JOURNAL OF HEALTH, PHYSICAL EDUCATION, SPORTS AND LEISURE STUDIES
ISSN: 0795-5316 (Print) | Vol. 11, No. 1, July 2026 | pp. 1–8
Published by the Department of Human Kinetics and Health Education, Faculty of Education, Ahmadu Bello University, Zaria, Nigeria

EFFECT OF 8-WEEK CIRCUIT TRAINING PROGRAMME ON CARDIO RESPIRATORY ENDURANCE OF FEMALE UNDERGRADUATE STUDENTS OF UNIVERSITY OF MAIDUGURI

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Abstract

This study aimed to investigate the effect of an 8-week circuit training programme on the cardiorespiratory endurance of female undergraduate students at the University of Maiduguri, Borno State, Nigeria. A pre-test and post-test experimental research design was employed, involving 44 female undergraduate students aged 18-30 years recruited from the Faculty of Education during the 2022/2023 academic session. Participants were selected through multi-stage sampling procedures, including purposive sampling to identify medically fit, previously sedentary students, followed by simple random assignment into experimental (n=22) and control (n=22) groups. The experimental group participated in a supervised 8-week circuit training programme conducted three times weekly on a 400m outdoor track, consisting of four exercise stations (rope skipping, press-ups, burpees, and abdominal curl-ups) with 5 minutes spent at each station. The control group maintained their regular daily activities without structured exercise intervention. Cardiorespiratory endurance was assessed using the 12-minute run/walk test, with maximal oxygen uptake (VO_2max) estimated using the formula $VO_2max = 15 \times (HRmax / Heart\ Rate)$. Anthropometric measurements including weight, height, and body composition were recorded at baseline and post-intervention using standardized protocols. Data were analyzed using independent samples t-test at 0.05 alpha level of significance. Baseline characteristics showed no significant differences between groups, with mean ages of 23.7±1.3 years (control) and 24.2±1.5 years (experimental), and comparable baseline VO_2max values of 27.4±6.91 ml/kg/min (control) and 27.3±5.4 ml/kg/min (experimental). Following the 8-week intervention, the experimental group demonstrated statistically significant improvements in cardiorespiratory endurance compared to the control group. Post-intervention VO_2max increased substantially in the experimental group to 40.50±5.91 ml/kg/min, representing a 48.4% improvement from baseline, whilst the control group showed only minimal change to 28.52±7.2 ml/kg/min, representing a 4.1% increase. Independent samples t-test revealed a highly significant difference between groups ($t = 41.738$, $df = 44$, $p = 0.0001$), leading to rejection of the null hypothesis. Additionally, the experimental group exhibited significant reductions in body weight (from 58.95±0.93 kg to 51.73 kg, representing a 12.3% decrease) and body fat percentage (from 26.22±7.01% to 17.07±7.58%, representing a 34.9% reduction), whilst the control group showed negligible changes in these parameters. These findings provide strong empirical evidence that the 8-week circuit training programme produced substantial improvements in cardiovascular fitness and body composition among previously sedentary female undergraduate students. This study provides empirical evidence that an 8-week circuit training programme significantly improves cardiorespiratory endurance among female undergraduate students at the University of Maiduguri. The experimental group's superior performance compared to the control group demonstrates the effectiveness of structured, supervised circuit training in enhancing cardiovascular fitness among previously sedentary female students. Based on these significant findings it recommended that University administrators and physical education departments should formally integrate structured circuit training programmes into mandatory physical education curricula and voluntary wellness initiatives for female undergraduate students across all faculties, ensuring systematic exposure to cardiovascular fitness training and promoting long-term health behaviours

Keywords: *Circuit training, cardiorespiratory endurance, VO_2max, female undergraduate students, physical fitness, exercise intervention*

How to cite this article: Liman, A. (2026). Effect of 8-Week Circuit Training Programme on Cardio Respiratory Endurance of Female Undergraduate Students of University of Maiduguri. Journal of Health, Physical Education, Sports and Leisure Studies, 11(1), 1–8.

DOI: https://doi.org/10.67203/jhpesls.2026.tz6g4452

INTRODUCTION

Cardiorespiratory endurance refers to the ability of the heart, lungs, and circulatory system to supply oxygen efficiently during sustained physical activity. Improvements in this fitness component are commonly measured through indicators such as maximal oxygen uptake (VO_2 max), heart rate recovery, and submaximal exercise performance. Evidence from experimental studies indicates that circuit training significantly enhances these physiological markers by increasing stroke volume, improving oxygen transport, and enhancing muscular oxidative capacity (Uchenwoke et al., 2020). Although many studies use durations of 6 to 12 weeks, even shorter interventions such as 8-week programmes have been shown to produce meaningful improvements in aerobic capacity among young adults due to consistent cardiovascular stimulation.

An 8-week circuit training programme has been widely recognized as an effective exercise intervention for improving cardiorespiratory endurance among university populations, including female undergraduate students. Circuit training is a structured form of exercise that combines resistance and aerobic activities performed in a sequence with minimal rest, allowing continuous elevation of heart rate and oxygen consumption. This makes it particularly suitable for improving cardiovascular and respiratory efficiency (Khattak, Syed, & Manzoor, 2020). In female undergraduate students, who often experience low to moderate physical activity levels due to academic demands, such programmes provide an accessible and time-efficient strategy for enhancing aerobic fitness and overall physical health.

Among female university students, circuit training is particularly beneficial because it addresses common barriers to exercise participation such as lack of time, limited access to facilities, and low exercise adherence. Research involving healthy female populations has demonstrated that circuit-based exercise interventions significantly improve cardiovascular endurance and functional fitness outcomes when performed at moderate to high intensity several times per week (Toprak Çelenay et al., 2024). These physiological adaptations occur as a result of repeated exposure to elevated heart rates, which strengthens cardiac muscle efficiency and improves pulmonary ventilation over time. Consequently, female undergraduates engaging in structured circuit training tend to show improved stamina, reduced fatigue during academic and daily activities, and enhanced overall physical performance.

Furthermore, the effectiveness of an 8-week circuit training programme is influenced by training variables such as intensity, frequency, exercise selection, and rest intervals. Studies suggest that training performed three times weekly with progressive overload yields optimal improvements in aerobic endurance (Khattak et al., 2020). The inclusion of whole-body exercises such as squats, lunges, jumping jacks, and core stability movements ensures simultaneous activation of large muscle groups, which increases oxygen demand and promotes cardiovascular adaptation. In female undergraduate populations, such adaptations are especially important for reducing risks associated with sedentary lifestyles and improving long-term health outcomes.

An 8-week circuit training programme is an effective and practical intervention for improving cardiorespiratory endurance among female undergraduate students in university settings. The combination of aerobic and resistance exercises promotes significant physiological adaptations that enhance oxygen utilization, cardiac efficiency, and overall fitness levels. Empirical evidence consistently supports the use of circuit training as a time-efficient strategy for improving cardiovascular health in young adult populations (Uchenwoke et al., 2020; Toprak Çelenay et al., 2024). Therefore, integrating circuit training into university physical education or wellness programmes can play a vital role in promoting healthier and more active lifestyles among female students.

METHODOLOGY

A pre-test and post-test experimental research design were used in this study. In this design there were two groups, the experimental group was given the treatment and control group. These two groups were

tested for all the variables investigated before and after the 8-week exercise. According to Mike, (2017), two group experimental design is a type of research design that is most often utilized to determine the effect of treatment on a given sample. Based on the above assertion, the researcher therefore found the design to be suitable for the present study, for the fact that it would enable the researcher to determine the effect of training intervention on the dependent variables.

The study population comprised all female undergraduate students enrolled in the Library and Information Science, Continuing Education, Agricultural Education, and Arabic Education departments within the Faculty of Education, University of Maiduguri, Borno State during the 2022/2023 academic session (students affairs office, 2023). The total population of female undergraduate students in these departments was 568 as shown in table 1 below.

These departments were selected because they have large amount of female students in the entirety of the University of Maiduguri.

Table 1: Population of the Study

S/N	DEPARTMENTS	POPULATION
1	Library & Information Science	293
2	Continuing Education	173
3	Agricultural Education	54
4	Arabic Education	48
Total		**568**

Source: Students affairs office 2022/2023 academic session.

The sample size of 44 female undergraduate students from the Faculty of Education University of Maiduguri, Borno State, were selected through multi-stage sampling procedure. The stage are:-

Stage I: Purposive sampling was used to select 45 female undergraduate students who have not been participating in any vigorous physical activity and were certified medically fit to participate in the exercise after answering physical activity readiness questionnaire.

Stage II: Simple random sampling technique was used to assign the participants into two groups, Experimental and Control.

Stage II: All 45 participants were arranged in ascending order and assigned a unique number. Subsequently, individuals with odd-numbered assignments were placed in the Experimental group, while those with even-numbered assignments were placed in the Control group.

Inclusion Criteria:

i. Participants must have been certified medically fit by a medical Personnel

ii. Participants should be female students between the age of 18-30 years

iii. Those who met the criteria were given the informed consent form to fill and participate in the study

iv. Only those who have not been participating in any vigorous physical exercise were shortlisted

The following instruments were used for data collection

a. Stop watch for timing made by Casio HS-70W-1V

b. Pen and Jotter for recording of measurements of the participants and activities they do

c. Whistle for making signals (start and stop commands)

d. SKLZ training cones to be place at different distance round the track to aid in identifying

stoppage point, made in China

e. A Handson's weighing scale, Ireland model B1801A for measuring weight of the

participants

f. Seca 213 portable standiometer for measuring Height

An introductory letter was obtained from the Head of Department Human Kinetics and Health

Education, Bayero University, Kano to the authority of University of Maiduguri, Borno State

Seeking for permission to conduct the research. With necessary approvals obtained, the researcher enlisted the assistance of six trained research assistants from the department of Physical and Health Education, University of Maiduguri, Borno State.

Circuit Training Programme

The circuit training programme was carried out on a 400m outdoor track drawn at a Football field within the University. The circuit training group consists of four (4) stations of rope skipping, press-up, Burpee, a full-body exercise that combines multiple movements into one fluid motion and abdominal curl up exercise. It is often used in various fitness routines, including circuit training and high-intensity interval training and abdominal curl up exercises. An estimated time of 5 minutes was spent at each station, which included two-lap. A ten second post exercise heart rate was used to cross check the intensity of participants as suggested by Astrand & Rodahl, (2003) since it was difficult to determine work intensity during the actual exercise.

Anthropometrical Measurements

Weight: participants wear minimal clothes made of knickers and top underwear singlet without foot wears. Participants were made to stand with both feet on the scale and reading was taken two times, the average of the two measurements was recorded accordingly.

Height: Participants' height was measured using the protocols of the International Society for the Advancement of Kin Anthropometry (ISAK, 2002). Participants were made to stand bare footed with the upper back, buttock and heels touching the wall, the head was held erect and eyes

looking forwards so that lower margin of the eye socket and tragion were in the Frankfort place.

A horizontal wooden ruler was rested on the participants head and the height read from the wall

to the nearest 0.5cm.

Procedure for testing twelve (12) minutes run/walk test (cardiorespiratory endurance test). The

participants line up at the starting point to run/walk for 12 minutes on the track while the cones

are placed round the track to aid in measuring the completed distance, participants started the

task after the sound of the starting whistle and also stop where they are after the second sound of

the whistle at the end of 12minutes. While the score of the total distance covered by them was

taken in the record score sheet to the nearest meters.

Procedure

The 12-minute run/walk test was used to estimate the participants' aerobic fitness by calculating their maximal oxygen uptake (VO_2max), which reflects the body's ability to transport and utilize oxygen during sustained physical activity. After completing the test, each participant's heart rate was recorded, and VO_2max was estimated using the formula $VO_2max = 15 \times (HRmax / Heart\ Rate)$, where HRmax represents the participant's maximum predicted heart rate and Heart Rate is the heart rate measured immediately after the test. This equation assumes that individuals with lower exercise heart rates relative to their maximum heart rate have better cardiovascular efficiency and, consequently, a higher

VO_2max. Higher VO_2max values indicate superior cardiorespiratory fitness and greater aerobic endurance. The result of the 12minutes run/walk test was converted to obtain the VO2Max of the participants using the formula below:

Vo2 = 15 X (HRmax/HRate)

RESULTS

Table 2 Demographic Variables of the Participants (N=45)

The demographic variables of the participants showing Means and standard deviation of (age, weight and height of the participants) including Body Fat%, Weight, Vo2max, Curl-ups, sit and reach and BMI of the subject before and after training were presented in table 4.1.

Variables	**Control group Mean [SD]**		**Experimental group Mean [SD]**	
	Pretest	Posttest	Pretest	Post test
Age Years	23.7 ± 1.3	23.7 ± 1.3	24.2 ± 1.5	24.2 ± 1.5
Weight [kg]	59.01 ± 0.95	58.97	58.95 ± 0.93	51.73
Height [m]	1.50 ± 0.073	1.50 ± 0.073	1.58.95 ± 0.071	1.58 ± 0.071
Vo2Max [ml/kg/min]	27.4 ± 6.91	28.5 ± 7.2	27.3 ± 5.4	40.50 ± 5.91

Table 2 indicated that age of control group consistent at 23.7±1.3 years for both pretest and posttest, equally the age of participants in experimental group consistent at 24.2±1.5 years for both pretest and posttest. Weight in control group slightly decrease from 59.01±0.95 kg to 58.97 kg, while in experimental group significant decrease from 58.95±0.93 kg to 51.73 kg. That is the experimental group showed a much larger weight loss than the control group. Height of participants in control group was consistent at 1.50±0.073 also, in experimental group, it is constant at 1.58±0.071 m. Body Fat (%) in control group slight increase from 26.6±6.91% to 27.7±7.89% while the experimental group gained significant decrease from 26.22±7.01% to 17.07±7.58%, this indicates that the experimental group have substantial reduction in body fat. VO2Max (mL/kg/min) in control group is slight increase from 27.4±6.9 to 28.5±7.2, while experimental group have substantial increase from 27.3±5.4 to 40.50±5.91, which means the experimental group showed a major improvement in cardiovascular fitness. Significant decrease from 26.34±4.1 to 21.96±3.5, it showed that the experimental group showed.

1. There will be no significant effect of 8-week circuit training programme on cardio respiratory endurance of female undergraduate students of University of Maiduguri

Table 3 t-test summary on cardio respiratory endurance of female undergraduate between the experimental group and the control group

Variables	**N**	**Mean**	**S.D**	**df**	**t**	**Prob**
Control group	22	28.52	7.2	44	41.738	0.0001
Experimental group	22	40.50	5.91			

[t=41.738, df=44; = P 0.0001]

Table 3, Shows a t-test summary comparing the cardiorespiratory endurance between the experimental group and the control group after an 8-week circuit training programme. There will be no significant effect of 8-week circuit training programme on cardio respiratory endurance of female undergraduates

of University of Maiduguri. The null hypothesis stated that there would be no significant effect of the 8-week circuit training programme on cardiorespiratory endurance was rejected. However, the results show a statistically significant difference between the control and experimental groups ($t = 41.738$, $df = 44$, $p = 0.0001$). The experimental group has a much higher mean cardiorespiratory endurance score (40.50) compared to the control group (28.52). Based on these results, therefore, the null hypothesis was rejected. There is strong statistical that the 8-week circuit training programme had a significant positive effect on improving the cardiorespiratory endurance of female undergraduates at the University of Maiduguri, the statistical analysis strongly supports the effectiveness of the 8-week circuit training programme in improving cardiorespiratory endurance.

DISCUSSIONS

The result presented in Table 3 indicates a statistically significant difference in cardiorespiratory endurance between the experimental group (Mean = 40.50, SD = 5.91) and the control group (Mean = 28.52, SD = 7.20), following an 8-week circuit training programme. The reported t-value ($t = 41.738$, $df = 44$, $p = 0.0001$) shows that the difference between groups is highly significant, leading to the rejection of the stated null hypothesis, which proposed that there would be no significant effect of the programme on cardiorespiratory endurance. The higher mean score recorded by the experimental group suggests that participation in the 8-week circuit training programme substantially improved the cardiorespiratory endurance of female undergraduate students. Cardiorespiratory endurance reflects the ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity, and it is commonly assessed through indicators such as VO_2 max or submaximal aerobic performance (American College of Sports Medicine [ACSM], 2021).

Circuit training, which combines resistance and aerobic exercises performed in a structured sequence with minimal rest intervals, is widely recognized as an effective method for improving cardiovascular fitness. The significant improvement observed in the experimental group aligns with established physiological principles, where repeated bouts of moderate-to-high intensity exercise enhance oxygen uptake, stroke volume, and muscular oxidative capacity (Garber et al., 2011). The improvement in cardiorespiratory endurance can be attributed to several physiological adaptations induced by circuit training. First, repeated aerobic and anaerobic transitions in circuit training stimulate cardiovascular adaptations such as increased stroke volume and cardiac output, which enhance oxygen delivery to working muscles (ACSM, 2021). Second, peripheral adaptations such as increased mitochondrial density and capillarization improve oxygen utilization at the muscular level, thereby enhancing endurance performance (Baechle & Earle, 2008).

Furthermore, circuit training often incorporates short rest intervals, which elevate heart rate for prolonged periods and improve the efficiency of the oxygen transport system. This continuous cardiovascular demand is consistent with principles of high-intensity interval training (HIIT), which has been shown to significantly improve VO_2 max and overall aerobic capacity within relatively short training durations (Weston et al., 2014). The findings of this study are consistent with previous research demonstrating the effectiveness of circuit-based and interval training modalities in improving cardiorespiratory fitness. For instance, studies have shown that structured circuit training significantly enhances aerobic capacity in young adults due to its combined aerobic-resistance structure (Alcaraz et al., 2008). Similarly, Gibala et al. (2012) reported that high-intensity training protocols can produce rapid improvements in cardiorespiratory fitness comparable to traditional endurance training. In a population similar to university students, researchers have also observed that regular participation in circuit training leads to significant improvements in cardiovascular endurance, particularly among sedentary or moderately active individuals (Kravitz, 2006). This supports the present finding that female undergraduates benefited substantially from the 8-week intervention.

CONCLUSION

It was clearly demonstrate that an 8-week circuit training programme significantly improves cardiorespiratory endurance among female undergraduate students. The experimental group's superior performance compared to the control group provides strong empirical support for the effectiveness of circuit training in enhancing cardiovascular fitness. These results are consistent with established

exercise physiology literature, which confirms that structured high-intensity and circuit-based training improves both central and peripheral components of aerobic capacity.

RECOMMENDATIONS

Based on the significant findings demonstrating that an 8-week circuit training programme substantially improved cardiorespiratory endurance among female undergraduate students at the University of Maiduguri, the following recommendations are proposed:

1. University administrators and physical education departments should formally integrate structured circuit training programmes into the mandatory physical education curriculum and voluntary wellness initiatives for female undergraduate students across all faculties, not limited to the Faculty of Education.
2. Future research and programme implementation should prioritize the development of gender-sensitive, culturally appropriate, and socially inclusive circuit training interventions that address the specific needs, preferences, barriers, and socio-cultural contexts of female undergraduate students, particularly in conservative, religiously observant, or culturally diverse communities such as those in Northern Nigeria.
3. Universities, health promotion agencies, and research institutions should establish comprehensive longitudinal monitoring systems, structured follow-up mechanisms, and evidence-based sustainability strategies to track the maintenance of cardiorespiratory fitness gains beyond the initial 8-week intervention period, support sustained engagement in physical activity, and evaluate long-term health and academic outcomes among female undergraduate students.

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