COMPARISON OF THE EFFECTS OF INTENSITY LEVELS OF CONTINUOUS TRAINING ON PHYSIOLOGICAL AND BODY COMPOSITION VARIABLES OF ADOLESCENTS IN KADUNA METROPOLIS, NIGERIA

BY

Jacob Maikano GAJERE (B. Ed., 1990; MSc. Ed., 2006)
PhD/EDU/46791/2012 – 2013

A DISSERTSTION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) IN EXERCISE AND SPORT SCIENCE

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

NOVEMBER, 2017

DECLARATION

I hereby declare that this Thesis has been written by me and that it is a record of my own research work. It has not been presented in a previous application for a higher degree.

All citations have been indicated and the sources of information were specifically acknowledged by means of reference.

------------------------------------ ------------------------

Jacob Maikano GAJERE **Date**

CERTIFICATION

This Thesis entitled: **"Comparison of the Effects of Intensity levels of Continuous Training on Physiological and Body Composition Variables of Adolescents in Kaduna Metropolis, Nigeria"** by **Jacob Maikano GAJERE**, meets the regulations governing the award of the degree of Doctor of Philosophy (PhD) in Exercise and Sport Science, Department of Physical and Health Education, Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

____________________ Prof. E. A. Gunen Chairman, Supervisory committee	____________________ Date
____________________ Prof. C.E. Dikki Member, Supervisory Committee	____________________ Date
____________________ Prof. J. O. Ayo Member, Supervisory Committee	____________________ Date
____________________ Prof. M. A. Suleiman Head of Department	____________________ Date
____________________ Prof. S. Z. Abubakar Dean School of Postgraduate Studies	____________________ Date

ACKNOWLEDGEMENTS

The Researcher is indebted to the supervisory committee that comprises Professors E. A. Gunen, C. E. Dikki, J. O. Ayo, and J. A. Gwani. This Thesis would not have achieved this magnitude and success, but for their expert scrutiny, critique, and guidance, the research met the expected standard, the researcher appreciates them all.

The researcher acknowledges the encouragement by Professors M. A. Suleiman and T. N. Ogwu, and the entire academic and non-academic staff of the Department. Their persistent pieces of advice and encouragement have inspired the researcher to attain this height.

The Researcher acknowledges with deep sense of appreciation the unflinching support and encouragement received from late Coach G. G. Musa, Hon. Shehu Garba Sarki Noma of the Federal House of Representatives, Abuja,for their inspiration and assistance in various ways.The researcher also acknowledges greatly the assistance of Mr. O. Alaye, Mr. Joshua Ndomi Yerima, Mrs, Victoria Hassan, Miss Vera Attuand Mr. James Sayi during the period of data collection.The researcher wishes to appreciate the contributions of Mr. Benjami Egaji for analysing the data. The researcher sincerely appreciates all family members, particularly Mrs Abigail J. Gajere (wife), for taking over the family responsibilities during the study period.

Finally, the researcher registers sincere thanks and appreciation to the Director and Management Staff of Imperial School, Kudenda, Kaduna metropolis for granting the researcher permission to involve selected the male students in the training. To the participants, you were remarkable andwithout your cooperation, it would not have been possible to realize this dream, Thank you all.

DEDICATION

This Thesis is dedicated to Late Mama Theresa Gajere and my family

ABSTRACT

The study compared the effect of different intensity levels of continuous training on physiological and body composition variables of adolescent students of Imperial School Kudend Kaduna Metropolis, Nigeria. The training programme comprised warm-up, continuous jogging and cool down activities ineach training session. A total of eighty(80) overweight adolescent male students aged 15 to 17volunteered to participate in this study. A 1 x 2 x 3 factorial experimental research design was used. Three experimental study groups and one control group in which participants were given different treatments. In this design, participants underwent low, moderate, and high-intensity training for 9 weeks.The training consisted of continuous jogging for 30 minutes on three alternate days a week at < 40-45% , < 45-50% and < 50-55% HR max of the participants from 1^{st} to 3^{rd},4^{th}-6^{th} and 7-9^{th} weeks of training, respectively, for low-intensity group; < 50-55%, < 55-60%, 60-65% HR max of the participants from 1^{st}-3^{rd},4^{th}-6th and 7-9^{th} weeks of training, respectively, for moderate-intensity group and < 60-65%, < 65-70%, < 70-75% HR maxof the participants from 1^{st}- 3^{rd},4^{th}- 6^{th} and 7-9^{th} weeks of training, respectively, for high-intensity group. Rate of Perceived Exertion scale was used to monitor the exertion of training throughout the research period. All participants were tested for MAP, RHR with Electronic sphygmomanometre (automatic arm cuff Blood Pressure and heart rate monitor) Omron CEO 197 and %BF and VF with Omron HBF 516B full body sensor body composition monitor and VO_2 max with cooper's 12-minute run test, before starting the training (base-line), this was repeated after 3^{rd}, 6^{th} and 9^{th} weeks of training. The baseline average values for MAP were 85.717, 85.365, 84.951 and 84.134 mm Hg, RHR 75.00, 74.600, 73.00, 72.950 bpm, VO_2max35.336, 35.478, 345.464 and 35.324 ml.kg /min^{-1}, %BF 21.25, 21.40, 20.85 and 20.95 and VF 11.450, 11.650, 10.750 and 10.700,for low, moderate, high and control groups, respectively. The data collected were analysed using descriptive and repeated-measures analysis of variance and Scheffe post-hoc test at 0. 05 level of significance. The participants MAP mean value of 82.600 mm Hg -3.6%, 76.615 mm Hg -10.3%, 78.184 mm Hg -6.9%, 86.170 mm Hg -2.4%for low, moderate, high-intensity and control group respectively. RHR mean value 69.00 bpm -8.0%, 66.450 bpm -10.9%, 64.100 bpm -12.2% and 75.300 bpm 3.0%, for low, moderate, high-intensity and control groups, respectively.VO_2max mean value 42.335ml.kg./min^{-1} 16.5%, 49.521 ml.kg./min^{-1} 28.4%,53.740 ml.kg./min^{-1} 34%, 33.44 ml.kg /min^{-1} -5.3%, for low, moderate, high-intensity and control group respectively. %BF mean value 17.10 -19.5%, 15.65 -26.9%, 12.05 -42.2% and 21.92 4.6%.for low, moderate, high-intensity and control groups respectively and VF mean value 8.250 -27.5%9, 7.150 -38.6%, 4.200 60.9% and 11.530 2.9% for low, moderate and high- intensity and control group respectively after 9 weeks of continuous training. The results revealed significant decrease in MAP ($P < 0.01$), RHR ($P < 0.001$), %BF($P < 0.001$) andVF ($P <0.001$) at low, moderate and high-intensity training. The result also indicated a significant increase in VO_2max ($P <0.001$) across the 3 training intensities due to 9 weeks of continuous training. It was concluded that low, moderate and high-intensity continuous training conducted at 40-55% HR max low-intensity, 55 to 65% HR max for moderate-intensity and 60 to 75% HR max for high-intensity for 30 minutes on three alternate days a week for 9 weeks significantly decrease MAP, RHR, %BF, and VF and significantlyincreasedVO_2max of overweight male adolescent students. Since continuous training was found to significantly improve the physiological and body composition variables, it was recommended that health professionals and fitness centres should use this method of training on overweight adolescents to reduce cardiovascular risk factor and improve body oxygen transport and utilisation.

TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS

ACSM	-	American College of Sports Medicine
BMI	-	Body Mass Index
BP	-	Blood Pressure
BPM	-	Beats per minute
CRF	-	Cardiorespiratory Fitness
CVD	-	Cardiovascular Disease
HIT	-	High Intensity Training
HR	-	Heart Rate
HRmax	-	Maximum Heart Rate
IOTF	-	International Obesity Task Force
LIT	-	Low Intensity Training
MAP	-	Mean Arterial Pressure
MIT	-	Moderate Intensity Training
MET_s	-	Metabolic Equivalent
PA	-	Physical Activity
%BF	-	Percent Body Fat
RHR	-	Resting Heart Rate
RPE	-	Rateof Perceived Exertion
VF	-	Visceral Fat
VO_2max	-	Maximum Oxygen Consumption
WHO	-	World Health Organisation

OPERATIONAL DEFINITION OF TERMS

The technical terms used in the study are defined below in their operational sense

i. Continuous Training: This is the work out protocol in which the activities are performed without break for specific period of time.

ii. Adolescent: A person aged from 15-17 years who are in Senior Secondary School

iii. Low-Intensity training: Continuous exercise protocol performed at 40-55% HRmax or RPE of 7-12 that does not cause any noticeable change in breathing rate.

iv. Moderate-Intensity training: Continuous exercise protocol performed at 50-65% HRmax or RPE of 11-14 that is conducted whilst maintaining a conversation uninterrupted.

v. High-Intensitytraining: Continuous exercise protocol performed at 60-75% HRmax or RPE of 13-16 which makes breathing harder or puff.

CHAPTER ONE

INTRODUCTION

1.1Background of the Study

The strong relationship between physical activity (PA), health and wellness is not in doubt because PA has many health and fitness benefits which are well documented.These benefits are enjoyed due to regular participation in an exercise programme. At the time when exercise scientists demonstrated the association between longevity and exercise, researchers (Nieman, 1998; Venkateswarlu, 2010; Kenny, Wilmore & Costill, 2012; &Heyward, 2014)in the field of cardiology began to understand that regular physical exercise reduces cardiovascular risk factors by reducing blood pressure, type-2 diabetes, hypertension, stroke, gallbladder disease, post-menopausal breast cancer, colon and other cancers.

The primary goal of exercise may dictate the mode (type),frequency, duration and intensity of the exercise prescription. The concern about the proper dose of exercise prescription that will bring about a desired effect (response) is similar to the physician's need to know the type and quantity of a drug as well as the time frame over which it must be taken to cause the desired health effects (Powers & Howley, 2012). It is a common fact that the dose of physical activity improves health-related outcomes, such as lower mean arterial pressure (MAP), resting heart rate (RHR), percent body fat (%BF), visceral fat (VF) and increased maximum oxygen uptake (VO_2max). Evidences from experts (Plowman & Smith, 2008; Venkateswarlu, 2011; Powers & Howley, 2012; Heyward, 2014) have shown that continuous aerobic exercise positively influences physiological variables such as MAP, RHR, VO_2max, % BF and VF. If the primary goal of the exercise programme is to develop and maintain cardiorespiratory fitness and other physiological variables, such prescribed exercise should be of continuous nature. This mode of exercise allows the individual to maintain constant exercise intensity. The most popular modes of continuous training are walking, jogging, and cycling (Kenney, Wilmore & Costill, 2012; Heyward, 2014). All have been found to show significant improvements when the frequency,duration and intensity of exercise are held and are prescribed in accordance with sound scientific principles.

Recent research studies clearly demonstrated strong evidences that participation in regular physical activity (PA) of continuous training enhances fitness benefits as well as cardiovascular function among adolescents, such as improved heart and muscular functions, build and maintain healthy bones, enhanced blood circulation and metabolic rate, and favourably influence body composition (Lee & Paffenbarger, 2000; Mackenzie, 2000; Gibala, Little, MacDonald, & Hawley, 2012; Wade, 2013; Heyward, 2014; Gladmohesh & Sundaramurthy, 2015).

Prentice (2006), ACSM (2011) & Kenney, Wilmore and Costill (2012) agreed that though the mode, frequency, duration and intensity are important for producing training effects, the intensity of the exercise is the most significant factor associated with aerobics development and appears to be the most critical determinant of the physiological responses to training. However, the optimal intensity of activity remains unclear. Kenney, Wilmore and Costill, (2012) defined exercise intensity as the amount of energy expended when exercising and howlight/low, moderate or high/hard an exerciser pushes to gain the benefits. Guidelines for adolescents suggest that 60 minutes or more of either moderate or vigorous aerobic Physical Activity per day three times per week provides additional health benefits. The 1998 Surgeon General Report recommended that American adolescents require at least 30 minutes of moderate intensity PA most days of the week, to maintain cardiovascular wellbeing and that greater intensity of exercise confers greater benefits. Recently, the American Heart Association recommended a minimum of 30 minutes of moderate intensity PA (AHA, 2014). The intensity of aerobic PA can be defined as either absolute or relative scale. An absolute measure of PA intensity is the amount of energy used by the body per minute, while doing the activity without taking into account a person's cardiorespiratory fitness. It includes heart rate (HR) and metabolic equivalent (METs). A relative measure of PA intensity is the level of effort required by a person to do an activity. It uses a person's level of cardio-respiratory fitness to assess the level of effort. It includes percent of heart rate maximum (%HRmax), percent of heart rate reserve (%HRR), maximal oxygen uptake (VO_2max) and Borg's scale rate of perceived exertion (RPE) (Norton, Norton & Sadgrove, 2009; Kenney, Wilmore and Costill, 2012); often used to set the intensity level of aerobic physical training into low (light), moderate and high (vigorous/ hard).

Low intensity exercise is an aerobic activity that does not cause any noticeable change in breathing rate and can be sustained for at least 60 minutes. For example, gardening, household cares, walking 4 kilometre per hour or less. Operationally, low intensity activities are those where the metabolic equivalent is between 1.6 to 3.0 METs or the relative intensity of 40% to 55% HRmax, 20 to 40 %HRR,20 to 40 % VO_2max and RPE of 11-12 (Norton, Norton & Sadgrove, 2009). Studies revealed that low intensity training (LIT) leads to improvements of both physiological and body composition variables. Fagard (2011); Mughal, Alvi, Akhund and Ansori (2001), reported reduction in MAP of

3 mm Hg after 30 minutes of brisk walking 3-5 times a week at 50% VO_2max. Lamina (2010), Teller (2012) and Simon (2013) also reported significant reduction in RHR with slow jogging training programme.

Moderate intensityexercise is an aerobic activity that is able to be conducted whilst maintaining a conversation uninterrupted and may last between 30 and 60 minutes consisting of activities like, walking 4.8 kilometre per hour and not more than 5.5 km/h, bicycling 16 km/h, calisthenics and home exercises. Its intensity ranges from 3 to 6 METs or have a relative intensity of 55 to 70%HRmax, 40 to 60 %HRR, and40 to 60 Percentage VO_2max and RPE 13-14 (Norton, K., Norton, L. & Sadgrove, D.,2009). Studies revealed that moderate intensity exercise positively influence both physiological and body composition variables. Abdel-Kader (2011) reported a reduction of 6.7% mean value of BMI after 3 months of moderate intensity aerobic exercise training. Gan, Kriketos, Ellic,Thompson, Kraegen and Chisholm (2003) also reported a reduction in visceral fat (r – 0.544, P= 0.02) after 10 weeks of moderate intensity physical activity and concluded that aerobic moderate intensity PA leads to reduction in visceral fat.

High intensity exercise is intensity level of aerobic PA most often made breathing harder or puff and pant, conversation generally cannot be maintained uninterrupted and may last up to 30 minutes. For example, walking 6 km / hror more, or jogging and running. Its intensity ranges from 6 to 9 METs or a relative intensity of 70 to 90% HRmax, 60 to 85% HRR, 60-85% VO_2max and RPE 15-18 (Norton, K., Norton, L. & Sadgrove, D, 2009).

Continuous training can be performed at low, moderate and high intensity level. Studies that have compared different intensities of continuous aerobic exercise showed that highintensity continuous training leads to significant improvement of physiological and body composition variables (Hottenrott, Ludyga & Schulze, 2012). Airin, Linoby, Zaki, Baki, Sariman, Esham and Azam (2014) reported that continuous training three times per week for six weeks training at 60 – 70% of HRmax for 30 minutes, caused significant reduction in % body fat (0.3%), lean body mass (0.8kg) and BMI (0.5kg/m^2).

1. 2Statement of Problem

Despite the established benefits of regular PA on health and well-being among adolescents in developed nations including the United States of America, current levels of PA within school aged youth are widely regarded as insufficient to meet the recommendations for intensity (Ekelund, Tomkinson & Armstrong, 2011). The current era is characterized by kinetic limitations, both in children and adolescents. Children and adolescents today, expend less energy than did their counterparts of 40 years ago, and are 40% less active than they were 30 years ago (Mavrovouniotis, 2012). Adolescents today spend their free time mainly in sedentary behaviours, such as television viewing, computer and video games, use of automation devices as means of transportation to and from school, phone chatting, messaging, washing clothes with machines dryers and other labour-saving and muscular work-saving technologies. This lack of adequate movement in children and adolescents' lives is one of the primary predisposing factors of increased morbidity, since many of the chronic diseases of adults are initiated in childhood. These conditions also provide fertile environment for increased risk factors for heart diseases, such as obesity, hypertension and high total cholesterol, or diabetes. These diseases are most often irreversible due to the continuous sedentary lifestyle that has been adopted since childhood. The health consequences of excess body fat, especially visceral fat do not immediately manifest in obesity in some adolescents, but, it translates into unprecedented number of cardiovascular risk factors and metabolic disorders like type-2 diabetes, hypertension, stroke, gallbladder disease, post-menopausal breast cancer, colon and other cancers, osteoarthritis, back pain, physical and mental disabilities (Chia, 2008; Bouchard & Katzmarzyk 2010; Baria, Kamimura, Aoike, Ammiratai, Rocha, Mello & Cupparati, 2016). Marrow (2013), reported that American adolescents have failed to meet national aerobics fitness capacity and have higher odds of not achieving health related physical fitness levels such as improved aerobic capacity, percent body fat and flexibility among others.

Scientific evidence supports the concept that participation in regular aerobic exercise has significant and perceivable benefits for the health of every individual. Guidelines for such aerobic programmes have been provided by health professionals, organizations and experts. Continuous aerobic exercise of moderate intensity for 30 to 40 minutes most days of the week have been the pivot point for which physical exercise attenuates physiological changes of people, irrespective of age and gender (Venkateswarlu, 2011).

However, the precise type and dose of exercise needed to accrue health benefits is a contentious issue with no clear consensus and recommendation for the prevention of inactivity related disorders. Though the mode, frequency, duration and intensity are important for producing training effects, the intensity of the exercise is the most significant factor associated with fitness improvement and appears to be the most critical determinant of the physiological responses to training. However, the optimal intensity of activity remains unclear. There is continued debate as to how much (intensity) can continuous training dose cause physiological changes in adolescents.

The beneficial effects of low, moderate and high level continuous training need to be clarified among adolescents in Nigeria. Thus, research is needed to clarify the effects of different intensity levels of continuous training on physiological and body composition indices of urban based adolescents, such as Kaduna metropolis of Nigeria.

Considering the sedentary lifestyles of urban based adolescents, this study investigated and compare the effects of different intensities of continuous training on mean arterial pressure (MAP), resting heart rate (RHR), VO_2max, percent of body fat (% body fat) and visceral fat of non-athletic male adolescents in Kaduna metropolis, Nigeria.

1.3Research Questions

The following research questions wereraised for this study.

1. Will MAP, RHR, VO_2max, % BF and visceral fat of adolescents change following low intensity continuous training?
2. Will MAP, RHR, VO_2max, % BF and visceral fat of adolescents change following moderate intensity continuous training?
3. Will MAP, RHR, VO_2max, % BF and visceral fat of adolescents change followinghigh intensity continuous training?
4. Which of these intensity levels will produce the greatest change in MAP, RHR.VO_2max, %BF and visceral fat of adolescents in Kaduna metropolis?

1.4Purpose of the Study

The purpose of this study was to:

1 Determine the effects of low intensity level of continuous training on MAP, RHR, VO_2max, % body fat and visceral fat of adolescent students in Kaduna metropolis

2 Determine the effects of moderate intensity level of continuous training on MAP, RHR, VO_2max, % body fat and visceral fat of adolescent students in Kaduna metropolis.

3 Determine the effects of high intensity level of continuous training on MAP, RHR,VO_2max, % body fat and visceral fat of adolescent students in Kaduna metropolis.

4 Compare the effects of low, moderate and high intensity levels of continuous training on MAP, RHR, VO_2max % body fat and visceral fat of adolescent students in Kaduna metropolis.

1.5Basic Assumptions

On the basis of available research evidence, the following assumptions were made for the purpose of the study:

1. Regular participation in physical activities significantly influence physiological and body composition variables of adolescents.
2. The effects of physical training on physiological and body composition variables depend largely on the training intensity level.

3. The effects of continuous training on physiological and body composition variable of adolescents can be measured.

1.6Hypotheses

To achieve the purpose of this study, the following hypotheses were tested:

Major Hypotheses

There are no significant effects of low, moderate and high intensity levels of continuous training on the physiological and body composition of overweight male adolescent students in Kaduna metropolis, Nigeria

Sub – Hypotheses

1. There is no significant difference in the effects of low, moderate and high intensity continuous training on MAP of adolescent students in Kaduna metropolis.
2. There is no significant difference in the effects of low, moderate and high intensity continuous training on RHR of adolescent students in Kaduna metropolis.
3. There is no significant difference in the effects of low, moderate and high intensity continuous training on VO_2max of adolescent students in Kaduna metropolis.
4. There is no significant difference in the effects of low, moderate and high intensity continuous training on % body fat of adolescent students in Kaduna metropolis.

5. There is no significant difference in the effects of low, moderate and high intensity continuous training on visceral fat of adolescent students in Kaduna metropolis.

1.7Significance of the Study

The consequences of sedentary life-styles lived by so many of our young people are grave. A physically inactive population is at the risk for many chronic diseases, including heart disease, stroke, colon cancer, diabetes, and osteoporosis. In addition to the toll taken by human suffering, surges in the prevalence of these diseases could lead to crippling increases in the national health care expenditures. Research has shown serious health implication of inactive life-style, characterized by kinetic limitations both in adolescence and adulthood. Therefore, prevention must start with a better understanding of exercise intensity impact in the early years of development. Hence, enhancing efforts to promote participation in physical activity and sports to improve energy expenditure among adolescents should be a critical national priority.

A lot of studies with regard to the effect of exercise training on the body has been carried out on various groups, with health challenges emanating from poor fitness level ofvarious physiological and body composition variables. These studies were aimed at developing exercise programme for treating and controlling these health challenges .But not so much information is available about the effects of intensity levels of continuous aerobic exercise training and which intensity level (low, moderate and high) is effective for producing and maintaining training effects on physiological and body composition of adolescent students in Nigeria.

The findings help the participants to reduce cardiovascular risk factor and provide appropriate exercise intensity for treating and controlling the health challenges associated with overweight.

The findings inthis study helps the government to have a robust long-term national policy to improve aerobic fitness of the children,reduce national health care expenditures and promotes strategies in schools to give adolescents opportunities for walking, jogging, cycling, playing, and sports on daily basis to have active youths for national productivity.

This research is significant to field of study as itcontribute to the available existing body of knowledge as literature on the effects of adolescent activity levels are very scanty, the findings, therefore,provides some basic information beneficial to physical education specialists, exercise scientists, coaches and trainers on how intensity levels of continuous training influence the physiological and body composition variables of adolescents,and which level of intensity of continuous aerobics training influences greater changes in physiological and body composition variables of adolescents in influencing and correcting cardiovascular risk factors.

The results also benefit the community to have active and healthy adolescents and ensurebetter productive citizens for economic growth and development.

1.8Delimitations of the Study

The study was delimited to the following conditions

1. Effects of low, moderate and high-intensity levels of continuous training on physiological and body composition variables of male adolescent students in Kaduna metropolis.
2. The training protocol was 3 days per week on alternate days of continuous training
3. The physiological components tested were MAP, RHR, and Vo_2max.
4. The body composition components tested were % body fat and visceral fat.
5. The subjects used were male overweight adolescent students of Imperial Schools, Kaduna.
6. The ages of the subjects were between 15 and 17 years, but time and duration of training was the same.
7. For this study, the Cooper's 12-minute run/walk test was used to estimate the participants' VO_2max. A 400- metre track was used so that the number of laps completed was easily counted.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1Introduction

The purpose of this study was to compare the effects of low, moderate and high-intensity levels of continuous training on physiological variables and body composition of adolescent students in Kaduna metropolis, Kaduna State, Nigeria. To achieve this purpose, available related literatures were critically reviewed and presented in this chapter under the following sub-headings:

2.2 Blood pressure

2.2.1 Mean arterial pressure

2.2.2 Effects of physical exercise/ aerobics training on blood pressure

2.2.3 Differential effects of low, moderate and high intensity training on blood pressure

2.3 Resting heart rate

2.3.1 Effects of physical exercise/aerobictraining on resting heart rate

2.3.2 Differential effects of low, moderate and high-intensity training on resting heartrate

2.4 Cardio-respiratory endurance

2.4.1 Effects of physical exercise/aerobics training on the VO_2max

2.4.2 Differential effects of low, moderate and high intensity training on VO_2max

2.4.3 Measurement of cardio-respiratory fitness

2.2Blood Pressure

Blood pressure (BP) is the force exerted by the blood on the walls of bloodvessels as it is being transported round the body. It is usually referred to as blood pressure within the arteries (Wilmore & Costill 2004). The more the heart pumps blood through narrow arteries, the higher the blood pressure.

Blood pressure is measured in millimetre mercury (mmHg). It is expressed by two numbers; the systolic pressure and the diastolic pressure. The upper number is the systolic pressure and the bottom number is the diastolic pressure (Kenny, Wilmore & Costill, 2012, Sembulingan & Sembulingan,2010). Shola and Chioma (2013) reported that according to WHO standard, the optimal BP is less than 120/80mmHg; normal BP is below 140/90mmHg, and high BP is 140/90mmHg and above. The upper number measures pressures in arteries when the heart contracts (systolic), which represents the high pressure in artery, and corresponds to ventricular systolic pressure. The bottom number measures the pressure when the heart relaxes (diastolic), which represents the lowered pressure in artery, corresponding to ventricular diastole when the heart relaxes (Guyton & Hall, 2012, Kenny, Wilmore & Costill, 2012).

2.2.1Mean Arterial Blood Pressure

As blood flows from the heart through arteries, the pumping effect exerts a force against the walls of these vessels, and this pressure is expressed as a ratio of the maximum (systolic pressure) over the minimum (diastolic pressure). Arterial pressure known as blood Pressure is a familiar vital sign as 120/80mmHg. Blood pressure (BP) is often affected by factors including age, heart disease, emotions, physical activities, body position.

The MAP expresses a relationship between the systolic and diastolic pressure (the mean, or approximately, the average). Its significance lies in the fact that it reflects the perfusion pressure or the force that enable the blood in circulation to supply the vital organs with oxygen and important nutrients. Angelica (2011) stated that MAP is affected by factors such as volume of blood pumped by the heart (cardiac output), heart rate, blood pressure and resistance to blood flow in the vessels. Any increase or decrease in any of these factors can proportionately affect mean arterial pressure and bring corresponding consequences to the perfusion of major organs like the brain and kidneys.

Mean arterial pressure (MAP) is significant to doctors, and health workers who are involved in monitoring patients' physical status and their responses to therapy, especially in critical situations. A normal MAP is 70- 110mmHg and a minimum of at least 60mmHg. Where adequate blood supply reaches the vital organs such as brain, kidney, and coronary artery, it delivers enough oxygen and nutrients. Angelica (2011) observed that a significant decrease in MAP results in deprivation of the supply of blood and can cause organ damage and death, when the condition is prolonged. Therefore, constant pressure is required to pump blood through the circulatory system. This ensures delivery of oxygen and nutrients and removal of carbon dioxide and metabolic waste from tissues. MAP, therefore, is generally regarded as a measure of cardiac output and peripheral resistance by organs in the body or the force that enables the blood in circulation to supply vital organs of the body with oxygen and nutrients (Kenny, Wilmore& Costill, 2012). It is a useful measure of the adequacy of tissue perfusion. It is not a simple average of systolic and diastolic pressures. This is because diastole continues for twice as long as systole. It is estimated from the diastolic blood pressure (DBP) and systolic blood pressure (SBP). MAP can be reasonably approximated using the following equations:

MAP = DBP + [0.333 x (SBP – DBP)] (Kenny, Wilmore & Costill, 2012)

The MAP is directly proportional to cardiac output and inversely proportional to total peripheral resistance.

John and Albert (2012) reported that elevated BP is a primary cardiac risk factor and increases the risks for stroke, kidney disease and vascular disease. Blood pressure therefore, needs to be controlled in order to prevent hypertension and other diseases. The control of BP and prevention of hypertension can be achieved by both pharmacological and life-style interventions. One of the important life-style interventions is physical activity (Duwai & Chado, 2012). Simon (2013) considered physical exercise to be the most promising, non-pharmacological treatment of hypertension and BP control. However, Sheehan (2010) earlier observed that, though regular exercise has a long term effect on blood pressure and pulse, these beneficial effects require a continued exercise programme, and that the benefit last only as long as individuals continue to exercise.

2.2.2Effects of physical exercise on blood pressure

While exercising, the body's need for blood and oxygen significantly increases. To meet the growing demands of the body, the heart must pump faster. Since the pulse rate is a direct measure of heart beats per minute, the pulse rate naturally increases during exercise. As the heart beats faster, it also pumps blood through the arteries faster. As the blood inside the arteries increases, the internal pressure also increases. As a result, the blood pressure also rises during exercise (Kenny, Wilmore &Costill, 2012).

Nieman(1998),Sheehan (2010),Kenney, Wilmore and Costill (2012)have stated that regular physical activity not only makes the heart stronger, but also more efficient. As the heart becomes more efficient, it becomes more able to pump greater amount of blood with less effort. As a result, the heart does not need to beat quickly to deliver blood to the body. Since the heart is pumping slower, it is also placing less stress and pressure on the arteries. Several weeks or months of regular exercise show a decrease in resting pulse and blood pressure. Nieman (1998) further reported that exercise relaxes the blood vessel, causing a post- exercise decrease in BP. Over time exercise may "loosen up" the blood vessels a bit, lowering the resting blood pressure in much similar way like widening of water pipe lowers water pressure. The blood vessels may relax each exercise session because of body warming effects, local production of certain chemicals (for example, lactic acid and nitric oxide), decreases in nerve activity, changes in certain hormones and their receptors. As exercise is repeated regularly, all these acute effects may create a chronic lowering effect on the blood pressure.

Several studies have also shown connection to specific physiological mechanism, leading to reduction in blood pressure following exercise, where regular aerobic exercise help to keep arteries elastic and in turn ensure good blood flow and normal blood pressure. Terjung (1995) reported that aerobic training increases the number of capillaries in trained skeletal muscles, thereby allowing greater capacity for blood flow in the active muscle. This enhanced capacity for blood flow is associated with a reduction in total peripheral resistance, thus the left ventricle can exert a more forceful contraction against a lower resistance to flow out of the ventricle as earlier reported by Blomqvist and Saltin (1983).

Simon (2013)noted that high intensity exercise may not lower blood pressure effectively as moderate exercise. He reported that moderately intense physical activity such as aerobic exercise (jogging & running) can help to reduce blood pressure and also help to reduce mild to moderate hypertension. Growing evidence has also shown that lasting reduction in resting blood pressure can be experienced through exercises, in other words, exercise training may lower the blood pressure, through the beneficial and addictive effects of regular bouts of PA, which is due to the widening or dilation and relaxation of the blood vessels, causing post-exercise decrease in blood pressure (Kenny, Wilmore & Costill, 2012).

Nieman (1998) reported that the aerobic exercise does not have to be too demanding to improve resting BP. Moderate intensity exercise such as brisk walking may have an even greater BP- lowering effect than high intensity training (like running) for some people. He concluded that the important exercise criterion is frequency that is near daily activities which the body experiences on regular basis and the beneficial effects of exercise is lowering BP. However, Burton, Stokes and Hall (2004) stated that the physiological responses to exercise depend on the intensity, duration and frequency of the exercise as well as the environmental condition. That is the optimal exercise prescription for competition training as well as for fitness improvement is a balance between frequency, intensity, duration and exercise mode

2.2.3Effects of low, moderate and high-intensity training on blood pressure

Regular aerobic exercises may lower resting blood pressure becauseexercise has been found to significantly lower systolic and diastolic BP on the average of 10.5/8.6 mmHg as a result of exercise therapy. Manna, Khanna and Dhara (2012) reported significant reduction in SBP and DBP after 12 weeks of aerobic, anaerobic and skilled training in India amongage under 19 male volleyball players. Buchan, Ollis, Young, Thomas, Cooper, Tong, Nie, Malina and Baker (2011) also reported a similar significant reduction in SBP and CRF in adolescent after 7 weeks of high intensity training intervention. ACSM (2010), and other reviewers (Duwai & Chado, 2012) explained that people with mild hypertension can expect systolic BP and diastolic BP to fall on average of 8 – 10 mm Hg and 6 -10 mmHg, respectively in response to regular aerobic exercise. They reported that even people with normal resting BP, exercise training is expected to lower the systolic and diastolic BP by an average of 4mmHg and 3mmHg, respectively.

The first Surgeon General reporting on physical activity (PA) and Health stated that regular PA prevents or delays the development of HBP and exercise reduces BP in people with hypertension. The ACSM (2010), found that effective lowering of BP can be achieved with moderate intensity aerobic exercise conducted 3-5 times a week for 20-60 minutes per session. Fagard (2011) reported a reduction in blood pressure in response to dynamic physical activity at an average of 3.4/2.3 mmHg (P<0.01).Inter-study difference in the changes in pressure are not related to weekly frequency, time per session or exercise intensity, which range from approximately 45-85%. He concluded that training for 3-5 times a week, 30-60 minutes per session at an intensity of about 40-50% of net maximal exercise performance appears to be effective with regard to blood pressure reduction. In another study on effect of aerobic exercise training on resting blood pressure in hypertensive patients, Mughal *et al*; (2001) reported a mean systolic reduction of -5, 7mmHg at (P<0.01) and diastolic mean reduction of -1.4mmHg. Reduction in mean arterial pressure of -3.4mmHg (P<0.01) has been observed after 12weeks of aerobic exercise for 30 minute brisk walking, 3-5 times a week at 50% VO_2max on cycle ergo meter. They concluded that aerobic exercise cause small reduction in resting systolic and diastolic BP. However, a significant reduction in systolic and diastolic BP after cardiovascular rehabilitation were reported (P□ 0.05) after six weeks of physical training (Tatjana, Biljana, Branislava, Lidija & Todorka 2007).

In a similar study by Stutnik and Banjamin (2013) on the effects of high intensity interval training on resting mean arterial pressure and C- reactive protein content in hypertensive subjects, aerobic exercise training was found to be a means for reducing BPin healthy and diseased subjects. They reported a decrease in mean arterial pressure of -9.7% after endurance training and -8.2% after high intensity interval training (P□ 0.05) difference between groups. This finding was similar to that reported by Fagard and Tipton (1994) that arterial blood pressure at rest, blood pressure during sub-maximal exercise, and peak BP all showed a slight decline as a result of endurance training in normotensive individual, They further observed that decreases are greater in persons with high BP; and that after endurance training, resting blood pressure (systolic and diastolic) decreased on average of -3/-3mmHg in persons with normal blood pressure. In borderline hypertensive persons, the decrease was -10/-8mmHg. Wallace (2003), reported that, following a single exercise treatment, cardio respiratory exercise training; and most recently, with physical activity, the reduction in BP was 5 – 8mmHg for 11 -12 hours for systolic and 6-8mmHg for 6 – 8 hours for diastolic BP. A similar result was also reported by Kokkinos, Giannelou, Manolis and Pittavas (2009), where reduction in blood pressure in women classified as having moderate and high fitness treatment test had significantly lowered diastolic BP (5mmHg and 7mmHg, respectively), when compared with women of low fitness level in both systolic and diastolic BP. Lamina (2010) also reported that continuous training shows significant reduction in systolic, diastolic blood pressure and mean arterial pressure ($P<0.05$) and concluded that the training program should form part of the kit for management of hypertension. Buchan *et al.* (2013); and Baria *et al*. (2016) also observed significant decrease in mean arterial BP and systolic BP post-intervention. They concluded that high-intensity aerobic exercise interventions may be used in the school setting for adolescents as a means of improving measures of physical fitness.

2.3Resting Heart Rate

Heart rate or pulse has been identified as a good index for evaluating cardiovascular fitness and how well the heart is working at rest and during exercise. Laskowski (2012);Kenny, Wilmore and Costill (2012) and Quinn (2014)defined heart rate as the number of times the heart beats per minute at rest, usually the heart beat between 60 and 80 times per minute at rest in untrained male and female subjects, respectively; but the rate is usually much lower (40-55 beats per minute at rest) in highly trained male and female endurance athletes. However, during exerciseincrease in heart rate is directly related to the intensity of the work performed. Laskowski (2012) and Quinn (2014) explained that the heart rate reflects the amount of work the heart must do to meet the increased demands of the body, when engaged in activity. They observed that as a result of exercise, the heart rate or pulse rate is slower and steadier and BP is also slower. The slower the heart rate at rest, the better it is as an indication of cardiovascular fitness.

Resting heart rate (RHR) refers to the number of times the heart beats in one minute while at rest. The average RHR is 70 - 80 beats per minute (bpm) (Laskowski, 2012). Though, athletes may have RHR as low as 40 - 50 BPM. This indicates aerobic fitness (Quinn, 2014). Resting heart rate is often the measure of fitness, as it become more fit as a result of exercise training, the RHR will decrease as the heart becomes more efficient and generally indicates aerobic fitness(Kenny, Wilmore &Costill, 2012, Teller, 2012, Wachner, 2014).

Quinn (2014)further reported that the heart rate influenced by age, gender and health and can vary greatly for both athletes and non- athletes, and that a person's RHR can be a good indicator of a person health and fitness level, and the stronger the heart, the more blood it can pump during each contraction, and the less frequently it needs to beat to get adequate blood and oxygen flow to the tissues. Endurance athletes have been shown to consistently have lower RHRs in gender and age, which shows that individuals with RHR higher than the gender average have been shown to be at a gender risk of heart attacks (Kashubara, 2014). Nieman (1998)reported that high RHR is associated with higher risks of death from ischamic heart disease (IHD). He explained that about10% higher risk of IHD mortality is attributed to10bpmincrease in RHR, regardless of age. He, therefore, recommended a non-pharmacological means to modulate heart rate by engaging in physical activity of moderate or high intensity, which can keep the heart rate in check and get the benefit.

2.3.1Effects of exercise/Training on Resting Heart Rate

The heart rate at rest can decrease markedly as a result of endurance training. Endurance training is defined as activity of at least 20 minutes duration, in which heart rate is elevated to 60 – 80% maximum (Carter and Banister, 2003). Research has indicated that long-term endurance training increases parasympathetic activity and decreases sympathetic activity directed to the human heart at rest (Goldsmith, Bloomfeld & Rosenwinkel 2000; Carter and Banister 2003). These training-induced autonomic changes, coupled with a possible reduction in intrinsic heart rate, decrease RHR and increase heart rate variability at rest (Areskog, 1985; Goldsmith, Bloomfeld & Rosenwinskel, 2000). Athletes have a lower RHR and more rapid HR recovery following exercise due to enhanced parasympathetic activity resulting from long-term training (Brenner, Thomas & Shephard,1997).

Data from studies show that regular participation in aerobic exercise often results in a decrease in RHR by 5–25 bpm, although the explanation of this well-established phenomenon has not been conclusively elucidated. A complex network and interaction of nerves and chemicals regulate the speed of the heart as well as the opening in blood vessels to accommodate the distribution of blood throughout the body. The RHR is under the influence of the autonomic nervous system sympathetic (accelerator) and parasympathetic (depressor) nerves. The lowered RHR from exercise training is proposed to be due primarily to an increase in the parasympathetic activity with a minor decrease in sympathetic discharge (Carter and Banister, 2003).

An adaptation to the lowering of the RHR as a result of aerobic training the heart's ventricles (specifically the left ventricle that pumps blood throughout the body) accommodates a greater volume of blood. As the RHR decreases, there is then more time for filling the ventricles with blood, and more time for the delivery of oxygen and nutrients to the body and the heart muscles, making the heart more efficient in meeting circulatory challenges at rest (Goldsmith, Bloomfeld & Rosenwinskel, 2000; Kenny, Wilmore & Costill,2012).

2.3.2Effects of exercise/training on the Resting Heart Rate

It is well known that trained athletes have a very low RHR and pump more blood than unconditioned individuals and that the reduction in RHR is fairly constantly observed in response to a period of physical training (Teller 2012; Laskowski 2012; Simon 2013). They further reported that when exercise is continued for a long time, the heart becomes larger, stronger, slower and steadier. This has earlier been reported by Butcher (1979), and the heart muscles as a result of training increases in size;and with greater demand placed on the heart as a result of physical activity, a hypertrophic condition exists. This indicates a healthy condition of the heart. He maintained that as a result of evidences obtained from tests performed on Olympic athletes and others, there appears to be evidence that the trained individual has a lower pulse rate than the untrained persons. He also observed that athletes RHR are 10, 20 and as much as 30 beats lower than in those individuals, who follow sedentary pursuits. This was supported by Quinn (2014), who reported that a healthy person average RHR is about 60-75 bpm and that athletes may have RHRs values as low as 40- 50 bpm. The RHR of80bpm or higher on a regular basis could be an indication of a cardiovascular threats, and need to be monitored by a medical Doctor. Simon (2013) further stated that those who exercise have slower RHR. This is because, less effort is needed to pump blood, and that a RHR above gender averages could mean that the heart is weak or the body is not using oxygen efficiently. He reported that gender average of adult males RHR is 70 bpm, adult females average RHR is 75 bpm. The healthy range for adults is between 60 and 72 bpm, while adolescents may have RHR well over 72 bpm. Wilmore and Costill (2004)stated that sedentary individuals with an initial RHR of 80 bpm, can decrease approximately 1 beat/min each week for the first few weeks of endurance training. After 10 weeks of moderate endurance training the heart rate could drop from 80 – 70 beats/min. The actual mechanisms responsible for this decrease are not entirely known, but training appears to increase parasympathetic activity in the heart but decrease sympathetic activity.

Not all research studies have found RHR to decrease dramatically with aerobic endurance training. Wilmore and Costill (2004) reported that in a highly controlled study, the Heritage Family study of several hundred subjects, 20 weeks of intense endurance in previously sedentary individuals resulted only in a small decrease in RHR(from 65 – 62 bpm). Several studies with fewer subjects found similar results with little or no change in RHR. However, several other studies have reported decrease in RHR as a result of endurance exercise training. Macbeth (1974) had earlier studied the effect of continuous and interval step training on cardiovascular fitness and tennis skills of beginning tennis students and found that 10 weeks of participation in either continuous or interval step training program effectively and significantly improved cardiovascular fitness, of which the post- test terminal pulse rate were significantly lower for all groups. James (1980)also reported that 10 weeks of one-hour training conducted 3 days/week decreased RHR and significantly changed systolic and diastolic BP.Holt (1972)also observed that efficient improvements in cardiovascular fitness of middle-aged men in his studies of two jogging program of different speed. He observed that both slow and fast jogging regiments training improved cardiovascular fitness in the first six weeks of training.

In a similar study on the effect of three modes of aerobic training on cardiovascular endurance Edwin (1978) found that aerobic exercise program of jogging, cycling or swimming produced significant gain in cardiovascular endurance when undertaken 3 days/week for seven consecutive weeks. Smith and Braven (1986) also found out that 6-weeks training programme of aerobic jogging increased cardiovascular efficiency and reduce percent body fat. However, Hunter (2014) reported that as a result of regular exercise RHR decreases and reduction in RHR depends on the type and intensity of the workouts, and that aerobics exercises are more effective in reducing RHR than other forms of exercise, while high intensities reduce RHR more than low intensity workouts.

2.4Cardio-respiratory endurance/ Vo_2max

Cardiorespiratory endurance is a major component of health-related fitness and depends on a large number of phenotype associated such as cardiac, vascular, blood, various muscle cell and respiratory functions making up the cardio-respiratory system. Efficient operation of the body depends on cellular functioning, which depends on adequate supply of oxygen, nutrients and; removal of carbon dioxide and other waste products. Life-sustaining activities, therefore, depend on adequate functioning of cardio-respiratory system (Heyward (2014).

Wilmore and Costill (2004) and Baumgartner, Jackson, Mahar and Rower (2007)defined cardio-respiratory endurance as the ability of the whole body to sustain prolonged exercise. Jackson, Marrow, Hill and Dishman (1999) and Heyward (2014) similarly defined cardio-respiratory endurance as the ability to perform dynamic exercises, involving large muscle groups at moderate to high intensity for a prolonged period. Cardio-respiratory fitness describes how well the persons' capacity to take up oxygen from the lungs by blood and then pump it through the heart to the working muscles,where it is utilised in the mitochondria to oxidise food to produce energy for muscular contraction. It reflects the efficiency of the heart, lungs and circulation. It is also the ability of the blood to pick up, transport and unload oxygen needed for prolonged physical activity. Cardio-respiratory fitness is always referred to as aerobic fitness or cardio-respiratory endurance, which is most regarded as the basis of entire fitness. This is because of the various health advantages or benefits associated with the development of high level of aerobic endurance (Plowman & Smith, 2008; Powers & Howley, 2012).

According to Hockey (1981), Brown, Dengel, Hoginkyan and Supiano, (2002 and Kenny, Wilmore and Costill (2012), some of the benefits included increased efficiency in supplying oxygen, increased fat tolerance, increased coronary supply and capillary development; increased collateral circulation, reduction of obesity and overweight. Other benefits include,reduced risks of heart diseases, strengthening of ligaments and tendons, reduced tension and stress, improved vitality, reduced fatigue, improved fat metabolism, enhanced self-confidence, body image and emotional stability. The cardio-respiratory system is solely responsible for supplying oxygen to the tissues and removes carbon dioxide and other waste products from the tissues. Therefore, cardio-respiratory fitness and endurance are essential to prolonged vigorous activities. The performance of repeated bouts of exercise over a period of time causes numerous physiological changes that result in improved performance in that exercise activity.

Jones and Carter(2000)stated that the magnitude of the training response depends on the duration of the exercise bout, intensity and the frequency with which they are performed, along with initial training status, genetic potential, age and gender of the individual. They further reported that the specificity of the training stimulus is also important in terms of the type of training practised (endurance, speed or strength) and the exercise modality used. Endurance training plays a major role in the ability to perform athletic movements for an extended period of time. For increase in cardio-respiratory fitness, aerobic endurance training must be improved, where performance in endurance events is heavily dependent upon the aerobic re-synthesis of ATP and this requires an adequate delivery of oxygen from the atmosphere. Endurance training causes adaptation in the pulmonary, cardiovascular and neuromuscular system to improve the delivery of oxygen form the atmospheric air to the mitochondria and enhance the control of metabolism within the muscles. One of the key parameters of aerobic endurance is the maximal oxygen uptake (VO_2max) (Jones and Carter, 2000).

Wilmore and Costill (2004); and Froek (2013) defined VO_2max as the body's maximum ability to transport and utilize oxygen during physical activity. Oxygen uptake at lactate threshold reflects the ability of the body to generate ATP predominantly via aerobic pathway prior to having an increase in reliance on anaerobic metabolism for energy production.Jones and Carter (2000); Michael, Butcher, Marcinuik and Bhutanik (2012) and Froek (2013)agreed that VO_2max is an indicator that determines cardiovascular fitness and aerobic endurance,associated with success in endurance sports. In exercises such as running, cycling, rowing and many others, it is believed that VO_2max is limited by the rate at which oxygen can be supplied to the muscles and not by the muscles ability to extract oxygen from the blood it receives. The VO_2max appears to be strongly related to the maximal cardiac output (Qmax). According to Jones and Carter (2000) the high Qmax and VO_2max values commonly found in elite athletes are,in turn, related to very high maximal stroke volumes. During training, exercising muscle may require less blood flow for the same submaximal exercise intensity because of an increase in the arterial-venous oxygen difference. The increase stroke volume resulting from increases in left ventricular size, myocardial contractility and end-diastolic volume with training, along with a decreased sensitivity to catecholamines, leading to reduced heart rate during sub-maximal exercise. During maximal exercise, the greater cardiac output, along with the increased extraction of oxygen by the exercising muscle, results in a greater VO_2max. In addition, the oxygen carrying capacity of the blood is increased following endurance training owing to increased total blood hemoglobin content (Wilmore and Costill, 2004).

Jones and Carter (2000) further maintained that VO_2max is influenced by a number of factors such as age, gender and genetic. A person's VO_2max is partially genetically determined and can be increased through training until the point that the genetically possible maximum is reached. Increase in training intensity and volume are primary ways to improve VO_2max. Training response therefore, depends on the duration, intensity and frequency of exercise bouts, which they are performed.The VO_2max, therefore, is considered the gold standard of aerobic fitness and best estimate of a person's cardiorespiratory fitness and aerobic power (Michael *et al;*2012). In view of the importance of cardiorespiratory fitness, ACSM (2011) recommended that every physical fitness evaluation should include the assessment of cardio-respiratory fitness during exercise and at rest.

According to Jones and Carter (2000) the magnitude of increase in VO_2max resulting from aerobic endurance training, depends on a number of factors, notably the initial fitness status of the participant, the duration of the training program, intensity, and frequency of the training session. Most studies of endurance training have shown some increase in VO_2max with time, however,the optimal intensity for developing this parameter is not very clear. Therefore, more comprehensive study is necessary.

2.4.1Effects of exercise training on VO_2max

Although a person's VO_2max is genetically determined, it can be increased through training until the point that the genetically possible maximum is reached. During exercise, VO_2maxincreases in direct proportion to the rate of work. The point at which a person's VO_2 is no longer able to increase is termed as the maximal oxygen uptake (VO_2max). Gutin, Yin, Humphries and Barbeen (2005) observed that a higher index for CVF was associated with higher amount of moderate and vigorous PA, and that more variance was explained by vigorous than by moderate PA.

Stephen (2015) observed improvement in VO_2max is directly related to frequency, intensity and duration of training, ranging from 5-25%, depending upon the quantity and quality of training. He further explained that the amount of improvement in VO_2max tends to plateau when frequency of training is increased above 3 days a week and participation less than 2 days a week may not show any change in VO_2max. This is in support of Ruiz,Rizo, Hurtig-wenn, Ortega, Warberg and Sjostrem (2006), who reported higher VO_2max among children who engage in □ 40 minutes highPA/day and had higher CVF than those who accumulate □ 18 minutes highPA. They concluded that moderate to vigorous PA may improve children CVF. Paoli, Quirco, Tatiana, Guiseppe, Marco and Antonino (2013) also observed that endurance training seems to be more effective and have greater impact on VO_2max. Mughal *et al;* (2001) observed that Brisk-walking yields significant increase in VO_2max (P□ 0.05). Similarly, Stuknik and Banjamin (2013) also observed increase in VO_2max after 8 weeks of aerobic endurance training. Gunen, Venkateswarlu and Chado (2012) compared effects of interval and continuous training programme on body composition and cardiovascular parameters of pre-adolescent children demonstrated a significant effect in both training methods on VO_2max of male and female children after nine (9) weeks of training. Significant difference was also observed between the training methods on the VO_2max of boys.However, Manna, Khanna and Dhara(2012) observed a different result where they observed a no significant change in VO_2max of India under 19 male volleyball players after 12 weeks of aerobic training.

Following observation derived fromstudies collected for up to 6-12 months with endurance training, ACSM (2011) explained thatimprovement in VO_2max was directly related to frequency, duration and intensity, depending upon the quantity and quality of training. It was also reported that improvement in VO_2max ranges from 10- 30% and the minimum increase in VO_2max was 10 -15% in programme that meets the recommended guidelines.

Jones and Carter (2000), in their review of VO_2max research, reported that in a recent study on the influence of 6 weeks of endurance training on parameters of aerobic fitness in 16 physical education students, reported that despite the relatively modest training program (3 – 5 session per week of 20-30 minutes duration at a running speed close to the lactate threshold), found that VO_2max increased by approximately 10%. Other groups have also shown a 5 – 10% improvement in VO_2max with short term endurance training program and for 9 weeks endurance training, VO_2max increased by 23%, but other increases (14%) occurred only after 3 weeks (Jones and Carter 2000). There are some evidences that during longer-term training program, VO_2max eventually stabilised, with subsequent improvement in performance resulting from continued improvement in sub-maximal factor such as exercise economy and lactate threshold.

2.4.2Effects of exercise/training on VO_2max

Recent studies suggest that beneficial effects of regular PA depend on intensity or amount of work performed during training (Adochi, Koike, Obayashi, Umezawa, Anonuma, Inada, (1996),Lee, Sesso, Oguma, Paffenbarger, 2003). ACSM (2010) also made some observations derived from studies collected for up to 6 -12 months with endurance training and concluded that improvement in VO_2max is directly related to frequency, intensity and duration, depending upon the quantity and quality of training, and that improvement in VO_2max ranges from 10- 30 %. This study showed that minimum increase in VO_2max is 10 – 15% in programme that met the requirement. Rosenkoetter, Brown and Hickson (1980); Hickson and Rosenkoetter (1981); Hickson, Kanakis, Davis, Moore, Rich (1982)in series of experiments, where frequency, duration and intensity of training were manipulated, found that, if intensity of training remained unchanged and frequency and duration were reduced by as much as two-third(⅔),and when frequency and duration of training remained constant and intensity reduced by one third(⅓) or two third(⅔), VO_2max was significantly reduced. Thus, it appears that missing an exercise session periodically or reducing training frequency or duration for up to 15 weeks will not adversely affect VO_2max and endurance as long as training intensity is maintained. Ole, Per, Jan, Jan-Bjorn, Tor, Ulrik and Oyvind (2005) reported an increased VO_2max by71% and 28% for high and moderate intensity respectively. They concluded that cardiovascular adaptations to training are intensity dependent as they reported significant higher benefits with higher intensity. Gormley, Swain, High, Spina, Darwling, Kotipaeli and Gandrakota (2008), reported significant increases in VO_2max by 7.2, 4.8 and 3.4 ml. min^{-1} kg^{-1} in near maximal, vigorous and the moderate intensity groups after 6 weeks of training. They concluded that when volume of exercise is controlled, higher intensities of exercise are more effective for improving VO_2max than lower intensities of exercise in healthy, young adults and that higher/vigorous intensity exercise confers greater cardio-protective health benefits than moderate intensity exercise.This was supported by Moradichaleshtori, Salami and Jafari, (2008) who reported that 3 days/week with 60 minutes of moderate intensity (50-60 % VO_2max) for 12 weeks is sufficient to improve VO_2max in overweight women by 21% ($P < 0.01$). However,they concluded that higher amount of activity is necessary for improving VO_2max. Hugh, 2013 showed increased VO_2max by 3.9% in continuous moderate exercise training group (33.2 $\pm$4.0 to 34.5$\pm$ 6.1 ml.kg^{-} min-1) and a decrease of 5.7% in control group (30.0^{+} 4.6 to 28.3 $^{+}$ 6.5 ml. kg^{-}1 min-1) after 12 weeks 30 min at 45-60% VO_2max.

2.4.3Measurement of cardio-respiratory fitness

The measurement of maximal oxygen consumption (VO_2max) is a good measure of individual's cardiorespiratory fitness (Maud and Foster, 1995), Malina, 2001&Froek, (2013) unfortunately the most accurate method to determine an individual's VO_2max is to use a direct method test in a laboratory setting with a cycle ergo meter or treadmill. The inspired and expired air is collected and analysed to determine oxygen consumption. Thus, physiologist considered direct measure of VO_2max or peak VO_2 to be the valid measurement of functional capacity of cardiorespiratory function (Baumgartner *et al.* 2007 &Heyward 2014). However, this measurement requires expensive equipment, expert personnel and it is vigorous and time consuming, which cannot accommodate a large population. This makes this measuring technique not practicable in many schools and colleges. Attempts have been made to devise reliable and valid methods of estimating VO_2max that could be administered to a large group of subjects with minimum cost.

Research findings have indicated that successful attempts have been made in the use of direct or field test to estimate individual VO_2max. The Cooper's 12- minute run test, 9 minute run test, 1 mile and 1.5 mile run-test, Harvard Step Test have been used. These field tests have provided a good substitute test that provides very high correlation with laboratory test. These findings have indicated that reliable estimate of vo_2max may be obtained from performance of Cooper's 12 minutes run/walk- test, result of this test correlate very highly (r.90) with laboratory VO_2max (Maud and Foster 1995; Jackson *et al.*, 1999; Wilmore and Costill, 2004; Heyward, 2014). This has made the Cooper(1968) 12-minute run-walk test to gain world-wide recognition. It is used to measure the extent of individual's ability to respond adequately and safely to endurance related work. It indicates the function of the heart, blood and oxygen consumption. Similarly, previous research findings (Gwani, 1986;Igbanugo and Fatokun, 1995) substantiated the administrative feasibility and suitability of the 12-minute run-walk test for young adolescent boys and girls.

Gwani (1986) reported a correlation of 0.778 between 6 minutes run-test and Cooper's 12- minute run test as a measure of cardiovascular fitness. Similarly, Tukur (1995) reported a high correlation with predicted VO_2max with running performance among college women. All relationships were significant and of similar magnitude. Consequently, 6-minute run test could be used in place of the 12 minutes' run-test, particularly among untrained persons.

For this study, the Cooper's 12 minute run-test was be used to estimate the participants' Vo_2max. To administer the Cooper's 12 minute run test, a 400 metre track was used so that the number of laps completed was easily counted. The participant run round the 400 metres track for 12 minutes and the number of laps covered in 12 minutes was multiplied by 400 metres and changed to kilometres and recorded for each participant. However, endurance performance may be influenced by the factors such as motivation, percent body fat, running efficiency, pacing ability and lactate threshold (Heyward, 2014). Some other factors include nervousness, tension and other emotional manifestation (Johnson & Nelson, 1979). Similarly, temperature, time of the day, exercise, changes in body position, altitude, humidity, digestion current state of health and air pollution may also influenced performance (Wilmore & Costill 2004; Powers & Howley, 2012). These variables are difficult to control and may influence the VO_2max measurement.

2.5Body composition

Body composition is a key component of the individual health and physical fitness profile. Williams (2007); Wildman and Miller (2004) and Nieman (1998)defined body composition as the ratio of fat mass to fat – free mass or weight and is often expressed as percent body fat; that is, the percentage of the total body that is composed of fat. Fat-free mass refers to all body tissue that is not fat, the body tissue that is not fat include; bone, muscle, organ and connective tissue.

Early studies that investigated fat cell and fat mass development suggested that the number of fat cells become fixed early in life. This led many scientists to believe that maintaining a low body fat content during the early period of development would minimize the total number of fat cells that develop greatly reducing the likelihood of obesity as an adult. However, evidences that are more recent suggest that the number of fat cells continue to increase throughout life. The most recent evidence suggested that as fat is added to the body, existing cells continue to fill with fat to a certain critical volume. Once these cells are filled to this point new fat cells are formed (Wilmore & Costill, 2004). In the light of this evidence, it is important to maintain good dietary and exercise habit throughout life to avoid obesity. Nieman (1998), Jackson *et al.* (1999); Wilmore and Costill (2004) and Heyward (2014) defined obesity as the excessive accumulation of body fat that is too much fat in the body. Body fat is stored around the main organs of the body and within the muscles, but half is stored in layers just beneath the skin, making over fatness visible.

According to McArdle, Katch and Katch (2010), the total amount of body fat exists in two depots or storage fat sites. The first storage site, termed essential fat, is the fat stored in the bone marrow as well in the heart, lungs, liver, spleen, kidney, intestine, muscles and lipid rich tissues throughout the central nervous system. This fat is required for normal physiologic functioning. In females, essential fat also include sex – specific fat or sex characteristic fat. The other fat depot, the storage fat consists of fat that accumulates in adipose cells or tissues. This nutritional reserve includes the fatty tissues that protect the various internal organs from trauma, as well as the larger subcutaneous fat volume deposited beneath the skin surface. The accumulation of fat in children is influence by "modifiable" factors such as those associated with socio – economic status such as diet, body fatness, overeating, physical activity, environmental and social factors as well as "non – modifiable" factors such as hormones level, growth and maturation or age,genetics and gender and psychological factors (Haruna, 1994; Goran 1999; Jackson *et al.*; 1999; Malina; Slawomir & Tadeuz 1999; Wilmore & Costill 2004 &McArdle *et al.*; 2010).

Excess fat in the body has a negative effect on health and physical performance. Wilmore and Costill (2004) observed that excess fatness contribute to low performance in most physical and sporting activities. Performances tend to decrease as fat increases, and reducing surplus of fat, result to increase in strength. The result clearly indicates that degree of fastness had a great influence on the performance of four fatness and athletics ability test. Other studies (Wildman & miller 2004& Nieman, 1998) have clearly shown that fatness is associated with poor performance on test of fitness component and is a major risk factor of cardiovascular diseases.

Measurement of percent body fat is important since obesity is a known health problem. The accumulation of excess body fat is of concern for long-term health consequences (Betty, Maritza & Maura, 2002). Several studies (Devries 1980; Nieman 1998; Goran1999; Wildman & Miller, 2004) have reported that excess body fat can substantially raise the risks of developing a number of disease conditions including high BP, stroke, cancer, renal and digestive disease, cirrhosis of the liver, degenerative joint disease, high mortality and morbidity rate and reduced life expectancy (Maud & Foster, 1995; Gwani, 1996; Nieman, 1998; Goran, 1999; Jackson *et al*., 1999; Willett, Dietz & Colditz 1999; Anu, Jacob, Susana, Jaako & Kari; 2000; Shifan, Darwin, Grunbaun & William 2002; June, Jianwen, Kelly & Raina 2002; Wildman & Miller, 2004; Heyward 2014). Preh (2002) stated that adults with more of central (more fat on the abdomen) fat distribution have a greater risk of developing cardiovascular disease and non-insulin dependent diabetes. This agrees with the findings of Nieman (1998), and Jackson *et al.*;(1999),had stated that obese people are most vulnerable to disease. Therefore, excessive body fatness has been implicated as risk factor in a number of instances.

In many instances, a change in body weight is a simple increase in body fatness. However, this is accepted only when the change is measured over a period of time and only if there has not been any case of illness. For example, dehydration or changes in muscles mass as a result of training or detraining programme. Physically active people possess less total body fat than the less active people. Differences in performance do exist between males and females. This according to Wilmore and Costil (2004) can be due to greater percentage of fat contained in the female body. Heyward (2014) explained that healthy adult body fat percentages fall under 15 percent for male and 23 percent for females, although large quantities of body fats are undesirable for good health and fitness. Optimum level varies from person to person and is greatly influenced by a variety of genetics factors (McArdle *et al*.,2010).

Studies suggesting the relationship between physical activity and percent body fat or skin fold thickness and body weight are numerous. Kaidal (1989), Haruna (1994); Jackson *et al,* (1999); McArdle *et al.* (2010),and Heyward (2014)reported findings in which percent body fats were found to decrease significantly with various training programs of various intensities. However, in a contrasting report Malina (2001) found no difference in four skin fold between active and inactive boys aged 13 - 18 years. In a related study, Shifan et al; (2002) in a longitudinal analysis of changes in indices of obesity from age 8 – 18 years, they measure six skin fold sites and observed that mean percent body fat decreased with age in males, increased with age in females and was constantly greaterfemales than males. The sex differences widen with age. Bedogni, Iugietti, Ferrari, Malvotti, Pol, Bernasconi and Battistini (2003) also found that age, weight, height and body mass index of children were similar in males and females. However, four skin fold (SKF) weight was higher and fat free mass (FFM) lower in females than males. They suggested that the use of four skin fold may increase the sensitivity of a screening procedure for excess adiposity in children. Malina (2001) also reported an increase of body fatness as age increases.

2.5.1Effects of continuous aerobic training on percent body fat

Regular exercise, in addition to increasing energy expenditure and creating a negative energy balance for weight loss, ensures that weight loss is caused by loss of fat than loss of muscle tissue. Research evidence (Venkateswarlu, (2011) supports the view that exercise in a weight loss program maintains Fat Free Mass (FFM). In other words, a significant portion of weight loss due to dietary control in weight loss program maintains FFM, enhances fat utilization for energy liberation and reduces fat stores. This reduction in fat stores, according to Venkateswarlu (2011), was due to increased levels of growth hormones (adrenaline and nor-adrenaline) due to exercise. These hormones stimulate the mobilisation of fat from the storage depots and activate the enzyme lipase to break-down triglycerides into free fatty acids. Free fatty acids are then metabolised and, thus, serve as an important source of energy, especially during prolonged aerobic exercise. On the other hand, heavy resistance exercise such as lifting weights, stimulate the secretion of anabolic hormones like testosterone and growth hormone. These hormones increase protein synthesis, muscle growth and fat free mass. Abdoli, Neda, Ardeshir and

Yaser(2012) observed decrease in body weight, %BF and BMI ($P<0.05$) after 70min aerobic 3 trainingsession, 3 days/week for 12 weeks.

2.5.2Effects of low, moderate and high intensity training on percentbody fat

Researchers have reported the effects of PA on the percent of body fat. Gutin *et al.* (2005), in their studies on moderate and vigorous PA on fitness and fatness in adolescents, found that lower percent body fat was associated with higher amount of vigorous PA but not with moderate PA. Ruiz *et al.* (2006) also reported that lower body fat was significantly associated with higher levels of vigorous PA. They observed that those children who engaged in □ 40 minutes vigorous PA/day had lower body fat than those who engaged in 10 – 18 minutes vigorous PA. They concluded that PA of higher intensity may have greater effect on preventing obesity in children than does PA of lower intensity.

Trembblay, Simoneau,& Bouchard (1994) in similar studies reported reduction in body fat after 15 weeks of training between high-intensity interval and endurance training group, high intensity training group lost over 3 times as much subcutaneous fats as the endurance training group despite depending on less than half as many calories. High intensity training group lost more fat than the endurance training group. This report was also supported by Joseph, Trisha, Elise, Eric and Curt (2011), in their study of the effects of exercise intensity on percent body fat, concluded that intensity of the exercise bout influences the percent body fat reduction. They observed significant differences between exercise intensities, where higher intensities produced greater reduction of percent body fat than lower intensities. Irving, Devies, Brock, Wetman, Swiff, Barrett, Graesser and Weltman (2008, reported a similar result which showed that high intensity exercise training significantly reduced total abdominal fat (P □ 0.001), abdominal subcutaneous fat ($P < 0.01$) and no significant changes observed in any of these parameters in the control group or low intensity exercise training. This indicates that changes are affected by intensity of exercise with high intensity exercise training being more effective for reducing total abdominal fat, subcutaneous fat, abdominal fat and visceral fat in obese women with metabolic syndrome. However, Joseph*et al.* (2011) reported a different result after 3 weeks of exercise, where fat mass decreased significantly (P □ 0.005) in all the groups. It was concluded that low intensity 40% of (VO_2max) of physical activity favours fat oxidation.It was recommended that obese adolescents should perform low-intensity physical activity than intense exercise.Lazzer, Lafortuna, Bustic, Galli, Agosti and Sartrio (2011) also reported that 3 weeks exercise training program at 40% and 70% VO_2max, body mass and fat mass decrease significantly ($P<0.05$) in all the groups, but significantly greater in low intensity (40% VO_2max)

Ho, Dhaliwal, Hills and Pal (2012) reported improvement in reduction in %BF (-2.6%, $P < 0.05$) after 12weeks of moderate intensity training for 30minutes, 5 days/week. Abdolali*et al.*(2012) also obtained similar result ($P<0.05$) after 12weeks of aerobic training, and concluded that aerobic training is effective for producing significant benefits on body composition. Manna *et al*. (2012), after 12 weeks of aerobic and anaerobic skill training of Indian male volleyball players less than 19 years, observed significant decrease in body fat. Abass and Moses (2013) also obtained a similar result in their study on aerobic and progressive resistance exercise effects on body composition of primary school children in Ibadan, Nigeria, where they observed enhanced improvement in percent body fat and BMI. They concluded that for effective achievement of idealbody composition, aerobic exercise should be mostly considered in training modes of primary schools in Nigeria.

In a related study, Godara and Bishnoi (2013) found significant changes in percent body fat after 6 weeks of endurance training for one hour, 3 days a week. It was concluded that aerobic training induces changes in percentage body and lipid profiles of children. Willis, Slenz, Bateman, Shied, Piner, Bales, Houmard and Kraus, (2012); andRegaieg, Charfi, Kamoun, Ghroubi, Rebai, Elleuch, Feki, and Abid (2013)reported that aerobic training reduces more total fat mass than resistance training. They concluded that aerobic training is the optimal mode of exercise for reducing fatness, fat free mass and body mass. Similar result was also obtained by Narayani and Sudhan (2010), who observed significant changes in percent body fat and concluded that aerobic training induces changes in the lipid profilesand percent body fat of women. Ramin, Shirin, Maryam, Akrame (2012) reported that high intensity aerobic training at (85-95% HR peak) did not significantly decreased %BF, but moderate intensity aerobic continuous training at (50-70% HR peak) significantly decreased %BF after 8-weeks of training. They concluded that moderate intensity aerobic continuous training causes further changes in body composition compared to high intensity aerobic training. This was also supported by Keating, Machan, O'conor, Gerofi, Sainsbury, Caterson, and Johnson (2014) and Dorota, Robert, Zbigniew, Aleksandra, Marta, Izabela, Lukasz, Agata, Ficek and Pawel 2015). However, Gutin, Barbeau, Owens, Lemon, Bauman, Allison, Kang and Litaker (2002) had earlier found that high intensity training was more effective than moderate training in enhancing body composition and showed favourable changes in cardiovascular fitness (P

< 0.01) %BF (P = 0.01) visceral adiposity (P = 0.02) after 2 days / week training for 12-weeks.

Training programme has beneficial effects on body composition and aerobic capacity of the participants most of the studies have not shown the various contributions of the various intensities of training program and amount of total reduction in percent body fat. Edson, Ezequiel, Andre, Gilguerra and Olgar (2015) reported a reduction in percent body fat (mean differences -5.58% and waist circumference -2.33 cm) observed in the study post-pubertal school children. Gibala *et al.* (2012) reported that exercise training is clinically proven, cost effective primary intervention that delays, and in many cases, prevents health burden associated with many chronic diseases. However, the precise type and dose of exercise needed to accrue health benefit is a contentious issue with no clear recommendations for the prevention of inactivity related disorders.

2.6Visceral fat

The word visceral in health means in or near vital organs. These are organs deep in the gut like the stomach, intestine, heart, liver and kidneys. Visceral muscles are found in walls of the visceral organs. Fats store around these organs is known as visceral fat or abdominal fat or intra-abdominal fat and located inside the abdominal cavity and packed in several adipose depots including mesenteric, epididymal white adipose tissue and perirenal depots between the organs (stomach, liver, kidneys, heart and intestines) (Bouchard & Katzmarzyk, 2010). Visceral fat (VF) lies out of reach, deep within the abdominal cavity, where it pads the spaces between the abdominal organs. It is different from subcutaneous fat underneath the skin, and intramuscular fat interspersed in skeletal muscles. Fat in the lower body such as thigh and buttocks is referred to as subcutaneous, whereas fat in the abdomen is mostly visceral and semi fluid. An excess of visceral fat is known as central obesity, or ‘belly fat’ in which the abdomen protrudes excessively, which is thought to be closely linked to increased level of fat in the blood vessels, and may lead to condition such as high cholesterol level, cardiovascular disease and type 2 diabetes (Venkateswarlu, 2010). Visceral fat is of particular concern because it is a key player in a variety of health problems much more than subcutaneous fat. Visceral obesity itself is an independent component of metabolic syndrome and the magnitude of obesity directly relates to the prognosis of this condition (Mathieu, 2008). These health risks are called visceral adiposity; and in order to prevent or improve this condition, it is important to reduce the amount of visceral fat to an acceptable level.

Maintaining of negative caloric balance, at least for some time, through physical activity (exercise), reduce caloric intake, or both determines amount of body mass loss. That is, it is possible to gain or lose adipose or lean tissue without negative caloric balance and perhaps locally. There are differential and conflicting reports on changes in fat from different sites (for example visceral versus subcutaneous) whether induced through diet or exercise alone or in combination. Some studies support exercise induced reduction in adipose tissue depots and changes in fat distribution (Ross, Jansen, Stalknech, 2002), while other data show no exercise induced effects (Wing & Phelan, 2005). Despite the general concensus that spot reduction does not occur, there is recent evidence that exercise induced relative loss of fat is higher in visceral and abdominal subcutaneous adipose tissue than in femoral adipose tissue resulting from general exercise (Bouchard & Katzmarzyk, 2010).

2.6.1 Effects of physical exercise on visceral fat

Regular PA may prevent the appearance of risk factors for cardiovascular and metabolic diseases or modify their expression or both. Physical activity during childhood and adolescence may also influence activity habits in adulthood and adolescence may reduce the accumulation of adiposity and unhealthy weights gain and also reduce risk in adulthood. Bouchard and Katzmarzyk (2010) reported that PA may potentially lower adult risk of overweight or obesity by reducing adiposity during adolescence. Non-obese youth who regularly participate in relatively high PA tend to have less adiposity of visceral fat.

Malina, Howley, and Gutin (2007) had observed reductions in overall and visceral adiposity in studies with overweight or obese youths programs of moderate to vigorous intensity activity. In another study, Baria*et al.* (2016) reported that centre-based aerobic exercise is an effective approach to reduce visceral fat. Exercise training with or without diet reduce weight loss, seems to promote greater reduction in visceral abdominal fat relative to general body fat (Bouchard & Katmaryzyk, 2010). Slenz, Aiken, Huomard, Bales, Jonhson, Tanner, Duscha and Kraus (2005), had earlier reported that modest exercise programme, consistent with recommendations from the Centre for Disease Control/American College of Sports Medicine (CDC/ACSM), prevented significant increases in visceral fat. Importantly, a modest increases over the CDC/ACSM exercise recommendations resulted in significant decreases in visceral, subcutaneous and total abdominal fat without changes in caloric intake. Exercise training induced reductions in visceral fat have been associated with improvements in insulin sensitivity in obese subjects, however, these associations have not been consistently observed. Thus, it remains to be determined whether the specific effects of PA on insulin resistance and other cardiovascular disease risk factors are due at least in part, to selective reduction in visceral abdominal fat independent of total fat loss (Bouchard & Katmaryzyk, 2010).

Exercise training provides an economically viable non-pharmacological approach for eliciting beneficial adaptations in body composition and cardio-metabolic risk. Endurance aerobic training has been shown to be a powerful strategy for inducing abdominal fat loss, particularly with respect to abdominal visceral fat (Bouchard & Katmaryzyk, 2010)

2.6.2Effects of low, moderate and high intensity training on visceral fat

Research has shown that participation in PA training programme reduces visceral fat in the participant and may be determined by the type of exercise and intensity of the training exercise programme. Soon-Mi, Man-Gyoon, Kyung-Shin, Yae-Young, Hyoung-Jun (2011) stated that total amount of exercise regardless of type and intensity determines the amount of visceral fat reduction. Studies suggest that high intensity exercise training may induce greater fat loss including abdominal visceral fat loss, than low exercise training. Soon-Mi*et al.* (2011) reported significant reduction in total abdominal fat and subcutaneous fat in high- intensity exercise ($P< 0.05$), but not in low exercise training. They concluded that high-intensity aerobic training is an effective intervention for abdominal visceral fat reduction.

Irving *et al.* (2008) postulated that high-intensity aerobic exercise training may increase fat loss in particular adipose visceral fat, than low-intensity exercise training for several reasons. High- intensity aerobic exercise training induces secretion of lipolytic hormones, including growth hormones and adrenaline, which may facilitate greater post exercise energy expenditure and fat oxidation. It is also reported that under equivalent levels of energy expenditure, high-intensity aerobic exercise training favours a greater negative energy balance compared with low intensity aerobic exercise training. Irving *et al.*(2008) reported that high-intensity aerobic exercise training significantly reduced total adipose visceral fat and abdominal subcutaneous fat ($P <0.05$),and abdominal visceral fat ($P < 0.01$). However, no significant changes were observed in any of these parametres in low intensity aerobic exercise training and control group after 16-week aerobic exercise intervention. The result suggest that high intensity aerobic exercise training may be effective stimulus for inducing favourable changes in body composition, especially percent body fat and visceral fat. In similar studies, Hottenrott, Ludyga and Schulze (2012) reported that continuous endurance training and high- intensity lead to significant improvement of body composition and aerobic capacity, with reduction in visceral fat from 5.6±- 2.2 to 4,7 ±1.9% after 12 week intervention.

Vissers, Hens, Taeymans, Baeyens, Poortmans and Van-Gaal (2013) reported that aerobic training of moderate or high- intensity has the potential to reduce visceral adipose tissue in overweight males and females. The results suggest that an aerobic exercise programme without hypo caloric diet can show beneficial effects to reduce visceral adipose tissue (VAT) with more than $30cm^2$ in women and more than $40cm^2$ in men after 12 weeks of continuous aerobic training programme. A similar study on the effects of aerobic exercise training dose on liver fat and visceral adiposity; Keating, Hackett, Parker, O’oconnor, Gerofi, Sainsbury, Barker, Chuter, Carterson, George and Johnson (2015) reported significant reduction in high versus low intensity, in high intensity (-258.38±87.78cm (3), in low: high-intensity, low (-386,80 ±119.5 cm (3) and in low: low (-212.96±105.54cm(3). There was no significant difference between the dose or intensity of exercise regimen and reductions in liver fat or visceral adipose tissue (P>0.05). All aerobic exercise regimens employed reduced liver fat and VAT by a small amount without clinically significant weight loss.

Similarly, Gutin *et al.* (2002) showed favourable changes in visceral adipose tissue (P<0.029). However, no evidence was found that high intensity aerobic training was moreeffective than moderate intensity aerobic training on enhancing body composition. They conclude that aerobic training reduced both visceral fat and total body adiposity but there was no clear effect of the intensity of physical training. Baria *et al.*(2016) reported a reduction (P < 0.01) in visceral fat of 6.4±6.4 mm in sedentary overweight male after 12 of weeks aerobic exercise. They concluded that aerobic exercise is an effective approach to reduce visceral fat. Gan *et al.* (2003) earlier reported a reduction in VF (r=0.544, P<0.05) after 10 weeks ofmoderate intensity PA and also concluded that moderate intensity PA leads to reduction in VF.

2.6.3Measurement of percent body fat / visceral fat

It is of paramount importance to determine the percent of body fat and visceral fat of the individual by identifying cases of obesity, or underweight, which can be a disadvantage to the students' fitness performance. Research to establish ways of determining percent body fat began during the 1940s (Heyward, 2014). Since then, several methods have been used in the laboratory to estimate body density, which is necessary for calculating percent body fat. These methods include densitometry, radiography, hydrometric (hydrostatic under water weighing), total body electrical conductivity and ultra-sound.

These methods are expensive, complex, time- consuming and require expertise, although they are available for estimating body density and percent body fat, which include skin folds, bioelectrical impedance analysis and body mass index (Heyward, 2014). The Bioelectric impedance analysis may be the most popular method used in health clubs today to measure percent body fat and visceral fat of their clients.

According to the ACSM, (2011) bioelectric impedance analysis (BIA) works by passing a low-intensity electric current through the body and measuring its resistance. The faster the current travels from one lead to another, the more muscle and less fat the person has. According to the ACSM prior to the test people should not eat or drink at least 30 minutes, exercise for at least 12 hours, drink alcohol for at least 48 hours, or ingest any diuretics (including caffeine), urinate 30 minutes before the test in order to generate the truest estimate. Fernandes, Rose, Buonani, Oliveira and Freitas (2007) reported that BIA achieves good performance in identifying excess visceral fat associated with overweight / obesity in both genders and was found to be more specific (male 92.4% and female 93.8%). The Department of Kinesiology and Health at Georgia State University, USA notes that the accuracy of BIA can be$\pm$3% from the “real” body fat (Cannon, 2011).

2.7Continuous Training

Continuous training is a form of exercise that is performed at one intensity throughout and does not involve any rest periods. It typically involves aerobic activity such as jogging, swimming, biking and rowing. These activities used large muscles groups performing movement over prolonged period of time. It can be performed at low, moderate or high-intensity depending on the purpose of the training and current fitness levels of the participants.

Continuous training method has been followed in all the sporting activities for a very long time. Continuous training is when low – to – mild intensity exercises are performed for more than 20 minutes without resting intervals or performed without interruption over a prolonged period of time at a relatively low speed (Venkateswarlu, 1982; Kenny, Wilmore & Costill 2012; Heyward, 2014). Continuous training allows the body to work from its aerobic energy stores to improve overall fitness and endurance. Thebenefits of continuous training include fat burning, muscle building and increasing aerobic potentials by improving respiratory and cardiovascular system, it is also great for building to cardiovascular endurance and improving the heart and lungs function to be able to cope with everyday tasks much easier without getting out of breath, it also help to lose weight when perform at relatively easy intensity, also therapeutic and stress relieving (Wade, 2013; Heyward, 2014). However, the main goal behind continuity training is to condition the heart for long periods of exertion.

Fitness benefits of continuous training: One of the greatest fitness benefits of continuous exercise plan is the slow but steady improvement overtime. A person may jog for 8 minutes at a start, may find after enough weeks or months have passed that 12 minutes is achievable. Before long, 20 or 30 minutes may become normal, usually at least three or four workouts per week are required to see improvement (Edwin, 1978&Heyward, 2014).

Health benefits of continuous training: In addition to helping athletes build up their endurance, continuous training helps people to lose weight and improve their cardiovascular strength. Contrary to some opinions, losing weight does not always require intense burst of energy. Regular low-intensity workouts that are long enough to count as continuous training usually lead to sustained weight loss after several months.Mackenzie (2000) and Wade (2013) and Heyward (2014) agreed that people who participate in continuous exercise typically have a lower resting heart rate, which can lead to a reduced risk of heart disease and cardiac, stoke. As the body becomes more efficient at processing and distributing oxygen during work-outs, the respiratory organs are strengthened as well. Mckenze, (2011) further reports that endurance training induces large and significant adaptation within the cardiovascular, musculoskeletal and haemotological system. They further agreed that continuous training is one of the safest forms of exercises, because the body is not working at full intensity, and the average duration is not long. The training may take the form of long slow work-outs or long fast work-outs. The pace can be even or perhaps preferably with moderate variation- faster and slower (Venkateswarlu, 1982; Heyward, 2014).

2.7.1Types of continuous training

Continuous slow work-outs: - This form of continuous training involves slow work-outs performed continuously over a prolong period of time at a slow pace. The pace may not be the same for all individuals. It should always be fast enough to elevate the heart rate to 150 beats per minute (Wilt, 1998). The distance or duration covered should be related to the athlete’s specific event. It should be between two to five times the duration and distance of the competition event (Venkateswarlu, 1982).

Continuous fast work-outs: - This form of continuous training differs from slow work-outs in that the pace is faster and less distance is covered. A 6 miler, for example, may run 8-10 miles at a steady, but fast pace (Powers and Howley, 2012).

Components of training or consideration for training: According to Prentice, (2006); Kenny, Wilmore and Costill, (2012), continuous training involves four considerations:Mode or type of activity, frequency of the activity, duration of the activity and intensity of the activity

The ACSM (2010) also stated that exercise prescription is based upon the frequency, intensity and duration of training, the mode of activity (aerobic in nature) and the initial level of fitness. Within this framework, the total volume of training becomes an important reference for improving fitness. In evaluating these factors, the following observations have been derived from studies conducted for up to 6-12 months with endurance training programme. Improvement in cardiorespiratory fitness and body composition is directly related to frequency, intensity and duration of training. Lower doses of exercise may improve VO_2max and metabolic fitness, and control or maintain body composition but at slow rate. However, long-term exercise training studies that compare various training models (volume, frequency, intensity) are few in number or not available especially when considering the metabolic fitness. Frequency refers to how often exercise is done per week.

The ACSM (2011) recommends a frequency of training of 3-5 days a week, and is required to influence changes in a person's body. Intensity of training refers to how hard one exercise. The ACSM (2011) also recommends intensity of training 55/65 – 90% of maximum heart rate (HRmax), or 40/50 – 85% of maximum oxygen uptake Reserve (VO_2R) or HRmax reserve are most applicable to individuals who are quite unfit, to influence changes in the individual's physiological and body composition components. Duration, refer to how long (weeks, months) or duration of a single exercise bout (minute/hour). The ACSM (2011), recommends duration of 20-60 minutes of continuous or intermittent (minimum of 10 minutes bouts accumulated throughout the day) aerobic activity is required to bring the changes in physiological and body composition components. Duration is dependent on the intensity of the activity (Wilmore and Costill, 2004; ACSM, 2011), thus lower intensity activity should be conducted over a longer period of time (30 minutes or more) and conversely, individual training at higher level of intensity should train at least 20 minutes or longer. Due to the importance of total fitness that is more readily attained with exercise sessions of longer duration, and because of the potential hazards and adherence problems associated with high- intensity activity, it is recommended for adults not training for athletics competition.

2.8Summary

Exercise prescription is based upon the frequency, intensity and duration of training, the mode of activity and the initial level of fitness. However, the intensity levels of exercise appear to be most important factor and determinant of the physiological responses to training. Typically, intensity level is described as low, moderate and vigorous (high). In evaluating these factors, independent contribution of these intensity levels of training have remain unclear.

Investigations already conducted have shown that aerobic exercise training of continuous natured, positively altered resting blood pressure, resting heart rate, VO_2max, percentage of body fat and visceral fat. Regular aerobic exercise training can lower and relax blood vessels, causing post-exercise decrease in resting blood pressure of people with normal resting systolic and diastolic blood pressure by average of 4mmhg-3mmhg respectively. This has been reported to delay the development of hypertension. Depending on the quality and quantity of training, improvement in VO_2max ranges from 10%-30% and a minimum increase in VO_2max 10-15% are generally attended in regular exercise training program and are usually associated with large losses of total body mass, reduction in resting heart rate. Participation at lower intensity and longer duration, compared with higher intensity of shorter duration of same energy cost had shown similar improvement. Training frequency of 3-5 days a week at intensity of 55% or 65%-90% of maximum heart rate and duration of 20-60 minutes of continuous training of aerobics activity for 6 weeks and above has shown positive influence on the cardiorespiratory and body composition of the participant.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1Introduction

The purpose of this study was to compare the effects of low, moderate and high- intensity levels of continuous training on physiological and body composition variables of male adolescent students in Kaduna metropolis. The research design, population, sample and sampling technique, procedures for the assessment of physiological and body composition variables, trainingprocedures, experimental control and statistical techniques were described in this chapter.

3.2Research design

A 1 x 2 x 3factorial experimental research design was used to achieve the purpose of the study.

Experimental design and grouping

Training Programme	Control group	Intensity levels		
Continuous Training	No training N = 20	Low N = 20	Moderate N=20	High N=20

Based on this design,one (1) training programme of(continuous training), two (2) experimental groups of(control group and experimental group)andthe three (3) intensity levels of low-intensity, moderate-intensity and high- intensity was used. Participants were placed in the control group and continuous training intensity levels of low, moderate and high-intensity.

The control group and base-line measures served as controls while the 3rd, 6th and 9th week measures of MAP, RHR, VO_2max, %BF and VF serve as the experimental manipulations.

3.3Population

The population for this study comprised of 287 male adolescent students in Imperial School Kaduna between the ages of 15 and17years as at September 2016. This record was obtained from personal files of the students in the Vice- Principal, (Administration) Office of the school.

3.4Sample and sampling techniques

A purposive sampling of weight and height ofNigerian male adolescent students of Imperial School was carried out. Students, whose BMI were between 25.0 $kg/m^2$and 29.9kg/m^2 and were within the ages of 15 to 17 years were identified, and 102 students made the inclusion criterion. After they were briefed regarding the purpose of the research and the type of training protocols, benefits and discomfort 80 students volunteered to participate and were used as a sample. The students were further grouped into three strata of ages accordingly: students 15 years (28) 16 years (28) and 17 years (28).

The simple random sampling technique was used to assign the participants into control group and training groups of low, moderate and high- intensity training groups. There were three boxes for ages 15, 16 and 17 years, respectively. Box 1 for ages 15 years with folded papers for control group (CG), low intensity (LI), moderate intensity (MI) and high intensity (HI) groups, box 2 for ages 16 years with folded papers for CG, LI, MI and HI groups, and box 3 for ages 17 years with folded papers for CG, LI,MI and HI groups.

The participants were grouped according to their ages to pick the folded paper and return to the intensity level of their proposed training intensity.

3.5 Experimental control

3.5.1Monitoring of training intensity

All participants for this study underwent continuous training programme on three alternate days for 9 weeks. The intensity of training wasmonitored using the Borg (1998) perceived rate of exertion (RPE) scale, shown below;

Ratings of intensity of training (Borg, 1998)

Rating	**Intensity**
6	No exertion at all
7 - 8	Extremely low
9 - 10	Very low
11 -12	Low
13 - 14	Moderate
15 - 16	High
17 - 18	Very high/hard
19	Extremely high/ hard
20	Maximal

3.5.2 Informed consent

All participants filled an informed consent form. Participants involved in this study were adequately briefed on the procedures of the experiment, the likely benefits to be derived from participation, the discomfort to be experienced, and the precaution to be taken to ensure a hitch free participation in the training programme, Thereafter, they filled and signed the informed consent form.

3.5.3Research assistants

The researcherpersonally administered and supervised the training programme from the beginning to the end. Four research assistants, consisting of one nurse and three Physical Education teachers were recruited and briefed about the experiment before the commencement of data collection. The Nurse assisted the researcher in taking blood pressure and resting heart rate of the participants. The three Physical Education teachersassistedthe researcher in measuring heights and weights and assessing participants in the 12- minutes run/walk test to ascertain the number of laps covered by each participant.

The researchercommenced the training of the participants after all base-line data had been collected.

3.6Research instrument

The following instruments were used for collecting data for this study:

A. Omron HBF 516B Full Body Sensor Body Composition Monitor - scale- 7, made in China (Fernandes, Rose, Buonani, Oliveira & Freitas, 2007).
B. Electronic sphygmomanometre (Automatic arm cuff Blood Pressure and Heart Rate Monitor, Omron CEO 197, Florida, USA)
C. Whistle. Used to start and stop participants in 12 minutes run-walk test
D. Digital stop-watch (Casio) was used. To time participant in 12 minutes run-walk test
E. Standard 400- metre track.
F. Wall marked in metres and centimetres.

G. Measuring tape: Field tape/ruler of non- elastic horse brand, model S1542, China made

3.7Sequence of Assessment

3.7.1 Physical characteristics of subjects

Subjects' physical characteristics (height and weight) were determined in accordance with the protocol of International Working Group on Anthropometry as described by Ross & Marfell-Jones (1982). Specifically, measurements included standing height and weight.

Height: Subjects' height was measured, while standing erect looking straight ahead and bare-footed against the standiometre. Horizontal broad blade wooden ruler was rested on the head of each participant against the instrument to measure height the nearest 0.1cm.

Weight: subjects' weight, were measured using Omron HBF516B. The weight was recorded to the nearest 0.5kg.

3.7.2Blood pressure and mean arterial blood pressure measurements

The blood pressure of the participants was assessed between 7.00a.m and 7.30am using an automatic electronic BP monitor, Omron CEO 197, Florida, USA. Participants were asked to remove all restrictive clothing and sit in a relax manner for five minutes in the school clinic. Each subject placed his feet on the floor and palm upside in front on a flat surface table. The middle of the cuff was placed at the same level of the right atrium of the heart. The cuff covers at least two third of the upper arm with the lower boarder 1- 2 centimetre above elbow joint. After applying the cuff and the body is in a comfortable position, the “START” button was pressed. A beep sound is heard and all display characteristics were shown. If the monitor has stored results, the LCD momentarily displays the most recent ones. If no result has been stored, zero appears on LCD. The voice function spoke and display on the screen measurement tips. Then the monitor inflates the cuff until sufficient pressure was built up for measurement. Then the monitor automaticallyslowly released air from the cuff and carries out the measurement. Finally, the BP and RHR were calculated and displayed on the LCD screen. The voice function announced the measured results and the result automatically stored in the monitor. The researcher recorded the results each participant.

To determine the mean arterial blood pressure (MAP)which represents the average pressure exerted by the blood as it travels through the arteries, was estimated from diastolic blood pressure (DBP) and systolic blood pressure (SBP) as recommended by (Kenny, Wilmore & Costill, 2012; Power & Howley, 2012). MAP = DBP + [0.333 x (SBP – DBP)].

For example,if DBP = 80mmHg, SBP = 120 mmHg; then MAP = 80 + [0.0333 X (120 – 80)] = 93mmHg.

3.7.3Resting Heart Rate

The resting heart rate (RHR) was recorded as captured during the process of evaluating SBP and DBP.

3.7.4 Body Composition Measurement

The purpose of this measurement was to estimate the percentage body fat and visceral fat level of each participant. The Bioelectrical Impendence Analysis (BIA) method was used (Omron HBF 516B) which was easier to apply, low operational cost and provided valid and reliable data. Bioelectrical impendence achieved reliable performance in identifying excess %BF and visceral fat (VF) in both genders(Fernandes, Rose, Buonani, Oliveira & Freitas, 2007), BIA device measured the resistance of body tissues to the flow of a small electrical signal as indicator of general body fat percent.

Procedure:

For accurate measurement, each participant was not in contact with any other non-conducting surface and measurement was not conducted after exercising, drinking large amount of water or bathing.

To start the measurement:

1. Pressed the power switch to turn the monitor 'ON'. The 'CAL' Symbol blinked on the display unit then 0.0 "kg" was displayed.
2. When the 00"kg" appeared on the display, the participant lifted the display unit out of the display unit holder, and placed both middle fingers along the dents of the grip electrodes, and held the inner grip electrodes firmly with thumb and index finger. He held firmly the grip electrodes and held the outer grip electrodes with his ring and small finger.
3. The researcher selected a Personal Profile Number for the participant and entered age, height and sex.
4. The participant stepped on to the measurement platform and placed his feet on the feet electrodes with his weight evenly distributed and he remained still, without movement until his weight measurement was completed.
5. When 'START" appeared on the display, the participant then extended his arms straight at a 90^0 angle to the body, and stood with knees and back straight and

lookedstraight ahead, and held the display unit in front and made sure the heels were positioned on the heels electrode and stood with weight evenly distributed on the measurement platform.

6. When the measurement was completed his weight was displayed again. Then he stepped off from the measurement platform. If there was at least one result in memory, the high reading was displayed in the “My History” area of the display. If no results in memory,”------‘’ was displayed. The display unit then showed the weight of the participants and the weight result blinked twice. Then, the monitor starts to calculate body composition variables. The indicators in the measurement progress bar at the bottom of the display gradually appeared from left to right, based on the measurement being taken.
7. To check for the measurement results, the researcher, pressedthe appropriate button for percent BF, VF and body weight. Then the result was displayed on the display screen and the researcher recorded each against the participant number on the record sheet.
8. After measurement was completed, the researcher pressed the power switch to turn the monitor ‘OFF’ and stored back the display Unit in the display unit holder.

3.7.5Cooper’s 12-Minute Run/Walk Test

The purpose: This test was designed to measure aerobic fitness and was a predictive test of a participant VO_2max (the ability of the body to use oxygen pathway to produce energy while running). A 400-metre track with marking cones was required.

Procedure: The researcher placed cones at intervals around the track to aid in measuring the completed distance (20 metresdistances intervalwas used) so that the number of laps completed by each participant was easily counted. The participant ran/walked for 12 minutes, and the total distance covered by the participant was recorded. Walking was allowed, though the participants were encouraged to push as hard as they could to maximize distance covered.

The participants were assigned identification numbers and asked to warm up for ten minutes, then they be their marks,and on the command "ready" and "GO", the researcher started the stopwatch and the participants started to run. The tester kept the participants informed of the remaining time at the end of each lap (400 m). When the 12 minutes elapsed the tester blew the whistle to mark the end of the test and each participants remained at where he is and the number of laps covered by each participant was recorded, and was converted to distance covered to the nearest 1 metre. The distance covered was converted to an estimated VO_2max using the following formula: (Powers & Howley; 2012).

Distance/Time x 0.2 + 3.5$kgm^{-1}min^{-1}$

3.8Training programme and protocol

Overweight adolescent senior secondary school students between the ages 15 and 17 years wereselected for the study and were randomly assigned to control group and three different intensity levels of continuous jogging training programme (low, moderate and high intensity) groups, respectively. All participants filled and submitted the informed consent form to participate in the study.

For easy identification of the participants, the following numbering patterns were used.

CG – for control group - CG1, CG2, CG3 CG4, CG5……

LI – for low intensity group – LI_1, LI_2, LI_3, LI_4, LI_5..........

MI – for moderate Intensity group – $MI_{1,}$ MI_2 MI_3, MI_4, M I_5.......

HI – for high intensity group – $HI_{1,}$ HI_2, HI_3, HI_4, HI_5.......

3.8.1Continuous jogging training programme

Table 3.1: Intensity and duration of continuous training:

Weeks	Mode of Training	N	Duration and Frequency	Intensity of % HRmax			Rate of Perceived Exertion		
1-3	Jogging	60	30 minutes 3d/wk	Low	Moderate	High	Low	Moderate	High
				40-45	50-55	60-65	7-8	11-12	13-14
4-6				45-50	55-60	65-70	9-10	12-13	14-15
7-9				50-55	60-65	70-75	11-12	13-14	15-16

Participants in low intensity group had three days training session per week (Mondays,Wednesdays and Thursdays).Training commences at RPE of 7-8 (extremely low) at intensity of 40-45% HRmax of each participant. All participants warmed up for 5 minutes and jogged continuously for 30minutes. This was followed with 5-minutes stretching and cool down activities. This training lasted for 3weeks. At the beginning of the 4th week (4-6 week), training intensity was monitored at RPE 9-10 (very low), corresponding with 45-50% HRmax of each participant. During this phase, all participants warmed up for 5 minutes and jogged continuously for 30 minutes, followed with 5 minutes stretching and cool down activities. They trained for 3 weeks. At the beginning of the 7th week (7-9 week), RPE 11-12 (low) was monitored corresponding to

50-55% HRmax. The participants warmed up and jogged 5 minutes and 30 minutes, respectively with cool-down and stretching activities for 5minutes.

Participants in moderate intensity grouphad three day training session per week (Tuesdays, Thursdays and Saturdays). Training commenced at RPE of 11-12 at intensity of 50-55% HRmax of each participant. All participants warmed up for 5 minutes and jogged continuously for 30 minutes. This was followed with 5-minutes stretching and cool-down activities. This training lasted for 3weeks. At the beginning of the 4th week (4-6 week), training intensity was monitored at RPE 12-13corresponding with55-60% HRmax of each participant. During this phase, all participants warmedup for 5 minutes and jogged continuously for 30 minutes. This was followed with 5-minutes stretching and cool-down activities. Participants trained for 3 weeks. At the beginning of the 7thweek (7-9 week), RPE 13-14 (moderate) was monitored, corresponding to60-65% HRmax. The participants warmed up and jogged for 5 minutes and 30 minutes, respectively, with cool-down and stretching activities for 5 minutes.

Participants in high-intensity grouptrained for three days a week on Mondays, Wednesdays and Fridays. Training commenced at RPE of 13-14at intensity of60-65% HRmax of each participant. All participants warmed up for 5 minutes and joggedcontinuously for 30 minutes. This was followed with 5-minutes stretching and cool-down activities. This training lasted for 3weeks. At the beginning of the 4th week (4-6 week), training intensity was monitored at RPE 14-15 corresponding with 65-70% HRmax of each participant. During this phase, all participants warmed up for 5 minutes and jogged continuously for 30 minutes. This was followed with 5 minutes of stretching and cool-down activities. They trained for 3 weeks. At the beginning of the 7th week(7-9 week)RPE 15-16(high) was monitored corresponding to70-75% HRmax. The participants warmed up and jogged for 5 minutes and 30 minutes, respectively with cool-down and stretching activities for 5 minutes. The researcher and research assistants were engaged in week days training sessions for 9 weeks.

The training schedule used isshown in the Table 3 below

Table 3.2: Training schedule for participants

Period	Aerobic activities			Total Duration	Intensity (HRmax %)			RPE		
	Warm-up	jogging	Cool down		low	moderate	high	low	moderate	high
1-3wks	5min	30min	5min	40min	40-45	50-55	60-65	7-8	11-12	13-14
4-6wks	5min	30min	5min	40min	45-50	55-60	65-70	9-10	12-13	14-15
7-9wks	5min	30min	5min	40min	50-55	60-65	70-75	11-12	13-14	15-16

Training was conducted three (3) times per week on alternate days for nine (9) weeks.

3.9Procedures for data analysis (Statistical Techniques)

The data collected were subjected to computer analysis using the SPSS (Version 20.2 BM) statistical package.

Descriptive statistics: This is to know the central tendency and variability ofthe data collected (means, standard deviation, standard, error of the mean, percentages) and was computed to know the effect of training after 3rd, 6th and 9th week of training.

Mean changes achieved after 3rd, 6th and 9th week of aerobic training was computed as training effects of 9 weeks of continuous training of low, moderate and high intensities on MAP, RHR, VO_2max, %body fat and visceral fat of adolescent students.Repeated-measures analysis of variance (ANOVA II) was used to determine significant effects of low, moderate and high intensity of continuous training on the selected variables on the basis of their group at (alpha 0.05).

Post-hocScheffe's test was used to determine where significant difference occurred between the intensity levels after 3rd, 6th and 9th week of training and the phase of training that was responsible for the difference.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1Introduction

The purpose of this study was to compare the effects of low, moderate and high intensity of continuous jogging on MAP, VO_2max, RHR, percentbody fat and VF of overweight male adolescents in Kaduna metropolis. A sample of 84 participants volunteered to participate in the study. During the period of the training programme, four (4) participants did not meet the required attendance of the training sessions for 9 weeks and were dropped from the study. Therefore, eighty (80) participants met the required attendance and the data were analysed in respect of the 80 and the result is presented and discussed in this chapter.

4.2Results

The data collected for this study at baseline, after 3^{rd}, 6^{th} and 9^{th} week of training were analysed using the Statistical Package of Social Science (SPSS), version 20.2 BMusing Repeated Measures Analysis of Variance (ANOVAII),and Post-hoc Scheffe's test.

4.2.1Physical Characteristics of the Participants

Table 4.1Base-line physical characteristics of the participants by level of intensity of training

Variables	Low intensity			Moderate intensity			High intensity			Control group		
	$\bar{X}$	SD	SE	$\bar{X}$	SD	SE	$\bar{X}$	SD	SE	$\bar{X}$	SD	SE
Age	16	.83	.18	16	.83	.18	16	.83	.1846	16	.86	.18
Height (m)	1.56	.08	.02	1.55	.07	.01	1.55	.06	.0132	1.56	.06	.01
Weight (kg)	61.10	5.49	1.23	61.10	5.40	1.21	61.18	5.59	1.25	61.63	4.69	1.05
BMI	25.7	0.64	0.14	25.4	0.46	0.10	25.9	0.85	0.19	25.7	0.82	0.18

Table 4.1 shows the base-line mean; standard deviation (SD) and standard error (SE) of the physical characteristics of age (years), height (m), weight (kg) and BMI (kg/m^2) of the participants. The low-intensity group, had mean scores of16±.83, 1.56±08, 61.10±5.49 and 25.7±0.64, for age, height, weight and BMI, respectively, The moderate-intensity group, had mean scores of16±.83, 1.55±07, 61.10±5.40 and 25.4±0.46,for age, height, weight and BMI, respectively, while high-intensity group, had mean scores of 16±.83, 1.55±06, 61.18±5.59 and 25.9±0.85,for age, height, weight and BMI, respectively. The control group had mean sores of 16±83, 1.56 ±056, 61.63±4.69 and 25.7± 0.82for age, height, weight and BMI, respectively.

Table 4.2:Post-test physical characteristics of participantsby level of intensity of training after 9th week of training

Variables	Low intensity			Moderate intensity			High intensity			Control group		
	$\bar{X}$	SD	SE	$\bar{X}$	SD	SE	$\bar{X}$	SD	SE	$\bar{X}$	SD	SE
Age	16	0.83	0.18	16	0.83	0.18	16	0.83	0.18	16	0.83	0.18
Height (m)	1.56	0.08	0.02	1.55	0.07	0.01	1.55	0.06	0.01	1.56	0.06	0.01
Weight (kg)	61.10	5.49	1.23	61.10	5.40	1.21	61.18	5.59	1.25	61.63	4.69	1.05
BMI	24.8	0.66	0.15	24.0	0.48	0.11	23.2	1.12	0.25	26.2	0.84	0.19

Table 4.2 shows the Post-test mean; standard deviation (SD) and standard error (SE) of the physical characteristics of age (years), height (m), weight (kg) and BMI (kg/m^2) of the participants. The low-intensity group had mean scores of16 ± 83, 1.56 ± .08, 61.10 ±5.49 and 24.8± 0.66 for age, height, weight and BMI, respectively.. Themoderate-intensity group had mean sores of16± 83, 1.55 ±07, 61.10 ±5.40 and 24.0 ±0.48 for age, height, weight and BMI, respectively. The high-intensity group had mean scores of 16±83, 1.55 ±.06, 61.18 ±5.59 and 23.2 ±1.12for age, height, weight and BMI, respectively. The control group had mean scores of 16±.86, 1.56 ±.056, 61.63 ±4.69 and 26.2 ±0.84 for age, height, weight and BMI, respectively.

4.2.2Tests of the Hypotheses

Major Hypotheses

There is no significanteffect of low, moderate and high-intensity levels of continuous jogging training on the physiological and body composition of overweight male adolescent students in Kaduna metropolis, Nigeria

In order to find out if intensity levels of continuous jogging training for 9 weeks had significant effects on the variables, the data collected were analysed according to the sub-hypotheses raised for the study.

Sub-hypothesis 1

There is no significant difference in the effects of low, moderate and high intensity levels of continuous jogging on MAP of male overweight adolescent students in Kaduna metropolis. Nigeria.

To test this hypothesis, data collected at low, moderate and high intensity at base-line after 3^{rd}, 6^{th} and 9^{th} week of training is presented in Table 4.3

Table 4.3: Descriptive statistics of means, standard deviation (SD) and standard error (SE) of mean arterial pressure (MAP) of participants at baseline, 3rd, 6th and after 9th week training.

Intensity levels	Period of Assessment	Mean	SD	SE	% Change
Low	Base-line	85.717±	4.3726	.9777	
	3rd Week	84.850±	4.2712	.9551	0.9 -1%
	6th Week	83.850±	4.2712	.9551	1.9 -2.2%
	9th Week	82.600±	4.6173	1.0325	3.1 -3.6%
Moderate	Base-line	85.365±	5.6070	1.2538	
	3rd Week	83.981±	5.7457	1.2848	1.4 -1.6%
	6th Week	81.748±	5.6853	1.2713	3.6 -4.2%
	9th Week	76.615±	4.7608	1.0645	8.8 -10.3%
High	Base-line	83.951±	4.0845	.9133	
	3rd Week	82.817±	4.2023	.9397	1.1 -1.4%
	6th Week	81.316±	4.2023	9397	2.6 -3.1%
	9th Week	78.184	4.1390	.9255	5.8 -6.9%
Control Group	Base-line	84.134±	4.4058	.9852	
	3rd Week	84.175±	4.4072	.9855	0.04 05%
	6th Week	84.958±	4.5433	1.0159	0.8 1.0%
	9th Week	86.170±	4.4703	.9996	2.0 2.4%

Table 4.3 shows the mean, SD and SE of MAP of overweight Nigerian male adolescent students at base-line, after 3rd, 6th and 9th week of training for the low intensity (LI), moderate intensity (MI) , high intensity (HI) and control group (CG) groups, An analysis of the data showed that the participants in Low intensity mean value at base-line, 3rd 6th and 9th week were 85.717 ±4.3726, 84.850 ±4.2712, 83.850 ± 4.2712 and 82.600± 4.6173mm Hg, respectively; had a total reduction of 3.1 mm Hg representing 3.6%. Moderate-intensity group had mean value of 85.365 ±5.6070, 83.981±5.7457, 81.748 ± 5.6853 and 76.615 ±4.7608 mm Hg for base-line, 3rd, 6th and 9th week, respectively, had

a total reduction of 8.8 mm Hg representing 10.3%. High- intensity group had mean values of 83.951± 4.0845, 82.817 ± 4.2023, 81.316±4.2023, 78.184± 4.1390 mm Hg for base-line, 3rd, 6th and 9th week, respectively, had a total reduction of 5.8 mm Hg representing 6.9%, after training and control group had mean value of 84.134 ±4.4058, 84.175 ±4.4072, 84.958 ±4.5433 and 86.170 ±4.4703 mm Hg at base-line and after 3rd6th and 9th week, respectively, had a total increase of 2.0 mm Hg representing 2.4%.

In order to find out whether these changes were significant, the data collected were analysed using repeated-measures analysis of variance (ANOVA), the result of which is presented in Table 4.4

Table 4.4: Repeated-measures analysis of variance (ANOVA) for differences in MAP at base-line, 3rd, 6th and after 9th week of training

Source	SS	Df	MS	F	P-value.
Corrected Model	1675.460[a]	11	152.315	6.899	0.001
Intercept	1642248.101	1	1642248.101	7.438E4	0.001
Intensity levels	282.488	2	141.244	6.397	0.01
Time of jogging	1169.025	3	389.675	17.649	0.001
Error	5033.941	228	22.079		
Total	1648957.502	240			
Corrected Total	6709.401	239			

$F(2, 228) = 6.397, P < 0.05$

Table 4.4 shows the result of repeated measures ANOVA onMAP at base-line, 3rd,6th and 9th week of continuous jogging. The result revealed significant effect of continuous jogging on MAP as a result of variation in intensity levels (P< 0.01). Therefore, the null hypothesiswas hereby rejected.

To establish which intensity level of training was responsible for the significant effects on the means in the 4 phases of data collected, post- hoc Scheffe's test was applied on the means at base-line, 3^{rd}, $6^{th}$and 9^{th} week of continuous jogging. The results are shown inTable 4.5

Table 4.5: Post-hoc Scheffe's test for Mean Arterial Pressure Measure

(I) intensity levels	(J) intensity levels	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
High	Moderate intensity	.053	.7429	.997	-1.778	1.883
	Low intensity	-2.275*	.7429	.010	-4.105	-.444
Moderate	High intensity	-.053	.7429	.997	-1.883	1.778
	Low intensity	-2.327*	.7429	.008	-4.158	-.497
Low	High intensity	2.275*	.7429	.010	.444	4.105
	Moderate intensity	2.327*	.7429	.008	.497	4.158

*. The mean difference is significant at the .05 level.

Table 4.5revealed that the significant difference observed in the means of MAP as a result of the variation in the intensity levels was due to the mean difference between high andlow and moderate and low intensity levels. However, there was no significant difference between high and moderate intensity level. This showed that moderate and high intensity levels of training had significant effect on the MAP of the participants.

Sub-hypothesis 2

There is no significant difference in the effects of low, moderate and high intensity Continuous jogging on RHR of male overweight adolescent students in Kaduna, metropolis, Nigeria.

To test this hypothesis, data collected at low, moderate and high intensity at baseline after 3^{rd}, 6^{th} and 9^{th} week of training is presented in the Table 4.6

Table 4.6:Descriptive statistics of means; standard deviation (SD) and standard error(SE)of resting heart rate(RHR) of participants at base-line, 3rd, 6th and after 9thweek of training

Intensity levels	Period of Assessment	Mean	SD	SE	% change
Low	Baseline	75.000±	3.9868	.8915	
	3rd Week	73.350±	3.6746	.8217	1.7 -2.2%
	6th Week	71.650±	3.0483	.6816	3.4 -4.5%
	9th Week	69.000±	2.4921	.5572	6.0 -8.0%
Moderate	Baseline	74.600±	4.3456	.9717	
	3rd Week	72.700±	3.7989	.8495	1.9 -2.6%
	6th Week	70.000±	3.0435	.6806	4.6 -6.2%
	9th Week	66.450±	3.4255	.7660	8.2 -10.9%
High	Baseline	73.000±	4.2920	.9597	
	3rd Week	70.600±	3.7613	.8411	2,4 -3.3%
	6th Week	67.150±	3.7613	.8411	5.9 -8.0%
	9th Week	64.100±	3.4167	.7640	8.9 -12.2%
Control Group	Baseline	72.950±	3.5611	.7963	
	3rd Week	73.050±	3.4864	.7796	0,1 0.1%
	6th Week	73.650±	3.6168	.8088	0.6 0.8%
	9th Week	75.300±	3.8539	.8618	2.3 3.0%

Table 4.6 shows the mean, SD and SE of RHR of overweight Nigerian male adolescent students at base-line, after 3rd, 6th and 9th week of training for thelow intensity (LI), moderate intensity (MI), high intensity (HI) and control (CG) groups, An observation of the datashowed that the participants in Low intensity group mean values of base-line, 3rd, 6th and 9th week were 75.000 ±3.9868, 73.350±3.6746,71.650 ±3.0483, and 69.00 ±2.4921beats/min, respectively, had a total reduction of 6.0 representing 8%.. Moderate intensity group had mean values of 74.600 ±4.3456.700 ±3.7989, 70.000 ±3.0435 and 66.450 ±3.4255beats/min for base-line and after3rd,6th and 9th week of training,

respectively had a total reduction of 8.2, representing 10.9%.. High intensity group had mean values of 73.000 ±4.2920, 70.600 ± 3.7613, 67.150 ±3.7613 and 64.100 ±3.4167 beats/min for base-line, 3rd, 6th and 9th week, respectively, had a total reduction of 8.9 representing 12.2%, after training and control group had mean of values of 72.050 ±3.5611, 72.950 ±3.4864, 73.650 ± 3.6168 and 75.300 ±3.8539 beats/min, at base-line and after 3rd, 6th and 9th week were respectively, had a total increase of 2.3 representing 3.0%.

In order to find out whether these changes were statistically significant, the data collected were analysed using repeated-measures analysis of variance (ANOVA), and the result of which is presented in Table 4.7

Table 4.7:Repeated measures analysis of variance for differences in Resting Heart Rate at base-line, 3rd, 6th and after 9th week of training

Source	SS	Df	MS	F	P-Value
Corrected Model	2245.650[a]	11	204.150	15.556	0.001
Intercept	1210692.150	1	1210692.150	9.225E4	0.001
Intensitylevels	328.675	2	164.337	12.522	0.001
Time ofjogging	1738.083	3	579.361	44.146	0.001
Error	2992.200	228	13.124		
Total	1215930.000	240			
Corrected Total	5237.850	239			

$F(2, 228) = 12.522$ $P<0.05$

Table 4.7 shows the result of repeated measures ANOVA RHR at base-line, 3rd,6thand 9th week of continuous jogging. The result revealed significant effect of continuous jogging on RHR as a result of variation in intensity levels ($P < 0.01$). Therefore, the null hypothesis was hereby rejected.

To establish which intensity level of training was responsible for the significant effects on the means in the 4 phases of data collected, post- hoc Scheffe's test was applied on the means at base-line, 3rd , 6th and 9th week of continuous jogging. The results are shown in Table 4.8

Table 4.8: Post-hoc Scheffe's test for Resting Heart Rate

(I) intensity levels	(J) intensity levels	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Moderate	-1.300	.5728	.078	-2.711	.111
	Low	-2.862*	.5728	.000	-4.274	-1.451
Moderate	High	1.300	.5728	.078	-.111	2.711
	Low	-1.563*	.5728	.026	-2.974	-.151
Low	High	2.862*	.5728	.000	1.451	4.274
	Moderate	1.563*	.5728	.026	.151	2.974

*. The mean difference is significant at the .05 level.

Table 4.8 revealed that the significant difference in the means of RHR as a result of the variations in the intensity levels was due to the means difference between high and low and moderate and low intensity levels. However, there was no significant difference between moderate and high intensity levels. This showed that moderate and high intensity levels of training had significant effect on the RHR of the participants.

Sub-hypothesis 3

There is no significant difference in the effects of low, moderate and high intensity levels of continuous jogging on VO_2max of male overweight adolescent students in Kaduna metropolis. Nigeria.

To test this hypothesis, data collected at low, moderate and high intensity at base-line after 3rd, 6th and 9th week of training is presented in Table 4.9

Table 4.9: Descriptive statistics of means, standard deviation (SD) and standard error (SE) of VO_2max of participants at base-line, 3rd,6th and after 9th week of training

Intensity levels	Period of Assessment	Mean	SD	SE	% change
Low	Base-line	35.336±	3.2082	.7174	
	3rd Week	35.817±	3.0882	.6905	0.48 1.3%
	6th Week	36.305±	3.0450	.6809	0,97 2.7%
	9th Week	42.335±	7.9030	1.7672	6.99 16.5%
Moderate	Base-line	35.478±	3.5402	.7916	
	3rd Week	36.258±	3.2710	.7314	0.78 2.2%
	6th Week	40.450±	2.8304	.6329	4.97 12.3%
	9th Week	49.521±	8.1794	1.8290	14.04 28.4%
High	Base-line	35.464±	3.3185	.7420	
	3rd Week	36.492±	3.1098	.6954	1.03 2.8%
	6th Week	42.631±	3.5198	.7954	7.17 16.8%
	6th Week	53.740±	7.2344	1.6177	18.28 34%
Control Group	Base-line	35.324±	2.5586	.5721	
	3rd Week	35.248±	2.5552	.5714	-0.76 -0.2%
	6th Week	34.683±	2.4004	.5368	-0.08 -0.2%
	9th Week	33.438±	1.5513	.3469	-3.89 -5.3%

Table 4.9 shows the mean, SD and SE of VO_2max of overweight Nigerian male adolescent students at base-line, after 3th, 6th and 9th week of training for the low intensity (LI), moderate intensity (MI) and high intensity (HI) and control (CG), groups, An observation of the data showed that participants in Low intensity group mean value atbase-line, 3rd 6th and 9th week after trainingwere35.336 ±3.2082ml.kg./min^{-1}, 35.817

±3.0882 ml.kg./min^{-1}, 35.305 ± 3.0450 ml.kg./min^{-1} and 42.335 ± 7.9030 kg/min^{-1}, respectively, had a total improvement of 6.99 ml.kg./min^{-1} representing 16.5%.. Moderate intensity group had mean value of 35.478 ± 3.5402 ml.kg./min^{-1}, 36.258 ±3.2710ml.kg./min^{-1}, 40.450± 2.8304 ml.kg./min^{-1}and 49.521± 8.1794 ml kg/min^{-1} for baseline, 3rd, 6th and 9th week, respectively. had a total improvement of 14.04 ml.kg./min^{-1} representing 28.4%. High intensity group had mean values of 35.464 ± 3.3185 ml.kg/.min^{-1}, 36.492 ± 3.1098ml.kg /min^{-1},42.631 ± 3.5198 ml.kg./min^{-1}, and 53.740± 7.2344 ml. kg/min^{-1} for base-line, 3rd, 6th and 9th week, respectively, had a total improvement of 18.28 ml.kg./min^{-1} representing 34%. after training and control group mean value at base-line, 3rd, 6th and 9th week were 35.324 ± 2.5586 ml.kg./min^{-1}, 35.248 ± 2.5552 ml.kg./min^{-1}, 34.683 ± 2.4004 ml.kg./min^{-1} and 31.438 ± 1.5513 kg/ min^{-1}, respectively, had a total decrease of 3.89 ml.kg./min^{-1} representing 5.3%.

In order to find out whether these changes were significant, the data collected were analysed using repeated-measures analysis of variance (ANOVA), and the result is presented in Table 4.10.

Table 4.10: Repeated-measures analysis of variance (ANOVA) for differences in VO_2max measure at base-line, 3rd, 6thand after 9th week of training

Source	SS	Df	MS	F	P- Value
Corrected Model	8311.384[a]	11	755.580	33.322	0.001
Intercept	373644.118	1	373644.118	1.648E4	0.001
Intensitylevels	484.437	2	242.219	10.682	0.001
Time of jogging	6746.405	3	2248.802	99.174	0.001
Error	5169.978	228	22.675		
Total	387125.481	240			
Corrected Total	13481.362	239			

$F(2, 228) = 10.682$ $P<0.05$

Table 4.10shows the result of repeat measures of ANOVA VO_2max at base-line, 3rd,6th, and 9th week of continuous jogging. The result revealed significant effect of continuous jogging on VO_2max as a result of variation in intensity levels ($P< 0.01$). Therefore, the null hypothesis was hereby rejected.

To establish which intensity level of training was responsible for the significant effects on the means in the 4 phases of data collected, post- hoc Scheffe's test was applied on the means at base-line, 3rd , 6thand 9th week of continuous jogging. The results are shown in Table 4.11.

Table 4.11 Post- hoc Scheffe's test for VO_2max Measure

(I) intensity levels	(J) intensity levels	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Moderate	.070	.7529	.996	-1.785	1.925
	Low	3.048*	.7529	.000	1.193	4.903
Moderate	High	-.070	.7529	.996	-1.925	1.785
	Low	2.978*	.7529	.001	1.123	4.833
Low	High	-3.048*	.7529	.000	-4.903	-1.193
	Moderate	-2.978*	.7529	.001	-4.833	-1.123

*.The mean difference is significant at the .05 level.

Table 4.11revealed that the significant difference in the means of VO_2max as a result of the variations in the intensity levels was due to the means difference between high and low and moderate and low intensity levels. However, there was no significant difference between moderate and high intensity levels. This showed that moderate and high intensity levels of training had significant effect on the VO_2max of the participants.

Sub-hypothesis 4

There is no significant difference in the effects of low, moderate and high intensity levels of continuous jogging on % body fat of male overweight adolescent students in Kaduna metropolis. Nigeria.

To test this hypothesis, data collected at low, moderate and high intensity at base-line after 3rd, 6th and 9th week of training is presented in Table 4.12

Table 4.12: Descriptive statistics of means, standard deviation (SD) and standard error of percentage body fat (%BF) of participants at base-line, 3rd, 6th and after 9th week training.

Intensity levels	Time	Mean	SD	SE	% change
Low	Base-line	21.25±	1.209	.270	
	3rd Week	20.20±	1.240	.277	1.1 -4.9%
	6th Week	18.25±	1.372	.307	3.0 -14.2%
	9th Week	17.10±	1.294	.289	4.2 -19.5%
Moderate	Base-line	21.40±	1.392	.311	
	3rd Week	19.75±	1.118	.250	1.7 -7.7%
	6th Week	18.05±	.999	.223	3.4 -15.7%
	9th Week	15.65±	1.226	.274	5.8 -26.9%
High	Base-line	20.85±	.875	.196	
	3rd Week	19.35±	1.182	.264	1.5 -7.2%
	6th Week	18.34±	1.183	.265	2.5 12.03%
	9th Week	12.05±	1.432	.320	8.8 -42.2%
Control Group	Base-line	20.95±	.999	.223	
	3rd Week	21.15±	1.14	.025	0.2 0.48%
	6th Week	21.60±	1.03	0.23	1.2 3.1%
	9th Week	21.92±	1.02	.0.23	1..0 4.6%

Table 4.12 shows the mean, SD and SE of %BF of overweight Nigerian male adolescent students at base-line, after 3th, 6th and 9th week of training for the low intensity (LI),

moderate intensity (MI) and high intensity (HI) and control (CG) groups, An observation of the data showed that the participants in Low intensity mean valuesat base-line, 3rd 6th and 9th week were 21.25 ± 1.209, 20.20 ± 1.240, 18.25 ± 1.372 and 17.10 ± 1.294, respectively, had a total decrease of 4.2 representing 19.5%. Moderate intensity group had mean values of 21.40 ± 1.392, 19.75 ± 1.118, 18.05 ± .999and 15.65 ± 1.226 for base-line, 3rd, 6th and 9th week, respectively, had a total decrease of 5.8 representing 26.9%. High intensity group had mean values of 20.85 ± .875, 19.35 ± 1.182, 18.34 ± 1.183 and 12.05 ± 1.432 for base-line, 3rd, 6th and 9th week, respectively, had a total decrease of 8.8 representing 42.2%, after training and control group mean values at base-line, 3rd, 6th and 9th week were 20.95 ± .999, 21.15 ±1.14, 21.60 ± 1.03 and 21.92 ± 1.02, respectively, had a total increase of 1.0 representing 4.6%.

In order to find out whether the changes were significant, the data collected were analyses using repeated-measures analysis of variance (ANOVA), and the result is presented in Table 4.13.

Table 4.13:Repeated-measures analysis of variance (ANOVA) for differences in % BF measure at base-line, 3rd, 6thand after 9th week of training

Source	SS	Df	MS	F	P-Value.
Corrected Model	1557.746[a]	11	141.613	95.653	0.001
Intercept	81659.704	1	81659.704	5.516E4	0.001
Intensity levels	134.558	2	67.279	45.444	0.001
Time of jogging	1245.246	3	415.082	280.369	0.001
Error	337.550	228	1.480		
Total	83555.000	240			
Corrected Total	1895.296	239			

$F(2,228) = 45.444$ $P < 0.05$

Table 4.13shows the result of repeat measures of ANOVA % BF at base-line, 3rd,6th, and 9th week of continuous jogging. The result revealed significant effect of continuous jogging on % BF as a result of variation in intensity levels (P < 0.01). Therefore, the null hypothesis was hereby rejected.

To establish which intensity level of training was responsible for the significant effects on the means in the 4 phases of data collected, post- hoc Scheffe's test was applied on the means at base-line, 3rd , 6thand 9th week of continuous jogging. The results are shown in Table 4.14.

Table 4.14: Post- hoc Scheffe's test for PercentageBody Fat

(I) Intensitylevels	(J) Intensitylevels	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
High	Moderate	-1.287*	.1924	.000	-1.762	-.813
	Low	-1.775*	.1924	.000	-2.249	-1.301
Moderate	High	1.287*	.1924	.000	.813	1.762
	Low	-.488*	.1924	.042	-.962	-.013
Low	High	1.775*	.1924	.000	1.301	2.249
	Moderate	.488*	.1924	.042	.013	.962

*. The mean difference is significant at the .05 level.

Table 4.14 revealed that, the significant difference in the means of %BF as a result of the variation in the intensity level was due to the mean difference between high and moderate; high and lowand moderate and low intensity level. This showed that the high, moderate and low intensity levels of training had significant effect on the % BF of the participants.

Sub-hypothesis 5

There is no significant difference in the effects of low, moderate and high intensity levels of continuous jogging on visceral fat of male overweight adolescent students in Kaduna metropolis. Nigeria.

To test this hypothesis, data collected at low, moderate and high-intensity at base-line after 3rd, 6th and 9th week of training is presented in Table 4.2.2.5

Table 4.15: Descriptive statistics of means, standard deviation (SD) and standard error of Visceral fat (VF) of participants at base-line, 3rd, 6th and after 9th week training.

Intensity levels	Period of Assessment	Mean	SD	SE	% change	
Low	Base-line	11.450±	1.2344	.2760		
	3rd Week	10.950±	1.0501	.2348	0.5	-4.4%
	6th Week	9.900±	1.0208	.2283	1.6	-13.5%
	9th Week	8.250±	.9105	.2036	3.2	-27.9%
Moderate	Base-line	11.650±	1.0894	.2436		
	3rd Week	10.900±	.9119	.2039	0.75	-6.4%
	6th Week	9.250±	.7864	.1758	2.4	-20.6%
	9th Week	7.150±	.8751	.1957	4.5	-38.6%
High	Base-line	10.750±	1.6819	.3761		
	3rd Week	9.500±	1.5390	.3441	1.25	-11.6%
	6th Week	9.150±	1.3485	.3015	1.6	-14.9%
	9th Week	4.200±	1.3992	.3129	6.6	-60.9%
Control Group	Base-line	10.700±	.9234	.2065		
	3rd Week	10.900±	1.2096	.2705	0.2	1.8%
	6th Week	11.050±	.7592	.1698	0.4	3.2%
	9th Week	11.53±	.6806	.1522	0.8	7.2%

Table 5.15 shows the mean, SD and SE of VF of overweight Nigerian male adolescent students at base-line, after $3^{rd,}$ 6^{th} and 9^{th} week of training for the low intensity (LI), moderate intensity (MI) and high intensity (HI) and control (CG) groups, An observation showed that the participantsin low intensity mean values of base-line, 3^{rd} 6^{th} and 9^{th} week were 11.450 ± 1.2344, 10.950 ± 1.0501, 9.900 ± 1.0208and 8.250 ± .9105, respectively, had a total decrease of 3.2 representing 27.9%, Moderate intensity group had mean values of 11.650 ± 1.0894, 10.900 ± .9119, 9.250 ±.7864 and 7.150 ± .8751 for base-line, 3^{rd}, $6^{th}$and 9^{th} week, respectively, had a total decrease of 4.5 representing 38.6%, High intensity group had mean values of 10.750 ± 1.6819, 9.500 ± 1.5390, 9.150 ± 1.3485 and 4.200 ± 1.3992 for base-line, 3^{rd}, 6^{th} and 9^{th} week, respectively, had a total decrease of 6.6 representing 60.9%, after training and control group mean values at base-line 3^{rd}, 6^{th} and 9^{th} week were 10.700 ±.9234, 10.900 ± 1.2096, 11.31 ±.7592 and 11.53 ±.6806, respectively, had a total increase of 0.8 representing 7.2%.

In order to find out whether these changes were significant, the data collected were analysed using repeated-measures analysis of variance (ANOVA). The result is presented in Table 5.16.

Table 4.16:Repeated measures analysis of variance (ANOVA) for differences in VF measure at base-line, 3rd, 6th and after 9th week of training

Source	SS	Df	MS	F	P-Value.
Corrected Model	988.813[a]	11	89.892	64.808	0 .001
Intercept	21375.937	1	21375.937	1.541E4	0 .001
Intensity levels	126.400	2	63.200	45.564	0 .001
Time of jogging	772.113	3	257.371	185.551	0 .001
Error	316.250	228	1.387		
Total	22681.000	240			
Corrected Total	1305.063	239			

$F(2, 228) = 45.564$, $P < 0.05$

Table 4.16shows the result of repeat measures of ANOVA visceral fat at base-line, 3rd,6th, and 9th week of continuous jogging. The result revealed significant effect of continuous jogging on visceral fat as a result of variation in intensity levels ($P < 0.01$). Therefore, the null hypothesis was hereby rejected.

To establish which intensity level of training was responsible for the significant effects on the means in the 4 phases of data collected, post- hoc Scheffe's test was applied on the means at base-line, 3rd , 6thand 9th week of continuous jogging. The results are shown in Table 4.17.

Table 4.17:Post- hoc Scheffe's testfor Visceral Fat Measure

(I) intensity levels	(J) intensity levels	Mean Difference (IJ)	SE	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Moderate	-1.300*	1862	.000	-1.759	-.841
	Low	-1.700*	1862	.000	-2.159	-1.241
Moderate	High	1.300*	1862	.000	.841	1.759
	Low	-.400	1862	102	-.859	.059
Low	High	1.700*	1862	.000	1.241	2.159
	Moderate	.400	1862	.102	-.059	.859

*. The mean difference is significant at the .05 level.

Table 5.17revealed that, the significant difference in the means of visceral fat as a result of the variation in the intensity level was due to the mean difference between high and moderate and high and low intensity levels .This showed that the high intensity level of training had significant effect on the visceral fat of the participants

4.3Discussion

The purpose of this study was to compare the effects of low, moderate and high intensity levels of continuous jogging on MAP, VO_2max, RHR, percent BF and VF of overweight male adolescents. A sample of eighty (80) male overweight adolescence students were used within mean age of 16±.83 years old.

The result of the analysis revealed significanteffect by intensity levels of jogging on MAP(P = 0.01). This result is in line with the findings of Manna, Khana, & Dhara (2013), whoobserved significant reduction in MAP after 12 weeks of aerobic training. In this study the, moderate intensity group showed greater improvement in the reduction of MAP after the training as this group had a MAP reduction of 10.3% after the 9^{th} week as compared to 3.6% and 6.9% of low and high intensity levels, respectively, as observed from the mean values (82.600 mm Hg; 76.615 mm Hg and 78.184 mm Hg in low, moderate and high intensity levels, respectively. This finding concurs with the results of Simon (2013), Nieman (1998) who reported that high and low intensityexercise training may not lower MAP as moderate intensity.This resultis similar to Heyward, (2014) and Gladmohesh and Sundaramurthy (2015) who clearly demonstrated strong evidences that participation in regular physical activity of continuous training improves cardiovascular functions among adolescents,This is due to the fact that blood vessels dilates during each exercise session because of body warming effects, local production of certain chemicals (for example, lactic acid and nitric oxide), decreases in nerve activity, changes in certain hormones and their receptors. As exercise is repeated regularly, all these effects may create a chronic lowering effect on the blood pressure, also there is specific physiological mechanism, leading to reduction in blood pressure following exercise, where regular aerobic exercise help to keep arteries elastic and in turn ensure good blood flow and normal blood pressure.

Theresult of this finding also supported the position of Heyward(2014) and Kenny, Wilmore & Costill(2012), who found significant improvements in physiological variables. The result also concurs with the findings of Nieman (1998), Sheehan (2010), Kenney, Wilmore and Costill (2012), who reported that regular aerobic physical activity not only makes the heart stronger, but also more efficientto pump greater amount of blood to central circulation during physical activity, thus, 9 weeks of continuous training in the present study showed a decrease in MAP.

The results of the analysis on RHR shows significant effect of intensity levels on the resting heart rate of overweight adolescent students (P = 0.001)..This result agrees with Hunter (2014) whoreported that cardio workouts are more effective in reducing RHR than other forms of exercises, In this study, the high intensity group showed greater improvement in the reduction of RHR by 12.2% while the moderate group had 10.9% and low group 8.0% after 9 weeks training. The result of present study is also similar to the findings of Kenny, Wilmore and Costill (2012) who reported that RHR in sedentary individuals, with an initial RHR of 80 bpm decrease approximately 1 beat/min each week for the first few weeks as endurance training progresses. They reported that after 10 weeks of moderate intensity endurance training the heart rate could reduce by approximately10.2%. The mechanisms responsible for the decrease in RHR are not entirely known, but regular aerobic training appears to increase parasympathetic activity in the heart and decreases sympathetic activity (Gunen, Venkateswarlu & Chado, 2012).Reduction in RHR as result of aerobic training is an indication of an improved healthy condition of the heart observed in low, moderate and high intensity levels. This finding agrees with the fact that aerobic exercises attenuate physiological changes in the participants.

The results of this study further revealed significant effect of the intensity levels of continuous jogging on VO_2max of the participants ($P = 0.001$). This finding is similar to the result obtained by Mughal *et al.* (2001), Stuknik and Banjamin (2013); Gunen, Venkateswarlu and Chado (2012), who all observed significance increase in VO_2max after continuous training among children and adolescence. The high intensity group in this study showed greater improvement in the VO_2max 34.0% after the 9th week as compared to moderate (28.4%) and low (16.5%) after the 9th week of training. However, Manna, Khanna and Dhara (2012) observed no significant change in VO_2max of Indians under 19 male volleyball players after 12 weeks of aerobic training. The finding of this study agrees with the findings of Heyward (2014) and Gladmohesh and Sundaramurthy, (2015) who clearly demonstrated strong evidences that participation in regular physical activity of continuous training enhances fitness benefits as well as cardio-respiratory function among adolescents, and also the popular saying that any exercise is better than no exercise.

The results of the analysis on % BF showed significant effect of intensity levels of jogging on % body fatof overweight adolescent students (P = 0.001). This result agrees with the finding of Elise, Eric and Curt (2011), who, in their study on the effects of exercise intensity on percent body fat,concluded that intensity of the exercise bout reduced percent body fat. It was also in agreement with the findings ofHo *et al;* (2012), who reportedreduction in percent BF (-2.6%, P < 0.01) after 12weeks of moderate intensity training for 30min 5 days/week. Abdolali,*et al;* (2012) reported similar result (P<0.05) after 12weeks of aerobic training and concluded that aerobic training, is effective for producing significant benefits on body composition. In this study high intensity group showed greater improvement, in the reduction of percent BF after the training, as this group experience percent BF reduction of 42% after the 9^{th} week as compared to 26.9% and 19.5%; of low and moderate intensity levels respectively. The result also concurs with the findings ofHaruna(1994),Jackson *et al;*(1999),McArdle *et al;*(2010), Heyward(2014),and Edson*et al;* (2015) who,observed that percent BF decreased significantly with various training programmes of various intensities.

The result of this study agrees withIrving *et al.* (2008), Devies *et al*. (2008), Joseph *et al.* (2011) and Baria *et al.* (2016) who, reported that intensity of exercise bout reducedpercent body fat reduction and significant difference was observed between exercise intensities, where higher intensities produced greater reduction of percent body fat than lower intensities. The low reduction in percent BF as a result of continuous aerobic training at low and moderate intensity indicates improvement of a healthy condition. The result concurs with the fact that aerobic exercise attenuates physiological changes in the participants.

The result of the analysis revealed significant effect by intensity levels of continuous jogging on visceral fat. (P = 0.001). This result is similar to those of Malina, Howley and Gutin (2007), Keating *et al.* (2015) and Baria*et al.* (2016), who all observed significant reduction in visceral adiposity in overweight youth programme of moderate to vigorous intensities activity and concluded thatphysical activity potentially lower the risk of overweight or obesity by reducing adiposity during adolescence. In this study the high intensity group showed greater reduction in VF after the training as the group had a VF reduction of 60.9% after the 9^{th} week as compared to 38.6% and 27.9% of moderate and low intensity levels respectively, this was observed from the mean values of 4.200, 7.150 and 8.250 in high, moderate and low intensity levels, respectively.This alsoresult agrees with the finding of Irving *et al.* (2008), who showed that high-intensity continuous aerobic training significantly reduced total adipose and abdominal subcutaneous fat ($P <0.05$), and abdominal visceral fat ($P < 0.01$) The result of the finding is also similar to the findings of Soon-Mi *et al.* (2011), Visser*set al.* (2013)who observed that high-intensity continuous aerobic training increase visceral fat loss, than moderate and low-intensity training. Gan *et al.* (2003) earlier reported a reduction in VF ($r = 0.544$, $P < 0.05$) after 10 weeks of moderate intensity physical activity, and also concluded that moderate intensity leads to reduction in VF. All aerobic exercised regimens reduced liver fat and VAT by a small amount without clinically significant weight loss. The mechanism for greater improvement in high intensity group could be that high-intensity aerobic training induces secretion of lipolytic hormones, including growth hormones and adrenaline, which may facilitate greater post-exercise energy expenditure and fat oxidation. Under equivalent levels of energy expenditure, high-intensity continuous jogging training also favoured a greater negative energy balance compared with low or moderate intensity aerobic jogging training.

Reduction in VF as a result of low and moderate and high intensity aerobic training suggest that such intensities are recommended for improving health condition of the participants andthat continuous aerobic training (jogging) provides an economically viable non-pharmacological approach for eliciting beneficial adaptations in body composition. It is a powerful strategy for inducing abdominal fat loss, particularly with respect to abdominal visceral fat loss(Bouchard & Katmaryzyk 2010, Baria *et al*. 2016). Increments in VF of control group suggest that inactivity makes the body to accumulate more visceral fat. Excess visceral fat in the body has health risks (Katmaryzyk 2010, Venkateswarlu, 2010).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1Introduction

The purpose of this study was to compare the effects of low, moderate and high intensity of continuous training on MAP, RHR, VO_2max, percentage BF and VF of overweight male adolescents. A sample of 80 volunteered participants took part in the study.The data collected for this study at base-line, after 3^{rd}, 6^{th} and 9^{th} week of training were analysed using the Statistical Package of Social Science (SPSS), version 20.2.This chapter presents the summary, findings, conclusion, limitations, contribution to knowledge and recommendations on the findings of the study on effect of different intensity levels of continuous training on mean arterial blood pressure, RHR, VO_2max, percentage BF and VF of overweight male adolescents in Imperial School Kudenda Kaduna, Nigeria.

5.2Summary

This study was conducted to assess and compare the effect of low, moderate and high-intensity levels of continuous training on MAP, RHR, VO_2max, percent BF and VF of overweight male adolescents. To achieve this purpose, 80 participants from Imperial Secondary School Kaduna, who met the inclusion criteria, based on their BMI were selected for the study. On their willingness to undergo 9 weeks aerobic training, base-line data including age, height, weight, and MAP, RHR, VO_2max, %BF and VF were assessed.Training commenced after all base-line measures were assessed. The training programme consisted of continuous jogging for 30 minutes on 3 alternate days a week at <40-45% ,<45-50% and<50-55% HR max of the participantsfrom 1^{st} - 3^{rd} week,$4^{th-}6^{th}$ week and 7-9^{th} week of training, respectively, for low-intensity group;<50-55%, 55-60%

and 60-65% HR max of the participants from 1^{st} - 3rd week,4^{th} - 6^{th} week and 7-9^{th} week of training, respectively, for moderate-intensity group;60-65%, 65-70% and 70-75% HR maxof the participants from 1^{st} - 3^{rd} week,4^{th} - 6^{th} week and 7-9^{th} week of training, respectively, for high-intensity group. Increase in intensity after 3 weeks of training was due to subjects' adaptation to training. Measurement for MAP, RHR, VO_2max, %BF and VF values were further assessed after 3^{rd}, 6^{th} and 9^{th}week of training to test for effects of training.The data collected were statistically analysed using descriptive statistics and repeated measures analysis variance (ANOVA) and Post-hoc Scheffes test.

The result of this study showed that:

i. Continuous aerobicstraining of low, moderate and highintensity levels significantly decreased MAP,RHR, %BF, VF; and significantlyincreased in VO_2maxof overweight male adolescentsin Kaduna, Nigeria.
ii. Moderate-intensity level of continuous training had greater reduction on MAP than high and low intensities after training
iii. High-intensity level of continuous training had greater significant reduction in RHR than moderate and low intensities after training
iv. High-intensity level of continuous training had greater significant improvement in the VO_2max than moderate and low intensities after training
v. High-intensity level of continuous training had greater significant reduction on %BF than moderate and low intensities after training.
vi. High-intensity level of continuous training had greater significantreduction on VF than moderate and low intensities after training.

vii. Control group had greater increase in MAP, RHR, %BF, VF and greater reduction in VO_2max than the experimental group after training.

5.3Conclusion

Continuous aerobic training performed on three days/week at low (40-55% HRmax) moderate (55-65% HRmax) and high-intensity levels (60-75% HRmax) of training session lasting 30 minutes for 9 weeks reveals that:

i. Moderate and high intensity decreased MAP of overweight Nigerian male adolescents ($P< 0.01$).
ii. High and Moderate intensity decreased RHR of overweight Nigerian male adolescents ($P < 0.01$).
iii. High and Moderate intensity increased VO_2max of overweight Nigerian male adolescents ($P < 0.01$).
iv. High, moderate and low intensity decreased %BF levels of overweight Nigerian male adolescent($P < 0.01$).
v. High intensity decreased VF levels of overweight Nigerian male adolescents ($P < 0.01$)

5.4Limitations

The study had the following limitations, which were taken into consideration while interpreting the results.

i. This study was conducted on overweight male adolescents without any structured physical training background and their fitness level or baseline measurement was not considered when they were randomly placed into the groups.

ii. All participants were boarding students; however, it was difficult to control the physical activity level of the participants outside their training routine. It was ensured that the participants minimised or reduced their being involved in any strenuous physical activity (especially labour, playing soccer and other games) by explaining to housemasters and form teachers to help check and avoid giving the participants, any form of PA that could affect the result of the training programme.

iii. Values of physiological and body composition states of the participants could be influenced by dietary. Though participants fed on same meals at school, researcher was not able to control what the participants bought and ate in the school shop. Participants were advised not to eat outside their normal school meals.

iv. Variables such as ambient temperature, air pollution, altitude and relative humidity are difficult to control and may influence the VO_2max measurement, and thus, lower the reliability and objective of the test. Therefore, training and measurement were done between 6.30 am – 7.30 am in the morning and on a flat surface.

5.5Contribution to knowledge

i. The results of this study revealed significant decrease in mean arterial blood pressure (P = 0.001) after the 6^{th} and 9^{th} week of high and moderate-intensity continuoustraining ofoverweight Nigerian male adolescents

ii. The results of this study revealed significant decrease in mean resting heart rate (P = 0.001) after the 3rd, 6th and 9th week of high and moderate-intensity continuous training of overweight Nigerian male adolescents

iii. The results of this study revealed significant increase in VO_2max (P = 0.001) after the 6th and 9th week of high and moderate-intensity continuous training of overweight Nigerian male adolescents

iv. The results of this study revealed significant decrease in percent body fat (P = 0.001) after the 3rd, 6th and 9th week of high, moderate and low-intensity continuous training of overweight Nigerian male adolescents

v. The results of this study revealed significant decrease in visceral fat (P = 0.001) after the 3rd, 6th and 9th week of high and moderate-intensity continuous training of overweight Nigerian male adolescents

5.6 Recommendations

On the basis of the findings of this study, the following recommendations wee made.

i. Continuous training at moderate and high intensity should be undertaken regularly by overweight Nigerian male adolescents to overcome the onset of life-style related diseases.

ii. Continuous training at moderate intensity had the greatest decrease on MAP; therefore, it is recommended that exercise scientists and fitness providers should use moderate intensity level on high blood pressure patients.

iii. Continuous training at high intensity had the greatest decrease on RHR; therefore, it is recommended that exercise scientists and fitness providers should use high intensity level on high blood pressure patients.

iv. Continuous training at high intensity level was found to increase the VO_2max, health professionals and fitness centres should use this method of training on overweight adolescents to improve the transport and consumption of oxygen.

v. Continuous training at high intensity level had the greatest decrease in %BF, health professionals and fitness centres should use this method of training on overweight adolescents to avoid risk of obesity and related diseases.

vi. Continuous training at high intensity level had the greatest decrease in VF, health professionals and fitness centres should use this method of training on overweight adolescents to prevent cardiovascular diseases.

vii. High MAP, RHR. %BF, VF and low VO_2max are implicated in hypertension. Exercise scientists and fitness providers should use continuous trainingat either moderate or high intensity for 30 minutes on three alternate days a week ontheir overweight adolescent hypertensive clients to regulate lipid concentration.

viii. In view of the beneficial role of exercise training for health in the overweight, overweight adolescents should personally engage in regular jogging as a prophylactic measure against obesity and its associated health problems.

5.7 Recommendation for Further Research

The researcher identified some related problematic areas in the course of this study that require further investigation.

i. The result of the study showed that continuous jogging training at different intensities reduces MAP, RHR, %BF, VF after 3rd,6th and 9thweeks of training in overweight adolescent. It is not clear whether the drop will continue if training continues after 9 weeks in cardiovascular risk factor subjects. It is, therefore, suggested that longitudinal investigation be conducted to investigate the effects of continuous jogging on obese and high blood pressure subjects.

ii. Studies have shown that significant decrease MAP, RHR. %BF, VF and increase in VO_2max of overweight students, a similar study on intensity levels of interval training is also needed.

iii. As this study was conducted on overweight male adolescent students, a similar investigation using the same variables should be conducted on overweight female adolescent students.

REFERENCES

Abass, A.O. & Moses, M.O. (2013) Aerobic and progressive resistance exercise effects on body composition in Ibadan, Nigeria. *British Journal of Education, Society and Behavioural Science,* 3(2): 163-173.

Abdel-kader, S. M. (2011). Moderate VS High endurance training on leptin and selected immune system response in obese subjects. *European Journal of General Medicine,* 8(4): 268-272.

Abdollahi, B., Neda, R., Ardeshir, Z. & Yaser, K. (2012) Effect of 12 weeks of aerobic training on visfatin levels in obese women, *European Journal of Experimental Biology,* 2(6): 2293-2296

Adochi, H.; Koike, A.; Obayashi, T.; Umezawa, S.; Anonuma, K. & Inada, M. (1996): Does apprpopriate endurance exercise training improves cardiac function in patient with prior myocardial iinfarction. *European heart journal* (17) 1511-21

Airin, S., Linoby, A., Zaki, M. S. M., Baki, H., Sariman, H., Esham, B. & Azam, M. Z. M. (2014) The Effects of High Intensity Interval Training and continuous Training on Weight Loss and Body Composition in overweight females *Proceedings of the International Colloquium on Sports Science Exercise, Engineering and Technology 2014 (ICOSSEET 2014)*: 491-409

America College of Sports Medicine, Pollock, M.L., Gaesser, G. A., Butcher, J.A., Despres, J.P., Dishman, R.K., Frank, B.A., Garoer, C.E. s& American College of Sports Medicine Position Stand (2010). The Recommended Quality and Quality of Exercise for developing and maintaining cardiorespiratory and muscular fitness and flexibility in Healthy adults *Medicine & Science in Sports & Exercise,* 30(6), 975-991,1998.

American College of Sports Medicine, Garber, C.E., Blissmer, B., Deschenpes, M.R., Franklin, B.A., Lamonte, M.J., Lee, I.M., Nieman, D.C., Swain, D. P. American College of Sports Medicine Position Stand (2011). "Recommended Quality and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness and flexibility in health and muscular fitness and flexibility in health adults" *Medicine & Science in Sports & Exercise,* 43(7): 1334-59.

American Heart Association Recommendation for PA in children (2014). Retrieved on June 21, 2016 *from Learn more heart org/kids Activity Recommendations.*

Angelica, M.D.(2011). Meaning of Mean Arterial Pressure Retrieved on August 31, 2016 *from http://www.ncbi.atm nlm.gov/pmc/articles/pmc 14140281.*

Anu, M., Jacob, C. S., Susana, S., Jaako, T. & Kari, K. (2000). Educational level, relative body weight and changes in their association over 10 years: An International

Perspective from the WHO MONICA A Project, *American Journal of Public Health, Washington,* 2(7) 1- 11.

Areskog, N. (1985). Effects and Adverse Effects of Autonomic Blockage in Physical Exercise. *American Journal of Cardiology,* 55 132 –134D

Baria, F. I., Kamimura, M. A., Aoike, D. T., Ammiratai, A., Rocha, M. I. & Mello, M. T. (2016): Randomized controlled trial to evaluate the impact of aerobic exercise on visceral fat in overweight chronic kidney disease patients. *Nephrology Dialysis Transplantation*, 29(4): 857-864.

Baumgartner, T. A., Mahar, M. T. & Rower, D. A. (2007) *Measurement for Evaluation in physical Education and Exercise Science (8th edition)*; Boston; McGraw Hill Higher Education 323-346

Bedgoni, G., Iugietti, L., Ferrari M., Poli M., Bernasconi, S. & Battistini, N. (2003). Sensitivity and Specificity of BMI and SKF thickness in detecting excess adiposity in children aged 8 – 12 years. *Annals of Human Biology,* 30(2): 132 – 139.

Betty p., Maritza L. J. & Maura V. (2002). Fat distribution in Venezuala children and Adolescent estimated by Connicity Index and Waste/hip ratio. *American Journal of Human Biology*, 14: 15-20.

Blomqvist, C. G. & Saltin, B. (1983). Cardiovascular adaptations to physical training. *Annual Review of Physiology*, 45: 169 – 189

Borg, G. A. V. (1998). *Borg's Perceived Exertion and Scale:* Human Kinetics, USA, PP 34-67

Bouchard, C. & Katzmarzyk, P. T. (2010). *Physical Activity and Obesity:* Human Kinetics(2nd ed), 409: 1-367 ISBN-13:978-0-7360-7635-7.USA.

Brenner, I, K., Thomas, S. & Shephard, R. J. (1997). Spectral Analysis of Heart Rate Variability during Heat Exposure and Repeated Exercise. *European Journal of Applied Physiology*, 76: 145-156.

Brown, M. D., Dengel, D. R., HoginKyan, R. V. & Supiano, M. A. (2002), Sympathetic activity and the heterogenous blood pressure response to exercise training in hypertensive; *Journal of Applied Physiology* 92: 1434 – 1442

Buchan, D. S., Ollis, S., Young, J. D., Thomas, N. E,, Cooper, S. M., Tong, T. K., Nie, J., Malina, R. M. & Baker, J. S. (2011). The effects of time and intensity of exercise on novel and established markers of CVD in Adolescents Youth. *American Journal of Human Biology,* 23(4) 517 – 526.

Bucher, C. A. (1979). *Foundation of Physical Education:* The CV Mosby Toronto, London 67-89

Burton, D. A., Stokes, K. & Hall, G. M. (2004). Physiological effects of exercise. Continuing Educ. in Anaesthesic, *Critical care and Pain,* 4(6) 185 -188

Cannon, J. (2011). Body fat measurement- A review of different methods. *Today's Dietitian 13 (5) 66*Retrieved on August 31, 2016 *fromhtt://www.todaysdietitian.com/tablecontents.shtml*

Carter, J. B., Banister, E. W. & Blabber, A. P. (2003). Effects of endurance exercise on Autonomic control of Heart. *Sports Medicine 2003,* 33(1) 33-36.

Chia, M. (2008). Physical Inactivity among Children and Adolescent in Singapore- A Paradoxical issue. *Acta kinesiologica* 2(2) 7-15

Devries, H. A. (1980). *Physiology of Exercise for Physical Education and Athlетics (3rd Ed)* Dubugue, M W C. Brown Company Publishers, U.S.A PP 91-113

Dorota, K.N.; Robert, N.; Zbigniew, J.; Aleksandra, Z.; Marta, B.; Izabela, D.K.;
Lukasz, R.; Agata, L.D.; Ficek K. & Pawel, C. (2015): Effect of 12-week-long aerobic training programme on body composition, aerobic capacity, complete blood count and blood lipid profile among young women. *Biochemia medica* 25 (1) 103-13

Duwai, M. H. & Chado, M. A. (2012). Importance of including Regular Physical activity as part of treatment for hypertension. *Journal of Health, Physical Education, Sports and Leisure Studies* 3(2) 83-94.

Edson dos Santos, F., Wzequiel, M. G., Andre, M. M., Gilguerra, J. & Olga, M. S. A. (2015). Effects of programme Physical Activity on body composition in post pubertal School children. *Journal de Paediatric* 91 (2)122-129

Edwin, G. M. (1978). The Effect of three modes of Aerobics Training on cardiovascular Endurance. *Dissertation Abstracts International Series A. Vol. 38*

Ekelund, U., Tomkinson, G. & Armstrong, N. (2011). What Proportion of Youths is Physically Active? Measurement issues, levels and recent time trends. *British Journal of Sports Medicine 2011,* 45(11) 859–865 PubMed Abstract

Fagard, R. H. & Tipton, C. M. (1994). Physical activity, fitness and hypertension in Bouchard, C. Shephard, R. J. and Stephen, T. (Editors): Physical activity fitness and health international proceedings and consensus statement. *Chapman, IL: Human Kinetics,* PP 633 – 655.

Fagard, R. H. (2011). Exercise characteristics and BP response to dynamic physical training *Medicine, Science and Sports Exercise.* 33(6) 5484-5492

Fernandes R. A., Rose, C. S. C., Buonani, C., Oliveira, A. R. & Freitas, I. F. J. (2007). The use of Bioelectrical impendence to test defect excess visceral fat and subcutaneous fat. *Journal de pediatria* 0021-755/07/83-06/529

Froek, B. (2013). Vo_2max Training: Retrieved on July 23, 2015 *from Livestrong.com, http//www.livestrong.com/article/447500Vo2maxtraining/*

Gan, S.K., Kriketos, A.D., Ellic, B.A., Thompson, C.H., Kraegen, E.W. & Chisholm, D.J. (2003). Changes in Aerobic Capacity and visceral fat but not myocyte lipids levels predict increased Insulin Action After Exercise in overweight oobese men. *DiabetesCarecare.dibetesjournals.org. Doi; 10. 2337/diacare.26.6.1706 Diabetes care June 2003* 26(6) 1706-1713

Gibala, M. J., Little, J. P., Macdonald, M. J. & Hawley, J. A. (2012). Physiological adaptation to low – volume, high intensity interval training in health and disease. *Journal of Physiology* 590, 1077-1084.

Gladmohesh, M. I. & Sundaramurthy, A. (2015). Effects of moderate exercise on vo_2max and blood pressure in individual with different body mass index. *Journal of clinical experiment* 3(1): 177-179.

Godara, H. L. & Bishnoi, C. (2013). Effects of aerobic training on percentage Body fat; Total cholester of and HDL - c among obese children. *IOSR Journal of sports and Physical Education (IORS – JSPE) P. Issue*: 2447 – 6737, 1(2) 46-52.

Goldsmith, R. l., Bloomfeld, D.M. & Rosenwinkel, E. T. (2000). Exercise and autonomic function. *Coronary Artery Dis 2000:* 11: 129 135.

Goran, L. M. (1999). Visceral Fat in Pre -pubertal children: Influence of obesity, Anthropometry, Ethnicity, Gender, Diet and Growth. *American Journal of Human Biology 11: 201 – 207.*

Gormley, S. E., Swain, D. P., High, R., Spina, R. J., Dawling, E. A., Kotipaeli, U. S. & Gandrakota, R. (2008). Effects of Intensity of Aerobic Training on VO_2Max. *Medicine Science and Sports Exercise 2008:* 40(7) 1336-1343.

Gunen, E. A., Venkateswarlu, K. & Chado, M. A. (2012) Comparative effects of Interval and Continuous training programme on body composition and cardiovascular parameters Pre-adolescent Children in Zaria, Kaduna Nigeria. *Journal of Health of Health Physical Education Sports and Leisure Studies*. 3(1) 59-68.

Gutin, B., Yin, Z., Humphry, M. C. & Barbeau, P. (2005). Relation of moderate and vigorous PA To fitness and fatness in adolescence 1 2 3. *American Journal of Clinical Nutrition* 81(4) 746-750.

Gutin, B.; Barbeau, P.; Owens, S.; Lemon, C.R.; Bauman, M.; Allison, J.; Kang, H.S.; Litaker, M.S. (2002): Effects of exercise intensity on cardiovascular fitness, total body composition and visceral adiposity of obese adolescents 1’2’3 *American journal clinical nutrition* 75 (5) 818-826

Guyton, A.C. & Hall, J.E. (2012). *Textbook of medical physiology (12th ed):* Saunders an imprint of Elsevier 1600 John F. Kennedy Blvd., Suite 1800 Philadelphia, Pennnsylvania 19103-2899. 166-167

Gwani, J. A. (1996). Body Fat Growth and Motor Fitness Performance of Secondary School Adolescents. Doctoral dissertation Department of Physical and Health Education, Ahmadu Bello University, Zaria.

Haruna, F. R. (1994). The role of Exercise Program in the treatment of obesity. *Kinesiologist* (11); 26-32.

Heyward, V. H. (2014). *Advanced Fitness Assessment and Exercise Prescription*. *Seven revised edition* Human Kinetics, Champaign Il United States. 145-171

Hickson, R. C. & Rosenkoetler, M. A. (1981). Reduced training frequencies and maintenance of increased aerobic power. *Medicine, Science and Sports Exercise* 13: 13-16.

Hickson, R. C., Kanakis, C., Davis, T. R., Moore, M. A. & Rich, S. (1982). Reduce training duration effects on aerobic power, endurance and cardiac growth. *Journal of Applied Physiology* 53: 225 – 229.

Hickson, R. C., Rosenkoetler, M. A. & Brown, M. M. (1980). Strength training effects on aerobics power and short term endurance. *Medicine, Science and Sports Exercise* 12: 336 – 339 (1) 33 – 36.

Ho, S. S., Dhaliwal, S. S., Hills, A. P. & Pal, S. (2012). The effect of 12 weeks of aerobic resistance or combination exercise training on cardiovascular risk factors in the overweight and obese in a randomized trial. *Biomed Central Public Health, 12:704, www ncbi.gov/pubmed/230064.*

Hockey, R.V. (1981) *Physical Fitness, The Pathway to Healthy Living.* C. V. Mosby Corp. Toronto 35-70

Holt, H. E. (1972). Two Jogging programs of different speed Related to the cardiovascular fitness of middle-aged men. *Dissertation Abstracts International Series A*, Vol.33

Hottenrott, K., Ludyga, S. & Schulze, S. (2012). Effects of high intensity training and continuous endurance training on Aerobic capacity and body composition in recreateonally active runners. *Journal of Sports Science and Medicine*, 11(3) 483-488

Hugh, R.B., (2013):The effects of continuous moderate intensity exercise training combined with high intensity interval training on cardiovascular disease risk factors. Retrieved on July 23, 2015 from *http:hdl.handle.net/2292/20089(http://hdl.handle.net/2292/20089*

Hunter, S. D. (2014). Does Exercise and Running Affect the Pulse and why? Living Healthy *Demand Media, Hearst Newspaper ILLC*

Igbanugo, V. C. & Fatikun L. A. (1995). Field Assessment of Aerobic Capacity of Adolescent 30 years. *Journal of Nigeria Association of Sports Sciences and Medicine* 7: 44 – 50.

Irving, B. A., Derie, C. K., Brock, D. W., Weltman, J. Y., Swiff, D., Barred, E. J., Graesser, & G. A. Weltman, A. (2008). Effects of exercise training intensity on Abdominal visceral fat and body composition. *Medicine and Science in Sports exercise.* 40(11) 1863 – 1872.

Jackson, W. A., Marrow, R. J., Hill, W. D. & Dishman, K. R. (1999). *Physical activity for health and fitness.* Human kinetics Hong Kong.

James, P. C. (1980). The Effect of a Physical Fitness Program on the Body composition, Flexibility, Heart Rate, Blood Pressure. And Anxiety of Senior citizens. *Dissertation Abstracts International Series A*, Vol. 41.

John, H. M. & Albert, F. (2012). The Physical Role in Prescribing Physical Activity for the Prevention and Treatment of essential Hypertensive cardiovascular Division.Kings College London; London UK.

Johnson, B. L. & Nelson, J. K. (1979). *Practical Measurement for Evaluation in Physical Education (3rd Ed):* Burgess Publishing Company Minnesota USA. 48-97

Jones, A. M. & Carter, H. (2000). The effects of endurance training on parameters of aerobic fitness *Sports Medicine*29(6):373-86

Joseph, L. A., Trisha, N., ; Elise, F., Eric, S. R. & Curt, B. D. (2011). Effect of exercise intensity on percentage body fat determine by LBIA and SBIA in adults. *Medicine and science in sport and exercise may 2011* 43(5). pp319. Doi: 10 1249/01. Mss 0000400878 8427.25.

June, S., Jianwen, C., Kelly, R. E. & Raina, T. (2002).Fitness and fatness as predictors of mortality from all causes and from cardiovascular disease in men and women in the lipid Research clinic study. *American Journal of Epidemiology* 156: 832 – 841.

Kaidal, A. (1989). A comparison of cardiorespiratory performance of selected athletic groups in 9, 12 and 15 minutes Run Test.(Unpublished) Department of Physical and Health Education, Ahmadu Bello University, Zaria, Nigeria.

Kashubara, K. (2014). What is healthy Resting Heart Rate Retrieved on june 15 from *.Livestrong ehow/htm Health Sports.*

Keating, S. E., Hackett, D. A., Parker, H. M., O'oconnor, H. I., Gerofi, J. A., Sansbury, A., Barker, M. K., Chuter,V. H., Carterson, I. D., George, J.& Johson, N. A. (2015). Effects of aerobic exercise training on liver fat and visceral adiposity. *Journal of Hepatology 2015,* 63 (1): 174-82. Doi: 10. 1016/jhep, 2015. 02022.

Keating, S. E.; Machan, E. A.; O'conor, H.T.; Gerofi, J.A.; Sainsbury, A.; Caterson, I.D.; Johnson, N.A. (2014): Continuous exercise but not high intensity interval training improves fat distribution in overweight adults. *Journal of obesity* Doi 10: 1155/2014/8334865 (12 pages).

Kenney, W.L., Wilmore, J.H. & Costill, D.L. (2012), *Physiology of exercise and sports. (5th ed)* Human Kinetics, Chapman IL 61825-5076. Web www.human kinetics.com United State of America PP 139-209

Kokkinos, P.F., Giannelou, A., Manolis, A. & Pittavas, A. (2009). Physical Activity in the Prevention and Management of High Blood Pressure. *Helenic Journal of Cardiology*50. 52-59

Lamina, S. (2010), Effects of Continuous and Interval Training Program in the Management of Hypertension: A Randomized Controlled Trial: *Journal of Clinical Hypertension* Vol. 12, Issue of PP 841-849 Doi: 10; 1111/s. 1751-7176, 2010, 00315X.

Laskowski. R. E. (2012). Heart Rate. Retrieved on Ju*ne 24, 2015* from *http://www.myoclinic.com/health/heart-rate/ANO1906.*

Lazzer, S.; Lafortuna, C.; Bustic, C.; Galli, R.; Agosti, F.& Sartirio, A. (2011). Effects of low and high intensity exercise training on body composition and substrate metabolism in obese adolescent. *Journal endocrinol invest* 34 (1) 45-52.

Lee, I. M.; Sesso, H. D.; Oguma, Y.& Paffenbarger Jr, R.S (2003): Relative intensity of physical activity and risk of coronary heart disease. *Circulation* (107) 1110-6

Lee, M. & Paffenbarger, R. S. Jr. (2000). Association of Light, Moderate and Vigorous Intensity Physical Activity with Longevity. *American Journal of Epidemology 2000;* 151: 293-9.

Lee, M., Park, K., Choi, S. C. & Kim, H. (2012). Effects of high intensity exercise training on body composition, abdominal fat loss and cardiorespiratory fitness in middle-aged Koreans females. *Applied physiology nutrition and metabolism (impact factor* 12(34) 08/2012; 37(6.Doi: 10.1139/h2012-084.

Macbeth, J. L. (1974). The Effects of continuous and Interval step Training on Attitudes, cardiovascular Fitness and Tennis Skills of Beginning Students. *Dissertation Abstracts International Series A*, Vol. 34.

Mackenzie, B. (2000).Continuous and Interval training: Retrieved on May *24, 2015* from. *http://www.brianmac.co.uk/conintm.htm*

Malina R. M., Howley, E. & Gutin, B. (2007). Body mass and composition. *Report prepared for the youth Health Subcommittee 2007 in Bouchard and Katzmarzyk, 2010.*

Malina, R. M. (2001). Physical Activity and Fitness. Pathway from Childhood to Adulthood, *American Journal of Human Biology* 13: 162 – 172.

Malina, R. M., Slawomir, K. & Tadeuz, B. (1999). Variations in subcutaneous Adipose tissue distribution Associated with Age, Sex and Maturation. *American Journal of Human Biology* 11: 189 – 200.

Manna, I., Khanna, G. L. & Dhara, C. D. (2013). Effect of training on Anthropometric, Physiological and Biomechanical variables of India male under 19 years Volley Ball players, *Journal of Human Sport Exercise* issue 1988 – 5202 Doi: 10 4100/Jhse.

Marrow, A. (2013), Physical Activity Why and How? *Journal of Biosafety HealthEduc / e 111* Doi: 10. 4172/2332-0893. 1000 e 111

Mathieu, P. (2008). Abdominal obesity and the metabolic syndrome; a surgeon's perspective. *Canadian Journal of Cardiology* 24; 19D-23D.

Maud, P. J. & Foster, C. (1995). *Physiological Assessment of Human Fitness.* Human Kinetics U.S.A.

Mavrovouniotis F. (2012). Inactivity in Childhood and Adolescent: A Modern Lifestyle Associated with Adverse Health Consequences. *Sports Science Reviewed* 21 (3-4) 75-99. Doi: 10 2478/v10237-012-0011-9.

Mcardle, W. D., Katch, F. I. & Katch, V.L. (2010). *Exercise physiology Energy Nutrition and Human Performance,* Lea and Fiberger. Philadelphia.PP165-435

Mckenze, D.C. (2011): Respiratory Physiology: Adaptations to high level exercise. *British journal sports medicine* Doi: 10.1136/bjsports-2011-090824

Michael, K., Butcher, S. J., Marcinuik, D. D. & Bhutani, M. (2012). Assessing Exercise Limitation using cardiorespiratory exercise testing. *Pulmonary Medicine* vol. 2012 (2012) Article ID 824091. Htt://dx.Doi.org/10.1155/2012/82409.

Moradichaleshtori, M.; Salami, A.; & Jafari, A (2008) The effect of amount of physical activity on cardiorespiratory fitness and body composition. *Journal of exercise science and physiotherapy,* 4 (2) 71-75

Mughal, M. A., Alvi, I. A., Akhund, I. A. & Ansari, A.K. (2001). The Effects of Aerobic Exercise Training and Resting Blood Pressure in Hypertensive Patients. *Journal of the Pakistan Medical Association 2001*, 51 (6) PP 222 – 226.

Narayani, U. & Sudhan PaulRaj, R.L. (2010). Effect of aerobic training on percentage of body fat, total cholesterol and HDL-C among obese women. *World Journal of Sports Sciences* 3(1)33 – 36, 2010 ISSN 2078 – 4724.

Nieman, D. C. (1998). *The Exercise Health Connection.* Human Kinetics USA PP 193-201

Norton, K., Norton, L. & Sadgrove, D. (2009). Review. Position statement on Physical activity and Exercise intensity terminology: *Journal of science and medicine in sport*, 13(2010) 496-502.

Ole, J. K.; Per, M. H.; Jan, P. L.; Jan- Bjorn, O.; Tor, S.; Ulrik, W.; & Oyvind,E, (2005) Moderate VS High intensity: Differential effects on aerobics fitness, cardiomyocyte contractility, and endothelial function. *Cardiovascular research* 67 (2005) 161-172

Paoli, A., Quirrico, F. P., Tatiana, M., Guiseppe, M., Marco, N. F. B. & Antonino,B. (2013). Effects of Higher Intensity Circuit Training, Low Intensity Circuit Training, Endurance Training on blood pressure and lipoproteins in middle aged overweight men. *Lipids in health and disease 22013, 12:131* Doi: 10. 1186/1476-511x-12-131

Plowman, S.A., & Smith, D.L. (2008). *Exercise physiology for health, fitness and performance,* (*2nd ed*). Philadelphia, Leppincott Williams and Wilkins PP57-145

Powers, S.K. & Howley, E. T. (2012). *Exercise Physiology, Theory and Application to Fitness and performance. (8th ed):* McGraw Hill: University of Florida, USA PP5-389

Powers, S.K. & Howley, E.T. (1997). *Exercise physiology. Theory and Application to Fitness and Performance,* Brown and Benhmark Publishers USA PP 229-434

Preh, T. O. (2002). Health Related Fitness Status of Obese and Non-obese Adolescents in Zaria. Unpublished MSc Thesis, Department of Physical and Health Education, Ahmadu Bello University, Zaria.

Prentice, W. E. (2006). *Arnheims Principle of Athletic Training: A Competency-Base Approach (12th ed):* McgGraw Hill USA. PP 150-154.

Quinn, E. (2014).What is normal Resting Heart Rate for an athlete and how it is measure. Retrieved on April 10, 2015 from *About..com 2014.*

Ramin, E.; Shirin, Z.; Maryam, Z.& Akrame, A (2012): Comparing two modes of exercise training with different intensity on body composition in obese young girls. *Physical education and sport/science, movement and health* 12 (2012) 473-478

Regaieg, S., Charfi, N., Kamoun, M., Ghroubi, S., Rebai, H., Elleuch, H., Feki, M.M. & Abid, M. (2013). The Effects of an exercise training programme on body composition and aerobic capacity parametres in Tunisian obese children. *Indian Journal of Endocrine Metabolism 2013*, 17:1040-5.

Ross, W.B. & Mayfell-Jones, M. J. (1982). Kinanthropometry, Macougal, J.D., Wanger, H. A, & Green (Editors).*Physiological Testing of Elite Athletes;* Champaign ii; Human Kinetics.

Ruiz, R. J., Rizo, N. S., Hurtig-wennLof A., Ortega, F. B., Warberg, J. & Sjostrem, M. (2006). Relation of total PA and intensity of fitness and fatness in children. *The Europe Youth Heart Study 1, 2, 3 American Journal of Clinical Nutrition August 2006* 84(2) 299 – 303.

Sembulingan, K. & Sembulingan, P. (2010). *Essentials of Medical physiology (7th ed).* St louis (USA); Jaypee Brothers Medical Publishers (P) Ltd PP57-98

Sheehan, K. (2010). The effects of exercise on the Blood Pressure and Pulse.Retrieved on march 20, 2014 from *Livestrong.com weight loss Tools Demand Media Inc*

Shifan, D., Darwin, R. l., Grunbaum, J. A., Ronal, B. H. & William, H. M. (2002).Longitudinal Analysis of changes in indices of obesity from 8 – 18 years. *American Journal of Epidemiology* 156: 720 – 729.

Simon, H. (2013). Physical Activity in depth. Report Exercise *effects* on the Heart Reviewed. *Harvard Medical School Massachusetts General Hospital, Health Guide.*

Skutnik, B. C. & Benjamin, C. (2013).The Effects of high Intensity Interval Training on Resting Mean Arterial Pressure and C – reactive protein in hypertensive subjects. Retrieved on April 11, 2015 *fromhttp://hdl.handle.net/2097/15774*

Slenz, C.A., Aiken, L.B.,Houmard J.A., Bales, C.W., Johnson, J.L., Tanner, C.J., Duscha, B.D.& Kraus, W.E. (2005).Inactivity, exercise, and visceral. STRIDE: a randomized controlled study of exercise intensity and amount. *Journal of Applied Physiology* 99(4) 1613-1618Doi: 10.1152/japphysiol.00124.2005s.

Smith, M. L. & Braven, B. B. (1986). Cardiovascular Response to Lower body negative pressure in endurance and static exercise- in Trained men, *Medicine and Science in sports and exercise, Official journal of the American College of Sports Medicine* 18. 19.

Sola, O. & Chioma, O. (2013). Hypertension why Nigeria Federal Government must act now, Retrieved on 0ctober 9, 2014 from *In health.com.*

Soon-Mi, C., Man-Gyoon, L., Kyung-Shin, P., Yae-Young, K. & Hyoung-Jun, K. (2011). Effects of aerobic exercise training on abdominal fat and ceramide in Korean Middle aged Women. *Medicine and Science in Sports and Exercise (2011),* 43(5) 813 Doi: 10.1249/01.MSS,0000402265.27463.29.

Stephen, P. (2015). Physical fitness: The facts. Retrieved on September 17 from *Htm healthguidience.org*

Tatjana, I., Biljana, V., Branislava, R., Lidija, S. & Todorka, S. (2007). The effects of physical training on cardiovascular parameters and reduction of visceral fatty tissue, *act Medica Medianae, 2007.*

Teller, R. (2012). Resting Heart Rate Health Measurement. Retrieve*d on August 25, 2014 from http://www.ivigor.com/articlesresting-heart rate health measurement.*

Terjung, R. L. (1995). Muscle adaptation to aerobics training. *Sports Science exchange* 1995: 8: 1-4

Trembblay, A., Simoneau, J. A. & Bouchard, C. (1994). Impact of Exercise Intensity on Body Fatness and Skeletal Muscle Metabolism. *Metabolism,* 43(7) 814 – 818.

Turkur, I. T. (1995). Relationship between physical and health related variables of the security men in College of Education Akwanga.(Unpublished) Physical and Health Education Department, Ahmadu Bello University, Zaria

Venkateswarlu, K. (1982). Theory of Athletic Training 2nd edition Mimeographed textbook,P.H.E Department. A. B .U. Zaria; Nigeria.

Venkateswarlu, K. (2010). *Exercise for Disease Prevention and Health Promotion.* Ahmadu Bello University Press, Zaria, Nigeria pp 81-97

Venkateswarlu, K. (2011).Role of Physical Education in the Promotion of Healthy Life Style. Paper presented at the International Conference on Lifestyle, 60a, India.

Vissers, D., Hens W., Taeymans, J., Baeyens, J. P., Poortmans, J. & Van Gaal L. (2013). Effects of exercise on visceral adipose tissue in overweight adults: A Systematic Review and Meta- Analysis *Plos one 2013;* 8(2):e56416 Doi: 10.1371/journalpone.0056415.

Wachner, P. (2014). Resting heart rate.Retrieved on June, 25, 2016 from *About. Com*

Wade, J. (2013), The health benefits of running (and jogging), *Retrieved on June, 25, 2016 from htm.Motley Health 2014*

Wallace, J. P. (2003). Exercise in hypertension. *Sports Medicine* 33(8) 585-608

Wildman, R. E. C. & Miller, B. S. (2004). *Sport and Fitness Nutrition;* Australia; Thomson Wadsworth

Willet, W.C., Dietz, W.H. & Colditz, G.A. (1999). Primary care guidelines for healthy weight. *The New England Journal of Medicine,* 34(6): 427 – 434.

William, M. H. (2007). *Nutrition for Health Fitness and Sport;* McGraw-Hill, Higher Education, Boston

Willis, L. H., Slenz, C. A., Bateman L.A., Shields, A.I., Piner, L.W., Bales, C.W., Houmard J.A. & Kraus, W. E. (2012). Effects of aerobic / or Resistance training on body mass and fat mass in overweight or obese adults. *Journal of Applied Physiology,* 113(12):1831– 1837 doi: 10: 1152/Jappl physiology. 01370. *2011.*

Wilmore, J.H. & Costill, D.L. (2004). *Physiology of exercise and sports.* United State of America; Human Kinetics141-687

Wilt, F. (1998). *Training for Competitive Running In Falls, H. (Ed) Exercise Physiology,* New York Academic Press. 29-97

Wing, R. R. & Phelan, S. (2005), Long-term weight loss maintenance *American. Journal of clinical Nutrition*, 85, 2225-2258.

World Health Organization (2015). *Global recommendations on Physical activity for health.* Geneva, Switzerland: WHO Press.

APPENDICES

APPENDIX A

ROW DATA FOR PARTICIPANTS

BASE-LINE DATA FOR MODERATE INTENSITY (MI)

S/No.	Age	Height	Weight	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.47	54.2	25.1	85.649	77	33.96667	23	13
2	15	1.49	56.1	25.3	83.647	74	35.33333	23	12
3	15	1.51	57.4	25.2	81.644	70	40.5	20	10
4	15	1.49	55.6	25.0	86.308	73	36.5	21	11
5	15	1.61	69	26.6	94.986	80	29.91667	24	14
6	15	1.43	52.4	25.6	86.65	78	32.5	22	12
7	15	1.53	59.1	25.2	83.315	72	38.21667	20	11
8	16	1.52	58.5	25.3	87.319	79	32.36667	21	12
9	16	1.5	56.5	25.1	79.31	71	37.5	20	11
10	16	1.65	70	25.7	84.65	80	32.5	22	12
11	16	1.58	62.3	25.0	81.64	73	36.55	21	12
12	16	1.45	56	26.6	83.98	73	36.4	20	11
13	16	1.54	59.5	25.1	79.975	68	38.55	20	10
14	16	1.64	68.2	25.4	86.648	77	33.83333	22	12
15	17	1.6	64.7	25.3	79.974	69	39.81667	20	11
16	17	1.62	67.5	25.7	92.986	78	31.58333	23	13
17	17	1.54	59.6	25.1	91.652	80	32.25	23	12
18	17	1.59	63.7	25.2	78.99	70	40.5	20	11
19	17	1.62	66.4	25.3	98.989	81	30.1	23	13
20	17	1.6	65.3	25.5	78.983	69	40.66667	20	10

MI (3rd week)

S/No.	Age	Height	Weight	MAP	RHR	VO2max	%BF	VF
1	15	1.47	54.2	84.982	75	34.95	21	12
2	15	1.49	56.1	82.647	72	36.36667	20	11
3	15	1.51	57.4	77.309	69	40.83333	19	10
4	15	1.49	55.6	85.308	71	37.5	20	11
5	15	1.61	69	93.986	78	30.91667	22	13
6	15	1.43	52.4	85.317	76	33.6	21	11
7	15	1.53	59.1	81.315	69	38.61667	19	11
8	16	1.52	58.5	86.319	76	33.41667	20	11
9	16	1.5	56.5	77.977	70	37.83333	19	11
10	16	1.65	70	83.65	78	33.55	20	11
11	16	1.58	62.3	80.974	70	37.4	19	10
12	16	1.45	56	82.98	71	37.31667	19	10

13	16	1.54	59.5	78.975	68	39.05	18	10
14	16	1.64	68.2	85.981	75	34.86667	20	11
15	17	1.6	64.7	78.974	68	40.15	18	10
16	17	1.62	67.5	91.319	76	32.58333	20	11
17	17	1.54	59.6	90.985	77	33.25	20	11
18	17	1.59	63.7	77.99	69	40.83333	19	10
19	17	1.62	66.4	96.655	78	31.1	22	13
20	17	1.6	65.3	75.983	68	41.01667	19	10

MI (6th week)

S/No.	Age	Height	Weight	MAP	RHR	VO2max	%BF	VF
1	15	1.47	54.2	82.982	71	39.3	19	10
2	15	1.49	56.1	79.98	68	40.71667	18	9
3	15	1.51	57.4	75.643	67	44.66667	17	8
4	15	1.49	55.6	83.31	69	41.3	18	9
5	15	1.61	69	91.986	74	35.3	20	11
6	15	1.43	52.4	83.317	72	37.95	19	9
7	15	1.53	59.1	79.315	68	42.3	17	10
8	16	1.52	58.5	84.319	72	37.96667	18	9
9	16	1.5	56.5	75.977	68	41.5	17	9
10	16	1.65	70	81.65	74	37.96667	19	10
11	16	1.58	62.3	77.974	68	41.13333	18	10
12	16	1.45	56	80.98	69	40.93333	18	9
13	16	1.54	59.5	76.642	66	42.71667	17	8
14	16	1.64	68.2	83.981	72	39.23333	18	9
15	17	1.6	64.7	76.974	65	43.96667	17	9
16	17	1.62	67.5	89.319	74	37.76667	19	10
17	17	1.54	59.6	87.985	75	37.61667	18	9
18	17	1.59	63.7	75.99	68	44.66667	17	9
19	17	1.62	66.4	93.655	73	37.16667	20	10
20	17	1.6	65.3	72.983	67	44.83333	17	8

MI (9TH week)

S/No.	Age	Height	Weight	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.47	50.7	23.5	78.982	69	45.46667	17	8
2	15	1.49	52.6	23.7	75.98	64	46.68333	16	8
3	15	1.51	53.9	23.6	72.311	60	50.83333	14	6
4	15	1.49	52.1	23.5	78.31	67	47.31667	16	7
5	15	1.61	65.5	25.3	86.986	70	41.98333	17	9
6	15	1.43	48.9	23.9	77.317	69	44.46667	17	7
7	15	1.53	55.6	23.8	74.649	67	48.48333	15	7
8	16	1.52	55.0	23.8	79.319	68	45.15	15	7
9	16	1.5	53.0	23.6	72.311	66	48.25	15	7
10	16	1.65	66.5	24.4	76.65	70	42.96667	17	8

11	16	1.58	58.8	23.6	74.975	64	49.46667	15	8
12	16	1.45	52.5	25.0	76.98	65	49.26667	15	7
13	16	1.54	56.0	23.6	72.977	62	67.73333	14	6
14	16	1.64	64.7	24.1	78.981	68	45.93333	16	7
15	17	1.6	61.2	23.9	73.31	64	50.66667	14	6
16	17	1.62	64.0	24.4	83.652	70	43.65	17	8
17	17	1.54	56.1	23.7	81.985	70	44.66667	16	7
18	17	1.59	60.2	23.8	69.99	63	64.66667	15	6
19	17	1.62	62.9	24.0	79.985	72	42.86667	18	8
20	17	1.6	61.8	24.1	66.65	61	69.9	14	6

BASE-LINE DATA FOR HIGH INTENSITY (HI)

S/No.	Age	Height	Weight	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.49	56.7	25.5	80.645	69	38.56667	20	9
2	15	1.55	59.1	25.0	81.323	70	37.73333	20	10
3	15	1.49	55.9	25.2	83.315	73	34.16667	21	12
4	15	1.51	60.1	26.4	85.316	80	32.56667	21	13
5	15	1.48	57.3	26.2	82.65	74	35.16667	21	12
6	15	1.52	50.9	26.4	83.983	72	36.53333	21	11
7	15	1.43	51.2	25.0	90.985	76	32.2	21	13
8	16	1.52	59.3	25.7	92.652	78	31.95	22	13
9	16	1.54	58.2	28.2	82.317	68	38.26667	20	10
10	16	1.55	64.1	26.7	80.316	67	40.58333	20	9
11	16	1.61	65.2	25.2	82.654	71	33.95	21	11
12	16	1.58	63.5	25.4	88.653	82	29.81667	23	12
13	16	1.61	66.3	25.6	81.99	73	36.6	20	10
14	16	1.61	65.3	25.2	82.98	74	35.83333	21	10
15	17	1.62	69.1	26.3	80.977	71	39	20	8
16	17	1.55	65.4	27.2	81.983	73	32.6	22	10
17	17	1.57	66.3	26.9	81.648	73	34.31667	21	12
18	17	1.65	70.2	25.8	78.321	66	40.75	20	8
19	17	1.6	64.3	25.1	92.653	79	29.98333	22	13
20	17	1.47	55.1	25.5	83.651	71	38.7	20	9

HI (3rd week)

S/No.	Age	Height	Weight	MAP	RHR	VO2max	%BF	VF
1	15	1.49	56.7	79.645	68	39.1	17	7
2	15	1.55	59.1	80.323	68	38.28333	18	8
3	15	1.49	55.9	82.315	70	35.21667	19	10
4	15	1.51	60.1	84.316	77	33.63333	18	11
5	15	1.48	57.3	81.65	71	36.3	18	10

6	15	1.52	50.9	82.983	69	37.7	18	9
7	15	1.43	51.2	90.652	73	33.36667	18	11
8	16	1.52	59.3	92.319	75	33.15	19	11
9	16	1.54	58.2	81.317	67	38.83333	17	8
10	16	1.55	64.1	79.316	66	41.11667	17	7
11	16	1.61	65.2	78.99	69	35.11667	20	10
12	16	1.58	63.5	85.652	79	31	21	12
13	16	1.61	66.3	81.657	70	37.8	17	8
14	16	1.61	65.3	81.98	71	38.5	18	11
15	17	1.62	69.1	79.977	69	39.58333	17	8
16	17	1.55	65.4	80.983	71	33.85	20	11
17	17	1.57	66.3	80.648	70	35.5	19	10
18	17	1.65	70.2	77.321	64	41.33333	18	8
19	17	1.6	64.3	91.653	76	31.18333	20	11
20	17	1.47	55.1	82.651	69	39.26667	18	9
21	17	1.63	67.3	82.648	73	35.05	19	10

HI (6th week)

S/No.	Age	Height	Weight	MAP	RHR	VO2max	%BF	VF
1	15	1.49	56.7	79.645	68	39.1	17	7
2	15	1.55	59.1	80.323	68	38.28333	18	8
3	15	1.49	55.9	82.315	70	35.21667	19	10
4	15	1.51	60.1	84.316	77	33.63333	18	10
5	15	1.48	57.3	81.65	71	36.3	18	10
6	15	1.52	50.9	82.983	69	37.7	18	9
7	15	1.43	51.2	90.652	73	33.36667	18	11
8	16	1.52	59.3	92.319	75	33.15	19	11
9	16	1.54	58.2	81.317	67	38.83333	17	8
10	16	1.55	64.1	79.316	66	41.11667	17	7
11	16	1.61	65.2	78.99	69	35.11667	20	10
12	16	1.58	63.5	85.652	79	31	21	11
13	16	1.61	66.3	81.657	70	37.8	17	8
14	16	1.61	65.3	81.98	71	38.5	18	9
15	17	1.62	69.1	79.977	69	39.58333	17	8
16	17	1.55	65.4	80.983	71	33.85	20	8
17	17	1.57	66.3	80.648	70	35.5	19	10
18	17	1.65	70.2	77.321	64	41.33333	18	8
19	17	1.6	64.3	91.653	76	31.18333	20	11
20	17	1.47	55.1	82.651	69	39.26667	18	9
17	17	1.57	66.3	80.648	70	35.5	19	10
18	17	1.65	70.2	77.321	64	41.33333	18	8
19	17	1.6	64.3	91.653	76	31.18333	20	11

20	17	1.47	55.1		82.651	69	39.26667	18	9

HI(9th week)

S/No.	Age	Height	WEIGHT	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.49	51.2	23.1	75.312	60	55.08333	11	3
2	15	1.55	53.6	22.3	75.99	61	52.63333	12	4
3	15	1.49	50.4	22.7	77.982	62	49.65	13	6
4	15	1.51	54.6	23.9	79.983	69	47.96667	14	6
5	15	1.48	51.8	23.6	76.65	66	50.65	12	5
6	15	1.52	45.4	19.7	78.65	63	52.13333	12	3
7	15	1.43	45.7	22.3	85.652	67	47.73333	14	6
8	16	1.52	53.8	23.3	87.319	68	47.65	14	5
9	16	1.54	52.7	22.2	76.65	62	53.91667	11	3
10	16	1.55	58.6	24.4	74.65	60	56.15	11	3
11	16	1.61	59.7	23.0	74.657	63	50.28333	12	5
12	16	1.58	58	23.2	81.319	72	46.21667	15	7
13	16	1.61	60.8	23.5	76.657	64	52.96667	12	3
14	16	1.61	59.8	23.1	78.314	66	54.61667	11	3
15	17	1.62	63.6	24.2	74.644	63	55.38333	10	3
16	17	1.55	59.9	24.9	77.317	64	50.98333	13	3
17	17	1.57	60.8	24.7	75.314	64	51.1	12	4
18	17	1.65	64.7	23.8	72.321	60	73.45	10	3
19	17	1.6	58.8	23.0	86.653	68	53.15	12	6
20	17	1.47	49.6	23.0	77.651	60	73.08333	10	3

BASE-LINE DATA FOR LOW INTENSITY (LI)

S/No.	Age	Height	Weight	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.48	57	26.0	84.317	78	33.91667	22	12
2	15	1.49	56.1	25.3	83.984	74	36.01667	20	12
3	15	1.42	52.5	26.0	83.658	72	38.83333	20	11
4	15	1.51	58.2	25.5	90.652	80	33	22	12
5	15	1.51	59.3	26.0	83.648	73	36.66667	21	12
6	15	1.46	54	25.3	94.319	80	31.85	23	13
7	15	1.53	59.8	25.5	83.65	73	36.5	21	11
8	16	1.52	59.7	25.8	87.653	79	32.65	23	12
9	16	1.54	60.5	25.5	82.99	70	41.5	20	9
10	16	1.58	63.6	25.5	90.987	78	31.83333	23	13
11	16	154	61.5	25.9	84.312	73	36.58333	20	11
12	16	1.63	67.5	25.4	91.319	80	32.66667	22	12
13	16	1.41	50.5	25.4	93.653	81	29.95	23	13
14	16	1.58	62.2	24.9	81.31	71	42.23333	20	9

15	17	1.6	64.7	25.3	85.984	78	32.5	22	12
16	17	1.69	70.5	27.5	85.313	73	34.93333	20	11
17	17	1.7	69.3	27.1	85.981	77	34.26667	22	12
18	17	1.65	67.4	26.3	79.643	71	37.05	20	11
19	17	1.64	62	25.5	79.984	69	37.26667	20	9
20	17	1.62	65.6	25.0	80.985	70	36.5	21	12

LI (3rd week)

S/No.	Age	Height	Weight	MAP	RHR	VO2max	%BF	VF
1	15	1.48	57	83.317	76	34.41667	21	11
2	15	1.49	56.1	83.984	73	36.5	19	11
3	15	1.42	52.5	83.658	70	38.98333	18	11
4	15	1.51	58.2	89.652	78	33.5	21	11
5	15	1.51	59.3	82.648	72	38.75	19	12
6	15	1.46	54	92.986	77	33.15	22	13
7	15	1.53	59.8	82.65	70	37	19	11
8	16	1.52	59.7	86.653	77	33.08333	22	11
9	16	1.54	60.5	82.99	69	41.5	19	9
10	16	1.58	63.6	89.987	76	32.43333	22	12
11	16	154	61.5	83.312	72	37	19	11
12	16	1.63	67.5	90.319	78	33.16667	20	12
13	16	1.41	50.5	92.653	80	30.31667	22	12
14	16	1.58	62.2	79.31	69	42.23333	20	9
15	17	1.6	64.7	84.984	76	32.91667	21	11
16	17	1.69	70.5	84.313	71	35.16667	19	10
17	17	1.7	69.3	84.981	75	34.8	21	11
18	17	1.65	67.4	78.643	70	37.16667	20	11
19	17	1.64	62	79.984	69	37.33333	20	9
20	17	1.62	65.6	79.985	69	36.91667	20	11

LI (6th week)

S/No.	Age	Height	Weight	MAP	RHR	VO2max	%BF	VF
1	15	1.48	57	82.317	74	34.8	19	10
2	15	1.49	56.1	82.984	70	36.83333	17	10
3	15	1.42	52.5	82.658	68	39.31667	16	10
4	15	1.51	58.2	88.652	76	34.08333	20	10
5	15	1.51	59.3	81.648	70	39.1	17	11
6	15	1.46	54	91.986	75	33.66667	20	12
7	15	1.53	59.8	81.65	69	37.36667	17	9
8	16	1.52	59.7	85.653	76	33.6	20	10
9	16	1.54	60.5	81.99	69	41.83333	16	8
10	16	1.58	63.6	88.987	74	32.96667	20	11

11	16	154	61.5	82.312	70	37.66667	17	9
12	16	1.63	67.5	89.319	75	33.75	19	11
13	16	1.41	50.5	91.653	76	30.85	20	11
14	16	1.58	62.2	78.31	69	42.73333	17	9
15	17	1.6	64.7	83.984	74	33.41667	19	10
16	17	1.69	70.5	83.313	70	35.81667	18	10
17	17	1.7	69.3	83.981	73	35.3	18	9
18	17	1.65	67.4	77.643	69	37.66667	18	10
19	17	1.64	62	78.984	68	37.86667	18	8
20	17	1.62	65.6	78.985	68	37.46667	19	10

LI 9th week)

S/No.	Age	Height	Weight	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.48	54.8	25.0	81.317	72	35.46667	18	9
2	15	1.49	53.9	24.3	80.984	70	37.5	16	9
3	15	1.42	50.3	24.9	81.658	68	51.46667	16	9
4	15	1.51	56	24.6	87.652	74	34.76667	18	9
5	15	1.51	57.1	25.0	79.648	68	39.61667	16	8
6	15	1.46	51.8	24.3	90.986	72	34.33333	20	9
7	15	1.53	57.6	24.6	80.65	69	51.21667	16	7
8	16	1.52	57.5	24.9	84.653	74	34.26667	18	9
9	16	1.54	58.3	24.6	79.99	67	50.83333	15	7
10	16	1.58	61.4	24.6	87.987	71	33.65	18	9
11	16	1.54	59.3	25.0	80.312	69	48	16	8
12	16	1.63	65.3	24.6	88.319	73	37.83333	18	9
13	16	1.41	48.3	24.3	91.653	74	31.66667	19	10
14	16	1.58	60	24.0	75.31	66	51.56667	15	8
15	17	1.6	62.5	24.4	82.984	70	35.75	18	8
16	17	1.6	68.3	26.7	82.313	68	49.85	17	7
17	17	1.6	67.1	26.2	82.981	71	36.13333	17	8
18	17	1.6	65.2	25.5	76.643	68	51.5	17	7
19	17	1.56	59.8	24.6	77.984	68	50.03333	17	7
20	17	1.62	63.4	24.2	77.985	68	51.25	17	8

BASE-LINE DATA FOR CONTROL GROUP (CG)

S/No.	Age	Height	Weight	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.51	59.3	26.0	81.31	70	38.5	21	9
2	15	1.48	57.1	26.1	83.992	73	35	22	11
3	15	1.55	57.6	27.8	82.98	72	35.16667	21	10
4	15	1.48	54.1	27.6	92.986	79	30.23333	23	12
5	15	1.54	59.5	25.1	83.65	72	36.85	20	10
6	15	1.47	54.1	25.0	89.319	76	32.2	20	11

7	15	1.49	57.5	25.9	81.99	71	38.75	20	10
8	16	1.58	63	25.2	90.652	76	35.23333	21	12
9	16	1.59	64.5	25.5	84.641	71	36.21667	21	11
10	16	1.63	66.5	25.0	91.32	77	32.2	22	12
11	16	1.64	68.4	25.4	83.647	71	35.2	21	12
12	16	1.52	58.3	25.2	81.323	71	36.55	21	10
13	16	1.57	64.1	26.0	82.983	76	33.53333	22	12
14	16	1.56	59.4	25.0	80.316	69	38.26667	20	9
15	17	1.52	58.5	25.3	82.314	74	36.46667	21	11
16	17	1.64	69.5	25.8	90.653	82	29.63333	23	14
17	17	1.62	66.5	25.3	81.323	71	36.51667	20	10
18	17	1.56	65.1	26.8	79.309	71	36.55	20	11
19	17	1.62	67.1	25.6	79.655	68	36.83333	20	10
20	17	1.58	62.5	25.0	78.309	71	36.58333	20	11

CG (3rd week)

S/N.	**Age**	**Height**	**Weight**	**MAP**	**RHR**	**VO2max**	**%BF**	**VF**
1	15	1.51	59.3	81.31	70	38.31667	21	9
2	15	1.48	57.1	84.992	73	34.75	22	11
3	15	1.55	57.6	82.98	72	35	21	10
4	15	1.48	54.1	92.989	79	30.16667	23	12
5	15	1.54	59.5	83.65	72	36.83333	20	10
6	15	1.47	54.1	89.321	75	32.16667	20	11
7	15	1.49	57.5	81.99	71	38.66667	20	11
8	16	1.58	63	90.653	75	35.16667	21	12
9	16	1.59	64.5	84.312	71	36.16667	21	11
10	16	1.63	66.5	91.36	77	32.2	22	12
11	16	1.64	68.4	83.649	71	35.16667	21	12
12	16	1.52	58.3	81.333	71	36.55	21	10
13	16	1.57	64.1	82.985	76	33.5	22	10
14	16	1.56	59.4	80.314	69	38.16667	20	9
15	17	1.52	58.5	82.314	74	36.33333	21	11
16	17	1.64	69.5	90.656	82	29.5	23	11
17	17	1.62	66.5	81.325	71	36.48333	21	10
18	17	1.56	65.1	79.376	71	36.5	20	11
19	17	1.62	67.1	79.665	68	36.83333	20	10
20	17	1.58	62.5	78.320	71	36.5	2o	11

CG (6th week)

S/No.	**Age**	**Height**	**Weight**	**MAP**	**RHR**	**VO2max**	**%BF**	**VF**
1	15	1.51	59.3	81.977	71	36.83333	22	10
2	15	1.48	57.1	85.139	73	34.25	23	12
3	15	1.55	57.6	83.02	72	34.5	21	11
4	15	1.48	54.1	93.988	80	29.83333	24	12

5	15	1.54	59.5	83.65	72	36.33333	22	12
6	15	1.47	54.1	90.210	76	31.66667	22	12
7	15	1.49	57.5	82.02	71	38.16667	23	13
8	16	1.58	63	91.657	76	34.66667	22	12
9	16	1.59	64.5	85.312	72	35.53333	22	12
10	16	1.63	66.5	91.989	78	31.83333	22	12
11	16	1.64	68.4	84.324	72	34.5	21	13
12	16	1.52	58.3	82.343	76	35.85	23	12
13	16	1.57	64.1	83.70	75	33.03333	23	13
14	16	1.56	59.4	81.318	68	36.83333	21	12
15	17	1.52	58.5	83.318	75	35.85	23	12
16	17	1.64	69.5	92.663	82	29.28333	22	12
17	17	1.62	66.5	82.523	72	36.03333	22	11
18	17	1.56	65.1	80.003	71	36.01667	21	12
19	17	1.62	67.1	81.005	68	36.5	21	13
20	17	1.58	62.5	79.010	73	36.15	22	13

CG (9th week)

S/No.	Age	Height	Weight	BMI	MAP	RHR	VO2max	%BF	VF
1	15	1.51	59.3	26.4	82.477	73	33.41667	23	11
2	15	1.48	57.1	26.5	86.059	74	29.58333	24	12
3	15	1.44	57.6	28.3	84.68	74	30.53333	22	12
4	15	1.4	54.1	28.1	94.053	82	29.25	25	13
5	15	1.54	59.5	25.5	85.117	75	34	24	12
6	15	1.47	54.1	25.5	91.153	80	31.18333	24	13
7	15	1.49	57.5	26.4	83.657	73	33.53333	24	13
8	16	1.58	63	25.6	93.319	80	30.75	23	13
9	16	1.59	64.5	25.9	86.642	73	33.5	23	12
10	16	1.63	66.5	25.4	93.054	79	31.33333	23	13
11	16	1.64	68.4	25.8	85.781	73	30.51667	22	13
12	16	1.52	58.3	25.7	84.323	77	31.83333	24	13
13	16	1.57	64.1	26.4	85.317	76	30.85	24	12
14	16	1.54	59.4	25.5	82.783	69	33.01667	22	13
15	17	1.52	58.5	25.8	84.643	76	30.2	23	13
16	17	1.64	69.5	26.2	93.953	83	28.95	23	13
17	17	1.62	66.5	25.7	83.450	73	32.03333	23	12
18	17	1.56	65.1	27.2	81.012	73	29.6	22	12
19	17	1.62	67.1	25.9	82.355	69	32.53333	22	13
20	17	1.58	62.5	25.4	79.576	74	32.15	23	14