Effect of Continuous and Interval Training on Variables of Metabolic Syndrome of Female Students of College of Education Katsina-Ala Benue State Nigeria

Titus Terwase Chior PhD
Department of Physical and Health Education
College of Education
Katsina-Ala
terwasett68@gmail.com
08102433749, 09023063462

Kartser Mngutor Titus
Department of Physical and Health Education
College of Education
Katsina-Ala
09049993566
DOI: 10.56201/ijmepr.v9.no3.2025.pg26.40

Abstract
This study examined the effect of continuous and interval training on variables of metabolic syndrome of female students of College of Education Katsina-Ala. To achieve this purpose, 4 null hypotheses were formulated for the study. Also the quasi-experimental research design was used in which 34 female students were randomly selected from a population of 422 female students of the College of Education Katsina-Ala, after screening. The participants were assigned to either continuous training group (n=17) or interval training group (n=17). Both groups underwent 8 weeks continuous or interval training, three times a week for 60 minutes at an intensity of 50-55% HRmax. The participants' systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting blood glucose (FBG) and waist circumference, were assessed at baseline, after 4th week and after 8th week. The data collected was analyzed using repeated measures of Analysis of Variance (ANOVA), with level of significance set at 0.05. The result of the study showed significant effect of continuous and interval training on SBP (p=.004), DBP (.000) and WC (p=.000) but not on FBG (p=.234). The study concluded that regular aerobic exercises can mitigate risks associated with metabolic syndrome among female students of College of Education Katsina-Ala in Benue State. It was recommended among others that female students of College of Education Katsina-Ala should be encouraged to participate in continuous jogging or walking and interval running to reduce risk factors and prevent the development of variables of metabolic syndrome.

Keywords; *Metabolic syndrome, Continuous training, Interval training*

Introduction

Metabolic syndrome (MetS) is a bunch of metabolic defects comprising hypertension, insulin resistance, visceral obesity, fatty liver, and atherogenic cardiovascular diseases (Mohamed, Shalaby, El-Shiekh, El-Banna, Emam, Bakr, (2023). If left untreated, MetS is

significantly related to a high danger of evolving type 2 diabetes and atherogenic cardiovascular diseases. Thus, MetS is a prominent cause of morbidity and mortality internationally and has become very important to investigate novel therapies in this context to decrease the heavy burden of the disease. Metabolic syndrome (MetSyn), characterized by a constellation of metabolic abnormalities, including central obesity, insulin resistance, hypertension, and dyslipidemia, poses a significant risk for the development of atherosclerotic cardiovascular diseases and type II diabetes mellitus. The diagnosis of metabolic syndrome necessitates the presence of three or more of these metabolic abnormalities, signaling an urgent need for proactive identification and intervention strategies, (Swarup, Ahmed, Grigorova & Zeltser, 2024). Metabolic syndrome is a cluster of related metabolic abnormalities and risk factors that consistently increase the risk of developing type 2 diabetes and cardiovascular (heart and blood vessel) problems.

The five recognized components of MetS are: waist circumference based on ethnicity to identify abdominal obesity, high blood pressure, impaired fasting blood sugar levels, higher levels of triglycerides, and a reduction in the amount of HDL cholesterol (Fahed, Aoun, BouZerdan, Allan, Bouferraa & Assi, 2022). Metabolic syndrome is a common pathophysiological condition with implications for the development of many chronic diseases, (Hassan, Abdelkreen, Mahmoud & Mohammed, 2022).

Studies have been carried out elsewhere on effects of exercises on metabolic syndrome in both pediatrics and adult populations. In Nigeria, metabolic syndrome has not been extensively studied in the various populations. Few studies (Jatau, 2012; Omeiza, 2012, Chior, Yahaya & Chior, 2021) that have been carried out in Nigeria used paediatrics and adult populations, especially males. This research was therefore intended to study effects of continuous and interval training on variables of metabolic syndrome among female students of College of Education Katsina-Ala.

Statement of the Problem

The prevalence of chronic and non-communicable diseases has escalated rapidly in developing countries than in industrialized countries (Kelishadi, 2007). The World Health Organization (WHO, 2010) had estimated that by the year 2020, non-communicable diseases would account for approximately three quarters of all deaths in the developing world (Livingstone, Nuriddin, Staggers, & Butler, 2013). Metabolic syndrome though mentioned around 1988 is still relatively known in Nigeria. In the western world, several studies have been done on metabolic syndrome in pediatrics and adult populations, (Coquart, Boitel, Borel, Matran, Mounier-Vehier, & Gorun, 2014). In the developing world, a few studies that have been carried out shows a considerably high prevalence of the metabolic syndrome among youths. In Nigeria, few studies have been done on several components of the syndrome in adult populations.

In Benue state, few studies exist on the metabolic syndrome in adults (Chior, Yahaya & Chior, 2021). In recent times, it is noted that people are experiencing the occurrence of non-communicable diseases than ever before, as they suffer from high blood pressure, elevated blood glucose and large waist circumference among others leading to the occurrence of Metsyn which results to diabetes and/or cardiovascular diseases. Metabolic syndrome (MetS) is a group of medical conditions that increase the risk of cardiovascular disease, stroke, and type 2 diabetes. While there are numerous studies on the prevalence of MetS in the general adult population worldwide, limited information exists regarding its prevalence among female students of College of Education, Katsina-Ala.

Research Hypotheses

1. There is no statistically significant effect of 8 weeks of continuous and interval training on SBP of female students of College of Education Katsina-Ala.
2. There is no statistically significant effect of 8 weeks of continuous and interval training on DBP of female students of College of Education Katsina-Ala.
3. There is no statistically significant effect of 8 weeks of continuous and interval training on FBG of female students of College of Education Katsina-Ala.
4. There is no statistically significant effect of 8 weeks of continuous and interval training on WC of female students of College of Education Katsina-Ala

Literature Review

Concept of Metabolic Syndrome

Metabolic syndrome (MetSyn) according to Regaieg, Charfi, Kamoun, Eulleuch, Marrakchi, Jamoussi, Damak and Abid (2015), is a constellation of metabolic abnormalities that includes abdominal obesity, glucose intolerance, hypertension, elevated triglycerides and low high density lipoprotein cholesterol (HDL-C). This clustering is associated with increased risk of developing diabetes and cardiovascular disease (CVD), (Swarup, Ahmed, Grigorova & Zeltser, 2024). According to the Global Burden of Disease study which included data from 204 countries, high blood pressure, elevated LDL cholesterol, high fasting blood glucose and obesity attributed to 10.8 million, 3.8 million, 2.3 million and 1.9 million cardiovascular deaths, respectively (Mohebi, Pathirana, Khoja, Wittwer, Lowe, Fisher, Kharwadkar, Gomes, Gamage, Toyer, Youn., Arstall, & Andraweera, 2025).

Metabolic syndrome (MS) is a frequent chronic condition related to physical inactivity, inadequate eating habits and obesity (Adnan, Rahman & Faridin, 2019). The pathophysiology of MS is related to vascular and metabolic alterations, such as arterial hypertension, visceral fat accumulation, dyslipidemia, insulin resistance (IR), glucose intolerance and persistent increases in various pro-thrombotic, antifibrinolytic and inflammatory factors. The increase in morbidity and mortality in patients with MS has required the application of preventive strategies and pharmacological and non-pharmacological treatment (Gallo-Villages, Aristizabal, Estrada, Vabuena, Narvaez-Sanchez, Osorio, Aguine-Acevedo & Calederfon, 2018). MS is a disorder of energy use and storage (Venugopal, Dongre & Sarvanan, 2019). According to them, it is defined by a cluster of factors, namely, central obesity, glucose intolerance, hyperinsulinemia, low-high-density lipoprotein (HDL) cholesterol, high triglycerides (TG) and systemic hypertension.

Components of metabolic Syndrome

Elevated blood pressure

High blood pressure or hypertension as it is popularly known is a major health problem and an independent risk factor for atherosclerosis, which is the most common cause of death worldwide (Ibrahim, 2012). Elevated systolic and diastolic blood pressure is associated with a higher risk of developing coronary heart diseases when blood pressure (persistently) is equal to or higher than 140/90mmHg. It is defined as a sustained elevation in systolic blood pressure, diastolic blood pressure or both (Sani, 2014). According to him systolic blood pressure is the maximum force of blood in the arteries as the heart beats, while diastolic blood pressure is the force of blood in the arteries as the heart relaxes between beats. He further stated that a consistent reading of 140mmHg systolic and 90mmHg diastolic or higher is considered hypertension and gave a classification of blood pressure levels as shown below:

Optimal BP = <120mmHg/<80mmHg; Normal BP = <130mmHg/<85mmHg; High-Normal = <130-139mmHg/85-89mmHg; Grade 1 (mild) hypertension = 140-159mmHg/90-99mmHg; Grade 2 (moderate) hypertension 160-179mmHg; Grade 3 (severe) hypertension >180mmHg/>, and Isolated systolic hypertension= >110mmHg/>90mmHg, (Sani, 2014)'

Untreated long standing hypertension causes serious complications to the vital organs of the heart, brain and kidney; usually referred to as the target organs. Elevated blood pressure imposes excessive work on the myocardium and damages systemic arterial vasculature. It affects the blood vessels in the body, the large arteries, small arteries and arterioles. The consequences are arteriosclerotic changes in the large arteries and thickening of the walls of small arteries and arterioles. Hypertension has been referred to as a silent killer (Ibrahim 2012); a silent enemy (Sani, 2014), since it can be largely asymptomatic until it has caused serious damage to the individual. In most people hypertension results from interplay between genetic and environmental factors. These factors include; heredity, age, salt intake, obesity, physical inactivity, excessive alcohol intake, stress, low potassium, low vegetable or fresh fruits content in diet, high saturated fats content in the diet, high or low socio-economic status, high educational level and high income status.

Elevated fasting blood glucose

Blood sugar concentration or blood sugar level is the amount of glucose present in the blood stream of human beings. Normally, the body maintains the blood glucose level at a reference range of between 3.6 – 5.8mmol/l. The human body regulates blood glucose through metabolic processes (homeostasis). Blood glucose levels outside the normal range are termed elevated and called hyperglycemia, while low levels of blood glucose are called hypoglycemia, (Ibrahim, 2012). Elevated blood glucose levels in the human body causes type 2 diabetes. The human body possesses variety mechanisms that help to regulate the body processes and keep the glucose level normal. The rise in blood glucose stimulates the pancreas to secrete insulin into the blood. This substance facilitates the uptake and utilization of glucose by the tissues of the body, especially the muscles and adipose tissues. Insulin acts to lower blood glucose levels by allowing the glucose to flow into cells. Glucagon acts to raise blood glucose levels by causing glucose to be released into circulation from its storage sites. Insulin and glucagon act in opposite but balanced fashion to keep blood glucose levels stable (Babalola, 2008).

Blood glucose levels outside the normal range may be an indicator of a medical condition. To determine the glucose level in blood a fasting blood test is carried out in which an individual fasts for at least 12 hours. The NCEP/ATP III (2001) gave the values for blood glucose that meet the criteria for metabolic syndrome as <110mg/dl. The result of a fasting test with respect to blood glucose levels (Ibrahim, 2012) is presented below;

(a) 3.9-5.5 mmol/L or 70-100mg/dl = normal.
(b) 5.8-7.0 mmol/L or 101- 128mg/dl = prediabetes or impaired glucose intolerance.
(c) <7.0 mmol/L or <128 mg/dl = diabetes.

Waist circumference

Waist circumference is a measure of the perimeter of or the distance around the abdomen. It provides information about the distribution of body fat and is a measure of risk for conditions such as coronary heart diseases. It is one way to determine whether you have an increased amount of fat around your stomach and whether you are at an increased health risk. The National Health and Medical Research Council (2013) maintained that your health is at risk if your waist

size is over 94cm for men and over 80cm for women.

Waist circumference (WC) is a convenient measure of abdominal adipose tissue and is unrelated to height, but inversely correlates with Body Mass Index (BMI) and total lean body (Ibrahim, 2012), and is associated with cardiovascular disease risk factor. Chior and Yahaya (2021), asserted that waist circumference has been shown to be a valid index of identifying people who need weight management, if they are to avoid a significant risk of heart attack. According to them, waist circumferences of more than 94cm in men and 80cm in women indicate danger. A high waist circumference or a greater level of abdominal fat is associated with an increased risk for type 2 diabetes, high cholesterol, high blood pressure and heart disease.

Effects of continuous and interval training on blood pressure

It is a well-established fact that sedentary lifestyle contributes to increased risk of cardiovascular disease, especially hypertension (Lamina, 2010). Regular physical activity is a corner stone treatment for the prevention and management of multiple chronic diseases, (Henson, Davies, Hall, & Yates, 2025). Indeed hypertension is a major independent risk factor for cardiovascular and renal disease, increasing the risk of myocardial infarction, stroke and heart failure. Many studies have shown that exercise training lowers blood pressure in hypertensive patients. Regular physical exercise has been recommended for the prevention and treatment of hypertension. The blood pressure-lowering benefits that a given hypertensive individual can expect to derive from participation in exercise programs is dependent on body weight, diastolic blood pressure, and the program itself. Interestingly, the reduction in blood pressure observed with regular aerobic endurance exercise has been proposed to be due to the accumulative effects of single exercise bouts rather than long-term adaptations to exercise, (Omeiza, 2012). Studies, for example (Ibrahim, 2012) have shown that active subjects have a lower risk of becoming hypertensive than do sedentary subjects. Again Lamina (2010) revealed a significant decrease in SBP and DBP in the experimental groups of continuous and interval training over a period of 8 weeks.

Effects of continuous and interval training on fasting blood glucose

Elevated blood glucose also known simply as diabetes is a multifaceted, heterogeneous and a multifactorial metabolic disorder characterized by chronic hyperglycaemia. Its prevalence estimated at 150 million people in 2001, increased to 382 million in 2013, and is expected to exceed 471 million by the year 2035 (Bakari, 2014). Exercise is considered a cornerstone in the treatment regimen for individuals with manifest Non-Insulin dependent diabetes mellitus (NIDDM). The recommendations that exercise training can be used as a therapeutic means to lower glucose levels in NIDDM subjects stem primarily from the fact that exercise has pronounced effects upon the metabolism of glucose. Ada (2012), classified the effects of exercise on glucose control in two ways; acute effects and chronic effects. According to her, the acute effects are directly related to the increased rate of muscle glucose restoration, (how much a muscle feeds itself from glucose in the bloodstream) called muscle glycogen repletion, while chronic effects are related to the increase in metabolically active muscle. As regular exercise produces more active muscles, these muscles utilize more glucose thereby keeping the blood level under control.

During exercise, blood insulin levels drop, and blood glucagon (a hormone in the pancreas that does the opposite of insulin) level rises. These changes are caused to oppose the insulin-like effect of muscle contraction (Babatunde, 2013). As exercise commences, muscles

contract, but do not require much insulin to transport glucose into the working muscles. The glucose uptake by the exercising muscle increases by 7 to 20 folds during the first 30 to 40 minutes of exercise, depending on the intensity. In addition, insulin receptors are made more sensitive to lower amounts of insulin present in the cell. This increased insulin receptor sensitivity lasts for many hours after exercise.

Effects of continuous and interval training on waist circumference

Waist circumference is a convenient measure of abdominal adipose tissue and unrelated to height but correlates closely with BMI and total body fat, and is associated with cardiovascular disease risk factor. A large waist circumference is considered a warning sign and put the individual at very high risk of developing metabolic syndrome and its serious health consequences (Jatau, 2012). Waist circumference is a measure of the distance around the abdomen. It is one of the most practical tools for assessing abdominal fat for chronic disease risk for type 2 diabetes, high cholesterol, high blood pressure and heart disease.

Camara (2015) postulated that reducing waist circumference has nothing to do with hundreds of crunches and sit-ups. To remove fat from ones waist, the author maintained, an individual must increase the amount of physical activity he gets everyday apart from changing eating habits. He then recommends performance of 60 minutes of moderate intensity aerobic activity each day. Exercising from 150-250 minutes per week will give one a modest weight loss result. He concluded by reporting that an individual weighing 170 pounds engaged in brisk walking for 60 minutes every day will burn 397 calories. Strength training has also been recommended as it has the ability to burn calories more efficiently. Generally, it is advised that physical activity should be included in ones daily routine to help lose waist fat.

Empirical Studies:

In the western world, a lot of studies, for example, Mohebi, Pathirana, Khoja, Wittwer, Lowe, Fisher, Kharwadkar, Gomes, Gamage, Toyer, Youn., Arstall, & Andraweera (2025); Borch-Johnsen (2013) and Shayo (2019), have been conducted on the prevalence and management techniques of metabolic syndrome in both pediatrics and adult populations (Coquart, Boitel, Borel, Matran, Mounier-Vehier, & Gorun, 2014). In Nigeria, few training studies (Ibrahim, 2012; Lawal, 2013; Abdul, 2014 & Ajiya, 2017; Chior, Tsauri, & Chior, 2021)) have been carried out on several components of the syndrome. For example, Ibrahim (2012), in a cross-sectional study of 1553 men and women in both rural and urban settings found that the metabolic syndrome was absent in rural men and the prevalence was low (0.3%) in rural women, and 1.2% in urban men. Urban rates were higher in both men and women and the prevalence increased with age. A study on the prevalence of metabolic syndrome in South-western Nigeria revealed that the overall prevalence was 12.1%, with males and females at 1.7% and 11.8% respectively (Omeiza, 2012). Similarly, Ibrahim (2012), studied the prevalence and gender distribution of the metabolic syndrome among subjects with type 2 diabetes in Lagos, Nigeria. The results showed a prevalence rate of 88% and the frequency similar for both men and women, (83% and 88% respectively). According to her, the prevalence increased from 11% among participants aged 20-29 years to 89% in participants aged 70-79 years.

Ali, Samadder, Shourove,Taher & Islam (2023) carried out a study on the prevalence of MetSyn and associated risk factors among Bangladesh university students (n=281) and academic staff (n=302) using a cross sectional design. Multivariate logistic regression models were used to determine the risk factors associated with MetSyn. Overall, the prevalence of MetSyn was

27.7% in students and 47.7% in staff. There was a significant difference ($p< 0.01$) in MetSyn prevalence between male students (34.8%) and female students (17.2%). In contrast, it was comparatively higher in female staff (52.3%) than in male staff (45.8%), although the difference was not statistically significant.

Jatau (2012), studied 30 healthy sedentary adult men, aged 20-30 years using a 2x3 factorial design. Descriptive statistics of mean and standard deviation were used for data description while independent t-test was employed to determine the differences between the experimental and control group. A comparism of the differences between changes in the test periods were made using repeated measure ANOVA. The results indicated significant decreases in waist circumference and cardiovascular efficiency variables. However, the study did not find significant changes in serum glucose, lipids and lipoproteins of sedentary Nigerian male adults.

Methodology

Design of the Study

The quasi-experimental research design was utilized for this study. There was no control group. This design is suitable for this study as it allowed the researchers to observe and analyze effects of continuous and interval training programmes on SBP, DBP, FBG and WC among female students of College of Education, Katsina-Ala.

Population and Sample Size

The population for the study comprised 422 female students of the College of Education, Katsina-Ala, Benue State ages 20 - 30 years. Available data from the admissions office of the College indicated that there were four hundred and twenty (422) female students, during the 2023/2024 academic session. Out of this number the researchers sampled 34 participants after screening.

Sample and Sampling Techniques

The sample for the study comprised thirty-four (34) female students who were selected after screening. Simple random sampling procedure was employed to assign the participants to the continuous training programme (n=17) and the interval training programme (n=17), in line with the recommendation of Thomas and Nelson (1990).

Instrument(s) for Data Collection

The following instruments were used for the study;

1. Running course
2. Two Tape measures
3. Two Digital blood glucose monitors
4. Four Stop watches
5. Two Digital BP monitors
6. Four cartons of Hand gloves
7. Note book /Pen

Training Protocols

Continuous Training

The **continuous training** group underwent training three times a week for 8 weeks. The training session for the 1st stage (1st 4weeks), consisted of 10 minutes of warm-up exercises. This

was followed by 15 minutes of continuous jogging (training duration). This was held on alternate days of the week (Mondays, Wednesdays and Fridays) at an intensity of 35-70 b/m. In the 2nd stage (2nd 4weeks), the 'activity duration' was increased by 5 minutes. This increase presented another stress, as the participants aree expected to adapt to the initial stress at the end of each period of time. Ten minutes of 'cooling down' was given at the end of each session. A trial test was conducted, before the actual programme commenced.

Interval Training

The **interval training** group underwent training three times a week for 8 weeks. Each training session consisted of 10 minutes warm-up; followed by the interval training. This consisted of 1-2 minutes of jogging followed by 1 minute of walking. This was repeated 3 times after which 3 minutes rest interval was given, which consisted of walking. This constituted 1 set; and each training session consisted of 3 sets. This programme was followed for the 1st 4 weeks; after which the number of repetitions in each set was increased to 4. At the beginning of the 5th week, the participants performed 5 repetitions of 3 sets. There was a cooling down of 10 minutes after each training session. The intensity of the exercise training was maintained at 35-75b/m which is equivalent to 3-6 METS. A trial test was conducted before the actual programme commenced.

Data Analysis

The data that was obtained from the eight weeks training programmes for continuous and interval training at 0, end of week 4, and end of week8 week for the participants were subjected to analysis using the Statistical Package for the Social Science (SPSS v.21) at the Information and Communication Technology Centre, Benue State University Makurdi. The descriptive statistics (means, standard deviations, standard errors of means) of SBP, DBP, FBG and WC was computed for interpretation. The two-way Analysis of Variance was utilized to determine the effects of continuous and interval training on each of the variables of metabolic syndrome as well as their effects between evaluations. All analyses were done at 0.05 percent level of significance.

Results

Thirty (34) female students of the College of Education Katsina-Ala participated in the study, the results of which are presented in tables 1-4.

Table 1: Results of repeated measures Analysis of Variance (ANOVA) on Systolic Blood Pressure of participants for Continuous Training (CT) and Interval Training (IT) at baseline (T_1), end of 4th week (T_2), and posttest (T_3), n=34

Source		SS	DF	MS	F	P
Group	Sphericity Assumed	124.578	2	62.289	29.351	0.000*
	Greenhouse-Geisser	124.578	1.423	87.539	29.351	0.000*
	Lower-bound	124.578	1.538	80.985	29.351	0.000*
Test	Sphericity Assumed	124.578	2	62.289	29.351	0.000*
	Greenhouse-Geisser	124.578	2	62.289	29.351	0.000*
	Huynh-Feldt	124.578	2	62.289	29.351	0.000*
	Lower-bound	124.578	1.538	80.985		
Group*Test	Sphericity Assumed	14.102	42	2.151	1.061	0.004*
	Greenhouse-Geisser	14.102	42.000	2.151	1.061	0.004*
	Huynh-Feldt	14.102	42.000	2.151	.000	1.000
	Lower-bound	14.102	42.000	2.151	.000	1.000

*=Significant difference among means at 0.05 level

Table 1 shows the result of repeated-measure ANOVA of continuous and interval training groups for 8 weeks on systolic blood pressure. The result revealed significant effects (p=.000) on the systolic blood pressure of the participants by group. Also, the analysis by group and test revealed significant effects (p=.004) on the systolic blood pressure of both continuous and interval training groups. By these results, the null hypothesis which states that there is no statistically significant effect of 8 weeks of continuous and interval training on blood pressure of female students of College of Education, Katsina-Ala is therefore rejected.

Table 2: Results of repeated measures Analysis of Variance (ANOVA) on Diastolic Blood Pressure of participants for Continuous Training (CT) and Interval Training (IT) at baseline (T_1), end of 4th week (T_2), and posttest (T_3), n=34.

Source		SS	DF	MS	F	P
Group	Sphericity Assumed	132.689	2	66.344	29.912	0.000*
	Greenhouse-Geisser	132.689	1.506	88.105	29.912	0.000*
	Lower-bound	132.689	1.000	132.689	29.912	0.000*
Test	Sphericity Assumed	128.644	58	2.218		
	Greenhouse-Geisser	128.644	43.674	2.946		
	Huynh-Feldt	132.689	1.571	84.486	29.912	0.000*
	Lower-bound	128.644	29.000	4.436		
Group*Test	Sphericity Assumed	14.102	42	2.151	1.061	0.004*
	Greenhouse-Geisser	14.102	42.000	2.151	1.061	0.004*
	Huynh-Feldt	14.102	42.000	2.151	.000	1.000
	Lower-bound	14.102	42.000	2.151	.000	1.000

*=Significant difference among means at 0.05 level

Table 2 shows the result of repeated-measure ANOVA of continuous and interval training groups for 8 weeks on diastolic blood pressure. The result revealed significant effects (p=.000) on the systolic blood pressure of the participants by group. Also, the analysis by group and test revealed significant effects (p=.004) on the diastolic blood pressure of both continuous and

interval training groups. By these results, the null hypothesis which states that there is no statistically significant effect of 8 weeks of continuous and interval training on blood pressure of female students of College of Education, Katsina-Ala is therefore rejected.

Table 3: Results of repeated measures Analysis of Variance (ANOVA) on Fasting Blood Glucose of participants for Continuous Training (CT) and Interval Training (IT) at baseline (T_1), end of 4th week (T_2), and posttest (T_3), n=34.

Source		SS	DF	MS	F	P
Group	Sphericity Assumed	5.041	1	5.041	0.461	.234
	Greenhouse-Geisser	5.041	1.000	5.041	0.461	.234
	Huynh-Feldt	5.041	1.000	5.041	0.461	.234
	Lower-bound	5.041	1.000	5.041	0.461	.234
Test	Sphericity Assumed	.002	2	.001	.000	1.000
	Greenhouse-Geisser	.002	2.000	.001	.000	1.000
	Huynh-Feldt	.002	2.000	.001	.000	1.000
	Lower-bound	.002	2.000	.001	.000	1.000
Group*Test	Sphericity Assumed	144.922	42	3.451	1.461	.234
	Greenhouse-Geisser	144.922	42.000	3.451	1.461	.234
	Huynh-Feldt	144.922	42.000	3.451	.000	1.000
	Lower-bound	144.922	42.000	3.451	.000	1.000

*=Significant difference between means at 0.05 level

Table 3 shows the result of repeated-measure ANOVA of continuous and interval training groups for 8 weeks on fasting blood glucose. The result revealed no significant effects (p=.234) on the fasting blood glucose of the participants by group. Also, the analysis by group and test revealed no significant effects (p=.234) on the fasting blood glucose of both continuous and interval training groups. By these results, the null hypothesis which states that there is no statistically significant effect of 8 weeks of continuous and interval training on fasting blood glucose of female students of College of Education, Katsina-Ala is accepted.

Table 4: Results of repeated measures Analysis of Variance (ANOVA) on Waist Circumference of participants for Continuous Training (CT) and Interval Training (IT) at baseline (T_1), end of 4th week (T_2), and posttest (T_3), n=34.

Source		SS	DF	MS	F	P
Group	Sphericity Assumed	2958.40	1	2958.40	33.512	.000*
	Greenhouse-Geisser	2958.40	1.000	2958.40	33.512	.000*
	Huynh-Feldt	2958.40	1.000	2958.40	33.512	.000*
	Lower-bound	2958.40	1.000	2958040	33.512	.000
Test	Sphericity Assumed	6.867	2	3.4533	.39	.962
	Greenhouse-Geisser	6.867	2.000	3.4533	.39	.962
	Huynh-Feldt	6.867	2.000	3.4533	.39	.962
	Lower-bound	6.867	2.000	3.4533	.39	.962
Group*Test	Sphericity Assumed	3707.733	42	88.279	33.512	.000*
	Greenhouse-Geisser	3707.733	42.000	88.279	33.512	.000*
	Huynh-Feldt	3707.733	42.000	88.279	.039	.962
	Lower-bound	3707.733	42.000	88.279	.039	.962

*=Significant difference between means at 0.05 level

Table 4 shows the result of repeated-measure ANOVA of continuous and interval training groups for 8 weeks on waist circumference. The result revealed significant effects (p=.000) on the waist circumference of the participants by group. Also, the analysis by group and test revealed significant effects (p=.000) on the waist circumference of both continuous and interval training groups. By these results, the null hypothesis which states that there is no statistically significant effect of 8 weeks of continuous and interval training on waist circumference of female students of College of Education Katsina-Ala is therefore rejected.

4.3 Discussion

The present study set out to investigate the effect of 8 weeks of continuous and interval training carried out 3 times a week on variables of metabolic syndrome among female students of College of Education, Katsina-Ala. The result of the analysis of data is presented as follows:

Blood pressure (systolic and diastolic) of the participants in this study was assessed at baseline, after 4th week and after 8th week of training for both continuous and interval training groups and the result showed significant effects (p=.000) on both systolic and diastolic blood pressure of the participants after treatment. The results showed a reduction from an average 129 mmHg (pretest) to an average117mmHg at post test for the continuous training group while interval training group had their mean systolic blood pressure of 127 mmHg at pretest reduced to 119 mmHg at posttest. The diastolic blood pressure of the participants of both groups showed a decrease from an average 83mmHg at pretest to an average 77mmHg at the end of training for the continuous training group while the interval training group showed a reduction from an average 82mmHg at pretest to 78 mmHg at posttest. This result is consistent with those of Plowman and Smith (1997), Fisher, Brown, Brown, Alcorn, Noles, Winwood, Resuehr, George, Jeansonne, and Allison (2015), who reported significant changes in earlier studies. This study is also in agreement with that reported by Karmal and Raggy (2012), who investigated changes in blood pressure in obese and non- obese children before and after treatment. After 12 weeks of exercise, both groups were reported to have shown reductions in their blood pressure. The study supports that of Lamina (2010), that reported significant decrease in the systolic and diastolic

blood pressure of the experimental groups of continuous and interval training over a period of 8 weeks.

The study again set out to determine the effects of continuous and interval training carried out 3 times a week for 8 weeks on the fasting blood glucose of female students of College of Education, Katsina-Ala. The result showed no significant effects (p=.234) on fasting blood glucose of the participants after 8 weeks of continuous and interval training. Mean values showed 4.99 mmol/l at pretest, 4.96mmol/l at the end of week 4 and 4.90 mmol/l at post test for the continuous training group and 5.77 mmol/l at pretest, 5.69 mmol/l at the end of week 4 and 5.66 mmol/l at post test for interval training group. This result is in agreement with Jatau (2013), who had reported insignificant differences in fasting blood glucose of sedentary Nigerian male adults after 12 weeks of aerobic and resistance training. This result supports that of Gross (2015), who reported insignificant effect on fasting blood glucose of participants on HIIT vs moderate intensity continuous training.

The study also set out to determine the effects of continuous and interval training carried out 3 times a week for 8 weeks on waist circumference of female students of College of Education, Katsina-Ala. The result showed significant effects (p=.000) on waist circumference of participants after 8 weeks of continuous and interval training. The means of the participants showed that the continuous training group had their waist circumference reduced form 60.66 cm at pretest to 58.50 cm at posttest while the interval training group had the waist circumference reduced from 60.64 cm at pretest to 57.48 cm at posttest. This finding does support earlier findings (Romain, Fankam, Karelis, Letendre, Mikolajacks, Stip, & Abdel-Baki, 2018), who reported significant changes in the waist circumference of participants after treatment. The result of this study agrees with Mazurek, Krawczyk, Zmijewski, Norkowski, and Czajkousa (2014), which reported significant decrease in waist circumference of collegiate females after 8 weeks of aerobic interval training verses continuous moderate exercise programme.

Conclusion

The study investigated the effect of 8 weeks of continuous and interval training on variables of metabolic syndrome of female students of College of Education, Katsina-Ala. From the analysis, the study found that the two training programmes had significant effect on SBP, DBP and WC while the training programmes had no significant effect on FBG of female students of College of Education, Katsina-Ala. It was concluded that regular aerobic exercises can mitigate risks associated with metabolic syndrome among female students of College of Education Katsina-Ala in Benue State.

Recommendation

Given the effect the training programmes had on variables of metabolic syndrome, it was recommended that regular jogging, running and walking can be used to reduce risk and prevent the development of variables of metabolic syndrome among female students of College of Education Katsina-Ala in Benue State.

Acknowledgement

We are greatly indebted to TETFUND for the financial support that aided this research. We also remain grateful to the College of Education Katsina-Ala for granting our request for use of students (participants) as well as facilities and equipment during the research work and lastly, to our female students who accepted to take part in the research.

References

Ada, J. (2012). Effects of aerobic training on blood sugar, lipid profile and blood pressure on gestational diabetic women. Unpublished Ph.D Dissertation, Department of Physical and Health Education, ABU, Zaria.

Adnan, E., Rahman, I. A. & Faridin, H. P. (2019). Relationship between insulin resistance, metabolic syndrome components and serum uric acid. *Diabetes and metabolic Syndrome: Clinical Research and reviews 13* (3): 2158-2162.

Ali, N., Samadder, M., S., Shourove, J. H., Taher, A., & Islam, F. (2023) Prevalence and factors associated with metabolic syndrome in university students and academic staff in Bangladesh

Babalola, J. F. (2008). *Introduction to Human Anatomy and Physiology.* Surulere, Lagos: Beacon Books

Babatunde, L. A. (2013). Effects of resistance and aerobic training on blood pressure, blood sugar and body composition of obese Nigerian male and female adults. Unpublished Ph.D Dissertation, Department of Physical and Health Education, ABU, Zaria.

Bakari, A. G. (2014). The challenge of diabetes mellitus: The urgent need for lifestyle modification. A compendium of Ahmadu Bello University 2014 inaugural lectures. Zaria: ABU Press.

Chior, T. T., Tsauri, Y. M. & Chior, F. D. (2021). Effects of continuous and interval training on metabolic syndrome among male young adults in Katsina-Ala in Benue State. *Journal of Health, Physical Education, Sports and Leisure Studies 7* (1), 52-69.

Coquart, J. B., Boitel, G., Borel, B., Matran, R., Mounier-Vehier, C. and Gorun, M. (2014). Effects of a training program at the crossover point on the cluster of metabolic syndrome abnormalities and cardiovascular risk factors. *Journal of Exercise Science and Fitness 12* (2), 73-79. Retrieved from www.e.jesf.com/article/s1728-869x.

Ezema, C. I., Onwali, A. A., Lamina, S., Ezugwu, U. A., Amaeze, A. A. & Nwankwo, M. J. (2014). Blood glucose response to aerobic exercise training program among patirents with type 2 diabetes mellitus at the university of Nigeria teaching hospital, Enugu, South-East Nigeria. *Sahel Medical Journal, 17* (2): 54-59.

Fahed, G., Aoun, L., BoeZerdan, M., Allam., Bouferraa, Y. & Assi, H. I. (2022). Metabolic Syndrome Updates on Pathophysiology and Management. *International Journal of Molecular sciences 23* (2), 786.

Fisher, G., Brown, A. W., Bohan-Brown, M. M., Alcorn, A., Noles, C., Winwood, L., Resuehr, H., George, B., Jeansonne, M. M. & Allison, D. B. (2015). High intensity interval Vs moderate intensity training for improving cardiometabolic health in overweight and obese males: A randomized controlled trail. From http://journals.plos.org. Retrieved 20th May, 2015.

Gallo-Villages, J., Aristizabal, J. C., Estrada, M., Vabuena, L. H., Narvaez-Sanchez, R., Osorio, J., Aguine-Acevedo, D. C. & Calederfon, J. C. (2018).Efficacy of high intensity, low volume interval training compared to continuous aerobic training on insulin resistance, skeletal muscle structure and function in adults with metabolic syndrome. *Trials,* 19:144

Gross, K. (2015). The acute effect of HIIT Vs moderate intensity continuous training on postprandial blood glucose regulation. *The Plymouth student scientist, 8* (2), 29-49.

Hassan, M.M.M., Abdelkreem, M.I., Mahmoud, H.E.M. & Mohammed, A.M. (2022). Cardiovascular risk factors and metabolic syndrome in patients with knee osteoarthritis. *SVU-International Journal of Medical Sciences 5* (1), 343-349.

Henson, J., Davies, M. J., Hall, A. P. and Yates, T. (2025). Physical activity and metabolic health: Is it all in timing? *International Journal of Obesity;* http//doi.10.1038/s41366-025-01736-2

Jatau, R. S. (2012). Effects of moderate intensity interval training in running on body fat patterns, blood pressure, serum glucose, lipids and lipoproteins of sedentary Nigerians male adults. Unpublished Ph.D dissertation, Department of Physical and Health Education, ABU, Zaria.

Kamal, N. N. & Raggy, M. M. (2012). The effects of exercise on C-reactive protein, insulin, leptin and some cardio-metabolic risk factors in Egyptian children with or without cardio-metabolic syndrome. *Diabetology and Cardio-metabolic syndrome, 4* (1): 27,

Kelishadi, R. (2007). Childhood overweight, obesity and the metabolic syndrome in developing countries. *Epidemiological Review* 29: 62-76.

Lamina, S. (2010). Effects of continuous and interval training program in the management of hypertension. A randomized controlled trial. *Journal of Clinical Hypertension Greenwich, 12* (11): 841-849.

Livingstone, I. L., Nuriddin, T, Staggers, R. and Butler, J. (2013). Globalization, stress and metabolic syndrome. A selected focus on sub-Saharan Africa. *Global awareness society international 22nd annual conference.*

Mendis, S, Graham, I., & Narula, J. (2022). Addressing the global burden of cardiovascular diseases; need for scalable and sustainable frameworks. *Global Heart*. 17, 48.

Mohebi, A., Pathirana, M. M., Khoja, A., Wittwer, M., Lowe, K., Fisher, D., Kharwadkar, S., Gomes, C., Gamage, T., Toyer, E., Young, S., Arstall, M. A. & Andraweera, P. H. (2025). Prevalence of metabolic syndrome among pregnant women: a systematic review and meta-analysis. Retrieved 8/5/2025 from http://doi.org/10.1007/s2020-025-04160-8.

Mazurek, K., Krawczyk, K., Zmijewski, P., Norkowski, H. and Czajkousa, A. (2014). *Annals of Agricultural and Environmental Medicine, 21*(4):844-849.

Mohamed, S. M., Shalaby, M. A,, El-Shiekh, R. A., El-Banna, H. A., Emam, S. R. & Bakr, A. F. (2023). Metabolic Syndrome: risk factors, diagnosis, pathogenesis and management with natural approaches. *Food Chemistry Advances* Retrieved 6/5/2025 from http://doi.org/10.1016/j.focha.2023.100335.

National Health and Medical Research Council (2013). Practice guidelines for the management of overweight and obesity in adults, adolescents and children in Australia.

Omeiza, S. U. (2012). Effects of continuous and interval exercise training on blood pressure, body weight and percent body fat overweight male and female adults in Nigeria. Unpublished Ph.D dissertation, Department of Physical and Health Education, ABU, Zaria.

Regaieg, S., Charfi, N., Kamoun, S., Eulleuch, M., Marrakchi, R., Jamoussi,K., Damak, J. & Abid, M. (2015). Prevalence of Metabolic Syndrome and Its Components among Overweight and Obese Secondary School Adolescent in SFAX, Tunisia. *International Journal of Clinical Nutrition, 3* (1): 1-6.

Romain, A. J, Fankam, C., Karelis, A., Letendre, E., Mikolajacks, G., Stip, E. & Abdel-Baki, A. (2018). Effect of interval training on metabolic risk factors in overweight individuals with psychosis. A randomized controlled trail. *Schzophrenia Bulletin, 44*(1) S17.

Sani, B. G. (2014). The dilemma of dealing with a silent enemy. A compendium of Ahmadu Bello University 2014 inaugural lectures. Zaria: ABU Press.

Silveira, L. S.; Buonani, C.; Monteiro, P. A.; Mello Antunes, B. M. and Freitas Junior, I. F.

(2013). Metabolic Syndrome: Criteria for Diagnosing in Children and Adolescents. *Endocrinol Metab Synd* 2:118.doi:10.4172/2161-1017.1000118

Swarup, S., Ahmed, I., Grigorova, Y. & Zeltser, R. (2024). Metabolic Syndrome. National Centre for Biotechnology Information. Retrieved from www. ncbi. nim.gov 4th June,2024

Thomas, J. R. & Nelson, J K. (1990). *Research method in physical activity.* (2nd ed.). USA: Human Kinetics

Vaduganathan, M., Mensah, G. A., Turco, J. V., Fuster, V., & Roth, G. A. (2022). The global burden of cardiovascular diseases and risk: a compass for future health. J. Am. Coll. Cardiol. 80, 2361–2371.

Venugopal, V., Dongre, A. & Saravanan, S. (2019). Prevalence and determinants of metabolic syndrome among rural adult population of pudecherry. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews 44*(1):21-2, doi.10.4103/ijcm:UCM_132_18

World Health Organization. (2010). Global recommendations on physical activity and health. Geneva: Switzerland.