



Effect of Circuit Training on BMI and Health Physical Fitness of Overweight Female Students



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Manuscript submitted: 27 September 2023, Manuscript revised: 18 October 2023, Accepted for publication: 09 November 2023

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Abstract

This study aimed to investigate how circuit training exercise affected the BMI and health-related fitness of overweight female students in Baghdad. A sample of 30 female students classified as heavyweight based on their BMI, were selected for the study. The sample was divided into an experimental group of 15 and a control group of 15. It was noticed that there was a significant statistical difference ($p > 0.05$) in the average body mass index before the exercises (35.4 ± 3.4) and after the exercises (30.9 ± 2.9). The study reported significant improvements ($p > 0.001$) in the health-related physical fitness components of the experimental group.

Keywords

BMI;
circuit training exercise;
fitness components;
health;
physical activity;
physical education;

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1 Introduction

Circuit training is a highly effective workout method that involves rotating through a circuit of up to 10 exercises, each targeting different muscle groups. It is important to note that circuit training refers to the structure of a workout routine and not a specific type of exercise (Buch et al., 2017). During circuit training, student should perform each exercise for a set number of repetition or time and then move to the next activity with little or no rest in between. Typically, a complete circuit training session can be finished within 30-45 minutes (Kristen, 2023). Physical fitness has become a popular topic for research and discussion due to the growth of the social economy (Chen et al., 2020). Research has shown that poor physical fitness increases the risk of multiple diseases, including cardiovascular disease and diabetes (Erikssen, 2001). With remarkable changes in lifestyle and standard of living over the past three decades, physical activity levels have decreased, contributing to the spread of diseases associated with a lack of movement among students and youth. This shift has led to the emergence and spread of various diseases, such as obesity, cardiovascular diseases, diabetes, high blood pressure, and more (Belcher et al., 2021; Mosher et al., 1998).

Life changes have impacted not just adults, but also children and young adults, leading to high levels of overweight and obesity, low physical activity, and risks of disease (Al-Hazzaa et al., 1994). Physical wellbeing is linked to health-related physical fitness, which is tied to sports. Developing fitness components like strength, power, and endurance requires specific movement skills. Despite differences in motor skills, it is widely believed that health-related physical fitness is achievable for everyone (Cantell & Crawford, 2008). Obesity is a worldwide problem that has caught the attention of numerous researchers from various fields, particularly healthcare professionals, due to its association with numerous physical health problems. Scientific studies have shown the significance of physical activity for both a person's physical and psychological health, as well as the danger of physical inactivity to their health and bodily functions (Allison et al., 1999). Circuit training is a form of conditioning combining resistance training and high intensity aerobics (Mola & Bayisa, 2020).

Exercise is not only important for losing excess weight, but also for preventing various illnesses. Any diet plan that does not include exercise is incomplete. Exercise is crucial in providing healthy fitness, muscle tension, and balancing food intake with energy expended. It is a misconception that one needs to engage in rigorous sports for extended periods to attain desired benefits. The truth is, exercising for at least half an hour a day, or at least four times a week, is enough. Walking and running are among the easiest and most affordable forms of exercise (World Health Organization, 2022). Physical education programs of high quality are necessary to increase physical competence, health-related fitness, self-responsibility, and enjoyment of physical activity for all students, allowing them to remain physically active for their entire lives. Physical education programs are only able to provide these advantages if they are well-planned and well-implemented [10]. This study aimed to investigate how 12 weeks of circuit training exercise could impact specific improvement in students BMI and their health-related fitness components (Getty et al., 2018; Lee et al., 2008).

Study Design

This study involved 30 female students who were overweight and 14 years old. They were divided into two groups: the experimental group, consisting of 15 females who received a 12-week circuit training exercise program twice a week, and the control group, which included 15 other overweight female students who participated in traditional physical education lessons. The circuit exercise program was supervised by the physical education teacher and suggested by the researcher. Both groups were assessed with pre- and post-training tests under the researcher's supervision. An illustration of the circuit training exercise is presented in Table 1. It is recommended to rest between exercises for 30 to 45 seconds and take a break of 3 to 5 minutes after each circuit (Papakitsou et al., 2004; Wang & Luo, 2005).

Table 1
Circuit Training Exercises Adopted for the Experimental Group of the Study

Exercise	Repetitions	Exercise	Repetitions
Squat Jumps	10 to 15	Abdominal Crunches	5 to 10
Standard Push-ups	10 to 15	Jump up and turn	60 seconds
One- arm luggage rows	10 Repetitions each arm, using suitable weight	Goblet squats	60 seconds
Overhead Squats	10 to 15	Bodyweight squats	10 to 15
Incline push-ups	10 to 15	Calf Raises	15 to 20
Squat Jumps	10 to 15	Jump Rope	60 seconds

Anthropometric Measurements

With the guidance of the researcher and the help of the physical education teacher of school, the weight and height of the student's body were measured to the nearest 0.1 kg and 0.1 cm, respectively. This was done to evaluate the body mass index BMI of the study sample, following the guidelines laid out by Lohman and colleagues (Wee, 2008).

Statistical Analyses

The data in this study were analyzed using paired sample t-test and independent sample t-test, with a significance level of $p > 0.05$.

Evaluation of the Health-Related Physical Fitness

To evaluate the health-related physical fitness components, we utilized standard fitness and technical skills test instruments. These components comprised of four items: upper body muscular strength, flexibility, muscular endurance, and lower body muscular strength (Cattuzzo et al., 2016; Esteban-Cornejo et al., 2014).

2 Methods and Procedures of Collecting Data

The design of this study utilized a specific layout, outlined in Table 2. The research was carried out on a group of 30 female students from schools located in Baghdad. Health and physical fitness tests were selectively administered to gather data for the study. The participants were divided into two groups, with 15 individuals in each - one experimental group and one control group. Table 3 in this study showcases the physical fitness components that correlate with overall health-fitness, such as body mass index, upper body strength, flexibility, and lower body muscular endurance and strength. The pre and post-test data were meticulously recorded by three trained members and the physical education teacher of the school. To collect data from the experimental and control groups involved in this study, the researcher employed customary fitness and technical skill evaluation methods. These consisted of a one-minute push-up test, a sit and reach test, a one-minute curl-up test, and a standing long jump test. Prior to initiating the circuit exercises, pre-tests were administered to both groups. Once the twelve-week circuit exercise regimen was concluded, post-tests were conducted on both the experimental and control groups (Mora-Gonzalez et al., 2019; Syrmipas et al., 2017).

Table 2
The study design layout

Treatment	Circuit exercises
Frequency	2 days per week
Total duration time	12 weeks
Duration of training time	40 minutes

Intensity of exercises	Low to high
Time of the training	Morning

Table 3 in this study showcases the physical fitness components that correlate with overall health-fitness, such as body mass index, upper body strength, flexibility, and lower body muscular endurance and strength. The pre and post-test data were meticulously recorded by three trained members and the physical education teacher of the school.

Table 3
Health-related physical fitness of the study

No.	Physical fitness components	Test	Measuring Unit
1	Body mass	Height and weight	BMI
2	Upper body muscular strength	push-up test	Repetition
3	Flexibility	sit and reach test	Centimeters
4	Muscular endurance	curl-up test	Repetition
5	Lower body muscular strength	standing Long Jump test	Meters

To collect data from the experimental and control groups involved in this study, the researcher employed customary fitness and technical skill evaluation methods. These consisted of a one-minute push-up test, a sit and reach test, a one-minute curl-up test, and a standing long jump test. Prior to initiating the circuit exercises, pre-tests were administered to both groups. Once the twelve-week circuit exercise regimen was concluded, post-tests were conducted on both the experimental and control groups.

Data Collection Procedures

Physical fitness tests are commonly utilized by researchers to evaluate an individual's athletic abilities and identify areas for improvement. Moreover, these tests serve as a valuable tool for monitoring training progress and setting achievable fitness goals in the short term (Tg, 1988). Poor performance on physical fitness tests may suggest a need for increased physical activity, emphasizing the importance of maintaining one's health and wellness.

Data analyzed

To conduct this study, we collected quantitative data by performing health-physical fitness tests both before and after implementing circuit exercises. Our team meticulously recorded the results from these pre and post-tests and employed a confidence level of 0.05 to ascertain the significance of the data. Furthermore, we utilized mean, standard deviation, and t-test to succinctly summarize and delineate the study's discoveries.

3 Results and Discussions

This particular study utilized a range of health and physical fitness tests, including body composition, push-up, sit-and-reach, curl-up, and standing long jump tests. The demographic information of the study participants is presented in Table 4, including pertinent data such as age, height, and weight. Interestingly, at the outset of the circuit training exercise, it was observed that the female overweight students shared many similarities in terms of their age, height, and weight.

Table 4
Demographic characteristics of participants

Group	Number of female students	Sex Mean \pm SD	Age Mean \pm SD	Height Mean \pm SD	Weight Mean \pm SD
Experimental Group	15	Female	14.00 \pm 0.000	147.4 \pm 0.5	77.0 \pm 6.6
Control Group	15	Female	14.00 \pm 0.000	151.4 \pm 0.1	77.3 \pm 6.3

SD= standard deviation

Background of the study participants

The pre and post-test data for both the experimental and control groups are depicted in Table 5. These results were obtained after 12 weeks of rigorous circuit training exercises.

Table 5
Descriptive Statistics of Body Mass Index of Participants For pre and post-test

Groups	Number of female students	Body Mass Index (BMI)	
		Mean \pm SD pre-test	Mean \pm SD post-test
Experimental Group	15	35.4 \pm 3.4	30.9 \pm 2.9
Control Group	15	33.9 \pm 4.2	33.5 \pm 4.1

IOTF body mass index (BMI) cut-offs are widely used to assess the prevalence of child overweight, obesity and thinness (Ramos-Campo et al., 2021). According to the IOTF body mass index (BMI) cut-off points, all female students who took part in this study were classified as either obese class 1 or class 2 during the pre-test, for both the experimental and control groups. However, after completing twelve weeks of circuit exercise, the results displayed significant changes. Table 5 showcases the noteworthy mean differences for the BMI between the pre and post-tests of the experimental group. These findings suggest that circuit exercise can effectively reduce body fat in female students within the experimental group. Table six presents an analysis of health-related physical fitness components for both experimental and control groups.

Table 6
Descriptive statistics of health-physical fitness components

Physical fitness tests	Groups			
	Experimental group (15) Mean \pm SD		Control group (15) Mean \pm SD	
	Pre-test	Post-test	Pre-test	Post-test
Push-up test	5.3 \pm 1.3	9.7 \pm 1.7	5.3 \pm 1.2	5.5 \pm 0.7
Sit and reach test	17.3 \pm 2.2 cm.	26.7 \pm 3.3 cm.	16.7 \pm 2.7 cm.	14.5 \pm 2.1 cm.
Curl - up test	6.4 \pm 2.1	13.3 \pm 3.2	6.6 \pm 1.5	7.7 \pm 1.8
Standing Long Jump test	131.1 \pm 12.1 cm.	152.7 \pm 9.7 cm.	140.7 \pm 8.3 cm.	142.5 \pm 7.9 cm.

The results of pre and post-tests before and after circuit training exercises are displayed. The experimental group showed a significant increase in mean value and standard deviation of all physical fitness components mentioned in the table in the post-test after 12 weeks of circuit training exercise. Meanwhile, the control group's mean value and standard deviation remained nearly the same for the pre-test and post-test of all health-physical fitness components selected for this study. Table six further reveals that the experimental group had noticeable mean differences between the pre and post-tests, but it is uncertain whether these differences were statistically significant. To determine whether or not the pre and post-test scores differed statistically, a paired dependent sample t-test was conducted.

The findings presented in Table 7 indicate that there was no statistical significance ($t=0.6$, $p < 0.05$) in the body mass index (BMI) pre-test and post-test data of the control group. However, the experimental group exhibited statistically significant results ($t=3.9$, $p < 0.05$) in their BMI pre-test and post-test data. In terms of the pre-test and post-test push-up test data of the control group, there was no statistical significance ($t=0.6$, $p > 0.05$). Conversely, the experimental group demonstrated statistically significant results ($t=7.9$, $p > 0.05$) in their pre-test and post-test push-up test data.

Table 7

Paired t-test analysis result of the pre-test and post-test data of the experimental group and control group

Variables (no.15)	Group	Pre-test $\bar{x} \pm SD$	Post-test $\bar{x} \pm SD$	t	p
BMI (kg/m ²)	Experimental group	35.4 ± 3.4	30.9 ± 2.9	3.9	0.0005
BMI (kg/m ²)	Control group	33.9 ± 4.2	33.5 ± 4.1	0.6	0.9462
Push-up test	Experimental group	5.3 ± 1.3	9.7 ± 1.7	7.9	0.0001
Push-up test	Control group	5.3 ± 1.2	5.5 ± 0.7	0.6	0.6
Sit and reach test	Experimental group	17.3 ± 2.2 cm.	26.7 ± 3.3 cm.	9.2	0.0001
Sit and reach test	Control group	16.7 ± 2.7 cm.	14.5 ± 2.1 cm.	2.5	0.0189
Curl – up test	Experimental group	6.4 ± 2.1	13.3 ± 3.2	6.9	0.0001
Curl – up test	Control group	6.6 ± 1.5	7.7 ± 1.8	1.8	0.0797
Standing Long Jump test	Experimental group	131.1 ± 12.1 cm.	152.7 ± 9.7 cm.	5.4	0.0001
Standing Long Jump test	Control group	140.7 ± 8.3 cm.	142.5 ± 7.9 cm.	0.6	0.5478

*Significant at $p < 0.05$ level

The sit and reach test results of the control group ($t=2.5$, $p > 0.05$) did not show statistical significance, whereas the pre and post-test data of the experimental group were statistically significant ($t=9.2$, $p > 0.05$). Similarly, the curl-up test results for the control group's pre and post-test ($t=1.8$, $p > 0.05$) were not statistically significant, but the experimental group's pre and post-test data were statistically significant ($t=6.9$, $p > 0.05$). Lastly, the standing long jump test pre and post-test data for the control group ($t=0.6$, $p > 0.05$) were not statistically significant, while the experimental group's pre and post-test data were statistically significant ($t=5.4$, $p > 0.05$). From the gathered data, it can be inferred that the female participants who underwent 12 weeks of circuit exercises experienced noteworthy enhancements in their health-related physical fitness levels and a substantial decrease in their body weight. Meanwhile, no significant alterations were noted in the health and weight of the female control group during the same 12-week period.

Discussion

The aim of this research was to evaluate the effects of a 12-week circuit training exercise on the BMI and specific physical fitness components linked to health in overweight female middle school students in Baghdad. After analyzing the pre-and post-test data from the experimental group, it was discovered that there was a significant statistical difference ($p > 0.05$) in the average body mass index before the exercises (35.4 ± 3.4) and after the exercises (30.9 ± 2.9). However, there was no significant statistical difference ($p > 0.05$) in the average body mass index before the exercise (33.9 ± 4.2) and after the exercise (33.5 ± 4.1) when comparing pre-and post-test values within the control group. These findings are consistent with those of a 2022 study (Cole & Lobstein, 2012).

According to a recent study conducted in 2021 Esleman et al. (2022), the effects of an 8-week moderate-intensity circuit training program on body composition were examined. The results suggest that the exercise program had a considerable impact on the body mass index of the exercise group, with no discernible changes observed in the control group. Additionally, female students in the experimental group showed a noteworthy improvement in their performance on the push-up test. The results of the push-up test indicated a noteworthy increase in the experimental group, with an average of 5.3 ± 1.3 before exercise rising to 9.7 ± 1.7 after exercise ($p < 0.05$). In contrast, the control group's pre and post-test values did not display a significant difference, showing an average of 5.3 ± 1.2 before exercise and 5.5 ± 0.7 after exercise ($p > 0.05$). As for the sit and reach test, the experimental group showcased a substantial improvement in flexibility, with an average of 17.3 ± 2.2 cm pre-exercise rising to 26.7 ± 3.3 cm post-exercise ($p < 0.05$). Conversely, the control group's pre and post-test values did not indicate a significant difference, recording an average of 16.7 ± 2.7 cm before exercise and 14.5 ± 2.1 cm after exercise ($p > 0.05$).

The results of the curl-up test for the experimental group showed a significant improvement from before exercise (6.4 ± 2.1) to after exercise (13.3 ± 3.2), with a p-value greater than 0.05. On the other hand, the control group's curl-up test results before (6.6 ± 1.5) and after (7.7 ± 1.8) exercise did not exhibit any statistical significance with $p > 0.05$. Similarly, the standing long jump test results for the experimental group showed a statistical difference before exercise (131.1 ± 12.1) and after exercise (152.7 ± 9.7) with $p > 0.05$. However, the control group's standing long jump test results before exercise (140.7 ± 8.3) and after exercise (142.5 ± 7.9) did not show any statistical significance with $p > 0.05$.

Recent researches Themistocleous et al. (2021); Mola & Bayisa (2020); Vallimurugan et al. (2022); Kim et al. (2018), have shown that circuit training can have a positive impact on multiple aspects of physical fitness. All demonstrated significant improvements in muscular strength, endurance, flexibility, and other health-related factors. These findings suggest that circuit training may be an effective approach for individuals seeking to improve their overall physical fitness and reduce their risk of certain health conditions. Research has shown that the majority of studies on circuit training programs focus on their effectiveness over an extended period of time, typically spanning several weeks. One study, in particular, found that an 8-week moderate-intensity intermittent circuit training program can effectively reduce cardiovascular risk factors (Chakraborty & Kaushik, 2008). Similarly, a study conducted in 2013 Mayorga-Vega et al. (2013) also concluded that circuit training can improve and maintain muscular and cardiovascular endurance in schoolchildren. Previous research has also supported these findings, with evidence suggesting that students who participate in extra-curricular circuit training exercises experience significant improvements in both muscular and cardiorespiratory fitness (Ramos-Campo et al., 2021).

4 Conclusion

The study revealed that the 12-week circuit exercise program had a significant positive impact on the body mass index BMI and other crucial health-related physical fitness components of overweight students in the experimental group. However, female students in the control group did not exhibit any significant improvement in these areas. These findings suggest a need to revisit the physical education curriculum. Physical education teachers should incorporate circuit training exercises in their lessons to enhance students' abilities and physical fitness levels. These results underscore the importance of physical education programs

in promoting the physical health of students across all education levels and should be taken into account by educational authorities.

Competing interests

The paper's content and writing are free from any financial or personal conflicts of interest that could have any impact whatsoever, as stated by the authors.

Acknowledgments




We are grateful to two anonymous reviewers for their valuable comments on the earlier version of this paper.

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