

Research Article

The synergistic effects of circuit training and diet on weight loss, body fat percentage, and BMI in obese Indonesian females: a randomized controlled trial

Ali Muthahhari Rahim^{1*}, Ahmad Nasrulloh²^{1,2} Yogyakarta State University, Sleman DI Yogyakarta, Indonesia*Corresponding author, email: alimuthahhari.2020@student.uny.ac.id**ABSTRACT**

Background: Despite the popularity of circuit training and dietary interventions, their combined effects on obese Southeast Asian populations remain underexplored. **Objective:** This study aims to examine the effects of circuit training (using free weights and body weight) and dietary interventions (low-calorie diet and intermittent fasting using the OCD method), as well as their interaction, on weight loss, body fat percentage, and body mass index in obese individuals. **Methods:** This type of research is an experiment using a 2 x 2 factorial design. This experimental study used four groups that received different treatments, namely the provision of circuit training with free weight and low-calorie diet, the provision of circuit training without tools (body weight) with a low-calorie diet, circuit training and OCD diet, and the provision of circuit training without tools (body weight) with the OCD diet. The place of data collection was carried out at the fitness Healty and Sport Center (HSC UNY). The population in this study is HSC UNY fitness members, and a sample of 20 obese females (aged 20–30) underwent a 6-week intervention with 16 training sessions was taken using the purposive sampling technique. The researcher conducted three initial measurement variables (pretest) of each HSC UNY fitness center member, namely weight, fat percentage, and BMI. **Result:** The results of the study showed that significant weight loss (7.48 kg, $p=0.00$), but no significant changes in fat percentage ($p=0.302$) or BMI ($p=0.841$). **Conclusion:** The study concluded that circuit training using free weights combined with the OCD diet was the most effective method for weight loss, though the reduction in fat percentage and BMI was not statistically significant. This combination is recommended for fitness programs targeting weight loss in similar demographics, though longer studies are needed to assess fat reduction. Future research should explore longer intervention periods, larger sample sizes, and additional variables such as metabolic rate and adherence levels to better understand the effectiveness of different training and dietary strategies. This combination is recommended for fitness programs targeting weight loss in similar demographics.

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BMI; circuit training; diet; transforming lives.

Introduction

The world's obesity problem has continued to increase to more than double since 1980. Obesity has always been a pressing global public health issue. Over the past few decades, the number of obese women and men has increased to 390 (363–418) and 281 (257–307) million worldwide (del Rio, 2019). In 2010 the number of obese people was 11.7%, then it increased to 15.4% in 2013 and the increase in obesity In 2016 18-year-old adults were 13% obese with an intensity of 11% in men and 15% in women and the latest survey of the Ministry of Health 2017, in adolescents over 18 years old who are overweight, namely 35.4% consisting of 13.6% overweight and 21.8% obese, This result is much higher than in 2013, which was 11.5% of overweight adolescents and 14.8% of obese adolescents (Fikri, 2017). WHO interprets that obesity cases in 2011 are expected to increase by 50% by 2025 so obesity cases in Indonesia are

raised as a health problem proclaimed in the National Development Indicators of the 2015-2019 RPJMN (National Medium-Term Development Plan) by the central government of Indonesia.

Obesity remains a significant health issue, as many individuals struggle to lose weight due to improper training methods and unbalanced diet programs. [Lonardo et al. \(2021\)](#) emphasize that managing and preventing obesity requires a combination of a healthy diet and proper physical activity. While aerobic exercise, flexibility training, and resistance training are commonly recommended, circuit training has emerged as an effective method for weight loss and fitness improvement. Introduced by Adamson and Morgan in the 1950s, circuit training aims to enhance physical fitness by regulating intensity, volume, and rest periods ([Al-Haliq, 2015](#)). Previous studies focused on aerobic exercise or standalone diets, neglecting the synergy between circuit training and intermittent fasting in Asian populations. This study explores the effectiveness of circuit training using free weights and body weight exercises in combination with diet programs, distinguishing itself from previous research by specifically examining the interaction between circuit training and dietary interventions. The novelty of this study lies in its comprehensive evaluation of different training and diet combinations to optimize weight loss outcomes. The findings contribute to the development of more effective weight management strategies, helping individuals achieve better fat reduction, body mass index (BMI) improvements, and overall fitness. The findings provide evidence-based guidance for fitness trainers and nutritionists in Indonesia.

Method

Research Design

This study is an experiment using a 2 x 2 factorial design. [Tentama & Jayanti \(2019\)](#) stated that factorial design is a modification of true experimental design, namely by paying attention to the possibility of moderator variables that affect the treatment (independent variables) to the results (dependent variables). This experimental study used four groups that received different treatments, namely circuit training and low-calorie diet, body weight circuit training with a low-calorie diet, circuit training and OCD diet, body weight circuit training with OCD diet.

Participants

The data collection location was conducted at the HSC UNY fitness center from July 15, 2022, to August 15, 2022. Inclusion criteria are criteria of subjects that are worthy of being met by each member of the population that can be taken as a sample. A sampling of this study uses a purposive sampling technique with criteria: (a) members who are still active in training, (b) not in a sick state, (c) females aged 20-30 years. This age group has a high metabolic risk and a homogeneous response to interventions, (d) Able to participate in all exercise programs and diets that have been prepared, (d) Have overweight (obesity). The field survey results showed that the criteria obtained were 20 people. By dividing it into 4 groups with the following description:

A1 B1: Group given free weight circuit training and a low-calorie diet

A1 B2: Group given bodyweight circuit training and a low-calorie diet

A2 B1: Group given free weight circuit training and OCD diet

A2 B2: Group given bodyweight circuit training and OCD diet

Research Instruments

The researcher will conduct three initial measurement variables (pretest) of each HSC UNY fitness center member, namely weight, fat percentage, and BMI, before the initial data collection is carried out. In weight measurement using anthropometric body scales, for fat percentage measurement using omron body fat monitor. Omron accuracy rate: $\pm 3\%$ based on manufacturer's manual. BMI measurement use the following formula.

$$IMT = \frac{\text{Weight(kg)}}{[\text{Height (m)}]^2}$$

In this study, a 16-session circuit training program was shown to have a significant impact on weight loss. The current research will incorporate 16 training sessions (Daher et al., 2018). Details of the training sessions are provided in the Table 1.

Table 1. List of Exercise

Types of Exercises	Training Dosage	Information
Exercise Circuit Bodyweight	Training Time 6 weeks Intensity 60% DN Max Frequency : 4 times/week Repetition time : 30 seconds Set : 3 Recovery: 5 seconds between posts, Rest : 60 – 120 seconds	Method : cirkuit training
Exercise Circuit free weight	Training Time 6 weeks Intensity 60% DN Max Frequency : 4 times/week Repetition time : 30 seconds Set : 3 Recovery: 5 seconds between posts, Rest : 60 – 120 seconds	Methods : cirkuit training

The low-calorie diet program is that each testi must reduce the portion of food or the number of calories consumed every day by taking normal calories every day and reducing 500-1000 calories for both men and women (Sugianto & Miftahudin, 2019). The OCD diet is a diet program that calculates the length of time between meals and also calories at each meal (Purnawan & Anggraini, 2016). Stretch time 4 hours each time with a small number of calories, 6 hours stretch meal time by adjusting the calories consumed, 8, 12, 24 hours stretch time is a long to very long stretch time, so that each testi needs a lot of calories at mealtime, in this study using a 12-hour stretch time eating window. This study will take a meal time window of 8 hours for the first week, 12 hours for the second week (Archer et al., 2018).

Data Analysis

The data analysis technique is divided into three parts, the first is the normality test. The normality test is used in conducting parametric statistical hypothesis tests. The second is that the homogeneity test is carried out to provide confidence that a group of data researched in the analysis process comes from a population that is not much different in diversity. The third is a hypothesis test conducted using ANAVA two-way. The double variance analysis technique is often called the two-way variant analysis technique, or the variant analysis technique for related (correlated) samples. This double variance analysis technique is used to distinguish the mean of several data distributions of research subject groups carried out at once for two types of variables.

Results and Discussion

Results

The results of the study were shown with preliminary data (pretest) and final data (posttest). The description of the research results from the data obtained is described in Table 2. The results from Table 2 indicate that after the intervention, participants experienced a notable reduction in weight, fat percentage, and BMI. The pretest measurements showed an average weight of 81.83 kg (± 5.47), which decreased to 74.35 kg (± 4.94) in the post-test phase. Similarly, the fat percentage dropped from a mean of 38.31% (± 3.26) to 34.43% (± 2.85). The body mass index (BMI) also declined from 31.3 (± 2.23) to 28.71 (± 1.95). These findings suggest that the combination of circuit training and dietary interventions led to

a significant reduction in body weight, while decreases in fat percentage and BMI were observed but to a lesser extent. The results of the normality test show that all categories are normally distributed, as can be seen in the [Table 3](#).

Table 2. Results of Pretest and Post-Test Data on Weight, Fat Percentage, and BMI

Variable	Pretest				Posttest			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Weight (kg)	81.83	5.47	76	92	74.35	4.94	69	84
Fat Percentage (%)	38.31	3.26	32.99	47.1	34.43	2.85	30.35	39.35
Body Mass Index (BMI)	31.3	2.23	27.2	35.4	28.71	1.95	25	32.5

Table 3. Circuit Training Normality Results

Circuit Training		Kolmogorov-Smirnov	Shapiro Wilk	Status
		Sig.	Sig.	Normality
Initial Weight Loss	Free Weight	0.200	0.407	Normal
	Body Weight	0.200	0.185	Normal
Final Weight	Free Weight	0.200	0.202	Normal
	Body Weight	0.200	0.749	Normal
Early Fat	Free Weight	0.037	0.077	Normal
	Body Weight	0.200	0.473	Normal
Final Fat	Free Weight	0.200	0.994	Normal
	Body Weight	0.200	0.972	Normal
Initial BMI	Free Weight	0.187	0.382	Normal
	Body Weight	0.200	0.606	Normal
Final BMI	Free Weight	0.200	0.988	Normal
	Body Weight	0.200	0.964	Normal

[Table 3](#) indicate that all variables in the circuit training groups were normally distributed, as assessed by the Kolmogorov-Smirnov and Shapiro-Wilk tests. For initial weight loss, both the free weight and body weight circuit training groups had significance values above 0.05 (0.200 and 0.407 for free weight; 0.200 and 0.185 for body weight), confirming normal distribution. Similarly, for final weight, the normality test results showed values of 0.200 and 0.202 for the free weight group and 0.200 and 0.749 for the body weight group, indicating normality. The initial fat percentage also showed normal distribution, with significance values of 0.037 and 0.077 for the free weight group and 0.200 and 0.473 for the body weight group. Likewise, the final fat percentage remained normally distributed with significance values of 0.200 and 0.994 (free weight) and 0.200 and 0.972 (body weight). Lastly, the BMI values before and after training also showed normal distributions, as all significance values exceeded 0.05. These findings confirm that the data meet the assumptions for parametric statistical analysis.

[Table 4](#) confirm that all variables in the dietary intervention groups were normally distributed, as indicated by the Kolmogorov-Smirnov and Shapiro-Wilk tests. For initial weight loss, both the low-calorie diet and OCD groups showed significance values above 0.05 (0.200 and 0.277 for low-calorie; 0.200 and 0.168 for OCD), ensuring normal distribution. Similar results were found for final weight, with values of 0.198 and 0.478 (low-calorie) and 0.135 and 0.512 (OCD). The initial and final fat percentages also followed normal distributions, with all significance values exceeding 0.05. Likewise, BMI measurements before and after the intervention met the normality assumption. These results confirm that the dietary intervention data were suitable for parametric statistical analysis.

Table 4. Table Normality Result

	Diet	Kolmogorov-Smirnov	Shapiro Wilk	Status
		Sig.	Sig.	Normality
Initial Weight Loss	Low Calorie Diet	0.200	0.277	Normal
	Diet OCD	0.200	0.168	Normal
Final Weight	Low Calorie Diet	0.198	0.478	Normal
	Diet OCD	0.135	0.512	Normal
Early Fat	Low Calorie Diet	0.193	0.243	Normal
	Diet OCD	.0183	0.352	Normal
Final Fat	Low Calorie Diet	.0200	0.415	Normal
	Diet OCD	.0200	0.963	Normal
Initial BMI	Low Calorie Diet	0.200	0.245	Normal
	Diet OCD	0.200	0.806	Normal
Final BMI	Low Calorie Diet	0.200	0.274	Normal
	Diet OCD	0.200	0.724	Normal

The results in testing Homogeneity showed that all pretest and posttest variables showed that all variables were the same and not different

Table 5. Homogeneity

Indicator	Statistik Levene	Df 1	Df2	Sig	Information
Weight	1.076	3	16	0.387	Homogen
Fat	.611	3	16	0.618	Homogen
IMT	.579	3	16	0.637	Homogen

Table 5 indicate that all pretest and posttest variables met the assumption of homogeneity, as demonstrated by the Levene's test. The significance values for weight (0.387), fat percentage (0.618), and BMI (0.637) were all above 0.05, confirming that the variances across groups were equal. These findings ensure that the data were appropriate for further statistical analysis using parametric tests.

The results of the hypothesis test. In this study, there are three hypotheses, and the results of the hypothesis are as follows. The results of the first hypothesis show that it has been proven. There was a significant weight loss, there was an insignificant fat loss, and there was an insignificant decrease in BMI. The results can be included in Table 6.

Table 6. First hypothesis

Signification	Weighth	Fat	IMT
Circuit Training Body weight dan Free weight	0,00	0,302	0,841

Table 6 indicate that the first hypothesis was partially supported. Circuit training, including both free weight and body weight exercises, had a significant effect on weight loss ($p = 0.00$), while its impact on fat percentage ($p = 0.302$) and BMI ($p = 0.841$) was not statistically significant. These findings suggest that circuit training effectively contributes to weight reduction but does not significantly impact fat percentage and BMI within the study period. The results of the second hypothesis show that it is not

statistically proven. No weight loss, no fat loss, and no decrease, all results show no drastic decrease when viewed from statistics. The results can be seen in the table as follows:

Table 7. Second Hypotesis

Signification	Weigth	Fat	IMT
Low-calorie diet and Diet OCD	0,504	0,114	0,439

The results from Table 7 indicate that the second hypothesis was not supported, as the effects of a low-calorie diet and the OCD diet on weight loss ($p = 0.504$), fat percentage ($p = 0.114$), and BMI ($p = 0.439$) were not statistically significant. These findings suggest that, within the study period, dietary interventions alone did not lead to significant reductions in body weight, fat percentage, or BMI.

The third hypothesis results are to look for the interaction between circuit training and diet. The results showed that it was statistically proven. There was an intectaction in weight loss, no significant fat loss, and no significant decrease in BMI.

Table 8. Thrid Hypotesis

Signification	Weigth	Fat	IMT
Circuit training and Diet	0,00	0,397	0,638

The results from Table 8 indicate that the third hypothesis was partially supported. There was a statistically significant interaction between circuit training and diet on weight loss ($p = 0.00$), while the effects on fat percentage ($p = 0.397$) and BMI ($p = 0.638$) were not significant. These findings suggest that combining circuit training with dietary interventions is effective for weight reduction, but its impact on fat percentage and BMI remains limited within the study period. Evidence of interaction can be seen in the Figure 1.

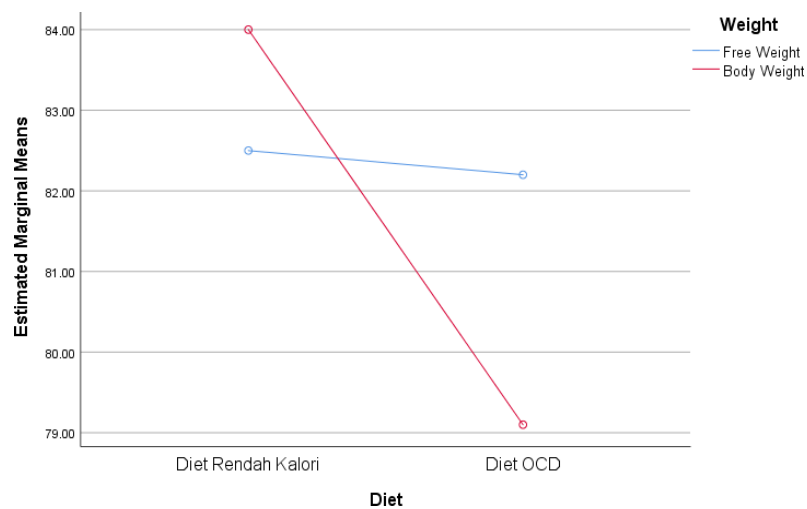


Figure 1. Weight Interaction Diagram Plot

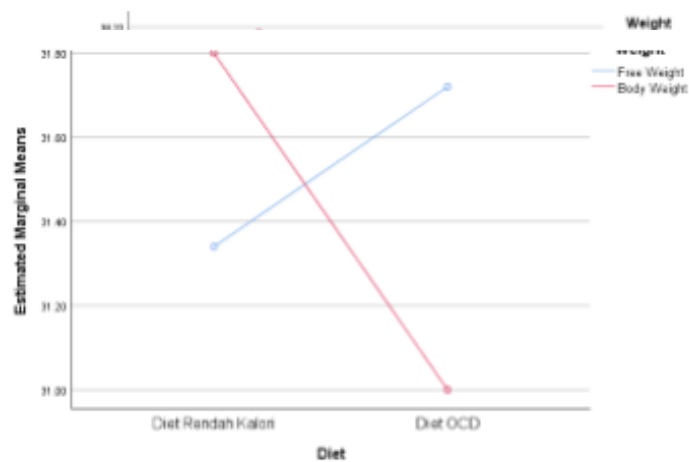


Figure 2. Fat percentage interaction plot plot

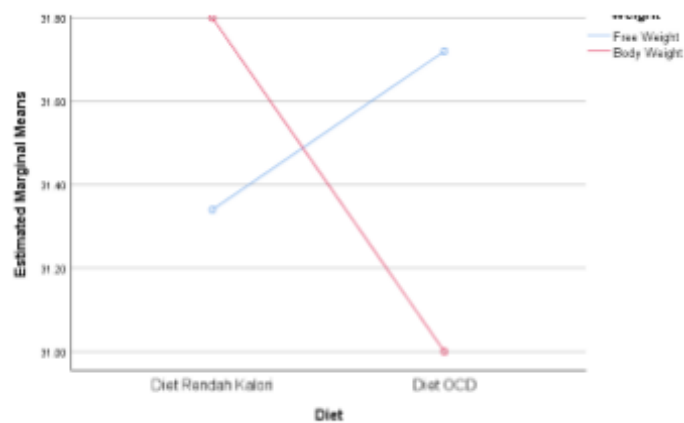


Figure 3. Plot the IMT Interaction Diagram

Discussion

The findings of this study indicate that circuit training significantly contributed to weight loss, particularly when combined with dietary interventions (Sugianto & Miftahudin, 2019), whereas its effects on fat percentage and BMI were not statistically significant. The data analysis revealed that circuit training, both free weight and body weight exercises, led to a notable reduction in body weight. However, dietary interventions alone, whether through a low-calorie diet or the Obsessive Corbuzier's Diet (OCD), did not produce statistically significant changes in weight, fat percentage, or BMI. The interaction between circuit training and diet demonstrated a significant impact on weight reduction (Archer et al., 2018), reinforcing the importance of combining exercise with dietary control for optimal results (Birgani et al., 2019). Changes in fat percentage and BMI may require a longer duration (>12 weeks) to reach statistical significance (Seyam et al., 2022). BIA devices also have a margin of error of $\pm 3\text{-}5\%$ so that small changes may go undetected (Gopinath et al., 2016).

These results partially align with the study's initial hypotheses. The expectation that circuit training would significantly reduce weight was confirmed (Kolnes et al., 2021), yet its effect on fat percentage and BMI remained limited. Additionally, the assumption that dietary interventions would independently contribute to body composition improvements was not supported (Seyam et al., 2022), suggesting that diet alone may not be as effective as previously thought (Sherry, 2019). The significant interaction

between circuit training and diet for weight loss further emphasizes the necessity of a comprehensive approach rather than relying on either exercise or diet in isolation (Kreider et al., 2011).

When compared to previous studies, these findings resonate with research emphasizing the role of circuit training in weight management. For instance, studies by Kim et al. (2018) and found that structured circuit training programs contributed to weight reduction and improved overall fitness (Williams & Cash, 2001). However, unlike some earlier research that reported significant reductions in fat percentage and BMI following dietary interventions, this study suggests that the duration and adherence to diet may play crucial roles in achieving measurable results (Jivraj et al., 2022). Differences in sample size, intervention duration, and individual metabolic responses could explain these variations in findings (Janez et al., 2017).

A critical analysis of the results suggests that while circuit training is an effective method for weight loss, other factors such as metabolic rate, duration of training, and individual commitment to the dietary regimen may have influenced the outcomes (Kaikkonen et al., 2019). The lack of significant changes in fat percentage and BMI could be attributed to the relatively short intervention period or variations in participants' adherence to dietary guidelines (Gopinath et al., 2016). Additionally, the study did not account for other lifestyle factors, such as sleep patterns and daily physical activity outside the structured program, which may have affected the results (National Library of Medicine, 2022). The implications of these findings extend to both theoretical and practical applications. From a theoretical standpoint, the study reinforces the importance of combining exercise and diet for effective weight management (Akarirmak, 2022).

Practically, it suggests that fitness programs should integrate both structured training and dietary monitoring to achieve substantial results. Policymakers and fitness professionals should consider implementing structured circuit training combined with guided dietary plans to optimize health outcomes (Pratiwi et al., 2021). However, this study has limitations, including a small sample size and a short intervention period, which may have affected the generalizability of the results. Future research should explore longer intervention durations, larger sample sizes, and additional variables such as metabolic rate and adherence levels to better understand the effectiveness of different training and dietary strategies.

This study has several limitations. First, only 20 participants (5 per group in a 2x2 design), so results lack generalizability to a broader obese population. The second is a short intervention duration (6 Weeks). Changes in body composition (especially fat percentage) take >12 weeks for statistical significance. Third, it does not use food diaries or biomarkers to monitor dietary adherence.

Conclusions

Bodyweight or device-based circuit training, combined with an OCD diet, showed the most effective effect on weight loss. However, significant changes were not observed in body fat percentage and BMI. Further studies with more significant duration and sample size are recommended. Longitudinal studies with larger samples and DEXA measurements are needed to validate the findings.

Authors' contributions

AMR and AN were responsible for data collection, analysis, article design, writing, and revision. AMR and AN were responsible for the article's conceptualization and conducted a rigorous and critical manuscript revision. All authors have read and approved the final manuscript.

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Competing interests

The authors declare no competing interests.

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