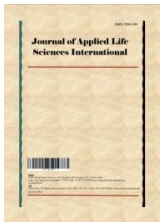

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Effect of Circuit Training on the Cardiovascular Endurance and Quality of Life: Findings from an Apparently Healthy Female Adult Population

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of this study was to assess the effect of a 6-week circuit training on the cardiovascular endurance and quality of life of an apparently healthy adult female population.
Methodology: This study adopted a pre and post-test experimental design. A total of 60 adult females who were randomly selected into experimental group and control group participated in the study. The variables for this study were obtained using a proforma which contained the anthropometric parameters, respiratory rate, mean arterial pressure, heart rate, maximum oxygen consumption, partial oxygen saturation, hip circumference and waist-hip ratio. The stations of exercises used included jumping lunges, curtsy lunges, torso rotation, knee raise claps, abdominal twist or knee combo, kick raise. Data were analyzed using descriptive analysis and paired t-test. Continuous variables were reported in tables as mean± Standard deviation (SD).

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Results: Findings from the study showed that there was a significant difference (*P*<.05) in partial oxygen saturation, respiratory rate, mean atrial pressure, maximal oxygen consumed, and heart rate. No significant effect was found in the domains of the quality of life of the experimental group.
Conclusion: Circuit training has positive effects towards improvement of cardiovascular endurance and maintenance of functional quality of life (QOL). It is therefore necessary for circuit training to be encouraged as a strategy that can be used among young female adults.

Keywords: Circuit training; cardiovascular endurance; quality of life; anthropometry.

1. INTRODUCTION

Health promotion policies and physical activity programs should be designed to improve physical fitness, as cardiovascular endurance and strength are the most important health-related physical fitness components [1]. Cardiovascular endurance is a physical fitness component concerned with the efficiency of the circulatory and respiratory systems in oxygen supply during continuous physical activity [2]. Some of the benefits of cardiovascular endurance include increase in an individual's maximum oxygen consumption (VO2max), exercise capacity and loss of excess body weight and body fat [3]. Short-term programs could also be effective to improve fitness, hence the essence of a circuit training (CT) program [4,5,6]. CT effectively reduces the time devoted to training while allowing an adequate training volume to be achieved [7].

CT can be defined as a combination of resistance based aerobic activities with short defined time period to complete each station. The training modality can incorporate a larger number of individuals' involvement in the same exercise session and in shorter time [8]. CT can either be of moderate intensity or of high intensity. High intensity interval exercise is likely to be a more effective training method than moderate intensity exercise and is used more in building the cardiovascular endurance [9,10]. CT that uses endurance exercises is effective in improving cardiopulmonary parameters by working on the maximum oxygen consumption, maximum pulmonary ventilation, functional capacity, myocardial strength, power and endurance thereby improving cardiovascular endurance [11]. Improving the hemodynamic parameters like heart rate, cardiac output and mean arterial pressure leads to an increased cardiorespiratory fitness and building of aerobic capacity [12]. Improved physical fitness which serves as a motivator has increased impact on an individual's quality of life [13].

World Health Organisation (WHO) defines quality of life which is known as a multidimensional subjective construct as "individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and their concerns". Health does not only imply the absence of infirmity and disease, it is a state of all round well-being which can be physical, mental, social and psychological [14]. The genetic disposition, environment and opportunities join to create attitudes and expectations which can affect the perception of quality of life by young adults, making the desire to improve the quality of life important [15]. Basic activities such as jogging, walking, swimming and aerobic exercises are excellent activities for individuals of all ages which are expected to promote cardiovascular endurance and quality of life [2]. However, the major reasons for not performing physical activities could be lack of time and motivation [16,17,18,19].

There is a dearth of research examining whether a 6-week CT program differentially has an effect on the cardiovascular endurance and quality of life (QOL) of apparently healthy adult females. Hence, in this present study, we sought to address this gap by ascertaining the effect of a 6-week circuit training on the cardiovascular endurance and QOL of an apparently healthy female population.

2. MATERIALS AND METHODS

2.1 Participants

A total of 60 apparently healthy female students who gave consent were randomly selected using simple randomized sampling technique and were further randomly assigned into the experimental group and control group. Participants with no history of musculoskeletal disorders, cardiopulmonary disorders, bone disorders, cancer or blood disorders, diabetes, acute fever and any severe illness were included in the study while those below 17 years and above 30 years with any history of knee and abdominal surgery

and all male participants were also excluded from the sampled population. The minimum sample size for the study was calculated and a total of 60 female students were recruited into the study.

2.2 Protocol Design

A pre-test-post-test control group experimental research design involving 60 apparently healthy females (30 in the experimental group, 30 in the control group) was undertaken. Ethical approval was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu State, Nigeria. Female students living within the campus were approached through a health education and screening program conducted. The program attracted 243 female students. The purpose of the study was explained and an informed consent form was given to those who volunteered to participate in the study. Data on the socio-demographic and anthropometric characteristics, cardiorespiratory indices and quality of life were recorded.

2.3 Study Measurements

The study was carried out at the gymnasium of the department of Medical Rehabilitation, faculty of Health Science and Technology, University of Nigeria Enugu Campus. Standard methods were used to assess body weight (kg) and body height (m) with electronic weighing scale and a height meter respectively. The following where checked before commencing the exercise and also after the exercise; the vital signs which includes the respiratory rate (in breaths per minute) was checked using a stop watch. The blood pressure was measured (in millimeters of mercury) using a sphygmomanometer and a stethoscope. The heart rate was also measured (beats per minute) using a stop watch. Partial oxygen saturation was assessed using the pulse oximeter.

2.4 Circuit Training Protocol

A 5-minute warm up exercise was carried out before the commencement of the circuit training. The circuit exercise was accompanied by a 5minutes cool down exercise. The circuit training duration for the first 2 weeks was 35 minutes with the warm up and cool down exercise time inclusive. The circuit training section was 3 times per week and duration of the training session was increased with 10 minutes after every 2 weeks for the 6-week duration of this study. The high intensive interval circuit training exercises was adopted and they include the following; high knees, knee raise claps, kick raise, alternating jump lunge, burpees and abdominal twist or knee combo. There was 6 stations with short periods of rest between them. The body composition parameters, anthropometric measures and quality of life of the participants were measured at the beginning and at the end of the 6-week duration. The control group involved in this study were not engaged in circuit training, rather they continued with their normal daily activities of life and their body composition parameters, anthropometric measurements and quality of life were also assessed before and after 6-weeks duration of the study using the WHO quality of life Brief (WHOQoL-Bref) questionnaire.

2.5 Safety of the Intervention

No adverse events were recorded that limited the ability of participants to perform the exercises prescribed in the training program.

2.6 Statistical Analysis

The data was summarized using descriptive statistics of mean and standard deviation, and paired t-test was also used to analyze the data obtained. All data were analyzed using IBM SPSS version 18.0 (IBM Co., Armonk, NY, USA). $P < 0.05$ was considered to indicate a statistically significant difference.

3. RESULTS AND DISCUSSION

3.1 Results

A Total of 60 apparently healthy females who volunteered to participate in the study were randomly assigned into two groups (experimental group and control group).The experimental group improved on average (Tables 1 and 2). The experimental group recorded an increase in the body composition (hip circumference), cardiorespiratory indices (RR, MAP, HR), and QOL (physical health and psychological domains). Over the course of study, the 6-week Circuit Training (CT) program was very effective in increasing all the cardiorespiratory indices examined (SPO_2, RR, MAP, VO_2max, HR) (Table 3).

The experimental group also after the 6-week CT Circuit Training program showed no statistical significance in the various quality of life domains, while that of the control group was significant for the social relationships domain (Table 4).

Table 1. Descriptive characteristics of the study groups, means ± SD (pre intervention)

Variable	Control (n=30) X ± SD	Experimental (n=30)X ± SD
HC (cm)	100.20±9.55	101.50±10.28
WHR(cm)	0.77±0.52	0.78±0.04
BMI (kg/m^2)	22.63±3.59	24.17±3.78
SPO2 (%)	97.50±1.43	97.03±2.27
RR (b/m)	20.80±3.85	21.07±3.78
MAP(mmhg)	85.67±5.74	85.73±6.37
VO2max (L/min)	36.33±3.84	37.53±4.88
HR (bpm)	82.67±8.79	80.03±9.96
Physical Health Domain	68.07±13.87	72.80±13.99
Psychological Domain	64.83±19.31	64.90±11.27
Social R/ships Domain	59.73±16.26	71.97±16.46
Environment Domain	51.73±11.83	56.40±10.84

Key: X: Mean, SD: Standard deviation, HC: Hip circumference, WHR: Waist-hip ratio, BMI: Body mass index, SPO2: Partial oxygen saturation, RR: Respiratory rate, MAP: Mean atrial pressure, VO2max: Maximal oxygen consumed, HR: Heart rate

Table 2. Descriptive characteristics of the study groups, means ± SD (post-intervention)

Variable	Control (n=30) X ± SD	Experimental (n=30) X ± SD
HC (cm)	102.90±10.26	99.70±9.55
WHR(cm)	0.77±0.04	0.78±0.05
BMI (kg/m^2)	22.83±3.89	24.03±3.61
SPO2 (%)	97.50±1.43	96.13±2.30
RR (b/m)	20.80±3.85	27.93±5.52
MAP (mmhg)	85.67±5.74	93.13±11.98
VO2max (L/min)	33.20±5.07	34.50±6.48
HR (bpm)	82.67±8.79	102.87±12.66
Physical Health Domain	71.33±14.72	72.93±14.56
Psychological Domain	67.93±15.23	68.53±12.68
Social R/ships Domain	72.30±17.01	66.67±17.29
Environment Domain	51.40±16.53	54.20±14.93

Key: X: Mean, SD: Standard deviation, HC: Hip circumference, WHR: Waist-hip ratio, BMI: Body mass index, SPO2: Partial oxygen saturation, RR: Respiratory rate, MAP: Mean atrial pressure VO2max: Maximal oxygen consumed, HR: Heart rate

Table 3. Paired t-test of the cardiovascular indices of the study groups (pre and post-intervention)

Variables	Control (n=30)		Experimental (n=30)	
	t-value	p-value	t-value	p-value
PREMAP – POSTMAP	-2.280	0.030*	-3.471	0.002*
PRERR – POSTRR	-1.342	0.190	-6.601	0.000*
PREHR – POSTHR	-4.747	0.000*	-9.637	0.000*
PRESPO2 - POSTSPO2	0.502	0.620	2.457	0.020*
PREVO2max - POSTVO2max	3.672	0.001*	3.082	0.004*

Table 4. Paired t-test of the QOL of the study groups (pre and post-intervention)

Variables	Control (n=30)		Experimental (n=30)	
	t-value	p-value	t-value	p-value
Physical Health Domain	-1.012	0.320	-0.058	0.954
Psychological Domain	-0.711	0.483	-1.370	0.181
Social R/ships Domain	-3.565	0.001*	1.737	0.093
Environment Domain	0.088	0.930	0.876	0.388

3.2 Discussion

This study shows a statistical significant difference in all the cardiorespiratory indices examined (VO_2max, MAP, SPO_2, HR, and RR) in the experimental group, but only VO_2max, MAP, and HR showed significance in the control group. This means that it is possible to improve the cardiorespiratory fitness (cardiovascular endurance) by means of a 6-week circuit training program among the apparently healthy adult females. Previous studies have investigated the benefits of a Circuit Training (CT) program for individuals with various health conditions [20,21,22], but none have studied its effects in an apparently healthy young adult female population. This current study therefore adds to the existing body of knowledge. According to some other studies, CT increased VO_2max from about 15% to 18.6%, with 8-12 stations carried out 3 days per week. [21,23]. Some other studies using the CT program also confirmed a significant improvement in cardiorespiratory fitness indices among other population groups [12,24,25,26]. A short rest period during CT tends tosupplement improvements in VO_2max [22].

We also found a slight improvement in the quality of life of the experimental group (physical health and psychological domains), with no statistical significant change. This implies that the 6-week circuit training program among the apparently healthy adult females did not statistically improve their overall quality of life. This result was inconsistent with the study by Teoman et al. [27], which found a statistical significance in the QOL of menopausal women taking hormone therapy using the CT program; and also in the study by Mastrangelo et al. [28], which found a significant improvement in the quality of life of the experimental group after circuit training exercise.

It has been recorded that one [1] out of every six [6] female deaths is associated with Congestive Heart Disease [29], with most of these women not being active enough for the various heart diseases' risk reduction [30]. Some of these women reported that issues like lack of motivation, self-efficacy, social support, and time during exercise could serve as barriers to exercising, which was consistent with previous studies [16,17,18,19,31]. Another study stated that women tend to respond differently than men to programs aimed at increasing exercise [32,33]. This was also congruent with previous studies which stated that gender-based differences points out the necessity of modifying certain training programs specifically for women [34,35].

The main objective of this current study is to improve the cardiovascular endurance and quality of life (QOL) of the apparently healthy young adult females. With this circuit training method, these women can easily execute many types of exercises. This can be attributed to the versatility of the circuit training program, where one can include the set of exercises selected, and also based on the fitness level of the individual [22,36]. Thus, the present results indicate that the particular design examined in this study could be effective and adopted as an exercise regimen for this target population.

One of the most important outcomes of this study was that a circuit training program of six [6] stations carried out three [3] times a week for six [6] weeks, with short periods of rest between them, could be effective to both improve and maintain the cardiovascular endurance, but not the quality of life of this population group. Also, in this present study, the sum of the periods of training was six [6] weeks, thus a short time for the fitness profits. Nevertheless, results were positive since the cardiorespiratory fitness indices were improved and maintained after these weeks. Furthermore, no detraining and follow-up maintenance programs were applied. This consequently implies that the effectiveness of circuit training to increase the cardiovascular endurance and QOL values, and then maintaining them during longer periods, could not be ascertained.

Even though more research is needed to confirm these results, the detraining and follow-up maintenance programs could become a key element in the future. Further studies may also consider longitudinal follow-up to determine the long-term effects of circuit training in this population group. Therefore, CT is a practical and effective approach to exercise training in apparently healthy adult females. Physiotherapists training this population should consider circuit training as an intervention or for lifestyle modification.

4. CONCLUSION

The present study suggests that it is possible to develop and maintain improved cardiovascular endurance (VO_2max), but not QOL, through a short term (6-week) circuit training program for

the apparently healthy young adult females. The circuit training appear to be necessary to make the cardiorespiratory fitness training effective and feasible, permitting at the same time regular activities of daily living (ADL). It is therefore, a great strategy to improve cardiovascular endurance and maintain functional QOL.

CONSENT

The purpose of the study was explained and an informed and written consent form was given to those who volunteered to participate in the study.

ETHICAL APPROVAL

Ethical approval was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu State, Nigeria.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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