# EFFECTS OF REGULAR JOGGING EXERCISE ON CARDIOPULMONARY PARAMETERS OF OVERWEIGHT ADOLESCENTS IN KADUNA METROPOLIS, KADUNA STATE NIGERIA

**BY**

**Francis Ali ALBERT**

**DEPARTMENT OF PHYSICAL AND HEALTH EDUCATION,**
**FACULTY OF EDUCATION**
**AHMADU BELLO UNIVERSITY, ZARIA**

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**Francis Ali ALBERT**
**MSC/EDUC/4584/09-10/P14EDPE8025**

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**FACULTY OF EDUCATION**
**AHMADU BELLO UNIVERSITY, ZARIA**

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## DECLARATION

I hereby declare and affirm that this thesis has been written by me and that it is a record of my own research work. This work has not been presented in any previous applications for higher degree. All sources consulted for information have been acknowledged by means of references.

**Francis Ali ALBERT** **Date**

## CERTIFICATION

This thesis entitled "Effects of Regular Jogging Exercise on Cardiopulmonary Parameters of Overweight Adolescents in Kaduna Metropolis, Kaduna State, Nigeria" by Francis Ali Albert meets the regulations governing the award of the degree of Master of Science (Exercise and Sports sciences), Department of Physical and Health Education, Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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Prof. M.A. Chado Date
Chairman, Supervisory Committee

____________________ _______________

Prof. C.E. Dikki Date
Member, Supervisory Committee

____________________ _______________

Prof. T. N. Ogwu Date
Head of Department

____________________ _______________

Prof. K. Bala Date
Dean School of Postgraduate Studies
Ahmadu Bello University, Zaria

# DEDICATION

This work is dedicated to my late brother Mr. Patrick Eche Albert, for his support and encouragement. May Almighty God grant him eternal rest, Amen.

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**ABSTRACT**

Inactivity and poor cardiopulmonary fitness are crucial problems affecting a growing number of adolescents globally. Research evidence shows that there is a tendency among adolescents to participate in less Physical Education programs in schools and in after school physical activities in many developing countries of the world as Nigeria. In recent years, jogging has become popular as a way of staying physically fit. In this study, a 12 weeks jogging programme of 30 – 60 minutes on three alternate days a week (Mondays, Wednesday and Fridays) was conducted involving overweight adolescents of Kaduna metropolis, Kaduna State Nigeria. A stratified sampling technique was used to select twenty (20) each of male and female overweight adolescents (13 to 16 years) with BMI between 25.0 – 29.9ml.kg.m$^2$ who served as sample for this study. Anthropometric and cardiopulmonary measurements were taken at baseline and after 12 weeks of training (post training). One group (pretest post- test) research design was used because, the pre-test value of cardiopulmonary variables of the overweight adolescents were measured at baseline (0 weeks) and after 12 weeks of jogging program. The Cooper 12 minute run test was used to infer $V0_2$ max, the resting heart rate and resting blood pressure were determined through the use of a Omron digital sphygmomanometer while the pulmonary variables were measured using the Spirobank G device by MIR, Italy. The Borg's rating scale was used to monitor the perceived intensity of the training programme. The descriptive statistics of means, standard deviation, and standard error of means was used to analyze the physical characteristics and raw scores of the variables. The student t-test was used to analyze the effect of the effect of the training programme on the variables. Decision to reject or retain the null hypotheses was at 0.05 alpha level. The study found significant effect of the training program on $V0_2$max, forced vital capacity (FVC), forced expiratory volume in one second ($FEV_{1)}$ and peak expiratory flow rate (PEFR). While no significant effect was found for vital capacity (VC). It was recommended that children should be encouraged to participate in regular physical activity programs in order to improve the cardiopulmonaryfunctions.

## TABLE OF CONTENTS

**CHAPTER TWO**



**CHAPTER THREE**

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF APPENDICES

## OPERATIONAL DEFINITION OF TERMS

**Adolescent:** According to WHO, an adolescent is a person between the ages of 13 and 17 years. It can also be defined as a young person who has undergone puberty but is yet to attain full maturity (teenager). Overweight adolescents between the ages of 13 and 16 were used as sample for this study.

**Forced expiratory volume in 1 second ($FEV_1$):** Maximal volume of air exhaled in one second by overweight adolescents of Kaduna Metropolis, Nigeria. The $FEV_1$ is the most important spirometry Value. It measures the average flow rate during the first second of an FVC maneuver (expressed in liters).

**Forced vital capacity (FVC):** Maximal volume of air exhaled using maximal effort following maximal inspiration by the overweight adolescents of Kaduna metropolis, Nigeria. FVC is measured in liters.

**Peak expiratory flow rate (PEFR):** It is the fastest flow rate that can be sustained for 10 milliseconds during a maximal expiration after a full inspiration by the adolescents of Kaduna Metropolis, Nigeria.

**Pulmonary function tests (PFTs):** Lung function tests performed using equipment such as peak flow meters and/or spirometers. PFTs include spirometry, diffusing capacity (DLCO), absolute lung volumes, such as total lung capacity (TLC) and residual volume (RV). For this research Spirometry was used to test for the pulmonary variables (FVC, VC and $FEV_1$ at baseline and post training

**Rating of perceived exertion (RPE):** the number or descriptor given when an individual uses a Borg scale to ascertain exercise intensity. The Borg's scale of 20 was used for this research. The number 12-13 level which is “somewhat hard” on the scale was used to infer moderate intensity for the overweight adolescents of Kaduna metropolis.

**Vital Capacity (VC):** The volume change at the mouth between the positions of full inspiration and complete expiration of air of the overweight adolescents of Kaduna metropolis, Nigeria.

# CHAPTER ONE

## 1.0 Introduction

## 1.1 Background of the Study

Inactivity and poor cardiopulmonary fitness are two crucial problems affecting a growing number of adolescents globally. Research evidence shows that there is a tendency among adolescents to participate in less Physical Education program in schools and in after school physical activities in many developing countries of the world as Nigeria. More so these age groups spend most of their time watching television and other electronic gadgets (Freedman, Khan, Sedula, Ogden and Diatz, 2006). Among the different systems affected by been overweight, the respiratory system deserves special attention, as been overweight can cause changes in respiratory function, exercise tolerance, pulmonary gas exchange, respiratory pattern, and strength and endurance of the respiratory muscles (van Huisstede, Cabezas, Birnie, van de Geijn, Rudolphus & Mannaerts 2013).

Overweight adolescents may have physical and metabolic disorders, psychosocial stress, and changes in respiratory function (Camilo, Ribeiro, Toro, Baracat, Barros & Filho, 2010). One of the mechanisms of alteration in respiratory mechanics caused by been overweight is the accumulation of fat in the chest, diaphragm, and abdomen (Li, Chan, Wong, Yin, Nelson, & Fok, 2003). According to ventilatory mechanics and pulmonary function, this accumulation of fat may lead to dysfunctions of the several structures that make up the respiratory system, particularly the muscles that take part in breathing. This may lead to changes in pulmonary functions due to the increase in respiratory effort and the compromise of gas transport (Miller, Hankinson, Brusasco, Burgo, Casaburi & Coates, 2005).

For the purpose of this research, the $VO_2$ max of the adolescents and the pulmonary variables: forced vital capacity (FVC), forced expiratory volume in one second ($FEV_1$), vital capacity (VC) and peak expiratory flow rate (PEFR) where measured pre and post training.

Maximal oxygen consumption ($VO_2$ max) is the maximum rate of oxygen consumption during incremental exercise (Dlugosz, Chappell, Meek, Szafranska, Zub, Konarzewaki, Jones, Bicudo, Careau & Garland 2013), it is one of the best indices of fitness, especially among adolescents. $VO_2$ max increases when jogging exercise is imposed, although the increase in $VO_2$ max is not immediate and does not reflect the level expected for a specific workload at the initiation of exercise. (Poole, Barstow, McDonough & Jones, 2008)

Pulmonary $VO_2$ max reflects the rate change in $VO_2$ max during jogging exercise, specifically the time needed for the cardiopulmonary system to deliver and skeletal muscle to consume the increased level of oxygen needed for aerobic metabolism. There is an increase in exercise tolerance as a result of transition from obese to non obese in research examining maximal oxygen consumption ($VO_2$ max) in obese and non obese adolescents (Guedes, Souza, Ferreirinha, & Jose Antonio, 2012). $VO_2$ Max is affected by age, sex, fitness, training, changes in altitude, and action on ventilator muscles, and that it is higher in adolescent males than Females (Noakes, 2011).

Forced Vital Capacity (FVC) is the maximal volume of air expired during a rapid, forced expiration, starting at full inspiration (Hojati, Kumar & Soltani, 2013). Jogging exercise in training conditions produces marked change in body functions, improves endurance and reduces breathlessness. Skeletal muscles control many crucial elements of aerobic conditioning, including lung ventilation. This is because regular forceful inhalation and deflation of the lungs for prolonged periods leads to strengthening of respiratory muscles. (Thaman, Arora & Bachhel, 2010). There is an increase in the maximal shortening of the inspiratory muscles as an effect of training improves forced vital capacity. On the effect of exercise on forced vital capacity, recent developments in exercise physiology have shown significantly positive improvements in FVC as a result of 12 weeks of moderate exercise (Nourry, Desuelle, Guinhouya, Baquet, Babic, & Bait, 2005).

FVC varies with body size and position during measurement. Average values range between 4 to 5 liters in healthy male adolescents and 3 to 4 liters in healthy female adolescents. FVC is a strong indicator of lung function, which decline due to obesity and sedentary life style (Acevedo-Garcia, Osypuk, McArdel & William, 2008). Research results indicate that male adolescent who remained in the active life style during the follow-up (19 months) showed 50 ml improvement in their FEV1 and 70 ml in their FVC, whereas adolescents who remained in sedentary life style had 30 and 20 ml reduction in their FEV1 and FVC, respectively (Mahrotra & Shrestha, 2013).

Forced expiratory volume in one second ($FEV_1$) is the volume of expired air in the first second of maximal expiration after a maximal inspiration and is a useful measure of how quickly full lungs can be emptied (Chung *et al.*, 2006). It is higher in male adolescents than females and its value ranges between 70 - 80% of the forced vital capacity in normal adolescents. $FEV_1$ may be reduced in either obstructive or restrictive patterns. Enhancement in FEV1 and FVC values after programmed physical activity in adolescents was observed by Radovich, Alekandrovich, Stojiljkovic, Ignjatovic Popovic & Marinkovic, (2009). Effects of jogging exercise on $FEV_1$ of adolescents shows that jogging has a significant effect on $FEV_1$ because it enhances contraction and expansion of the chest wall for an extended period of time (Nourry *et al*., 2005)

Peak expiratory flow rate (PEFR) is the highest flow value measured during forced expiration. It is an effort dependent value. PEFR measures how fast the adolescents can exhale air. Effects of jogging exercise on PEFR of adolescents shows that jogging has a significant effect on PEFR because it improves the exchanges of gases between the blood and and lungs by improving the compliance of the airways (David & Rob, 2007). Trained adolescent females may be particularly susceptible to developing expiratory flow limitation by virtue of their smaller diameter airways, smaller lung volumes and lower peak expiratory flow rates relative to age- and height matched men (Bell, Game, Jones, Webster, Forbes, & Syrotuik, (2013). These anatomical differences ultimately result in a smaller maximum flow–volume loop which may cause female adolescents to experience expiratory flow limitation at a lower level of minute ventilation and oxygen consumption relative to their male counterparts (Harms, 2006).

Vital capacity is the volume of air that is discharged by deep expiration after maximum inspiratory effort. Effects of training on vital capacity depend on the work style and the severity of the exercise. In practice changes can be seen mainly in sports that require long-term durability performance. Effects of jogging exercise on vital capacity of adolescents shows that jogging has a significant effect on vital capacity when performed at high intensity. This is true because of the increase in the strength of contraction of the respiratory muscles. Male adolescents generally have a higher vital capacities than their Female counterparts and once the VC is below normal, a concomitant restrictive defect may be present (Ruppel, 2012).

Jogging as a form of aerobics; is the process of running at a slow steady pace usually for an extended period of time (Collins English Dictionary, 2006). It is an important exercise for cardiopulmonary fitness development especially in overweight and obese adolescents who after few years become adults.

The review of literature on cardiopulmonary researches significantly revealed that more evidence-based studies on the effect of aerobic exercise on pulmonary variables of adolescents in Nigeria are required. This necessitates the need for a study that will streamline the focus of healthcare providers and fitness professionals in assisting and identifying children with cardiopulmonary disorders in their early stage of life to prevent cardiovascular disturbances and improve the quality of life in adulthood.

### 1.2 Statement of Problem

There is a daily increase globally on the number of mortalities as a result of the harmful health consequences of adolescent risk taken behaviors. Several researches have been carried out in the area of Jogging exercise and cardiopulmonary parameters (Watts, Jones, Davis & Green, 2005; Owen, Salmon, Humpel, & Oja, 2004), but very little documentation have been seen in the area of pulmonary variables of overweight adolescents in Kaduna metropolis especially on their spirometric indices. Most adolescents in Kaduna metropolis leave sedentary lifestyles, they indulge in activities that discourage any form of physical activity like playing computer and TV games, browsing and chatting with their mobile phones and indulging in harmful social vices like smoking. To make it worse, these sedentary adolescents hardly go for any form of pulmonary test (i.e spirometry) to ascertain the quality and compliance of their pulmonary system..

It is now also a fact that heart diseases begin in childhood, especially in overweight and inactive adolescents (Baje, 2011). Overweight adolescents may have physical and metabolic disorders, psychosocial stress, and changes in respiratory function (Camilo, Ribeiro, Toro, Baracat, Barros & Filho, 2010). One of the mechanisms of alteration in respiratory mechanics caused by been overweight is the accumulation of fat in the chest, diaphragm, and abdomen (Li, *et al*., 2003). According to ventilatory mechanics and pulmonary function, this accumulation of fat may lead to dysfunctions of the several structures that make up the respiratory system, particularly the muscles that take part in breathing. This may lead to changes in pulmonary functions due to the increase in respiratory effort and the compromise of gas transport (Miller *et al.*, 2005).

The risk factors associated with cardiopulmonary diseases in adolescents include being overweight then obese, having high blood pressure, and high cholesterol levels, heart failure and Diabetes mellitus. A research reported that the prevalence of overweight among 457 school children in the age group 6-19 years in Nigeria is 3.2% for males and 5.1% for females (Akinpelu, Oyewole, & Oritogun, 2007).

An observational study showed that inactivity and obesity was previously rare in Africa (including Nigeria) where people especially children trek long distances, consumed unprocessed foods and support their parents in domestic activities like farming (Zaraba, Fotso, & Ochako, 2009). To reduce accumulation of excess fat by adolescents in Kaduna metropolis, advocacy for frequent jogging should be increased among healthcare providers including physical and health education teachers at the primary and post primary school levels. Jogging program is generally considered one of the cornerstones of childhood treatment for overweight and cardiovascular disturbances (Sebanjo, & Oshikoya, 2010).

As the desire for improved jogging increases among adolescents in Kaduna metropolis, this study was planned to investigate the effects of regular jogging on $VO_2$ max, FVC, $FEV_1$, PEFR, and VC of adolescents in Kaduna Metropolis of Kaduna State, Nigeria.

## 1.3 Research Questions

This research attempted to answer the following questions:

(i) Can regular jogging program influence $VO_2$ max of overweight adolescents of Kaduna metropolis?

(ii) Can regular jogging program influence forced vital capacity (FVC) of overweight adolescents of Kaduna metropolis?

(iii) Can regular jogging program influence forced expiratory volume in one second ($FEV_1$) of overweight adolescents of Kaduna metropolis?

(iv) Can regular jogging program influence Peak Expiratory Flow Rate (PEFR) of overweight adolescents of Kaduna metropolis?

(v) Can regular jogging program influence Vital Capacity (VC) of overweight adolescents of Kaduna metropolis?

## 1.4 Basic Assumptions

Based on the available research evidence and professional opinion, the following assumptions were put forward for the purpose of this study:

(i) Regular jogging program can improve $VO_2$ Max of overweight adolescents of Kaduna metropolis.

(ii) Regular jogging program can improve FVC of overweight adolescents of Kaduna metropolis.

iii) Regular jogging program can improve $FEV_1$ of overweight adolescents of Kaduna metropolis.

iv) Regular jogging program can improve PEFR of overweight adolescents of Kaduna metropolis and

v) Regular jogging program improve VC of overweight adolescent of Kaduna metropolis.

## 1.5 Hypotheses

### Major Hypothesis

There will be no significant effects of 12 weeks regular jogging program on $VO_2$ max, FVC, $FEV_1$, PEFR and VC of overweight adolescents in Kaduna metropolis.

### Sub-Hypothesis

(i) There is no significant effect of jogging program on $VO_2$ max of overweight adolescents in Kaduna metropolis.

(ii) There is no significant effect of jogging program on FVC of overweight adolescents in Kaduna metropolis.

(iii) There is no significant effect of jogging program on $FEV_1$ of overweight adolescents in Kaduna metropolis.

(iv) There is no significant effect of jogging program on PEFR of overweight adolescents in Kaduna metropolis.

**(v)** There is no significant effect of jogging program on VC of overweight adolescents in Kaduna metropolis.

## 1.6 Significance of the Study

Jogging has become popular as a means to develop cardiopulmonary fitness worldwide. It is expected that the findings in this research would: motivate adolescent population of the world and Kaduna metropolis to participate in regular jogging. Spirometry is recommended as the “gold standard” for the diagnosis of obstructive lung disease. (Ruppel, 2009). Spirometry is very important in aiding an accurate diagnosis and monitoring changes that can be extremely delicate.

Forced vital capacity (FVC), and Forced expiratory volume in one second ($FEV_{1)}$ are the two most important measurements of spirometry (Altalag, & Wilcox, 2009). Another variable derived from spirometry is the vital capacity (VC).

The FVC usually equals VC in healthy adolescents and should be within 150ml of each other. The FVC and VC may differ if the child's effort is variable or if significant airway obstruction is present (FEV1 / FVC is less than 70%). The FVC may be lower than VC in adolescents with obstructive diseases as forced expiration can cause airway collapse. Healthy children and adolescents may exhale their FVC in less than 4 seconds. Children with severe obstruction may require 15 seconds or more to exhale completely.

$FEV_1$ is reported as a volume, although it measures flow over a specific interval. $FEV_1$ may be reduced in either obstructive or restrictive patterns. The $FEV_1$ is one of the most standardized indices of obstructive diseases. The severity of an obstructive disease may be gauged by the extent to which $FEV_1$ is reduced. The American Thoracic Society 2005 Task force suggests the following classifications of severity:

Mild $FEV_1$ > 70% predicted

Moderate $FEV_1$ = 60% - 69% predicted

Moderately severe $FEV_1$ = 50% -59% predicted

Severe $FEV_1$ = 35% - 49% predicted

Very severe $FEV_1$ < 35% of predicted

Once the VC is below normal, a concomitant restrictive defect may also be present, and this can be determined by further measurement of volumes. Restrictive processes such as fibrosis, oedema, and been overweight may all cause a decrease in $FEV_1$. Unlike the pattern seen in obstructive diseases, in which VC is preserved and $FEV_1$ reduced, in restriction VC and $FEV_1$ values are proportionally decreased.

The $FEV_1$ is the most widely used spirometric parameter, particularly for the assessment of airway obstruction. It is also used in conjunction with VC for simple screening, assessment of response to bronchodilators, and detection of exercise-induced bronchospasm.

The result of this study would be the determinant in routine screening test that would indicate cardiopulmonary pathologic problems. It will contribute to the existing knowledge on effect of regular jogging on cardiopulmonary indices. Finally, result of the study could serve as a standard for reference by other students to compare their own performance in health related fitness research of cardiopulmonary indices.

## 1.7 Delimitations of the Study

This study was delimited the overweight adolescent children of Kaduna Metropolis. The training duration was 12 weeks of regular jogging program 3 times a week. The Cooper 12 minutes run/walk field test was used to calculate $VO_2$ max, Omron automatic sphygmomanometer was used to evaluate the blood pressure and heart rate while a Spirobank G device was used to evaluate the VC, FVC and $FEV_1$ and the peak flow meter was used to evaluate the PEFR of the subjects.

## 1.8 Limitations of the Study

The researcher also encountered problems of compliance and regular participation in the training program by the subjects. However, the researcher monitored and encouraged the subjects in conformity with their initial interest. There were motivational rewards (colourful sportswear to represent the subject's house) for active subjects as training progressed up to the end.

# CHAPTER TWO

## 2.0 Review of Related Literature

## 2.1 Introduction

The purpose of this research was to determine the effects of regular jogging program on cardiopulmonary parameters of overweight adolescents. The variables of focus here were; $VO_2$ max, forced vital capacity (FVC), forced expiratory volume in one second ($FEV_1$), peak expiratory flow rate (PEFR), and vital capacity (VC) of overweight adolescent children in Kaduna metropolis. To accomplish this task, available literature was critically reviewed which is presented and discussed in this chapter under the following sub-headings:

2.2 Training guidelines for cardiopulmonary fitness.

2.3 Effects of training on cardiopulmonary parameters.

2.4 Impact of Jogging on Cardiopulmonary fitness of adolescent.

2.5 Measurement of cardiopulmonary parameters.

2.6 Summary.

## 2.2 Training Guidelines for Cardiopulmonary Fitness

Jogging as a form of Aerobic exercise is an activity that can be sustained for an extended period of time without building oxygen debt in the muscles. It is a type of exercise that overloads the heart and lungs and causes them to work harder than they do when a person is at rest (Graves, Ridgers, Williams, Stratton, & Atkinson, 2010). From the foregoing, it is understood that for an activity to elicit the required response in cardiopulmonary fitness it needs to be for a period enough to task the circulatory and pulmonary systems, and that for adaptations to take place the frequency must be enough to allow for them to take place.

In this regard Laursen & Jenkins, (2002) stressed that a long period of training 3 to 5 times per week 12 to 38 days is required for increases in maximal oxygen uptake to occur in adolescents. Kemp, (2009), reported that exercise-induced bronchoconstriction is very common in both patients with asthma and those who are otherwise thought to be normal. The intensity of exercise as well as the type of exercise is important in producing symptoms. This is especially important for school children who are usually enrolled in physical education classes and elite athletes who may desire to participate in competitive sports. Pulmonary function and serum lipids Improvements in Tread-mill performance time, $VO_2$ max and diastolic blood pressure were in proportion to duration of the training session.

Helgerud, Hoydal, Wang, Karlsen, Berg Bjekaas & Hoff, (2007), found a significant improvement in aerobic capacity in college men who trained 3 days a week for 10 weeks. In another study by Metcalfe, Babraj, Fawkner & Vallaard (2012), on the effects of 5, 3 and 1 day week training, found both 5 and 3 days per week groups had significantly greater gains in work capacity scores than the one day group. No difference was found between 5 and 3 day per week groups. This has been substantiated by Powers, Howley Cotter, de Jong, Leicht, Mundel and Rattray (2014), who stated that an exercise programme conducted three to five times per week, for twenty to sixty minutes session, at an intensity of about 50 to 85% $VO_2$, max brings about improvement in cardio respiratory fitness. Other studies show that higher intensity and frequency are required to increase cardiopulmonary efficiency than to maintain it and that as low as one to two times per week training can help to maintain cardiopulmonary gains (Helgerud *et al.*, 2007).

American College of Sports Medicine (2013) stated in their guidelines that: as few as 6 to 10 training sessions, lasting as low as 5 to 10 minutes per session could result in improved aerobic capacity, although programmes of shorter duration show significantly lower training effect than do programmes of as long as 30 to 60 minutes duration.

Garcia, *et al*., (2007) studied the Lipid and metabolic profiles in adolescents are affected more by physical fitness than physical activity (AVENA study), to determine whether the level of physical activity or physical fitness in Spanish adolescents influences lipid and metabolic profiles. From a total of 2859 Spanish adolescents (age 13.0-18.5 years) taking part in the AVENA (Alimentaciony Valoracion Del Estado Nutricional en Adolescents) study, 460 (248 male, 212 female) were randomly selected for blood analysis. Their level of physical activity was determined by questionnaire. Aerobic capacity was assessed using the Course-Navette test. Muscle strength was evaluated using manual dynamometry, the long jump test, and the flexed arm hang test. A lipid-metabolic cardiovascular risk index was derived from the levels of triglycerides, low-density lipoprotein cholesterol (LDLC), high-density lipoprotein cholesterol (HDLC), and glucose. No relationship was found between the level of physical activity and lipid-metabolic index in either sex. In contrast, there was an inverse relationship between the lipid-metabolic index and aerobic capacity in males (P=.003) after adjustment for physical activity level and muscle strength. In females, a favorable lipid metabolic index was associated with greater muscle strength (P=.048) after adjustment for aerobic capacity. These results indicate that, in adolescents, physical fitness, and not physical activity, is related to lipid and metabolic cardiovascular risk. Higher aerobic capacity in males and greater muscle strength in females were associated with lower lipid and metabolic risk factors for cardiovascular disease.

In conclusion, Helgerud *et al*., (2007), pointed out that for improvement to occur, a demand must be placed on the body, for a sufficient period of time, and on regular basis.’ The demand generally should approximate 75-80% of an individual’s maximum heart rate.

Generally speaking 15 to 20 consecutive minutes is considered sufficient for the ‘training effect’ to occur. A ‘regular basis’ consists of 3 to 4 times per week.

### 2.2.1 Cardio Pulmonary Exercise Testing (CPET)

Cardiopulmonary exercise testing involves the simultaneous evaluation of the cardiovascular and pulmonary functions during exercise. (American College of Sports Medicine, (ACSM), 2000). In cardiopulmonary exercise testing, pulmonary variables, blood pressure and exercise capacity are all continuously monitored and recorded. Cardiopulmonary exercise testing (CPET) is frequently used as a tool for evaluating chronic condition (Wasserman *et al.*, 2005), including congenital heart disease (CHD) in children (Takken, Blank, Hulzebos, Van Brussels, Groen, & Helders, 2009).

In recent years, integrated cardiopulmonary testing has become a common procedure in major hospitals and medical centers around the world. (Fletcher, Balady, Amsterdam, Chaitman, Eckel, & Fleg, 2001) It objectively assesses the cardiac and respiratory responses of individuals to constant or graded exercise stress, (Myers, 1996). These responses can then be compared to previously establish "normal" values, so inferences regarding limitation of exercise due to cardiac, respiratory, metabolic, endocrine, neuromuscular, or other factors may be made (ACSM, 2000).

Currently, most children who have undergone surgical or interventional treatment for congenital heart defect nowadays survive till adulthood (Connuck, 2005). However, residual defects or problems resulting in decreased exercise capacity often occur relatively. Many cardiopulmonary variables may contribute to a reduced exercise tolerance, including systolic and diastolic ventricular dysfunction, sinus node dysfunction, and changes in cardiac autonomic nervous activity, whereas reduced physical activity in these patients may further lead to reduced exercise tolerance (Reybrouck & Mertens, 2005).

Physical training such as jogging at recommended levels may increase exercise tolerance (Hirth, Reybrouck, Bjarnason-Wehrens, Lawrenz, & Hoffman, 2006), while the use of different cardiopulmonary parameters in the evaluation of exercise tests may give more insight into the mechanisms of reduced exercise tolerance (Moalla, Maingourd, Gauthier, Cahalin, Tabka, & Ahmaidi, 2006). Some of these parameters lack normal values for the adolescent population especially in Africa. Equipment for CPET has evolved from the Douglas bag technique to breath-by-breath analysis of expired gases (Macfarlane, 2001).

Numerous studies have shown that regular jogging program improves scores on cardiopulmonary fitness tests. Regular aerobic exercises such as jogging brings health benefits, better vigor, improved eating, sleep and rest habits, reduced risk of variety of disorders including low back pain and cardiovascular diseases and reduced reaction to stress. It also improves the quality of life. The Bucknell University student health service magazine, (2001) reported a group of 135 College students who exercise regularly were found to be better equipped to handle life's hassles than less active students and therefore suffered fewer physical symptoms of stress.

Another important parameter in the evaluation of cardiopulmonary performance is through heart rate measurement. Heart rate is closely related to work output, the rate that is measured immediately following work indicates how hard the individual is working (Kadiri, 1989). The speed with which the individual recover from activity and even the resting heart rate are indicators of the ability of the cardiopulmonary and respiratory system endurance (Bruce, 1999).

Research evidence also reveals that the oxygen consumption to a given exercise is decreased due to training. This has been attributed mainly to the improved muscle efficiency, neuromuscular coordination and decreased respiratory frequency (Fox, Bowers, & Foss, 1993). Furthermore, Venkateswarlu, (1971), attributed the improvements in cardio respiratory efficiency resulting from regular training to improved vagal tone and peripheral circulation.

Cardiopulmonary fitness has numerous advantages, people who are involved in regular aerobic exercises such as jogging, report benefits which fall into two broad categories each of which has substantial confirmation by research evidence. First, a fit cardiopulmonary system is more resilient to coronary heart diseases (CHD) and other circulatory problems such as hypertension, stroke and varicose veins (Brown, Dengel, Hogikyan, & Supiano, 2002; Warchman, Wong, Hennings, Mitchel, Rennie, Cruickshank. & Day, 2000). The protective benefits of exercise are twofold. Large-scale studies of whole communities have shown that with regular activity there is reduction in the coronary heart disease risk factors such as improved blood fat profile, lowered diastolic blood pressure (among those with hypertension) and reduced stress levels (Malina, 2001). In addition, a lifestyle of regular aerobic exercise such as jogging contributes to more efficient function of various systems, weight maintenance, and reduced risk of mortality and overall improvement of quality of life (Bouchard, Shepherd & Stephens, 1994). Furthermore, muscle cells become more active users of oxygen and there is increased capillarisation in the working muscles. This is particularly significant in the heart muscle itself where it is known as coronary collateral circulation. The second benefit of cardiopulmonary exercises lies in the effect it has on helping people to look better. For example, few regular joggers are over fat even though many start out that way.

Furthermore, cardiopulmonary exercise testing offers a unique opportunity not only to diagnose specific pathophysiology involving the cardiovascular or pulmonary systems but also to quantify the severity of dysfunction. Indeed, recent joint guidelines from the American College of Cardiology and the American Heart Association stated that exercise testing with measurement of gas exchange can;

1. Provide the best estimate of functional capacity;
2. Grade the severity of functional impairment;
3. Objectively evaluate the response to interventions that may affect exercise capacity;
4. Objectively track the progression of disease that may limit exercise capacity; and
5. Assist in differentiating cardiac from pulmonary limitations in exercise capacity".

Moreover, exercise capacity was recently shown to be a strong predictor of the risk of death in patients referred for exercise testing for medical reasons. (Myers *et al.*, 2002).

The use of cardiopulmonary exercise testing has truly expanded around the world, and physicians are now provided with a powerful diagnostic tool to help guiding decisions, regarding medical management in broad spectrum of patients. Despite its worldwide use as a diagnostic tool for the assessment of cardiovascular and pulmonary diseases, personal observation indicated that cardiopulmonary exercise testing appears underutilized in the Africa.

## 2.3 Effects of Training on Cardiopulmonary Parameters

Training programs that are implemented regularly have positive effect on the respiratory and circulatory system as well as body fit rate (Gokdemir, Koc, & Yuksel, 2007). It is also noted that genetic factors and diseases that affected the respiratory system by early childhood and regular athletic activities that started in the early childhood all have relation to the lung capacity. Even though the lung functions are determined by unchangeable factors such as genetic and race, studies have shown that active individuals have higher value of breathing in comparison to the individuals that are not physically active groups in the same gender, age, height and weight regardless of their progressions. In addition, the width of the rib cage and respiratory muscles are important factors for individual efficient breathing capacity (Mann, Lamberts & Lambert, 2013). The effect of training on cardiopulmonary parameters would be discussed based on the various research variables thus:

### 2.3.1 Effects of Training on $VO_2$ Max

Maximal aerobic capacity ($VO_2$ Max) is an important measurement because it is considered to be the metric that defines the limits of the cardiopulmonary system. Majorly aerobic exercises enhance breathing efficiency, decrease pulmonary resistance and decreases fat percentage (Guiney, & Machado, 2013). A significant change in the breathing volume and frequency occurs by training. By trainings, $O_2$ consumption rate which in the maximal aerobic metabolism ($VO_2$ max) increases: By 7-13 weekly training, $VO_2$ Max increases by more than 10% in adolescent school children (Dobbins, Husson, Decorby & LaRocca, 2013). A sustained exercise requires increase in $O_2$ supply to meet metabolic needs. Normal exercise responses include 10 $\pm$ 2mmHg/MET) in association with reduced vascular resistance to facilitate increased muscular perfusion. $VO_2$max is measured in liters of oxygen per minute, it is usually expressed in milliliters of oxygen per kilogram of body weight per minute to facilitate inter subject comparisons. This is important, because a larger adolescent will have a higher $VO_2$max based simply on a larger body weight, and the expression of $VO_2$ in mL _ kg_1 _ min_1 normalizes for body weight.

The $VO_2$ response within the first 60 to 120 seconds of exercise has been identified as the on-response. This is observed by examining $VO_2$ Max during a constant work rate. It is initially dominated by an increase in pulmonary blood flow cardio dynamic phase, followed by a slower, mono exponential increase that reflects muscle extraction of $O_2$. These are followed by a steady state, if the exercise intensity is reduced. The lag in$VO_2$ max experienced before steady state has been termed the $O_2$ deficit. It is during this period that energy requirements are supplemented by anaerobic energy sources, such as high-energy phosphates (e.g., phosphocreatine) and anaerobic glycolysis (Wasserman, Hasen, & Sue, 2005*)*. For this reason, lactic acid accumulation has been directly related to the duration of the on-response (Palange, Ward, Carlsen, Casaburi, Gallagher, Gosselink, O'Donnell, Puente-Maestu, Schols, Singh, & Whipp, 2007). Thus, a prolonged on-response phase may contribute to exertional dyspnea and exercise intolerance. In healthy adolescents, the on-response speed correlates with $VO_2$ max across a wide spectrum of exercise capacity (Powers *et al*., 2014). In this respect, examination of the sub maximal exercise response provides information that may be more clinically relevant in that; most daily activities are sub maximal in nature.

Satipati, Pratima & Amit, (2005) in their study evaluated cardiopulmonary fitness in terms of $VO_2$ max in obese adolescent boys of west Bengal of India, 49 obese of 10 to 16 years age range were studied against 70 non obese counterparts. The observed absolute $VO_2$ max was higher among obese group because of higher values of body mass and lean body mass, but $VO_2$ Max per kg of body mass was significantly higher among non obese groups. The $VO_2$ max per unit of body surface area was significantly higher in obese group. They concluded that reduced oxygen utilization by adipose tissue during exercise reduces the overall $VO_2$ max.

### 2.3.2 Effects of Training on Vital Capacity (VC)

The degree of vital capacity increase is limited by the development of respiratory muscles, the capability of expansion of lungs and thorax wall and the elasticity of bronchi and bronchioles (Abel, Lloyd & Williams 2013). Vital capacity increase by training depends upon the work style and the intensity of the exercise. In practice this sort of increase can be seen mainly in some types of sports that require long-term durability performance (Field, 2012). The vital capacity of 13-16 years old handball players found to be higher than children who had not been involved in any sport activity (Kurkcu & Gokhan, 2011).

Alpay, Altug & Hazar, (2008) indicated that the children in a school sports team (with a mean age of 12.63±15.13 years) have lower resting heart rate and blood pressure values than those of students who identified as sedentary. Other researchers also found the same sedentary students to have lower VC and FVC values (Alpay *et al.*, 2008).

### 2.3.3 Effects of Training on Forced Vital Capacity (FVC)

The total volume of air rapidly exhaled is the forced vital capacity. In a normal healthy adolescent, this forced expiratory test can be completed in 3 - 4 seconds but in increasing airflow obstruction it takes longer to push air out of the lungs. Alpay, Altug & Hazar, (2008) found out from their study that FVC values are 3.13±0.68 L for the children who engaged in sports and 2.71±0.64 L for the children who do not engage in sports, and between the forced vital capacity of these groups they found a meaningful ($p<0.01$) difference. They further added that; sedentary students have lower VC and FVC values. (Field, 2012) compared to the four different groups of students who engaged in basketball, volleyball and other individual sports among themselves; they concluded that FVC and $FEV_1$ values of all groups were higher than sedentary. Tasgın & Donmez, (2009) compared the effects 3 month training program on respiratory parameters like

FVC, FEV1, on the sedentary children who were 10-16 years old. Exposed to a 3 month training program they indicated that exercise had no effect on FVC, and FEV1. (Cakmakcı, Cınar, Boyalı, & Bayan, 2009) established that a 4-week technical and tactical training increased the FVC values of taekwondo athletes. In a normal healthy adolescent, this forced expiratory maneuver can be completed in 3 - 4 seconds but in increasing airflow obstruction it takes longer to push air out of the lungs.

As BMI increases particularly in morbidly obese adolescents there is evidence of a reduction in expiratory flow and a decrease in $FEV_1$ and forced vital capacity (FVC) (Topp, Jacks, Wedig, Newman, Tobe, & Hollingsworth, 2009). In a study by Hyatt, Scanlon, & Nakamura, (2014) on reductions in FEV1 and FVC, both FEV1 and FVC were similarly reduced (in terms of percentage predicted), the FEV1 to FVC ratio was normal and static lung volumes were reduced, suggesting the reduction may be due to restriction as opposed to air flow obstruction. Finally, in morbidly obese subjects (defined as individuals with a body weight (in kilograms) to height (in centimeters) ratio greater than 0.9 kg/cm), Hyatt and his couleagues found a reduction in mid expiratory flows and the $FEV_1$ to FVC ratio. (Hyatt *et al*., 2014)

### 2.3.4 Effects of Training on Force Expiratory Volume in 1 Second ($FEV_1$)

$FEV_1$ is the maximal volume of air exhaled during the first second. This is usually 70 - 80% of the forced vital capacity. Larson, DeWolfe, Story & Neumark-Sztainer, (2014) performed a study on athletes who were non-smokers between the ages 13-19 years, they found athletes engaged in team sports like football, volleyball, basketball and handball had higher $FEV_1$ values as compared to swimmers, long-distance runners and skiers. Alpay *et al*., (2008) found that $FEV_1$ values of children 13-16 who were engaged in sports was 2.78±0.60 L while $FEV_1$ values of the children who were also 13-16 years of age but not engaged in sports was found to be 2.57±0.64 L. In terms of $FEV_1$ and FEV1% they found out that there were no significant differences between the groups. As stated above, Mahotra *et al*., (2013) compared the four different groups that engaged in basketball, volleyball and other individual sports among themselves and with sedentary group; they concluded that FVC and FEV1 values of all groups were higher than sedentary.

In another research to compare lung functions among Yogis, Athletes and Sedentary individuals, the researchers found out that both athletes and Yogis have better PEFR and FEV1 than sedentary individuals. Yogis and athletes had similar lung function except for better PEFR among Yogis. (Prakash, Meshram & Ramtekkar, 2007)

When exercise testing is performed to identify the presence of exercise-induced asthma, spirometry is measured periodically over the 30 minutes after a 6- to 8-minute bout of high-intensity exercise. A decrease in $FEV_1$ in the post exercise recovery period of 15% or more compared with before exercise is the most widely used criterion for identifying exercise-induced bronchoconstriction. (Larson *et al.*, 2014)

### 2.3.5 Effects of Training on Peak Expiratory Flow Rate (PEFR)

Peak Expiratory Flow Rate (PEFR) can be defined as the highest flow value measured during forced expiration (David & Rob, 2007). According to Kulnik Macbean, Birring, Moxham, Rafferty & Kalra (2015) PEFR is a simple index of pulmonary function often used in clinical and epidemiological studies for the assessment of ventilator capacity. It is effort dependent and reflects the status of the large airways. PEFR is the single best test for ventilatory efficiency.

As stated earlier in a research to compare lung functions among Yogis, Athletes and Sedentary individuals; the researchers found out that both athletes and Yogis have better PEFR and $FEV_1$ than sedentary individuals. Yogis and athletes had similar lung function except for better PEFR among Yogis. (Prakash *et al.*, 2007).

## 2.4 Impact of Jogging on Cardiopulmonary Parameters

Hoeger & Hoeger, (2014) defined jogging as a term that used to include all speeds of running. But it now refers to slow, continuous running. However one person's jogging may be another person's running, depending on the exercise habits and goals of the participants. In their own opinion Lindsay, Hongu, Spears, Idris, Dyrek & Manore, (2014), saw jogging as a graduated programme of moderate exercise which can be adapted to men and women of varying ages and levels of fitness. It is a simple type of exercise, requiring no highly developed motor skills. They further concluded that jogging is an exercise programme of relaxed walking and running that will improve the level of physical fitness of nearly everyone from 7 to 70 years. It is the easiest and most effective way of applying the aerobic principles of exercise. Jogging is probably one of the safest forms of physical exercise for the over-weight and under-exercised with special benefit for the elderly, the middle-aged and the young.

Jogging is different from most popular physical fitness programmes, unlike resistance exercise, isometric exercises and calisthenics with their emphasis on muscle building, jogging works to improve the heart, lungs and circulatory system. Jogging is free, it is convenient and enjoyable. It is safe, and requires no special motor skills or equipment. And it can benefit nearly everyone who is not ill or disabled. At the same time it has special benefits for the 'below 30' and the 'well over 30' groups who do not exercise regularly. Through jogging they can recapture a level of physical fitness they thought they had lost (Hoeger & Hoegar, 2104). Several research findings have revealed a lot of cardiopulmonary benefits that can be derived through jogging. Victor & Vipene, (2014), reported after an 8 week of regular jogging, three days a week for distance of 6km per session that although boys had better cardiopulmonary endurance, both sexes showed improved cardio respiratory endurance post-training. In another study conducted by Cox, (2014) showed that the dropout rate in a high intensity interval training programme was twice that of a continuous jogging programme. The physiological effects of the training programs were equal, both groups improved significantly in aerobic capacity. In the same study, by Pollock another group of men trained in interval training and jogging on alternate days, at the end of the study 90% of this group preferred continuous jogging training to interval training. Also, more injuries were recorded with the interval training groups.

Studies have shown that Jogging can be done anytime, anywhere and involves only one person. It has all the benefits of walking; it conditions the heart, improves muscle tone and strength, relieves stress and can help with a variety of health problems, such as osteoporosis, heart diseases and arthritis.

Other measurable rewards of jogging include improvement in time, distance, endurance and strength (Acquaviva, 2003). Awopetu, (2014), summarized the physiological effects of jogging as:

The Heart; similar to all muscles, the heart's reaction to stressful activity is to increase in size during the activity. This increase results in a stronger contractions which in turn increase the amount of blood pumped out with each stroke. Because more blood is now available with each beat, the resting heart rate lowers. The heart, like any other machine can certainly be expected to last longer.

Lungs: As a result of regular programme of various exercises (e.g. jogging) the individual's lungs will increase their level of strength, endurance and capacity for work. The internal lung volume will increase, creating greater surface areas for gas exchange. These increases the number of alveoli utilized, and a greater efficiency of exchange of oxygen and carbon dioxide. There will be reduction in the breathing rate during rest and smaller increases during exercise.

Capillaries; oxygen is unloaded in the capillary beds in the muscles, Long, slow running such as jogging results in the increase in number and size of these capillary beds in both the lungs and musculature. This further improves the exchange of gases. Blood, regular training such as jogging increases the blood volume along with the number of red blood cells per unit of whole blood. This in turn increases the oxygen carrying capacity of the body. And finally the muscle glycogen stores increase their capacity as a result of regular aerobic training such as jogging. (Awopetu, 2014).

### 2.5 Measurement of Cardiopulmonary Parameters

Parameters for determining cardiopulmonary fitness include measures as Lung Volumes and capacity (measured majorly by spirometry), peak work rate (WRpeak), heart rate (HR) response to exercise, maximum oxygen uptake ($VO_2$ max), and more recently proposed measures as the ventilation to carbon dioxide exhalation ($VE/VCO_2$) slope. Equipment for cardiopulmonary testing has evolved from the Douglas bag technique to breath-by-breath analysis of expired gases (Balady, Arena, Sietsema, Myers, Coke, Fletcher, & Milani, 2010). Spirometry is a method of assessing lung function by measuring the volume of air that the patient expels from the lungs after maximal inhalation to maximal exhalation. This process involves using the maximum force the patient can generate to blow all the air out as hard and as fast as possible. Spirometry measures all lung volumes except residual volume, total residual capacity and total lung volume. (Quanjer, Stanojevic, Cole, Baur, Hall, Culver, & Schindler, 2012). In this research I used spirometry to test for Forced Vital Capacity (FVC), Forced expiratory volume in one second ($FEV_1$) and Vital Capacity (VC). Furthermore, important changes have occurred in body weight and activity level of children in industrialized countries. To obtain reference data for exercise testing, I will investigate the cardiopulmonary results of 34 healthy overweight Nigerian school children with an age range of 13 – 16 years.

Unfortunately, the most accurate way to determine one's maximal oxygen uptake is to test a person in a laboratory setting with a treadmill or cycle ergometer. The inspired and expired gases are usually collected and analyzed to determine oxygen consumption. However, this is not always practicable to administer due to either problem of time or equipment. Since, it involves much time and expensive equipment to administer. Attempts have therefore been made to devise other methods found also to be valid and reliable means of estimating maximal oxygen uptake and which could also be administered to a large group of subjects with minimum cost in duration and money (Ezra, 1986). Thus field tests were therefore devised to predict VO2 max. The tests can be used to classify the cardio respiratory fitness level of healthy men $\leq$ 40 years and women $\leq$ 50 years (Heyward, 1998).

Evidences from research findings indicated that a reliable estimate of maximal oxygen consumption may be obtained from the performance during the 12 minutes run test. The result of this test correlate very highly (r= 0.90) with laboratory $VO_2$ Max. This test is therefore, considered to predict a person's maximal oxygen uptake. (Breithaupt, Cikkey, & Adamo, 2012). The identification of population maximum oxygen uptake levels ($VO_2$ max) is an aid to studies that propose to relate physical fitness to cardiovascular risk. It is also important to point out that $VO_2$ max measurements are also used for prescribing exercise and analyzing the effects of training programs. (Obert *et al.,* 2003). Other studies conducted on the relationship between the laboratory assessment and the 12 minutes run test reported significant correlation. The 12-

minutes run test was found to be a valid measure of cardio respiratory fitness because it was more accurate test for measuring cardio respiratory fitness than Astrand's Rhyming test which consistently underestimates maximal oxygen consumption (Cairney, Hay, Veldhuizen, & Faught, 2010; Ezra 1986; & Gwani 1986).

In his contribution, Chado, (2011) stated that the 12-minutes run test as suggested by Cooper 1968 has since gained worldwide recognition. It is used to measure the extent of an individual's ability to respond adequately and safely to endurance related work. It indicates the functions of the heart, blood and oxygen consumption. Similarly, previous research findings substantiated the administrative feasibility and reliability of the 12- minute run test for young adolescent boys and girls (Gwani, 1986).

## 2.6 Summary

Based on the various literature reviewed by the researcher, jogging was found to be the most effective way of applying the aerobic principles of exercises. Regular jogging brings an improvement in cardiopulmonary endurance even in children with heart diseases, because it increases the flow of blood to the damaged heart. Cardiopulmonary exercise testing is a powerful tool that facilitates functional assessment reliably and accurately providing a critical enhancement of other diagnostic and prognostic tool. A number of studies show that a reliable estimate of maximal performance can be obtained during the 12 minutes run/walk test, and that a strong correlation was found between the 12 minute run/walk test and the laboratory tests as measures of maximal oxygen uptake. Finally, the changes observed in blood pressure as a result of exercise are not consistent as those in heart rate. This may be as a result of the dynamic nature of the human body. Several factors affect the relative equilibrium of the human body, such factors as environmental condition, psychological state, body position during measurement, physiological condition etc.

## CHAPTER THREE

### 3.0 Research Methodology

### 3.1 Introduction

The purpose of this research was to investigate the effect of regular jogging on the cardiopulmonary variables of adolescent children in Kaduna metropolis. To achieve this purpose, the research design, population, sample and sampling techniques, instruments and statistical techniques are described in this chapter.

### 3.2 Research Design

For this study, a pre-experimental research design (one group pretest post- test) was used because, the pre-test value of cardiopulmonary variables of the overweight adolescents was measured at baseline (0 weeks) and after 12 weeks of jogging program.

### 3.3 Population

The population for this study was the 87 overweight Junior secondary school overweight adolescent children between the ages of 13 and 16 years within Kaduna metropolis, Kaduna State, Nigeria.

### 3.4 Sample and Sampling Techniques

All the junior students of the school children of St. Ann's secondary school, Kaduna were stratified by gender into two by gender (males and females). All the male students whose names were on odd numbers and all the female students whose names were on even numbers were selected.

Using the measurement results, the body mass index (BMI) was computed as weight (kg) divided by height in meter squared as recommended by McArdle, Katch and Katch, 2010). Only students whose BMI were between 25.0kg/$m^2$ and 29.9kg/$m^2$ were used for this study.

20 each of male and female students who met the inclusion criteria (BMI between 25.0 and 29.9kg/m$^2$) were selected. Using the simple random sampling technique, the students were distributed.

### 3.5 Instrumentation

The following instruments were used for the purpose of this research:

i. Omron automatic sphygmomanometer (Made in Japan) was used to measure the blood pressure and heart rate of the subjects.

ii. Stop watches; Digital Sport timer alarm, (Casio, made is China 2010) was used for this study. They were used in the course of the 12 minutes distance run test.

iii. A Spiro Bank G machine made by Medical Institute of Research (MIR) in Italy was used to conduct spirometry tests.

iv. A digital Weighing Scale in Kilograms made by Camry, China (2012).

v. A peak flow meter (Microlife USA made in China, 2004) was use to measure the Peak expiratory flow rate (PEFR) of the subjects.

### 3.6 Research Assistants

Five research assistants were involved in this research. Three assistants were trained to record time and number of laps (400m) covered by each subject during 12-minute run/walk test while two research assistants recorded the heart rate and blood pressure of the subjects.

### 3.7 Test Procedures

All the selected participants met during the scheduled physical education period of the school in the morning hours where the pre-training tests were administered. They were informed about the nature of the training program, the risks and benefits that could accrue as a result of regular participation in the training program.

### 3.7.1 Informed Consent Form

The subjects were given informed consent forms for their parents to fill, indicating their willingness to allow their children/ward to participate in the program. Each subject had a column to fill and sign to attest to his/her readiness to participate.

### 3.7.2 Spirometric Measurements

Spirometry is a method of assessing lung function by measuring the volume of air a subject expels from the lungs after maximal inhalation. This process involves using the maximum force the subject can generate to blow all the air out as hard and as fast as possible. Spirometry measures all lung volumes except residual volume, total residual capacity and total lung volume. All the volumes were reported in Body Temperature and Pressure Saturated (BTPS) (Madsen, Mortensen, Hanel & Pedersen, 2014). The spirometric variables measured were;

#### 3.7.2.1 Forced vital capacity (FVC)

This is the largest volume of air that can be delivered by a maximal forced exhalation after a full inspiration. Each subject was told to breath tidally, inhale slowly to total lung capacity and exhales as hard and as fast as possible to residual volume. Each subject was made to repeat the process twice and the average was recorded as the forced vital capacity. Assessment of FVC involves preparing the subjects, measuring the variable, determining accuracy of 1 spirometric tracing and quality control.

**Preparing the Subject**

The subjects were made comfortable and well seated. They were told the purpose and the technique of the procedure. The correct technique was demonstrated to the subjects before inviting each of them to carry out the test. The first ($1^{st}$) attempt by the subject is not recorded to make sure the subject carry out the process properly. Then vital information about the subject which include:  Age, Sex, Weight, Height, Race, Clinical information, Medications, especially bronchodilators and steroids where noted and Indication for referral and the type of test required where also recorded. (Gregory, 2010)

**Measuring FVC**

The procedure for measuring FVC involves first using clean, disposable mouthpiece attached to the spirometer (a fresh one for each subject). The subject was asked to breathe in as deeply as possible (full inspiration). Then the subject holds his/her breathe just long enough to seal the lips around the mouth piece. After which the subject is asked to blow the breath out forcefully as fast as possible until there is nothing left to expel. They kept blowing out until maximum expiration was achieved. The MIR spirometer then gives a beep to confirm the maneuver is complete. The number of practice and recording was limited to 4 or less at each session in order to prevent respiratory muscle fatigue. Finally the result appears on the display of the spirometer which is stored against the date and time and later printed out. (Gregory, 2010)

**3.7.2.2 Forced expiratory volume in 1 second ($FEV_1$)**

Forced expiratory volume ($FEV_1$) was measured in one second. It is the maximal volume of air exhaled during the first second. Measurement of $FEV_1$ reflects conductive or resistive properties of the large airways. (Gregory, 2010)

The subjects were made to comfortably seat and were told the purpose and the technique of the testing procedure. The correct technique was demonstrated to the subjects before inviting each of them to carry out the test. The first ($1^{st}$) attempt by the subject is not recorded to make sure the subject carry out the process properly. Then vital information about the subject which include:  Age, Sex, Weight, Height, Race, Clinical information, Medications, especially bronchodilators and steroids where noted and Indication for referral and the type of test required where also recorded. (Gregory, 2010)

**Measuring $FEV_1$**

The procedure for measuring $FEV_1$ involves first using clean, disposable mouthpiece attached to the spirometer (a fresh one for each subject). The subject was asked to breathe in as deeply as possible (full inspiration). Then the subject holds his/her breathe just long enough to seal the lips around the mouth piece. After which the subject is asked to blow the breath out forcefully as fast as possible until there is nothing left to expel. They kept blowing out until maximum expiration was achieved. The MIR spirometer then gives a beep to confirm the maneuver is complete. The number of practice and recording was limited to 4 or less at each session in order to prevent respiratory muscle fatigue. Finally the result appears on the display of the spirometer which is stored against the date and time and later printed out. (Gregory, 2010)

**3.7.2.3 Peak Expiratory Flow Rate (Peak Flow Rate)**

It is the fastest flow rate that can be sustained for 10milliseconds during a maximum expiration after a full inspiration. It can be measured using a spirometer but more conveniently, it is measured using a peak flow meter.  It is the fastest flow rate that can be sustained for 10 milliseconds during a maximal expiration after a full inspiration. It reflects changes in airway diameter but measurements do not reliably discriminate between airway and alveolar disease. It is recorded in liters/min. Its main use is in the diagnosis, monitoring and self management of asthma. This is the least expensive and the simplest of the lung function measurement. The peak expiratory flow is measured using a peak flow meter. This was pioneered by Dr. Martin Wright who made the first peak flow meter specially designed to measure this index of lung function (Gregory, 2010).

**Measuring Peak Expiratory Flow Rate (PEFR)**

The procedure was demonstration to the subject so as to minimize error in the reading. The cursor at the side of the peak flow meter was set to zero. Then the subject was asked not to touch the cursor when breathing out. The subject then stands up and holds the peak flow meter horizontally in front of his mouth. He/She takes in a deep breath and closes his lips firmly around the mouth piece, making sure that there are no air leaks around the lips. The subject was then asked to breathe out as hard and as fast as possible. The number indicated by the cursor is noted. The cursor is returned to zero and the procedure is repeated again. Three readings are obtained and the highest or best reading of all three measurements was selected as the peak flow at that time.

**3.7.2.4 Vital Capacity (VC)**

This is a non-force maneuver. It is similar to the forced vital capacity except in conditions like chronic obstructive airway disease which causes dynamic closure of the airways. The subject was asked to breathe tidally then inhale slowly to total lung capacity followed by slow exhalation to residual volume. The total volume of air slowly exhaled is the slow vital capacity. (Gregory, 2010).

**Measuring Vital Capacity**

**Procedure**

A clean, disposable mouthpiece was attached to the spirometer (a fresh one for each subject). The subject was asked to breathe in as deeply as possible. Then they he/she was asked to hold his/her breathe just long enough to seal the lips as if blowing a trumpet and also to wear a nose clip. Then the subject was asked to breathe out steadily at a comfortable pace. It was continued until expiration was complete. The maneuver was repeated two more times and the highest value recorded. (Gregory, 2010)

In this study, weight was measured using a digital scale (kg), height was measured in (cm) and adiposity was assessed by calculating body mass index (BMI=weight/height2 [kg/m2]) before the training commences (0 weeks) and at the end of the training (12 weeks).

Respiratory parameters were measured by experienced technicians using the Spirobank G Spirometer (MIR, Roma, Italy) in accordance with the recommendations of the Spirobank G user manual (Medical International Research (MIR) Spirobank G User Manual, 2007). Subjects rested for 15 minutes before measurements and were informed about the procedure.

### 3.7.3 12 Minutes Run/Walk Test

The cardiopulmonary fitness of the subjects ($VO_2$ max) in this study was determined through the use of the Cooper's 12 minutes distance walk/run test. The test was conducted in a standard 400m track. At the beginning of the test, the subjects were grouped in to 5 groups of 6 persons each. Each subject was assigned a lap scorer to record the number of laps covered. All the subjects assembled at the starting point and each group took turn to run for twelve minutes. The subjects were instructed to 'run', 'jog' or walk for 12 minutes, but they would not stop entirely, they were instructed to stop at the sound of a whistle. The number of laps covered by each subject was recorded to the nearest meter and then American College of Sports Medicine formula was used to convert the distance in to individual's assessment of maximal aerobic power. (ACSM, 2010) $VO_2$ max = Distance (m) x 0.2 + 3.5 ml. kg Min-1 Time (min).

## 3.8 Training Protocol

Training was conducted three times per week during the PE lessons on alternate days (Monday, Wednesday and Friday) between 8:00 – 8:45am. The following phases were used.

### 3.8.1 Warm-up Exercises

All subjects performed 10 minutes of warm-up exercise, which comprised of walking round the track for 5 minutes and 5 minutes of flexibility exercises, involving different range of motion exercises to all joints of the upper and lower limbs and trunk (Kluding, Singh, Goetz, Rucker & Bracciano, 2010). Each joint was moved for 8-10 repetitions.

### 3.8.2 Aerobic Exercises

All the subjects jogged round the track continuously for 15 minutes at 50% to 60% of their heart rate maximum (HRmax). This training intensity was maintained for four weeks. Training intensity was increased from 55% to 65% and 60% - 70% HRmax during the $5^{th}$ – $8^{th}$ and $9^{th}$ to $12^{th}$ week of training respectively. Rate of perceived exertion (RPE) of OMNI for Children. The first 4 weeks of training, representing condition phase was maintained between 8 and 9 which is ‘very light’. The second phase of 4 weeks of training was monitored at between 10 and 11 representing ‘light’. The final 4 weeks was monitored at between 12 and 13 representing rate of perceived exertion (RPE) of ‘somewhat hard’. The adolescents were taught the OMNI RPE rating of between 6 and 20. The detail of the training programme is shown below:

| Week | Jogging Time | | Intensity (HRmax) | RPE | Cool down | Total duration |
|---|---|---|---|---|---|---|
| | Warm up | Training | | | | |
| 0-4 | 10 minutes | 15 minutes | 50% - 60% | 8 - 9 | 10 minutes | 35 minutes |
| 5-8 | 10 minutes | 20 minutes | 55% - 65% | 10 - 11 | 10 minutes | 40 minutes |
| 9-12 | 10 minutes | 25 minutes | 60% - 70% | 12 - 13 | 10 minutes | 45 minutes |

## 3.9 Statistical Techniques

(i) Descriptive statistics of mean and standard deviation of all the parameters for the different stages of training were used to explain the stages of training after the Pre (0 weeks) and Post ($12^{Th}$ weeks) duration. This is to check and see the effect of the training program on the subjects.

(ii) The Student t-test for dependent data was used to find significant differences between Pre and post test data of the variables: this is because the researcher was trying to compare two sample mean (pre and post test) on one variable.

(iii) An alpha level of 0.05 was used to retain or reject the hypotheses raised for this study.

## CHAPTER FOUR

### 4.0 Results and Discussion

### 4.1 Introduction

The purpose of this research was to assess the effect regular jogging program on cardiopulmonary variables of adolescents in Kaduna metropolis. To achieve this purpose, the data collected during this investigation were statistically analyzed and the results were discussed and presented in this chapter.

### 4.2 Results

Thirty four (34) adolescents participated in the study for duration of 12 weeks. Training was conducted on three alternate days per week. Information on the physical characteristics (age, weight and height and body mass index: BMI) of the subjects used in this study is presented in the table 4:2:1

**Table 4.2.1: Physical Characteristics of the Participants**

| Variable | Mean | SD | SE |
|---|---|---|---|
| Age (yrs) | 13.35 | 1.43 | 0.25 |
| Weight (kg) | 69.82 | 6.99 | 1.20 |
| Height (m) | 1.617 | 0.08 | 0.01 |
| BMI ($kg/m^2$) | 26.71 | 1.78 | 0.31 |

Note: BMI = Body mass index

The mean age of the participants was $13.35 \pm 1.43$ years with an average height, weight and BMI of $1.617 \pm 0.08$m, $69.82 \pm 6.99$kg and $26.71 \pm 1.78 kg/m^2$) respectively. An observation of the BMI classification revealed that the participants were overweight ($26.71 kg/m^2$).

**Hypotheses Testing**

Data was collected at baseline (pre-test) and after $12^{th}$ week (posttest) of regular low intensity jogging on $VO_2$ max, FVC, $FEV_1$, PEFR and VC of adolescent children in Kaduna metropolis. The baseline and posttest descriptive statistics of the data is presented in table 4:2:2.

**Table 4.2.2: Mean, Standard Deviation and Standard error of Pre and Posttest scores of Cardiopulmonary Variables of the Participants**

| | | Pre test | | | Post test | | |
|---|---|---|---|---|---|---|---|
| Variable | N | Mean | S.D | S.E | Mean | S.D | S.E |
| $VO_2$ max | 34 | 35.47 | 6.34 | 1.09 | 40.17 | 7.38 | 1.27 |
| FVC | 34 | 1.93 | 0.87 | 0.15 | 2.27 | 0.97 | 0.17 |
| VC | 34 | 3.69 | 8.27 | 1.42 | 3.12 | 1.69 | 0.29 |
| $FEV_1$ | 34 | 1.79 | 0.82 | 0.14 | 2.40 | 0.77 | 0.13 |
| PEFR | 34 | 342.29 | 34.52 | 5.92 | 364.76 | 37.95 | 6.51 |

Note: FVC = Forced vital capacity; VC = Vital capacity; $FEV_1$ = Forced expiratory volume in 1 second; PEFR = Peak expiratory flow rate

The results on table 4:2:2 shows the pre and posttests cardiopulmonary scores for the participants in this study. An observation of this table revealed that $VO_2$ max increased from 35.47±6 $ml.kg^{-1}.min^{-1}$ to 40.17±7.38 $ml.kg^{-1}.min^{-1}$ by an increment 13.250%, FVC from 1.93±0.87 to 2.27±0.97 by an increment of 15.3886% after 12 weeks of training. Similar increases were observed on $FEV_1$ from 1.79±0.82 to 2.40±077 (30.078%) and peak expiratory flow rate (PEFR) increased from 342.29±34.52 to 364.76±37.95 by 6.565% respectively. However, such improvement was not observed in the pre and posttest scores of vital capacity (VC) which decreased from (3.69±8.27 to 3.12±1.69), which had a decrease of -15.447% indicating 15.45% reduction. To test if these changes were statistically significant, the data was analyzed using student t-test and the results are presented according to the sub-hypotheses raised for this study.

**SUB-HYPOTHESIS 1:** There is no significant effect of 12 weeks jogging program on $VO_2$ max of overweight adolescents in Kaduna metropolis.

**Table 4.2.3: Paired t-test analysis of the pre and post test scores of $VO_2$ max of the subjects**

| Variable | Test Period | Mean | SD | DF | t | P |
|---|---|---|---|---|---|---|
| $VO_{2\ Ma}$ | Pre test | 34.5 | 6.34 | 33 | 23.977* | 0.000 |
| | Post test | 40.2 | 7.38 | | | |

$t(33) = 2.021$ $P \geq 0.05$ * = significant

The results on table 4:2:3 shows the paired t-test analysis of the pre-posttest scores of the $VO_2$ max of the participants.

An observation of the result in table 4:2:3 showed that 12 weeks of jogging had significant effect on the $VO_2$ max of the subjects ($t(33) = 23.977$, $P \geq 0.05$). Therefore, the null hypothesis which states that there is no significant difference between the pre and posttest effect of regular jogging program on $VO_2$ max of overweight adolescents in Kaduna metropolis was rejected.

A histogram of the pre-posttest scores is presented in figure 4:1

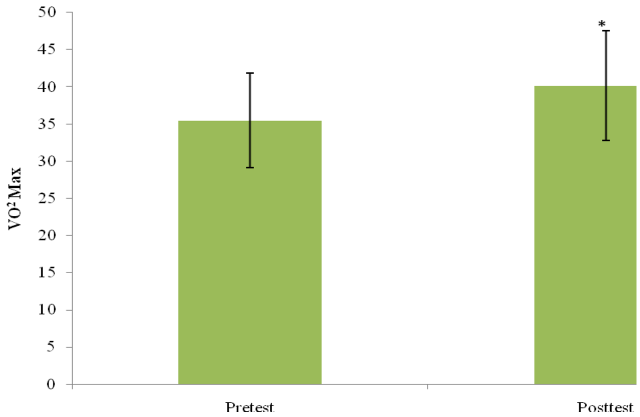


**Figure 4.1: Histogram of the $VO_2$ max of Adolescents in Kaduna metropolis before and after 12 weeks of regular jogging program**

**SUB HYPOTHESIS 2**: There is no significant effect of 12 weeks jogging program on FVC of overweight adolescents in Kaduna metropolis.

**Table 4.2.4: Paired t-test analyses of the pre and posttest scores of FVC of the subjects.**

| Variable | Testing Period | Mean | SD | SEE | DF | t | P |
|---|---|---|---|---|---|---|---|
| | Pre test | 1.93 | 0.87 | | 33 | 6.463* | 0.000* |
| FVC | Post test | 2.27 | 0.97 | | | | |

t(33) = 2.021 P≥ 0.05 * = significant

The results on table 4:2:4 shows the paired t-test analysis of the pre-posttest scores of the FVC of the participants.

An observation of the result on table 4:2:4 showed that 12 weeks of jogging had significant effect on the FVC of the subjects (t (33) = 6.463, P ≥ 0.05). Therefore, the null hypothesis which states that there is no significant difference between the pre and posttest effect of regular jogging program on FVC of overweight adolescents in Kaduna metropolis was rejected. A histogram of the pre-posttest scores is presented in figure 4:2

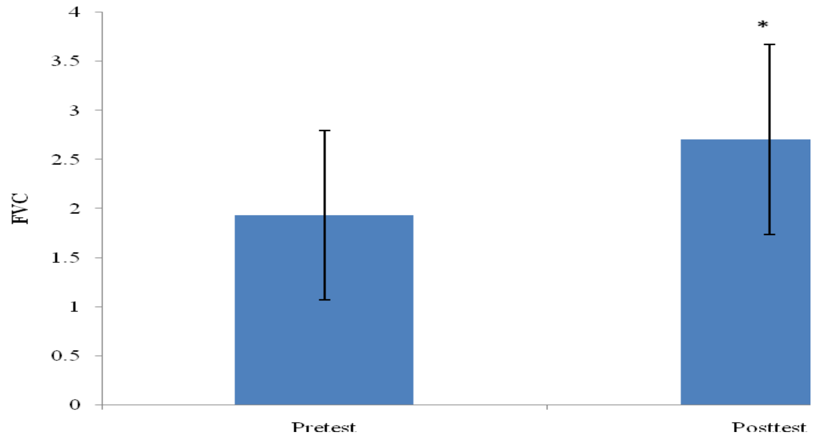


**Figure 4.2: Histogram of the Forced Vital capacity of Adolescents in Kaduna metropolis before and after regular 12 weeks of regular jogging program.**

**SUB HYPOTHESIS 3:** There is no significant effect of 12 weeks jogging program on $FEV_1$ of overweight adolescents in Kaduna metropolis.

**Table 4.2.5: Paired t-test analysis of the pre and post test scores of $FEV_1$ of the subjects**

| Variable | Testing Period | Mean | SD | DF | t | P |
|---|---|---|---|---|---|---|
| | Pre test | 1.79 | 0.82 | 33 | 5.690* | 0.000 |
| $FEV_1$ | Post test | 2.40 | 0.77 | | | |

$t(33) = 2.021$, $P \geq 0.05$ * = significant

The results on table 4:2:3 shows the paired t-test analysis of the pre-posttest scores of the $FEV_1$ of the participants.

An observation of the results on table 4:2:6 showed that 12 weeks of jogging had significant effect on the $FEV_1$ of the subjects ($t (33) = 5.690$, $P \geq 0.05$). Therefore, the null hypothesis which states that there is no significant difference between the pre and posttest effect of regular jogging programme on $FEV_1$ of overweight adolescents in Kaduna metropolis was rejected. A histogram of the pre-posttest scores is presented in figure 4:3

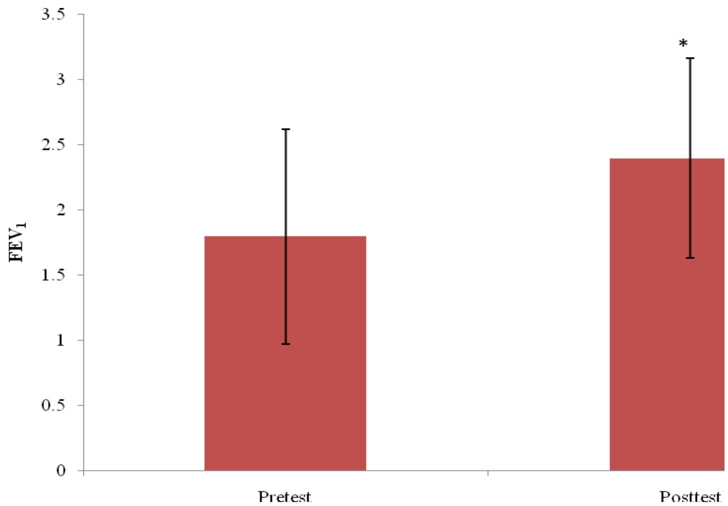


**Figure 4.3: Histogram of the $FEV_1$ of Adolescents in Kaduna metropolis before and after 12 weeks of regular jogging program**

**SUB HYPOTHESIS 4:** There is no significant effect of 12 weeks jogging program on PEFR of overweight adolescents in Kaduna metropolis.

**Table 4.2.6: Paired t-test analysis of the pre and post test scores of PEFR of the subjects**

| Variable | Testing Interval | Mean | SD | DF | t | P |
|---|---|---|---|---|---|---|
| | Pre test | 342.29 | 34.52 | 33 | 11.61 | 0.000 |
| PEFR | Post test | 364.76 | 37.95 | | * | |

t(33) = 2.021  $P \geq 0.05$  * = significant

The results on table 4:2:6 shows the paired t-test analysis of the pre-posttest scores of the PEFR of the participants.

An observation of the results on table 4:2:6 showed that 12 weeks of jogging had significant effect on the PEFR of the subjects ($t(33) = 11.610$, $P \geq 0.05$). Therefore, the null hypothesis which states that there is no significant difference between the pre and posttest effect of regular jogging program on PEFR of overweight adolescents in Kaduna metropolis was rejected. A histogram of the pre-posttest scores is presented in figure 4:4

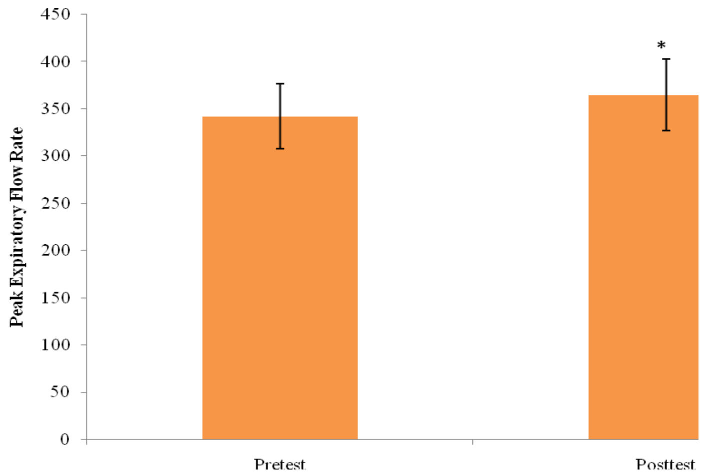


**Figure 4.4: Histogram of the Peak expiratory flow rate of overweight adolescents in Kaduna metropolis, before and after 12 weeks of regular jogging program**

**SUB HYPOTHESIS 5**: There is no significant effect of 12 weeks jogging program on VC of overweight adolescents in Kaduna metropolis.

**Table 4.2.7: Paired t-test analysis of the pre and post test scores of VC of the subjects**

| Variable | Testing Period | Mean | SD | DF | t | P |
|---|---|---|---|---|---|---|
| | Pre test | 3.69 | 8.27 | 33 | 0.389 | 0.700 |
| Vital Capacity | Post test | 3.12 | 1.69 | | | |

$t(33) = 2.021$ $P \leq 0.05$

The results on table 4:2:7 shows the paired t-test analysis of the pre-posttest scores of the VC of the participants.

An observation of the result on table 4:2:5 showed that 12 weeks of jogging had no significant effect on the vital capacity (VC) of the subjects ($t\ (33) = 0.389$, $P \geq 0.05$). Therefore, the null hypothesis which states that there is no significant difference between the pre and posttest effect of regular jogging program on VC of overweight adolescents in Kaduna metropolis was retained. A histogram of the pre-posttest scores is presented in figure 4:5

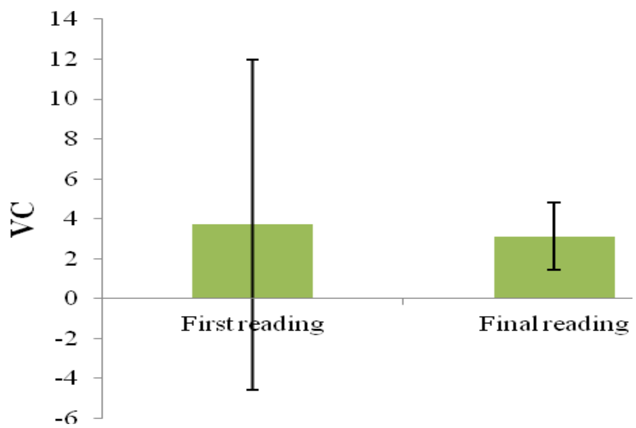


**Figure 4:5** **Histogram of VC of overweight adolescents in Kaduna metropolis before and after 12 weeks of regular jogging program.**

## 4.3 Discussion

Physical inactivity and low cardiopulmonary fitness are recognized as important causes of morbidity and mortality (Luszynska, & Abraham 2012). It is generally accepted that adolescents with higher levels of physical activity tend to have higher levels of fitness and tendency to improve their cardiopulmonary fitness (Rote, Swartz & Klos, 2013). The result in this research demonstrated that being overweight (25<BMI<29.9) has significant influence on cardiopulmonary parameters of adolescents. It is known that being overweight reflects not having adipose tissue, but also the presences of muscles. Therefore, the association between being overweight and cardiopulmonary function in adolescents may be due in part to the strength of the respiratory muscles (Litteton, 2012). This study investigated the effect of regular jogging program (3 times a week 45 – 60 minutes daily at moderate intensity) on cardiopulmonary parameters of overweight adolescents in Kaduna Metropolis. The result shows the ability of training to reduce the amount of adipose tissues from the pulmonary system. Similar results have been reported in the literature (Vargas-Ortiz, Jiminez, Flores, Diaz, Montano-Ascencio, Vazquez-Perez, Figueroa & Macias 2014; Bray, 2000).

The findings of the study revealed a significant improvement in $VO_2$ max of the participants after the twelve week of the training program. The result is similar to that reported by Laursen & Jenkins, (2002) who found an increase in $VO_2$ max after 83 days of training 3 times per week. Furthermore, Bowen, Neil, Norton & Padgett, (2012) found significant improvement in aerobic capacity on College boys who trained three days a week for ten weeks. This result was also supported by the findings of Pate & Ward, (1990) who found a group of initially sedentary adolescents to manifest a mean increase in $VO_2$ max of 15% due to aerobic dance training. This increase in $VO_2$max resulting from the training program could be attributed to an increase in the amount of oxidative enzymes which enable the muscle tissues to use the available oxygen and an increase in cardiac output, blood volume and better perfusion of active muscles with blood due to a decrease in peripheral resistance (Ashokan & Abraham 2014). A study comparing the cardio-pulmonary function between a moderate exercise program and a severe exercise program; reported that there was a significant improvement in $VO_2$ max and maximum voluntary ventilation after both types of exercise (O'Donovan *et al.*, 2005).

The findings of this study revealed a significant improvement on forced vital capacity (FVC) of the participants after 12 weeks of the training program. This is consistent with the study of Zahra Hojati, Rajesh Kumar & Hossein Soltani, (2013), they used interval aerobic exercise with intensity of 65% -80% of heart rate reserve, and they had a significant improvement in forced expiratory vital capacity (FVC) after the 12 weeks of interval aerobic exercise. The increase in forced vital capacity is as a result of the ability of various muscles of respiration to aid in both inspiration and expiration which requires changes in the pressure within the thoracic cavity. The principal muscles are the diaphragm, the external intercostal and the interchondral part of the internal intercostal muscles. Both the external intercostal muscles and the intercondral elevate the ribs, thus increasing the width of the thoracic cavity, while the diaphragm contracts to increase the vertical dimensions of the thoracic cavity, and also aids in the elevation of the lower ribs. Maximal inspiration results from contraction of the diaphragm downward and the movement of the ribs upward and outward, both of which expand the chest cavity. Forced expiration is the result of the rapid contraction of chest and abdominal muscles, as well as the relaxation of the diaphragm (McArdle & Willian, 2006).

The increase in FVC post exercise might be related to the enhanced strength of respiratory muscles following training, a reduction in air trapping, improvement in lung compliance, reduced air way resistance and the process of motivation which enforces the subject to take deep inspiration and fill all air passages after training (Nourry, Deruelle, Guinhouya, Baquet, Fabre, Bart & Mucci, 2005). Shashikala & Ravipati, (2011) showed that the pulmonary function tests values are higher after exercise training. The cause for this could be regular forceful inspiration and expiration for prolonged period during training leading to the strengthening of respiratory muscles. Skeletal muscle control many crucial elements of aerobic conditioning including lung ventilation.

In the Amsterdam Growth and Heart study, physical activity was observed to be positively correlated to changes in FVC between ages 13-27 years over a period of 15 years (van de Laar, Ferreira, van Mechelen, Prins Twisk & Stehouwer, 2010). Furthermore the result of this is supported by a study by Fuster, Rebato, Rosique & Fernandez, (2008) who also observed increment in FVC as an effect of increased physical activity.

The findings of this study revealed a significant improvement on forced expiratory volume in one second ($FEV_1$) of the participants after 12 weeks of the training program. This is consistent with the study of Topp *et al.*, (2009) who stated that there is an evidence of reduction of $FEV_1$ in overweight adolescents as BMI increases. In a study by Faria, Ribeiro, Marson, Schivinski, Severino & Baros (2014), there was a reduction in $FEV_1$ in overweight and obese subjects. $FEV_1$ was reduced (in terms of percentage predicted) the $FEV_1$ to FVC ratio was normal and static lung volumes were reduced, suggesting the reduction may be due to restriction as opposed to air flow obstruction.. It was explained with abnormality in alveolar diffusion with possible structural alterations of the lung interstice by lipid deposition and/or a reduction in alveolar surface area (Rio Navaro *et al*., 2000). The increase in $FEV_1$ in overweight adolescents due to training as observed in this study is also in agreement with the findings of Jones & Nzekwu, (2006) who concluded that aerobic exercise training in adolescents leads to improveed lung function parameters ($FEV_1$ and FVC).

Also the findings of this study revealed a significant improvement on the peak expiratory flow rate (PEFR) of the participants after 12 weeks of the training program. This is consistent with the study of Aaron, Dearwater, Anderson, Olsen, Kriska, & Laporte, (2004), who reported a reduction in airway obstruction in obese asthmatics who underwent an 8-week aerobic training and low calorie diet that resulted in 14% reduction in body weight which was associated with increases in peak expiratory flow rate (PEFR) and dyspnea score. The result of this research correlates with that of Cheng & Macera (2003) who showed in their study that participation in constant physical activity improved pulmonary function especially PEFR in healthy sedentary adolescents. In a study by Chaitra & Vijay Matri, (2011), they found out from their study that PEFR increased significantly in the experimental group after 16 weeks of aerobic exercise plan.

This is consistent with the findings of this study and can be explained that as both groups had similar conditions at the beginning of the study, aerobic exercise caused the increase among the experimental group.

There was no significant improvement on the Vital Capacity (VC) of the participants in this study after 12 weeks of the training program. From available literature this the degree of vital capacity increase is limited by the development of respiratory muscles, the capability of expansion of lungs and thorax wall and the elasticity of bronchi and bronchioles. Futhermore vital capacity increase by training depends upon the work style and the intensity of the exercise. In practice this sort of increase can be seen mainly in some types of sports that require long-term durability performance (Faria *et al.*, 2014). This result is consistent with the studies of Kurkcu & Gokhan who found that the vital capacity of 13-16 years old handball players found to be higher than children who had not been involved in any sport activity (Kurkcu & Gokhan, 2011).

The result of this study also showed improvement in aerobic capacity similar to the current findings and elicited a positive effect on both body weight and cardiopulmonary indices through exercise (Watts *et al.*, 2004). This study adds to other evidences that increased physical activity and good nutritional habits decrease weight gain and can improve the health status in overweight and obese adolescents

# CHAPTER FIVE

## 5.0 Summary, Conclusion and Recommendations

### 5.1 Summary

This study was conducted to find out the cardiopulmonary adaptations to a twelve-week program of jogging among overweight adolescents in Kaduna Metropolis. To this end, the random sampling technique was employed to select the subjects. This was due to the fact that not all students may be ready to participate in a programme lasting for twelve weeks. Thus, thirty four male and female volunteers constituted the subjects for this research. Maximum oxygen uptake ($VO_2$ max) was inferred from the Cooper 12 minute run test taken at pre and post training. The resting systolic and diastolic blood pressure and resting heart rate were determined through the use of Omron automatic sphygmomanometer, while the Pulmonary parameters where determined by the use of Spirobank G from MIR, Italy .

The training protocol was a jogging program of one hour, three alternate days for 12 weeks. The period was between 8.30 am and 11.30am; a participant was free to come within the span of two hours. However, He or She has to jog for 15 minutes to one hour. The data collected were analyzed on the computer using the SPSS package to test the hypotheses of the study. A significant level of $P< 0.05$ was used to retain or reject a hypothesis.

### 5.2 Conclusion

Based on the limitations of this study, it was found that regular jogging program

(i) Improved $VO_2$ max of overweight adolescents by 13.2% in Kaduna metropolis.

(ii) Improved FVC of overweight adolescents by 43.5.56% in Kaduna metropolis.

(iii) Improved $FEV_1$ of overweight adolescents by 30.07% in Kaduna metropolis.

(iv) Improved PEFR of overweight adolescents by 6.56% in Kaduna metropolis.

(vi) Did not improve the VC of the overweight adolescents in Kaduna metropolis

## 5.3 Recommendations

On the basis of the findings of this study, the following recommendations were made:

1. To optimize the efficiency of the cardiopulmonary system of adolescents, frequent low to moderate intensity physical activity programs should be encouraged among junior secondary school pupils in order to help check the scourge of overweight in adolescents.
2. Adolescents should be encouraged to take part in any form of aerobic activity in order to improve their $VO_2$ max. This will help to improve the vitality of their cardiopulmonary system.
3. Government and private school owners should be encouraged to provide pitch for track and field events in order to encourage adolescents to participate in jogging.
4. Parents should encourage their children to trek to school especially if the school is nearby, do domestic chores and pick one or more physical activity programs as a hobby in order to mitigate the incidence of been overweight in their children.

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## APPENDIX A

**DEPARTMENT OF PHYSICAL AND HEALTH EDUCATION**
**AHMADU BELLO UNIVERSITY, ZARIA - NIGERIA**
**(OFFICE OF THE HEAD OF DEPARTMENT)**

**Vice-Chancellor:** PROFESSOR ABDULLAHI MUSTAPHA, *B.Sc. (Hons) Pharm. (A.B.U), Ph.D. (London), FPSN*
**Head of Department:** PROFESSOR C. E. DIKKI, *NCE, B.Sc.Ed., M.Ed., Ph.D. (ABU)*

Our Ref: ~~M.Sc/Educ/4584/2~~009-2010 Date: 7th January, 2014

Your Ref: ____________

THE PRINCIPAL,
ST. ANNE'S SCHOOLS,
KAKURI, KADUNA STATE
NIGERIA.

Dear Sir,

**INTRODUCTION OF COLLECTION OF DATA –**
**FRANCIS ALI ALBERT (M.SC/EDUC/4584/2009-2010)**

The bearer is an M.Sc student of this Department, he required to conduct a research on the **"Effect of Regular Jogging as Physical Exercise on Cardiopulmonary Parameters of Adolescents in Kaduna Metropolis"** in which your school is one of his selected samples.

In this regard, I wish to request for your permission and support to use your students to collect data for his M.Sc Thesis

Please assist him.

Thanking you.

Department of Physical & Health Education
Sign.
Date
A. B. U. Zaria

Prof. C.E. Dikki
*Supervisor*

**APPENDIX B**

INFORMED CONSENT FORM

DEPARTMENT OF PHYSICAL AND HEALTH EDUCATION, AHMADU BELLO UNIVERSITY, ZARIA

CONSENT FORM FOR PARTICIPATION IN 12 WEEKS JOGGING PROGRAM

I Mr/Mrs…………………………………………………………………………………of……..
………………………………………………………………………….hereby give consent to my child/ward……………………………………………………………………………………….
of………………………………………………………………………………………….School, Kaduna to undergo a jogging program for 12 weeks, 1 hour, three alternate days a week (Mondays, Tuesdays, and Fridays) for research purpose. The nature and effects of the program has been duly explained to me by the researcher.

I understand that this activity has been found to have very rare risk factors but a possibility that certain abnormal changes in heart rate or blood pressure may occur, this will be looked out for and avoided by proper supervision. I am aware that I can withdraw my child/ward from the program whenever I find that he/she cannot cope.

I also understand that the information gathered would be confidential and shall be used purely for research purpose and shall not be used for any other purpose without my prior approval.

Name……………………………………………Sign…………………Date…………………

Child/Ward………………………………………Sign…………………Date…………………

Witness Name……………………………………Sign ………………...Date………………..