclusion criteria or declined participation. The remaining 30 eligible participants were allocated equally into the Circuit Weight Training (CWT) group and the Walking Exercise (WE) group. All participants completed the six-week intervention program, resulting in a 100% adherence and retention rate without missing outcome data.

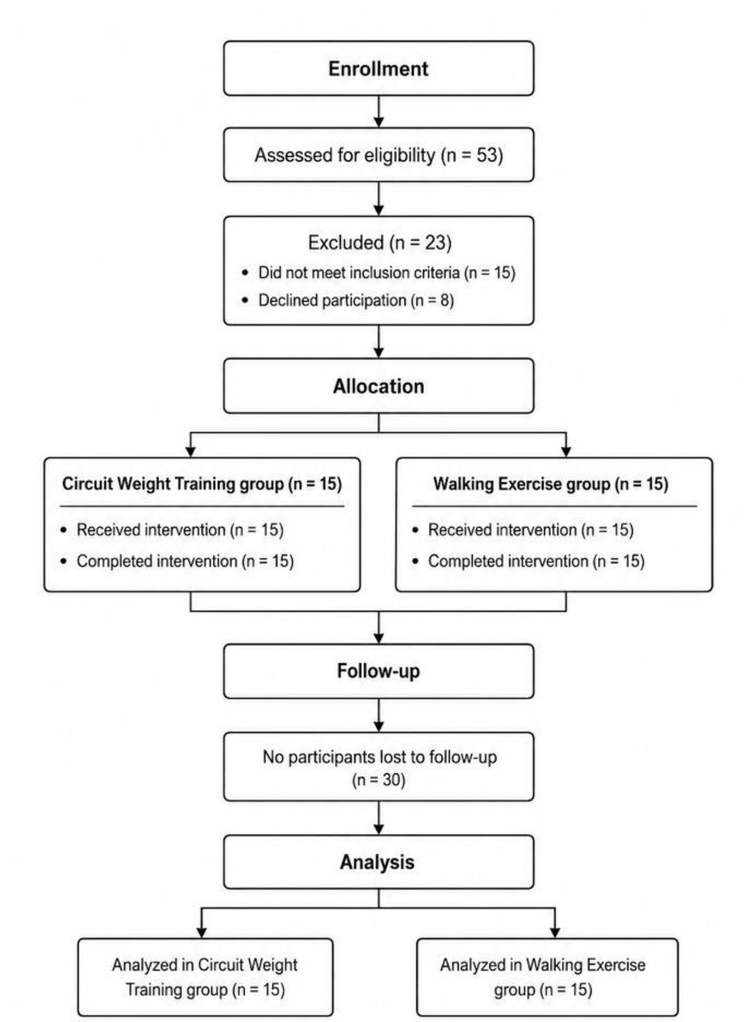

Figure 1. Participant Recruitment and Allocation Flowchart

Baseline demographic and anthropometric characteristics of the participants are presented in Table 1. Statistical comparison demonstrated no significant baseline differences between groups, indicating acceptable baseline equivalence prior to intervention implementation.

Table 1. Baseline Characteristics of Participants

Variables	Circuit Weight Training (n = 15) Mean ± SD	Walking Exercise (n = 15) Mean ± SD	p-value
Age (years)	21.06 ± 0.79	20.46 ± 1.12	0.102
Body weight (kg)	72.79 ± 6.16	70.80 ± 5.93	0.374
Height (cm)	156.2 ± 2.98	154.8 ± 4.71	0.338
BMI (kg/m²)	29.80 ± 2.23	29.53 ± 1.86	0.721

Independent t-test; significance level $p < 0.05$.

Table 1 demonstrates that participants in both groups had comparable baseline characteristics before the intervention period. The absence of statistically significant baseline differences reduced the likelihood that post-intervention outcomes were attributable to pre-existing anthropometric disparities between groups.
Changes in body weight across the intervention period are summarized in Table 2. Both intervention groups demonstrated progressive reductions in body weight from baseline to week 3 and from week 3 to post-intervention.

Table 2. Within-Group Changes in Body Weight During the Intervention Period

Group	Baseline Mean ± SD (kg)	Week 3 Mean ± SD (kg)	Post-Intervention Mean ± SD (kg)	Mean Reduction (kg)	95% CI	p-value	Effect Size (d)
Circuit Weight Training	72.79 ± 6.16	68.61 ± 6.51	65.61 ± 6.80	7.18 ± 1.26	6.48–7.88	<0.001	2.11
Walking Exercise	70.80 ± 5.93	68.74 ± 5.97	66.81 ± 6.01	3.99 ± 0.60	3.66–4.32	<0.001	1.42

Repeated Measures ANOVA for normally distributed data and Friedman test for nonparametric data; significance level p < 0.05.

As shown in Table 2, both interventions produced statistically significant reductions in body weight during the six-week intervention period. The CWT group demonstrated a greater magnitude of weight reduction and larger within-group effect size compared with the WE group. The average body weight in the CWT group decreased from 72.79 ± 6.16 kg at baseline to 65.61 ± 6.80 kg post-intervention, whereas the WE group demonstrated a reduction from 70.80 ± 5.93 kg to 66.81 ± 6.01 kg. To facilitate interpretation of longitudinal body weight changes throughout the intervention period, Figure 2 summarizes the mean body weight trends in both intervention groups.

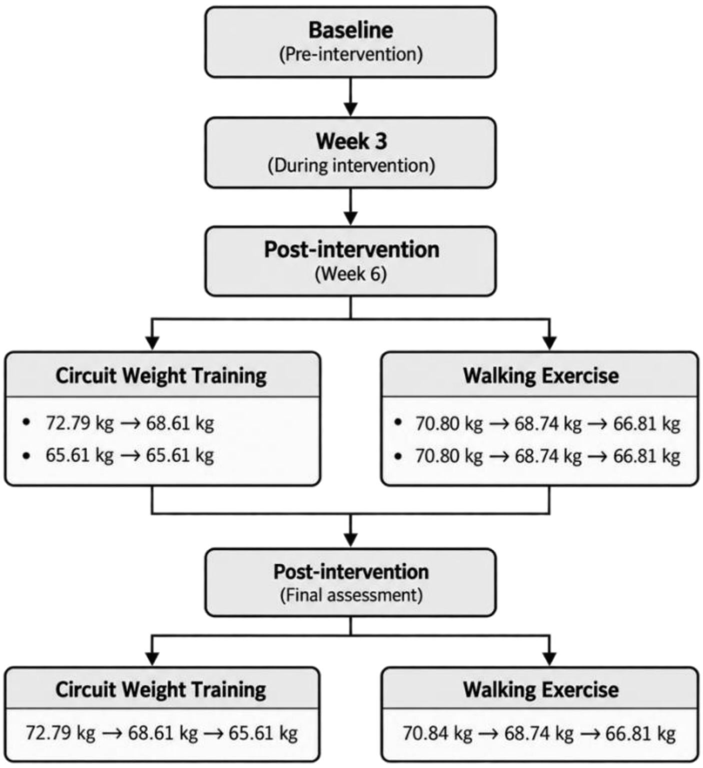

Figure 2. Longitudinal Changes in Mean Body Weight

Figure 2 illustrates that both intervention groups demonstrated progressive body weight reduction throughout the study period. The decline in body weight appeared more pronounced in the Circuit Weight Training group across repeated measurements.

The between-group comparison of intervention effectiveness is presented in Table 3. Comparative analysis demonstrated that participants in the Circuit Weight Training group experienced significantly greater body weight reduction than those in the Walking Exercise group.

Table 3. Between-Group Comparison of Weight Reduction Outcomes

Variable	Circuit Weight Training Mean ± SD (kg)	Walking Exercise Mean ± SD (kg)	Mean Difference (kg)	95% CI	p-value	Cohen's d
Weight reduction	7.18 ± 1.26	3.99 ± 0.60	3.19	2.45–3.93	<0.001	3.23

Independent t-test; significance level p < 0.05.

The between-group analysis demonstrated a statistically significant difference favoring the Circuit Weight Training intervention, with a mean difference of 3.19 kg (95% CI: 2.45–3.93; p < 0.001). Sensitivity analysis using baseline-adjusted comparison demonstrated consistent directional findings favoring the CWT intervention. The calculated effect size (Cohen's d = 3.23) indicated a very large intervention effect. However, this effect magnitude should be interpreted cautiously because the relatively small sample size and nonrandomized allocation procedure may have contributed to effect size overestimation.
No adverse events, intervention-related injuries, or exercise intolerance were reported during the intervention period.

Discussion

This study aimed to compare the effectiveness of Circuit Weight Training (CWT) and Walking Exercise (WE) on weight reduction among obese female university students. The findings demonstrated that both interventions produced significant reductions in body weight during the six-week intervention period. However, participants in the Circuit Weight Training group experienced greater weight reduction and larger effect sizes than those in the Walking Exercise group. These findings support the study hypothesis and reinforce previous evidence indicating that resistance-based circuit exercise may produce greater short-term weight reduction than moderate-intensity aerobic exercise alone in overweight and obese populations.[12]

The significant body weight reduction observed in both intervention groups confirms the important role of structured exercise in obesity management. Exercise contributes to negative energy balance by increasing total energy expenditure and improving metabolic regulation.[7,8] Walking Exercise, which represented moderate-intensity aerobic activity in the present study, produced progressive body weight reduction throughout the intervention period. This finding is consistent with previous systematic reviews demonstrating that aerobic exercise improves body weight and adiposity outcomes through increased caloric expenditure and enhanced oxidative metabolism.[12] Moderate-intensity walking exercise is also considered feasible and accessible for sedentary individuals because of its relatively low physical demand and minimal equipment requirements.[10,11] Therefore, walking-based exercise interventions remain clinically relevant as practical first-line strategies for obesity management among young adults.

Despite the effectiveness of both interventions, the magnitude of weight reduction was substantially greater in the Circuit Weight Training group. Several physiological mechanisms may explain this difference. Circuit-based resistance exercise simultaneously recruits multiple large muscle groups with minimal recovery intervals, thereby increasing metabolic and neuromuscular demands during exercise sessions.[15] Resistance training has also been associated with improved skeletal muscle adaptation and increased resting metabolic rate because lean muscle tissue contributes substantially to daily energy expenditure.[13,14] In addition, previous studies have suggested that circuit-based resistance exercise may induce greater Excess Post-Exercise Oxygen Consumption (EPOC) responses than steady-state aerobic exercise, potentially increasing post-exercise caloric expenditure.[17], However, EPOC, resting metabolic rate, and body composition variables were not measured directly in the present study. Therefore, these physiological explanations should be interpreted cautiously and considered inferential rather than definitive mechanisms underlying the observed outcomes.[16]

The findings of this study are broadly consistent with previous investigations reporting beneficial effects of resistance-based exercise interventions on body weight and body composition. Ramos-Campo et al. demonstrated that resistance circuit-based training significantly improves body composition and cardiorespiratory fitness in overweight and obese individuals.[16] Similarly, Lopez et al. reported that resistance training interventions contribute to favorable body composition changes across overweight and obese populations.[19] More recent evidence has suggested that resistance-dominant or combined exercise programs may produce greater improvements in adiposity outcomes than aerobic exercise alone.[17] Nevertheless, most previous high-quality studies were conducted using randomized controlled trial designs, whereas the present study used a quasi-experimental nonrandomized approach. Consequently, the current findings should be interpreted as supportive comparative evidence rather than definitive causal confirmation.

The present findings also have important translational implications for physiotherapy and university-based obesity management programs. University students frequently experience sedentary behavior, prolonged academic activities, irregular dietary patterns, and reduced participation in structured physical activity.[3–5] Consequently, identifying exercise interventions that are both effective and feasible within academic settings is clinically important. Circuit Weight Training may offer practical advantages because it combines resistance and cardiovascular demands within a relatively time-efficient exercise model. The absence of participant dropout and the high adherence rate observed in this study further support the feasibility of supervised exercise implementation among university populations.

Several methodological limitations should be considered when interpreting the findings of this study. First, the use of a quasi-experimental nonrandomized allocation design increased the potential risk of selection bias and residual confounding. Participants were allocated using an alternating assignment procedure rather than concealed randomization. Although baseline equivalence analyses demonstrated no statistically significant differences between groups before intervention, unmeasured confounding variables may still have influenced the observed outcomes.[18] Therefore, the level of evidence generated by this study remains lower than that of randomized controlled trials, and causal inferences should be interpreted cautiously.

Second, several potentially important confounding variables were not objectively monitored during the intervention period. Dietary intake, sleep quality, psychosocial stress, and physical activity outside the intervention sessions may all influence exercise-related weight reduction outcomes. Although participants were instructed to maintain their usual dietary habits and avoid additional structured exercise, objective monitoring procedures were not performed.[19] This limitation is particularly important because behavioral compensation mechanisms may influence total daily energy expenditure and attenuate exercise-induced weight changes.

Another limitation relates to the use of body weight as the primary outcome measure without comprehensive body composition assessment. Consequently, it remains unclear whether the observed reductions primarily reflected decreases in fat mass, lean mass, or body water composition. Because resistance training may preserve or increase lean muscle tissue during weight reduction interventions, future studies should incorporate validated body composition assessments such as bioelectrical impedance analysis or dual-energy X-ray absorptiometry to provide more comprehensive physiological interpretation.[20]

The statistical analysis approach also warrants consideration. Although repeated-measures analyses demonstrated significant longitudinal changes, more advanced statistical approaches such as mixed-model analysis or ANCOVA may provide stronger adjustment for repeated measurements and baseline variability in nonrandomized studies. The very large effect size observed in the present study should therefore be interpreted cautiously because small sample sizes may contribute to effect size inflation and magnitude bias. Nevertheless, the consistency of longitudinal trends across repeated measurements supports the overall direction of the intervention effects.[21]

This study demonstrated several methodological strengths, including standardized intervention protocols, supervised exercise implementation, repeated outcome assessments, and complete participant retention throughout the intervention period. These factors improved procedural consistency and reduced attrition-related bias. However, external validity remains limited because the study included only obese female university students from a single institution within a relatively narrow age range. Therefore, generalization of the findings to other populations should be undertaken cautiously.

Overall, the findings suggest that both Circuit Weight Training and Walking Exercise are effective exercise interventions for reducing body weight among obese female university students. Within the limitations of a quasi-experimental nonrandomized design, Circuit Weight Training demonstrated greater short-term effectiveness than Walking Exercise. However, additional randomized controlled trials with larger sample sizes, longer follow-up durations, objective confounder monitoring, and comprehensive body composition assessments are required to strengthen causal interpretation and improve generalizability.

Conclusion

Both Circuit Weight Training and Walking Exercise were effective in reducing body weight among obese female university students after six weeks of intervention. However, participants who underwent Circuit Weight Training demonstrated greater weight reduction than those who performed Walking Exercise. These findings suggest that circuit-based resistance exercise may provide a stronger short-term stimulus for body weight reduction in young adult female populations.

Within the limitations of a quasi-experimental nonrandomized design**,** the present study supports the potential role of Circuit Weight Training as an effective exercise strategy for obesity management programs in university settings. Nevertheless, the findings should be interpreted cautiously because several potentially important confounding variables, including dietary intake and physical activity outside the intervention sessions, were not objectively monitored.

From a practical perspective, both interventions may be incorporated into physiotherapy, fitness, and public health programs targeting obesity management among university students. Walking Exercise may remain appropriate for individuals requiring accessible and lower-complexity exercise programs, whereas Circuit Weight Training may be considered when greater short-term weight reduction is desired within supervised exercise settings.

Future randomized controlled trials with larger sample sizes, longer intervention durations, objective confounder monitoring, and comprehensive body composition assessments are recommended to strengthen causal interpretation and improve generalizability.

Author Contribution

Muhammad Azka Niam: Data curation, Formal analysis, Investigation, Writing original draft.
Mahendra Wahyu Dewangga: Conceptualization, Methodology, Investigation, Writing review and editing.
Tiara Fatmarizka: Formal analysis, Writing review and editing, Supervision.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This study was approved by the Health Research Ethics Committee (KEPK) of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Indonesia, under Ethical Approval Number 1523/KEPK-FIK/VIII/2025. Written informed consent was obtained from all participants prior to study participation.

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