RELATIONSHIP BETWEEN BLOOD PRESSURE AND BODY COMPOSITION OF ACTIVE AND INACTIVE STUDENTS OF AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

BY

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA:

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

MARCH, 2011

DECLARATION

I hereby declare that this thesis entitled "Relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria" has been written by me in the Department of Physical and Health Education under the supervision of Professors K. Venkateswarlu and M. A. Chado. The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree at any University.

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ABAH Joshua Agene DATE
NAME OF STUDENT

CERTIFICATION

This thesis entitled "Relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria" by **ABAH Joshua Agene** has met the regulations governing the award of the degree of Master of Science 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.

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Prof. K. Venkateswarlu Date
Chairman, Supervisory Committee

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

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Prof. C.E. Dikki Date
Head of Department

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Prof. A. A. Joshua Date
Dean, Postgraduate School

DEDICATION

This research work is dedicated to the Glory of God for the gift of:

My darling wife

Deaconess Mary Salamatu Abah (Oli-oko)

and my beloved children:

Eleojo Hannah

Ojochide Felicia and Ojogbane Felix

Laraba Patience

Enemali Paul and Enemona Peter

and Mummy's pet,

Ojonugwa Sunday (Jnr.)

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ABSTRACT

This study investigates the relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria. Similar investigations especially in northern universities were very scanty. Furthermore, it was not very clear how blood pressure was affected by such factors as body mass index, waist circumference, waist-to-hip ratio and percent body fat. To this end the hypotheses were formulated for testing. The ex-post facto research design with stratified random sampling technique was used. Thereafter, a sample of 1,297 subjects representing 5% of the targeted population was randomly selected for the study. The Omron automatic digital blood pressure monitor, a flexible measuring tape, bathroom weighing scale, stadiometre and Harpenden skinfold calliper were used to collect data on blood pressure, waist and hip circumferences, body weight, height and three skinfolds from both genders respectively. While waist to hip ratio and body mass index were determined, percent body fat was calculated from total skinfolds and gender specific body density formula. The completed International Physical Activity Questionnaire (IPAQ) - short version were coded and used to categorise the students into active and inactive subjects. The data were imputed into the system and was analysed using the Pearson Product Moment Correlation Coefficient (SPSS 14 for Windows) to determine relationship between the variables. Decision to accept or reject the hypotheses was made at $P \leq 0.05$ alpha level of significance. Major findings of the study revealed that: Relationship between systolic and diastolic blood pressures was positively significant among the active and inactive subjects in this study; Relationship between systolic blood pressure and body mass index was positively significant among the active and inactive subjects in this study; Relationship between diastolic blood pressure and body mass index was positively significant among the active and inactive subjects in this study and Relationship between waist circumference and body mass index was positively significant among the active and inactive subjects in this study. On the basis of these findings, it was therefore recommended that since high blood pressure is a silent killer disease; adults should be encouraged to participate in at least moderate intensity physical activity three to five times per week throughout life.
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CHAPTER ONE

INTRODUCTION

1:1 Background of the Study

Body composition is the relative amount of fat and fat free mass of the body (Maud and Foster, 1995; Dikki, 1996; Gwani, 1996; Heyward, 1997; Plowman and Smith, 1997; Oladipo and Angba, 2005 and Venkateswarlu, 2007). It has been well established that with increasing age, adults become more and more inactive as they store fats in their bodies, which slow down metabolism leading to the secretion of chemicals such as cortisol, leptin and other hormones which are more likely to cause obesity (United States Department of Health and Human Services, 1996 in Heyward, 1997; and Varo, *et al;* 2003). Furthermore, people accumulate fat mass when their caloric intake is higher than their caloric expenditure, although, a host of factors like genetics, metabolism, culture, and lifestyle confound the picture as body fat increases and lean body mass decreases (Standford, 1988 in Duquet and Day, 1990; Maud and Foster, 1995 and Ganong, 2005). The density of bone and muscle tissue are greater than the density of fat tissue, hence, the leaner, more muscular individual will weigh more than an individual with a large amount of fat (Plowman and Smith, 1997). It was also found, however, that active lifestyle has a positive effect on the age related changes in body composition. Active adults have moderate amount of fat and more lean body mass than their inactive peers (Wilmore and Costill, 1988 in Naohiro, *et al;* 2002); supporting the idea that regular physical activity may decrease the risk of overweight and obesity among adults (United States Department of Health and Human Services, 2004 in Santos, *et al;* 2008).

For majority of adults, physical activity is the primary setting for reducing the likelihood of high blood pressure, heart disease, colon cancer and depression (Koop, 1999 in Haruna, 2006b). Unfortunately, there has been a decrease in daily participation in physical activity among university students (Haruna, 2006c and Venkateswarlu, 2007).

The tendency has been to give less attention to physical activity, under the assumption that physical fitness is not as important as reading, writing and mathematics. Similarly, in many universities of the world, physical activity is perceived as being a non-productive cognitive activity, less important to a successful future than other academic subjects, thus physical activity occupies a low position at the bottom of the curriculum barrel (Varo, *et al;* 2003; Oladipo and Angba, 2005; and Haruna, 2006c); settling down for a more sedentary lifestyle (Venkateswarlu, 2007). Claude and Depres, (1995) in Adegun, (2005) observed that a sedentary lifestyle is a risk factor for a number of diseases that become more prevalent with age in both genders. It was rightly observed from studies that the incidence of fat accumulation due to inactive lifestyle and other tendencies such as positive energy balance and excessive gestational weight gain affect quality of life with serious health implications of high blood pressure or hypertension, ischaemic heart disease, certain cancers, type two diabetes mellitus and cardiovascular disease.

Cardiovascular Disease (CVD) is among the most killer diseases. This disease is more serious than cancer (Bakari, *et al;* 2007). If all forms of cardiovascular diseases are eliminated, total life expectancy could increase by about ten years. If all forms of cancer are eliminated life expectancy would increase by only three years (Nwabunike, 1992; Onyemelukwe, 2003; Brambilla and Pietrobelli, 2007; and Venkateswarlu, 2007). Cardiovascular disease is not a single disease but is a general term given to more than twenty different diseases of the heart and its blood vessels like hypertension, Ischaemic Heart Disease, Coronary Heart Disease, cerebrovascular disease (stroke), peripheral vascular disease, heart failure, and atherosclerosis (Hampton, 1983; Ogundipe, 2006; Roy, 2006; and Yang, *et al;* 2006). Atherosclerosis, the building up of fatty plaque materials in the layer of blood vessels, and the most important disease of larger and medium sized arteries in the western world, is the underlying factor of most of the cardiovascular diseases (Hampton, 1983; Venkateswarlu, 2007; Kalichman, *et al;* 2006). When atherosclerosis plaque blocks one or more of the hearts coronary blood vessels, the diagnosis is coronary heart disease, the major form of cardiovascular disease. In this disease process, a blood clot is often formed in the narrowed coronary artery, blocking the blood supply to the part of the heart muscle supplied by the artery. This causes heart attack or myocardial infarction. Atherosclerosis can also block blood vessels in the brain that leads to stroke, or legs that lead to peripheral artery disease (for instance, gangrene). In all parts of the system, blood flow is always from a region of higher pressure to one of lower pressure. The pressure exerted by any fluid is termed hydrostatic pressure. In the cardiovascular system, this denotes the force exerted by the blood against any unit area of the walls of the blood vessels (Vander, *et al;* 2001; Musa, *et al;* 2001 and Hlaing, *et al;* 2001). Pressure is the force generated in the blood by the contraction of the heart, and its magnitude varies throughout the system (Butkap, 2002).

High blood pressure (HBP), also called hypertension is a sustained elevation of the systemic arterial pressure It is both a risk factor for coronary heart disease and disease by itself. Blood pressure is usually categorised as follows:

(a) Normal category in which systolic blood pressure (SBP) is less than 130mm Hg and diastolic blood pressure (DBP) is less than 85mm Hg.

(b) High normal category in which systolic blood pressure is between 130mm Hg and 139mm Hg and diastolic blood pressure is between 85mm Hg and 89mm Hg.

(c) High or severe category in which systolic blood pressure is 140mm Hg and higher and diastolic blood pressure is 90mm Hg and higher (United States Department of Health and Human Services, 1996 in Heyward, 1997; Dudeja, *et al;* 2001; Musa, *et al;* 2001; Onyemelukwe, 2003; Varo, *et al;* 2003; Ganong, 2005 and Venkateswarlu, 2007).

There are millions of people who have high blood pressure (hypertension), one fourth of whom don't even know that they are hypertensive (asymptomatic). There are many more that are at high risk of developing high blood pressure. High blood pressure is a killer disease because it does not give any warning. It increases the risk of heart disease, stroke and kidney failure. If it is not detected and treated, it can cause:

(a) Enlargement of the heart, leading to heart failure.

(b) Formation of small blisters called aneurism in the blood vessels of the brain, leading to stroke, (c) Hardening of arteries faster throughout the body, leading to stroke, heart attack, or kidney failure, and (d) Narrowing of blood vessels in the kidney, leading to kidney failure.

There are several factors associated with the incidence of high blood pressure. Some of these factors like heredity, family background, age and sex are unmodifyable. There are factors that are modifyable like diet, exercise, sleep, consumption of fatty diet, obesity, overweight and cigarette smoking. Exercise physiologists attempt to use different forms of exercise as an intervention to prevent the incidence of overweight and obesity. Appropriate, adequate and timely intervention can be beneficial and effective only when it is based on the relationship between blood pressure and different modifyable risk factors.

This investigation was therefore conducted to determine the relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria. To the best of the researcher's knowledge, studies of this magnitude were very scanty, especially in institutions of higher learning in northern Nigeria. Furthermore, it was not very clear how blood pressure was affected by such factors as body mass index, waist circumference, waist-to-hip ratio, percent body fat hence the problematic of this study. The study was therefore conducted to determine the relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio, and percent body fat of active and inactive students of Ahmadu Bello University, Zaria.

1:2 Research Questions

This investigation was designed to answer the following questions:

(i) What is the relationship between blood pressure and body composition of active students of Ahmadu Bello University, Zaria?

(ii) What is the relationship between blood pressure and body composition of inactive students of Ahmadu Bello University, Zaria?

(iii) What is the relationship between blood pressure and body composition of active male students of Ahmadu Bello University, Zaria?

(iv) What is the relationship between blood pressure and body composition of active female students of Ahmadu Bello University, Zaria?

(v) What is the relationship between blood pressure and body composition of inactive male students of Ahmadu Bello University, Zaria?

(vi) What is the relationship between blood pressure and body composition of inactive female students of Ahmadu Bello University, Zaria?

1:3 Basic Assumptions

This investigation was based on the following assumptions:

(i) Blood pressure of males is higher than that of females.

(ii) Males are more active than females.

(iii) Percent body fat, obesity, overweight, body mass index and other indices are influenced by lifestyle factors which include nutrition, physical activity, sedentarism, and smoking; like in the case of blood pressure.

(iv) Blood pressure, body mass index, waist circumference, waist-to-hip ratio and percent body fat can be determined.

(v) Inactive individuals are likely to suffer certain kinds of hypokinetic diseases than the active subjects.

1:4 Purpose of the Study

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The study was conducted to determine the:

(i) Relationship of blood pressure with body composition of active subjects.

(ii) Relationship of blood pressure with body composition of inactive subjects.

(iii) Relationship of blood pressure with body composition of active male subjects.

(iv) Relationship of blood pressure with body composition of active female subjects.

(v) Relationship of blood pressure with body composition of inactive male subjects.

(vi) Relationship of blood pressure with body composition of inactive female subjects.

1:5 Hypotheses

Based on the research questions and purpose of this study, the following hypotheses were formulated for testing this study:

Major Hypothesis

There is no significant relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria.

Sub-Hypotheses

(i) There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active students of Ahmadu Bello University, Zaria.

(ii) There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of inactive students of Ahmadu Bello University, Zaria

(iii) There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active male students of Ahmadu Bello University, Zaria

(iv) There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active female students of Ahmadu Bello University, Zaria

(v) There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of inactive male students of Ahmadu Bello University, Zaria.

(vi) There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of inactive female students of Ahmadu Bello University, Zaria.

1:6 Significance of the Study

This study is justified on the following basis:

(i) Research evidence regarding the relationship of blood pressure with body composition is inconsistent, especially among active and inactive Nigerian males and females. This study would show how blood pressure relates with body composition.

(ii) The research would add to the existing literature in exercise and sport science.

(iii) The study would guide sport organizers in the selection and placement of athletes, for instance, the endomorphs, mesomorphs and the ectomorphs could assume different placements as swimmers, throwers or sprinters respectively.

1:7 Delimitation

The study was delimited to the following:

(i) All undergraduate and postgraduate students of Ahmadu Bello University, Zaria between ages 20 - 49 years within the Main Campus, Samaru.

(ii) Assessment of blood pressure, body mass index, waist circumference, waist-to-hip ratio and percent body fat.

1:8 Limitations of the Study

The following limitations were considered while interpreting the result:

(i) Although percent body fat can be assessed more objectively with greater precision in the use of such sensitive methods such as, underwater weighing or hydrostatic, ultrasonography, Computer Tomography Scan, Lunar Prodigy DXA scanner, and Magnetic Resonance Imaging; only skinfold measurement was used to estimate percent body fat in this study because it is simple and easy to use.

(ii) A better understanding of blood pressure can be made by assessing it in different positions - sitting, lying, and standing. The sitting position was adopted because it was more conventional with relatively comparable results.

1:9 Operational Definition of Terms

Terms to be defined in this study are:

Active students: students whose energy expenditure ratio is ≥ 6.0 metabolic equivalent task (in mL/kg/min) or ≥ 1000 (man hours).

Blood pressure: the force exerted by the blood against any unit area of the walls of the blood vessels. It is assessed in millimmetres of mercury (mm Hg)

Body composition: this is the relative amount of fat and fat free mass (for example, bones, blood vessels, cartilage, ligaments, nerves, tendons and water) of the body.

Inactive students: students whose energy expenditure ratio is ≤ 6.0 metabolic equivalent task (in mL/kg/min) or ≤ 1000 (man hours).

.**Students:** all postgraduate and undergraduate male and female subjects between 20 – 49 years of age of 2007/2008 academic session of Ahmadu Bello University, Zaria.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2:0 Introduction

The purpose of this chapter is to review literature related to the relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria. The literature review is discussed under the following sub-titles:

2:1 Concept of Blood Pressure

2:2 Blood Pressure and Age of Active and Inactive Subjects

2:3 Blood Pressure and Sex of Active and Inactive Subjects

2:4 Blood Pressure and Body Mass Index of Active and Inactive Subjects

2:5 Blood Pressure and Waist-to-hip ratio of Active and Inactive Subjects

2:6 Blood Pressure and Percent Body Fat of Active and Inactive Subjects

2:7 International Physical Activity Questionnaire (IPAQ)

2:8 Summary of Review of Related Literature

2:1 Concept of Blood Pressure

The task in this section is to introduce the concept of blood pressure: high and low pressures, causes and prevention. In all parts of the system, blood flow is always from a region of higher pressure to one of lower pressure. The pressure exerted by any fluid is termed hydrostatic pressure. In the cardiovascular system, this denotes the force exerted by the blood against any unit area of the walls of the blood vessels (Vander, *et al;* 2001; Musa Musa, *et al;* 2001 and Hlaing, *et al;* 2001). Pressure is the force generated in the blood by the contraction of the heart, and its magnitude varies throughout the system (Butkap, 2002). The units for the rate of flow are volume per unit time, usually liters per minute (L/min). The units for the pressure difference driving the flow are millimeters of mercury (mm Hg) because historically blood pressure was measured by determining how high a column of mercury could be driven by the blood pressure (Toselli, *et al;* 2001 and Vander, *et al;* 2001). When one says that the pressure in a vessel is 50mm Hg, one means that the force exerted is sufficient to push a column of mercury up to a level 50mm high.

For convenience, it is important to state that, blood pressure consists of systolic and diastolic blood pressures. The orderly process of depolarization triggers a recurring cardiac cycle of atria and ventricular contractions and relaxations (Bakari, *et al;* 2007 and Brambilla and Pietrobelli, 2007). The cycle is divided into two major phases, both named for events in the ventricles: the period of ventricular contraction and blood ejection, systole, followed by the period of ventricular relaxation and blood filling, diastole. At an average heart rate of 72 beats per minute, each cardiac cycle lasts approximately 0.8seconds, with 0.3 seconds in systole and 0.5 seconds in diastole (Dudeja, *et al;* 2001; Musa, *et al;* 2001 and Vander, *et al;* 2001).

Hypertension is a sustained elevation of the systemic arterial pressure. Hypertension can be produced by elevating the cardiac output, but sustained hypertension is usually due to increased peripheral resistance. Since the arterial pressure is the product of the cardiac output and the peripheral resistance, it is affected by conditions that affect either or both of these factors. Emotion, for example, increases the cardiac output, and it may be difficult to obtain a truly resting blood pressure in an excited or tense individual (Toselli, *et al;* 2001; Varo, *et al;* 2005 and Haruna, 2006C). There is a good deal of controversy about where to draw the line between normal and elevated blood pressure levels (hypertension), particularly in older subjects. However, the evidence seems incontrovertible than in apparently healthy humans both the systolic and the diastolic pressure rise with age (Venkateswarlu, 2007). The systolic pressure increase is greater than the diastolic. An important cause of the diastolic pressure rise is decreased distensibility of the arteries as their walls become increasingly rigid. At the same level of cardiac output, the systolic pressure is higher in old subjects than in young ones because there is less increase in the volume of the arterial system during systole to accommodate the same amount of blood (Vander, *et al;* 2001 and Venkateswarlu, 2007).

The cause of hypertension is increased release of rennin from the kidneys, with subsequent increased generation of the potent vascoconstrictor angiotensin II (Vander, *et al;* 2001 and Varo, *et al;* 2005). However, for more than 95 percent of the individuals with hypertension, the cause of the arterial constriction is unknown. Hypertension of unknown cause is called primary hypertension (formerly "essential hypertension"). At present, much evidence suggests that excessive sodium retention is a contributing factor in genetically predisposed ("salt-sensitive") persons. Many persons with hypertension show a drop in blood pressure after being on low – sodium diets or receiving drugs termed diuretics that cause increased sodium loss via urine. Obesity and a sedentary lifestyle are definite risk factors for primary hypertension, and weight reduction and exercise are frequently effective in causing some reduction of blood pressure in persons with hypertension. Cigarette smoking, too, is a definite risk factors (Vander, *et al;* 2001; Butkap, 2002; Yang, *et al;* 2006 and Venkateswarlu, 2007).

The term hypotension means a low blood pressure, regardless of cause. One general cause of hypotension is loss of blood volume, as for example in hemorrhage. It may occur in the basic loss of salts, particularly sodium, and water. Such fluid loss may occur via the skin, as in severe sweating or burns. It may also occur via the gastrointestinal tract, as in diarrhoea or vomiting, or via unusual large urinary loss (Vander, *et al;* 2001; Oladipo and Angba, 2005 and Haruna, 2006C). Hypotension may be caused by events other than blood or fluid loss. One major cause is depression of cardiac pumping ability (for example, during a heart attack). Another cause is strong emotion, during which hypotension can cause fainting (Venkateswarlu, 2007). Massive liberation of endogenous substances that relax arterial smooth muscle may also cause hypotension by reducing total peripheral resistance. An important example is the hypotension that occurs during severe allergic responses (Musa, *et al;* 2001; Toselli, *et al;* 2001; Butkap, 2002 and Varo, *et al;* 2005). The most serious consequences of hypotension are reduced blood flow to the brain and cardiac muscles.

2:2Blood Pressure and Age of active and Inactive Subjects

It is well understood that blood pressure and age are directly proportional: Blood pressure increases as age increases since the ageing process causes a thickness of the walls of the blood vessels, especially in the inactive populations. This phenomenon is usually associated with overweight and obesity, among other factors. The statement is duly supported by Zhang and Wang, (2004), and Sjostrom, *et al;* (2006) in Santos, *et al;* (2008) that, older males and females were more frequently overweight and obese than young adults. In addition, decreased physical activity and decreased energy expenditure with ageing predispose individuals to fat accumulation and fat redistribution. Ageing, according to Beaufrere and Morio, (2000); and Villareal, *et al;* (2004) in Santos, *et al;* (2008), reduction in muscle mass (sarcopenic obesity) is an important determinant of sedentary lifestyle and resting metabolic rate, suggesting the need for tailored improvement in activity level and promotion strategies in this group.

Findings of similar studies by Varo, *et al;* (2003); Henry, *et al;* (2004); Babatunde, (2005) and Santos, *et al;* (2008) suggested that not only is age an effective means of increasing blood pressure, but also that it may not be necessary to achieve excessive weight in certain populations due to certain environmental factors, traditions, existing lifestyle and immunity. White, *et al;* (1986); Heyward, (1997); Naohiro, *et al;* (2002), and Westerterp and Plasqui, (2009) however advised that it is necessary to adopt active lifestyle throughout life (all ages) on the average to reduce the incidence of overweight, a harbinger of high blood pressure and other cardiovascular diseases. The prevalence rates of diastolic hypertension for males under 50 years were significantly higher than the rate for females under 50 years, hence, the prevalence of hypertension greatly increased among women aged 50 – 69 and the rates increased consistently with age except for a slight decrease in men aged 60 to 69. This study was therefore, corroborated by White, *et al;* (1986); Shimato, *et al;* (1989) in Venkateswarlu, (2009). According to Stanford, (1988) in Duquet and Day, (1990), it has been well established that with increasing age in adulthood, body fat increases and lean body mass decreases. It was also found, however, that training had a positive effect on the age related changes in body composition. Active adults have less fat and leaner body mass than their inactive peers. In supporting, Wilmore and Costill, (1988) in Duquet and Day, (1990); Plowman and Smith, (1997); and Henry, *et al;* (2004) opined that, since it is known that in sedentary or inactive females, fat increases between 40 and 70 years of age, intensive training in the present group of subjects may have helped them in maintaining a lean body type well into the 6th and 7th decades of life. This is further observed by prominent scholars like Stirling, *et al;* (1986) in Westerterp and Plasqui (2009), that moderately active lifestyle in females were higher in mesomorphy and lower in ectomorphy than inactive control subjects. Blair, *et al;* (1988) in Duquet and Day, (1990) lend further support that increased relative body fat has been linked to coronary heart disease and adult onset of diabetes and that staying physically active may go a long way in preventing these debilitating diseases of old age. According to Anyanwu (1999) in Babatunde (2005); Henry, (2004) and Mutikainen, (2009), they confirmed that after age thirty-five, muscular strength, endurance, maximum oxygen uptake and even the rate of heart beat decrease. This is the more reason why sports scientists consider it a waste of time, human and material resources to concentrate on athletes who are above thirty-five years for high level sports competition. Empirical observations have shown that athletes in the prime of their youth are sure to respond promptly to sports training and display exciting performances provided that an enabling environment is provided for them. No doubt excellent performance in sports goes with age of participants and other endogenous and exogenous factors such as gender, strength, availability of facilities, equipment, motivation and planning strategy. It has been rightly observed by Ajayi-Vincent, (2005); and Haruna, (2006a) that physical activity before age thirty-five is significant if purposeful achievement is envisaged, and should continue throughout life for maximum health. The study failed to show the level of significance between blood pressure and age in relation with other variables in this study.

2:3 Blood Pressure and Sex of Active and Inactive Subjects

There is a unanimous acceptance by many researchers in the fields of exercise science, health and medicine that blood pressure varies with sex as in age. This was by White, *et al;* (1986); Mufunda, (2007) and Naohiro, (2007) that resistance in the vessel may raise, for instance, when the nervous system increases its tonicity or when age causes a thickness of the walls. It also varies according to season, since it is lower in summer than in winter. But the blood pressure also varies over 24 hours and in period of sleep. A recording of the blood pressure monitor provides this data. Lastly, the blood pressure fluctuates in the short-term according to our emotions, the respiratory rate, and our nervous commands, which automatically control the blood pressure. Kenny and Seals, (1993) and Thompson, (2001) in Lakha and Laaksonen, (2007) and Haruna, (2006b) held that systolic blood pressure increases during active exercise in relation to the intensity of effort in males than in females, but blood pressure levels drop bellow resting levels in the two to four hour or more following an exercise session of at least twenty minutes in both genders, systolic blood pressure decreases after a single bout of exercise of eight to ten mm Hg and diastolic blood pressure decreases by three to five mm Hg, but the decrease can be up to two – fold greater in subjects with hypertension (White, *et al;* 1986; Naohiro, *et al;* 2002 and SIRC, 2007). This condition was supported by Maud and Foster, 1995; Fox, 1996 and Heyward; 1997 that relatively low – intensity physical activity, corresponding to 40% of maximal oxygen consumption (VO2 max), acutely lowers blood pressure in both males and females. However, Hanson, (1998) in Heyward, (1997) that failure of systolic blood pressure to raise or a significant drop in systolic blood pressure (20mm Hg) during the exercise test are indicators of coronary heart disease or heart failure.

In an eight weeks study conducted by Whelton, *et al;* (2002) in Lakha and Laaksonen, (2000), it was indicated that physical activity decreases systolic and diastolic blood pressures by 3.8 mm Hg and 2.6 mm Hg in adult male and females with normal or elevated blood pressure. The decrease in blood pressure was similar in trials in which no weight loss occurred, and also in both lean and obese individuals. Haruna, (2000c); Naohiro, *et al;* (2002) and Ojeme, *et al;* (2005) concluded that the benefit of physical activity in males and females with hypertension was slightly more than in those without hypertension. It is equally imperative to discuss a little of cardiovascular responses evidenced between the sexes. According to Adeyanju, *et al;* (1993) and Plowman and Smith, (1997), females have a higher heart rate than cardiac output with a lower stroke volume than males during submaximal physical activity when work is performed at the same absolute workload. The lower stroke volume is due to the smaller heart size in females. The higher rate more than compensates for the lower stroke volume in females, resulting in the higher cardiac output seen at the same absolute workload. Thus, in line with Malina, *et al;* (1991); and Ogawa, *et al;* (1992) in Plowman and Smith, (1997) if a male and a female perform the same workout, the female will typically be stressing the cardiovascular system to a greater extent. Males and females display the same pattern of response for blood pressure; however, males tend to have a higher systolic blood pressure than females at the same relative workload. Much of the difference in the magnitude of the blood pressure response is attributed to differences in resting systolic blood pressure. Diastolic blood pressure response to submaximal physical activity is very similar for both sexes. Thus, mean arterial pressure is slightly greater in males during submaximal work at the same relative workload. The pattern of response for resistance is similar for males and females, although males typically have a lower resistance owing to their greater cardiac output. According to Plowman and Smith, (1997); Kouvonen, *et al;* (2006); and Oladipo and Angba, (2006) males and females both exhibit cardiovascular drift during heavy, prolonged submaximal physical activity because males have approximately six percent more red blood cells and 10 – 15% more heamoglobin than females, thus, males have a greater oxygen – carrying capacity than females.

Epidemiological studies conducted by Astrand, and Rodahl, (1986); in Plowman and Smith (1997) and Venkateswarlu, (2009) reported an inverse relationship between blood pressure and physical activity level in males and females, which is in agreement with this study. Paffenbarger, *et al;* (1991) in Heyward, (1997) also argued that regular physical activity reduces systolic and diastolic blood pressures by about 10 mm Hg in hypertensive in both males and females; moreover, these reductions in blood pressure in overweight and normal weight individuals are independent of weight loss. Hagberg, (1990); and Tipton, (1994) in Heyward, (1997) assured that regular physical activity, however, does not lower blood pressure which is already normal and resistance training also lowers blood pressure in both adolescents and adults with hypertension. Cononic, *et al;* (1991) in Heyward, (1997) reported no change in blood pressure in both males and females (70 to 79 years) with normal or slightly elevated blood pressure in response to six months of resistance training. Adeyanju (1999) and Nwankwo (2001) in Babatunde (2005) reported that female sports participation has increased globally, in the nation, state or local and at the university level, not minding many discriminatory practices that exist against their involvement in sports: There are those who dare the consequences. These individuals participate, sponsor, encourage and reward sports. However, the ratio of sports females to male is still very low and not impressive considering the highlighted benefits that females often exercise for cosmetic reasons such as weight and figure control (Pollock, 1978, and Haruna, 2000c). With this situation of females in sports, exercise scientists are still required to plot out some logistics to bail the female population out of sports enslavement so that they can have more and equal opportunity to sports (Adeyanju, 1999, and Nwankwo 2001 in Babatunde, 2005). As mentioned earlier, myriad of authors pointed to the fact that sex variation and increased age with a sedentary lifestyle are important factors in high blood pressure. Meanwhile, efforts should be made to group the active population according to sex and age for effective sport participation.

2:4 Blood Pressure and Body Mass Index of Active and Inactive Subjects

Weight and height are the subsets of body mass index (BMI) in anthropometric measurement; similarly, body mass index is a ratio of total body weight to height expressed as kilogramme per metre squared (Wt/H^2). This ratio is also known as Quetelet index (Brodie, 1988; Revicki and Israel, 1986 and Satwarts, *et al;* 1980 in Plowman and Smith (1997). In a recent population study by White, *et al;* (1986); Bouten, (1995), Maud and Foster, (1995); Oladipo and Angba, (2006); and Santos, *et al;* (2008) weight and height were assessed directly through a self-reported questionnaire and used to evaluate weight status according to World Health Organisation (WHO) recommendations. In Nigerian setting, for instance, the self-report method might be practically impossible, even among the elites because many people are unaware of this vital information. Body mass index based on self-reported data, could indicate an under-estimation of the true prevalence of overweight and obesity (Yun, *et al;* 2006 in Santos, *et al;* 2008). Nevertheless, body mass index from self-reported data was found to be sufficiently accurate and widely used in epidemiological studies, since objective measurements of weight and height in large samples can be difficult and unaffordable. To calculate body mass index, Duquet and Day, (1996); Philipaerts, *et al;* (2007); and Santos, *et al;* (2008) submitted that for each subject we used self-reported values for weight and height because large samples make direct measurements difficult and unaffordable. When asked for their weight and height, participants tended to over-report height and under-report weight, but despite this tendency, self-reported weight and height had been found to be sufficiently accurate for use in epidemiological studies involving comparative and relative measures, and their errors do not include significant effects on measures of association (Matthews, *et al;* 2000 in Varo, *et al;* 2003). Calculated body mass index can then be compared against table values to determine whether the individual has acceptable body weight, overweight or obese (White, *et al;* 1986; Maud and Foster, 1995; Plowman and Smith, 1997, Oladipo and Angba, 2006, and Santos, *et al;* 2008). Ekelund, *et al;* (2002) in Henry, *et al;* (2004) suggest that obese subjects are less physically active than the normal weight populations, but that activity related energy expenditure is not different between male and females. In a recently conducted study on the United Arab Emirates (UAE), the overweight (BMI >85th percentile) adolescent females did not appear to be less physically active than the normal weight subjects. Rolland – Cachera, *et al;* (1991) in Santos, *et al;* (2008) affirmed that typically in developed countries, adults tend to gain weight between the third and the sixth decade, after this period, weight is often maintained, followed by a modest decrease in the nineth decade which means that these men may continue to gain weight for the next two or three decades if their lifestyle remain unchanged. This segment of the populations should be considered at risk and assigned for selective lifestyle interventions (Santos, *et al;* 2008).

Participation in physical activity, according to Hill and Peters, (1998) in Henry, *et al;* (2004) has been affected by advancement in technology and transportation. Male and female students prefer indoor activities to outdoor activities, such as watching television, video games, and using the computer. In a recently conducted study on United Arab Emirate, television watching was the predominant leisure time pursuit. The findings agreed with previous observations in a cohort study by Andersen, *et al;* (1998) in Henry, *et al;* (2004); hence, overweight may restrict physical activities in some individuals. Thus, physical activity and levels of inactivity in overweight populations in the United Arab Emirate warrants further investigation. Since both weight and amount of body fat tend to increase with age, it is relevant to compare the strength of the association of body mass index and skinfold measurement with high blood pressure. In a sample of Canadian study, body mass index proved overall to be more closely related to high blood pressure than did skinfold measurement. Findings of Duquet and Day, (1990); and SIRC, (2007) suggested that not only is weight loss an effective means of lowering blood pressure, but also that it may not be necessary to achieve "ideal weight" to reduce blood pressure to normal levels. Meanwhile, it is pertinent to note from the preceding section that while a low body mass index predicts a low blood pressure, a proportional increase in body mass index also influences a concomitant increase in blood pressure. Increased risk of blood pressure predisposes an individual to several non-communicable diseases like cardiovascular disease, coronary heart disease, osteoarthritis and metabolic abnormalities in adulthood. As pointed out by Durnin, (1994) in Plowman and Smith, (1997), subjects with low body mass index in relation to height, expressed as the body mass index, have less difficulty moving their body during weight – bearing activities like walking or stair climbing, than subjects with a higher body mass index. These individuals regularly have lower systolic and diastolic blood pressures in either active or inactive population.

Body mass index is often a decisive factor in the constitution of the body and contributes greatly to functional performance. It is not mass per se that is of primary concern, but rather, the proportion of total body fat to fat free mass (FFM). Williams, (2002); Jeukendrup, (2005); Otinwa, (2005 in Venkateswarlu, (2009) the gain of muscle fiber must probably have been as a result of hypertrophy of the muscles with its major contributory factors; according to Fox, (1996), are an increased diametre of existing fibres. This in itself, is due to a greater number of myofibrils per fibre, more total protein and ligamentous tissues; an increased number of fibres, resulting from longitudinal fibre splitting. Therefore, Duhu, (1978); Bouten, (1995); Agwubike, (1988) in Ajayi – Vincent, (2005); and Kouvonen, *et al;* (2006) held that hypertrophied muscles have an increase in the size and functional capacities of the active populations and imposed energy reserve is assured in hypertrophied muscles; hence, lean tissue is metabolically active, and the more its quantity relative to fat, the more likely with mechanical efficiency. The study is therefore in conformity with the position of Mayhew and Gross, (1974); Wilmore, (1974); Fox and Matthews, (1981); and Agwubike, (1992) in Mwisukha, *et al;* (2009) who supported a significant gain in lean body weight following appropriate aerobic training. Following advances in technology, transportation and a sedentary lifestyle, weight gain and increased fat deposition reach their peak within the second and third decades of life. In this documentary, it has been well stressed that increased body weight, height and body mass index influence blood pressure, however, the study failed to show activity level of the subjects in relation to increased blood pressure and other variables in this study. Meanwhile, exercise intervention should be mounted early in life to curb the menace of overweight, obesity and cardiovascular disease or metabolic syndrome.

2:5 Blood Pressure and Waist to Hip Ratio of Active and Inactive Subjects

Computation of waist-to-hip ratio was suggested as a way to estimate the risk pattern of fat distribution. Research has shown that the waist-to-hip ratio (WHR) is a stronger predictor for diabetes, coronary artery disease, and overall morbidity risk than body weight, body mass index, or percent body fat as reported by White, *et al;* (1986); Brownell, *et al;* (1987) and Falson, *et al;* **(xx)** in Plowman and Smith, (1997) and SIRC, (2007). Waist circumference is measured with a tape measure, to the nearest centimeter, at the level of the natural indentation or at the navel if no indentation is apparent. Hip circumference is measured at the largest site. Both measures should be taken while the individual is standing with loosed indoor clothing. The average values for the females ages 17 – 39 are 0.80, and this value increases with age to 0.90. Comparable averages for males range from 0.90 to 0.98. Values above these averages raise the health risks for individuals of both sexes (McArdle, *et al;* 1991; Stamford, *et al;* 1991 in Plowman and Smith, 1997; Fox, 1996; and Christensen, *et al;* 2008). Similarly, the waist-to-hip ratio is able to distinguish between patterns of fat distribution in the upper and lower body as it is strongly associated with visceral fat and appears to be an accepted index of intra-abdominal fat and systolic blood pressure (Seidell, *et al;* 1987 in Heyward, 1997). Generally, young adults with waist-to-hip ratio values in excess of 0.94 (Males) or 0.82 (Females) are at higher risk for adverse health consequences (Bray and Gray, 1986b in Heyward, 1997). However, Peters*, et al;* 1992 in Heyward, 1997 postulated that this index is not valid for evaluating fat distribution in prepubertal children. Hartz, *et al;* (1984) in White, *et al;* (1986) and Heyward, (1997) confirmed that Waist-to-hip ratio appeared to be closely associated with high blood pressure in males aged 40 to 59 years and in females aged 40 to 69. The contribution of waist-to-hip ratio to the prevalence of high blood pressure has previously been assumed in both gender. Recently conducted study also found the ratio to be a strong independent predictor of high blood pressure in both males and females, although its importance is secondary to that of body mass index (White, *et al;* 2008). It is highly imperative to also note that correlations of body mass index, waist-to-hip ratio and skinfold measurement with diastolic hypertension varied with age and sex (Oladipo and Angba, 2006 and Haruna, 2006c). In addition, some recently conducted studies by Ross, *et al;* 2000; Irwin, *et al;* 2003 and Slentz, *et al;* 2004 in Lakha and Laaksonen, (2007) found that physical activity reduces total body adiposity rather than preferentially decreasing visceral or abdominal subcutaneous fat. Similarly, other recent studies suggested that physical activity decreases visceral fat more effectively than total or abdominal subcutaneous fat (Lee, *et al;* 2005 in Lakha and Laaksonen, 2007) and it was also shown that exercise training decreases total, visceral, and abdominal subcutaneous fat even without weight loss in individuals with normal body mass index, abdominal obesity, or type two diabetes (Ross, *et al;* 2004 and Lee, *et al;* 2005 in Lakha and Laaksonen, 2007). Similarly, Yang, *et al;* (2007) and Christensen, *et al;* (2008) lend their support that an inverse association between the levels of physical activity and the prevalence of obesity as defined by waist circumference during adulthood suggest that encouragement to participate regularly in physical activity should be considered as an important tool in obesity prevention. It has been suggested that physical activity might prevent weight gain and rise in blood pressure through increased energy expenditure or favourable changes in adipose tissue (Ross and Jansen, 2001 in Yang, *et al;* 2007). While the waist circumference is an indicator of adipose tissue in the waist and abdominal area; hip circumference is an indicator of adipose tissue over the buttocks and hips (Maud and Foster, 1995 and Henry, *et al;* 2004); which is used to determine body fat percent of the active populations (SIRC, 2007, Christensen, *et al;* 2008 and Mutikainen, *et al;* 2009). The ratio thus provides an index of relative fat distribution in adults, whereas; the higher the ratio the greater the proportion of abdominal fat. However, the validity of these circumferences as measure of fat distribution in youth is unknown (Mueller and Nalina, 1987 in Maud and Foster, 1995). The waist-to-hip ratio norms were established using the standardized measurement procedures described in the Anthropometric Standardization Reference Manual. Further, prevalence of central obesity expressed as waist circumference also showed a marked gender difference, with the highest prevalence among urban females; a gender and residential distribution which were similar to that of body mass index (Haruna, 2006b and Venkateswarlu, 2007). Abdominal (or central) obesity as defined by waist circumference (88cm and 102cm for females and males, respectively) in rural and urban populations respectively was seen in recent studies (Christensen *et al;* 2008); which suggested that regular physical activity prevents unhealthy weight gain and obesity, whereas sedentary behaviour such as watching television, working at the computer or playing video games for more than six hours per day promote them (Coakley, *et al;* 1998 and Jeffery, *et al;* 2002 in Lakha and Laaksonen, 2007; SIRC, 2007 and Christensen, *et al;* 2008). Physical activity decreases abdominal visceral and subcutaneous fat independently of changes in dietary energy intake in healthy, overweight, and obese males and females (Irwin, *et al;* 2003 and Slentz, *et al;* 2003 in Lakha and Laaksonen, 2007). Larger amounts of physical activity appear to result in a greater reduction in abdominal fat (Maud and Foster, 1995; Haruna, 2006b; Kouvonen, *et al;* 2006).

In a nutshell, waist circumference and waist-to-hip ratio are two most important considerations in this concept. Increased waist circumference relative to hips and increased waist-to-hip ratio separately confound the health status of the individual male or female especially in the inactive populations. Since exercise physiologists, trainers and coaches are yet to resolve most potent exercise to adopt in burning off the central adiposity, suffice to say that early exercise intervention would place active individuals on a healthy track through adulthood.

2:6 Blood Pressure and Percent Body Fat of Active and Inactive Subjects

The most widely used anthropometric estimation of body size or composition involves the measurement of skinfolds at selected sites. Skinfolds (or fatfolds) are the double thickness of skin plus the adipose tissue between the parallel layers of skin. Technically, however, adipose tissue (and hence the subcutaneous fatfolds) has both a fat and fat free components. The fat free component is composed of water, blood vessels, nerves, tendons, cartilage, ligaments and bones. As the adipose tissue increases in size (as in obesity), the water content also decreases (Roche, 1987 in Plowman and Smith, 1997; McArdle, *et al;* 1991 and Christensen, *et al;* 2008). Furthermore, a skinfold thickness is actually two layers of skin and two layers of fat. To measure this thickness, a caliper that is accurately calibrated and has a constant pressure of $10g/mm^2$ is recommended (Behnke and Wilmore, 1974 in Maud and Foster, 1997; Gunen, 1997; and Venkateswarlu, 2009). Depending on which caliper is used, measures are recorded to the nearest 0.1cm or 0.5cm. For the purpose of standardization and uniformity, all measurements were taken from the right side of the body (Maud and Foster, 1997). Three different sites were marked separately and captured by a single trained specialist, for consistency. While triceps, chest and subscapular skinfold measurements were assessed from the males; triceps, abdominal and suprailiac were read-off in the females. The mean of three readings was recorded at each site and the sum of all skinfolds thickness according to gender was used for the calculation of percentage body fat using the standard equation (Durmin and Wormersely, 1974 in Dudeja, *et al;* 2001; Dikki, 1996; Gwani, 1996 and Gunen, 1997). The equation for the calculation of body fat from skinfold thickness has been validated in Asian Indians (Kuriyan, *et al;* 1998 in Dudeja; *et al;* 2001).

For men, according to White, *et al;* (1986); Maud, and Foster, (1995); Dudeja, *et al;* (2001) and Naohiro *et al;* (2002), high blood pressure was more highly correlated with body mass index than with any of the skinfold measurement in almost every age group. For some age groups in females, the subscapular skinfold measurement was more highly correlated with high blood pressure than was body mass index, but overall, it was a somewhat less useful measure of the relation of excess fat or excess weight to high blood pressure in the females. The triceps measurement showed the second lowest correlation with hypertension (only the calf measurement was lower), and the sum of the five measurements showed no superiority over the subscapular measurement alone for both male and female (White, *et al;* 1986; Heyward, 1997; Plowman and Smith, 1997; and Christensen, *et al;* 2008).

Body weight and percent fat are factors that influence performance (Otinwa, 2005 in SIRC, 2007). Even though a high body mass index, could not lead to an indirect interpretation of overweight in lean individuals with excessive muscle mass, it implied that African university athletes may either and or have to develop muscle hypertrophy and then burn stored fat calories (Williams, 2000 in SIRC, 2007). For job activities, only a few significant differences were found. Active subjects had smaller skinfold and low percent body fat than the inactive population. For active leisure time, active adults differed significantly from the inactive for height, subcutaneous skinfolds and a higher mesomorphy score than the inactive (Duquet and Day, 1996, and Mwisukha, *et al;* 2009). Blair, *et al;* (1985) reported that the more active individuals of the Tecumseh Community Health Study (TCHS) had a lower sum of four skinfold measurements than the less active persons ($P<0.05$). Also, Slattery and Jacobs (1987), found that active men had smaller skinfolds than sedentary men ($P<0.01$). This is in agreement with the results of this study where active adults during work and during leisure time had less adiposity.

At birth, females have slightly more fat than males, but no difference in patterning is apparent (Maud and Foster, 1995, Haruna, 2006c and Naohiro, *et al;* 2002). While this declines with age in both sexes, females show a consistently faster decline than the males, leading to the android/gynoid distinction in early adulthood; and the decline of fatness in the males can be readily attributed to the pubertal increase in testosterone (Varo, *et al;* 2003 and Mutikainen, *et al;* 2009). In the males, increasing age brings about more centralized adiposity (increasing waist-to-hip ratio), due mostly to increasing intra-abdominal deposition. Females in their reproductive years tend to accumulate fat as they age, but still retain the gynoid pattern (Duquet and Day, 1996). And in rounding, it is pertinent to note that the absolute working capacity of the active female has been established to be approximately 20% less than that of the active male (Klafs and Lyon, 1978). Fat being metabolically inactive tissue, has detrimental effect on most sports performances. The primary purpose of cells is to store lipid (Duquet and Day, 1996; and Agwubike and Oboh in Ojeme, *et al;* 2006). Consequently, the greater percentage of fat is detrimental (performance – wise) in two ways – the cells do not contribute towards energy production (that is manufacture of Adenosinetriophosphate for use by the muscle), and it costs energy to move the fat (Kristen, 2009; and Venkateswarlu, 2009). It is a physiological fact that higher body density, which is an index of greater quantity of metabolically active tissue, like muscles and bones, favour performance because of the muscular hypertrophy, which serves an adaptive alteration capable of enhancing muscular strength and endurance (Agwubike and Oboh in Ojeme, *et al;* 2006).

Based on data from the Nurses' Health Study, about 30% of new cases of obesity could be prevented by adopting a relatively active lifestyle, including more 30 minutes of brisk walking per day and less than ten hours of watching television per week (Hu, *et al;* 2003 in Lakha and Laaksonen, 2007). Epidemiological studies suggest that 45 to 60 minutes of moderate – intensity physical activity per day may be needed to prevent unhealthy weight gain and obesity (Fogelholm and Kukkonen-Harjula, 2000; Saris, *et al;* 2003 in Lahka and Laaksonen, 2007 and Venkateswarlu, 2009).

The average percent body fat is 15% for males and 23% for females. The standard for obesity that places an individual at risk for disease is >25 and >32% body fat for males and females respectively. Minimal fat levels that place an individual at risk for diseases associated with too little body fat are estimated to be ≤5% and ≤8% (inactive) for males and females respectively (Heyward, 1997 and Christensen, *et al;* 2008). Similarly, summation of skinfolds indicates the relative degree of fatness between individuals and can be used to detect changes within a given individual if measurements are taken repeatedly over time. It is also meant to determine the pattern of distribution of subcutaneous fat. Such a pattern has emerged as an important predictor of the health hazards of obesity (Roche, 1987 and Van Itallie, 1988 in McArdle, *et al;* 1991 and Venkateswarlu, 2009). In brief, body fat is partitioned to fat and fat free mass. The fat mass is second to body mass index in correlation with blood pressure and many studies pointed to the fact that it is metabolically inactive. Fat mass tends to influence physical activities when it exceeds 25 and 32% of body weight for both males and females respectively. For this reason, exercise should be started early to forestall the incidence of fat accumulation.

2:7 The International Physical Activity Questionnaire

Although most people are used to seeing energy cost expressed as kilocalories, exercise physiologists and physicians often use metabolic equivalent task (MET) values. MET is an acronym derived from the term metabolic equivalent task. One metabolic equivalent task represents the average, seated, resting energy cost of an adult and is set at 3.5mL/kg/min of oxygen, or 1 kcal/kg/hr (Plowman and Smith, 1997 and Pollard, *et al;*

2008). To calculate metabolic equivalent task levels, divide the amount of oxygen utilized (in mL/kg/min) by 3.5. Hence, if an individual expends 29mL/kg/min of oxygen on a task, the metabolic equivalent task level is 29mL/kg/min/3.5mL/kg/min = 8.3metabolic equivalent task (Plowman and Smith, 1997). According to Heyward, (1997), if the VO2 max is 35mL/kg/min; the functional capacity is 10 metabolic equivalent task (1 MET =3.5 mL/kg/min). The minimum training intensity is 50% of this value or 5 metabolic equivalent tasks; the average intensity is 60 to 70% or 6 to 7 metabolic equivalent task; the maximum exercise intensity is 85% or 8.5 metabolic equivalent tasks. Thus, the exercise prescription for an apparently healthy, active individual should include activities that produce an average intensity of 6 to 7 metabolic equivalent task. Of the collected data of a more recent twin study, metabolic equivalent task indices (for leisure time physical activity and community physical activity separately) were calculated by assigning a multiple of the resting metabolic rate (intensity of activity x duration of one session x monthly frequency). This was expressed as a sum of score of metabolic equivalent task – hours/day (Kujala, *et al;* 1998 and Waller, *et al;* 2008 in Mutikainen, *et al;* 2009).

Metabolic equivalent task represents the ratio of energy expended during a physical activity in the metabolic rate of sitting quietly, and are independent of body weight. The participants (Pakistani females) were asked to complete the short last seven days self-administered version of the International Physical Activity Questionnaire (Craig, *et al;* 2003 in Pollard, *et al;* 2008). Responses to the International Physical Activity Questionnaire were scored according to version 2.0 of the guidelines published at *www.ipaq.ki.se* to produce a total metabolic equivalent task in minute score for the active and sedentary populations. Sedentary people were defined in two ways: (1) Those expending less than 10% of their leisure time expenditure in activities involving <6.0 metabolic equivalent task, and (2) those who did not practice any leisure – time physical activity and who also were above the median in the number of hours spent sitting down during leisure time; whereas, subjects whose ratio was >6.0 metabolic equivalent task were classified as active (Varo, *et al;* 2003; Santos, *et al;* 2008; Pollard, *et al;* 2008 and Mutikainen, *et al;* 2009). Leisure time physical activity was calculated by asking participants to report their average weekly participation in various physical activities including: athletics, cycling, dancing, equestrian sports, fishing, jogging, martial arts, racquet sports, rowing, canoeing, skiing, skating, swimming, team sports, water sports, and walking (Varo, *et al;* 2003). Information about leisure time sedentary activities (number of hours sitting down) was also requested from participants, as well as the lack of any physical activity. In addition, physical activity was assessed via the International Physical Activity Questionnaire-short version and participants were classified in three categories according to their metabolic equivalent tasks – min/week values: low physical activity level, moderate physical activity level and health enhancing physical activity (Heyward, 1997; Plowman and Smith, 1997 and Santos, *et al;* 2008). Males with low physical activity level and higher sitting time (> 6h/day) were more likely to be obese (Mutikainen, *et al;* 2009).

Obese and lean people showed statistically significant higher levels of sedentary lifestyle than males with normal weights (reference group). Hence, obesity and physical inactivity are important risk factors for coronary heart disease, hypertension, dyslipidemia, type two diabetes, and certain types of cancer (Fang, *et al;* 2003 and Fransson, *et al;* 2003 in Santos, *et al;* 2008) and have a direct relation to premature mortality (Erlichman, *et al;* 2002; and Katzmazyk, *et al;* 2003 in Santos, *et al;* 2008). However, assessment of leisure time physical activity has been controversial and there is still a lack of universal measurement. Most studies are based on self-reported physical activity from questionnaire, since they are easier, cheaper, and more reproducible than other methods. In addition, they are easily appraised using a relatively simple questionnaire which is friendly and convenient for the participant. Varo, *et al;* (2003); Hagstromer, *et al;* (2005); Barnet, *et al;* (2007); and Santos, *et al;* (2008) opined that physical activity accessed by self-reported data is not as precise as more objective methods such as accelerometers; but questionnaires have acceptable validity and reliability for population studies, particularly when the intention is to differentiate those with "high" vs. "low" physical activity levels (Katzmarzyk, *et al;* 2003 in Santos, 2008).

In this research, the short last seven days questionnaire was used. The researcher wishes to adapt the instrument in this population. Finally, the US Surgeon General's report includes recommendations that every adult should accumulate at least 30 minutes of moderate to vigorous activity on most, and preferably all days of the week throughout life.

The question was on how the physical activities could be assessed; and to quantify the amount of physical activity, metabolic equivalent task (MET) was used (Plowman and Smith, 1997; and Mutikainen, *et al;* 2009). One metabolic equivalent task represents the average, seated, resting energy cost of an adult and is set at 3.5 mL/kg/min of oxygen, or one kilocalorie per kg/hr (Plowman and Smith, 1997; Varo, *et al;* 2003; and Santos, *et al;* 2008). The number of time spent participating in each activity was multiplied by the metabolic equivalent task score specific to each activity (Varo, *et al;* 2003). According to Hagstromer, *et al;* 2006, the International Physical Activity Questionnaire was developed to measure health-related physical activity in populations. The questionnaire was designed specifically for adults (18-65 years old) and consists of four domains: (i) transportation (ii) occupation (iii) household chores and gardening, and (iv) leisure time physical activity (Barnet, *et al;* 2007; Pollard, *et al;* 2008 and Mutikainen, *et al;* 2009).

2:8 Summary of Review of Related Literature

In this chapter, extensive review works with particular reference to blood pressure and key study variables were discussed as highlighted in the following paragraphs:

Relationship of blood pressure and age is directly proportional, which means, as age increases, blood pressure also increases. Heredity, environment, nutrition, lifestyle and culture or tradition is major feature that influences age. This phenomenon precipitates fat deposition and accumulation of subcutaneous and visceral tissues. Blood pressure varies with sex and it fluctuates due to weather conditions, temperature, ageing, stress and season. It was rightly observed that blood pressure, in normal individuals, increases during active exercise in relation to intensity of effort in male than in females. Blood pressure with body man index was discussed in relation with weight, height, overweight and obesity. It was found that adults tend to gain weight between the third and fourth decades of life.

The waist-to-hip ratio is derived from the waist and hip circumferences. The following findings were made: Regular physical activity prevents unhealthy weight gain, obesity, and high blood pressure, abdominal visceral or subcutaneous and metabolic disease like diabetes. While the waist circumference is an indicator of adipose tissue in the waist and abdomen, the hip circumference is an indicator of adipose tissue over the buttocks and hips. Blood pressure with percent body fat was effectively discussed and the following findings were made from literature: Blood pressure was more correlated with body mass index than percent body fat. Active subjects had lower sum of skinfold measurement than overweight inactive subjects. Females had more fat than males. The last segment dealt with two vital instruments necessary for the partition of subjects into active and inactive groups. First is the International Physical Activity Questionnaire (IPAQ) which the subjects were made to score. The quantities were summed and multiplied by the critical value of the metabolic equivalent task (MET) to access each subjects' level of activity in mL/kg/ minute. It is a standing truth that nature has no provision for storage of vitamins and oxygen. In the same way, one cannot deposit the benefit of physical activity into a fitness bank to withdraw at a later date. Furthermore, genetics has a definite impact on fitness scores. It is a hard but sad truth that some individuals will score high on fitness tests without doing any activity, but others who are very active may never achieve high fitness scores. It is the pattern of consistent activity that is most important for both types of individuals and everyone in between (Plowman and Smith, 1997: 2000).

CHAPTER THREE

METHODOLOGY

3:0 Introduction

The purpose of the study was to determine the relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria. The research design, population, sample and sampling techniques, sequence of assessment, testing protocols, validation and instrumentation, the International Physical Activity Questionnaire methodology, research assistants and statistical techniques used in the study are described in this chapter.

3:1 Research Design

Ex-post facto research design was used because the information required was available with the respondents (Miller, 1964, 1991 & Trochin, 2006). It was meant to guide the researcher in the process of collecting, analyzing and interpreting the results (Frankfort-Nachmias and Nachmias, 1992)

3:2 Population

The student population consists of 17,948 and 7,809 male and female (25,757) undergraduate and postgraduate students of 2007/2008 academic session. The subjects were between 20 – 49 years of age. This data was released on request by the Management Information System, Ahmadu Bello University, Samaru, Zaria

3:3 Sample and Sampling Techniques

The stratified random sampling technique was adopted because the student population had distinct sub-groups (strata) according to gender and educational status. The available stratification includes:

(i) Oba Akenzua Hall for male postgraduate students.

(ii) Yar'adua and Sassakawa Halls for male and female postgraduate and undergraduate students.

(iii) Queen Amina and W.H. Halls for female postgraduate and undergraduate students.

(iv) Alex and Ribadu Halls for female undergraduate students.

(v) Suleiman Hall for male postgraduate and undergraduate students.

(vi) Danfodio Hall for male undergraduate students.

(vii) ICSA and Ramat Halls for male undergraduate students.

The simple random sampling technique was used to select the subjects for this study from the seven halls of residence in the University. The researcher met the hall administrators two days before the exercise for a formal introduction and arrangement of venue. Thereafter, copies of notification bills were placed in strategic locations to intimate the students and volunteered subjects usually gathered in the student's common room for a briefing. One hundred ballot papers with fifty percent marked **YES** were shaken together in a deep carton and only those who picked **YES** received the International Physical Activity Questionnaire for completion. One thousand two hundred and ninety seven (1,297subjects: 907males and 390females) students represents five percent of the total population following Roscoe, (1969); Krejcie and Morgan, (1979); Nworgu, (1991) and Alamu and Olukosi, (2008) who opined that where a population is large in research, a minimum of five percent (5%) could be used as sample to represent the entire population.

Table 3:1 Population and Sample size for the study

Gender	Undergraduate	Postgraduate	Total	5%
Male	15,130	2,818	17, 948	907
Female	6, 754	1, 055	7, 809	390
Total	21, 884	3, 873	25,757	**1297**

(Roscoe, 1969; Krejcie and Morgan, 1979; Nworgu, 1991 and Alamu and Olukosi, 2008)

3:4 Sequence of Assessment:

The procedures for data collection are discussed in this section:

3:4:1 Blood Pressure

Following 5 – 10 minutes quiet rest in the sitting position, resting systolic and diastolic blood pressures were determined by auscultation indirectly in the right arm using Omron Automatic Digital Blood Pressure Monitor (endorsed by the American Heart Association, model no. HEM 713C) with contoured cuffs. Measurement took place each day between 8:00am through 11:30am for a period of twenty-eight days in accordance with the protocol of the American Heart Association, 1976; and Dudeja, *et al;* 2001. The blood pressure monitor was preset at the maximum value of 200 mm Hg from the beginning to the end of the exercise. The cuff was applied evenly and snugly about the bare arm with the lower edge at 2.5cm above the antecubital fossa. A soft touch on the **ON** button prepared the screen in seconds which showed that the monitor was ready for use. A little stroke on the **START** key marks the onset of inflation with a buzzing sound at geometric progression up to the maximum preset value of 200 mm Hg. From this ceiling, it began to deflate at arithmetic progression and to the rhythm of the heart rate. Finally, the screen displayed the systolic, and diastolic blood pressures (in mm Hg), and the heart rate (in beats per minute). The blood pressure of every subject was subsequently recorded in the Raw Data Sheet. For each subject, two measurements were taken on the right arm with at least a minute interval and the average of the readings was recorded; systolic pressure over diastolic pressure in millimeters of mercury.

3:4:2 Body Mass Index

Weight and height were measured separately and used to determine the body mass index.

The body weight of the randomized subjects were measured in light indoor clothing, without shoes, overcoat, hat, hair braids, or handsets using a bathroom weighing scale (Hanson Model H89 DK Blue) both within precision measurement to the nearest 0.1Kg (Hlaing, *et al;* 2001and Wang, *et al;* 2002) Shukla, *et al*, 2002; Gallo, *et al;* 2005; and Venkateswarlu, 2007). The scale was tested regularly with a known measure (10kg dumb-bell) to verify accuracy. The body weight value of each subject was written in the appropriate column of the raw data sheet in kilogramme.

The participants were hereafter requested to step on the horizontal plane with their bodies stretched upward to the fullest extreme and their heads to the Frankfurt plane (Lohman, 1991 in Nichols and Cadogan, 2008). The self-constructed wooden stadiometer was two meters high with adjustable flat set-square placed above the head to reduce parallax error. Measurements were recorded in metres (m) to the nearest 0.1cm.

Body mass index (BMI) was determined by dividing weight (wt) in kilogrammes (kg) by height (ht) in square metre (m2) as in the following formula:

$$\text{BMI} = \text{wt (kg)}/\text{ht}(\text{m}^2)$$

The international body mass index classification by the National Institute of Health and the International Obesity Task Force as approved by the World Health Organization, Geneva, (2006) was adopted

3:4:3 Waist-to-Hip Ratio

The waist and hip circumferences were measured with a flexible measuring tape following the guidelines recommended in the Anthropometric Standardisation Reference Manual (Lohman, *et al;* 1988 in McCreary, *et al;* 2006; Hivert, *et al;* 2007) and according to the procedure of Norton and Olds, 1996 (Venkateswarlu, 2007). Waist circumferences >88cm in women: and >102cm in men (all ages) were identified with central/abdominal adiposity. Waist and hip circumferences were measured to determine the waist-to-hip ratio. While the waist circumference was measured at the level of the narrowest point between the lowest coastal borders and the iliac crest after expiration, the hip circumference was taken at the greatest posterior protuberance of the buttocks. The waist-to-hip ratio was determined by dividing the waist circumference by the hip circumference: mathematically calculated as:

$$\text{Formula for WHR} = \frac{\text{Waist Circumference (cm)}}{\text{Hip Circumference (cm)}}$$

The average values of waist-to-hip ratio between 0.80 – 0.90 and 0.90 – 0.98 for both females and males respectively are considered safe (Centre for Disease Control and Prevention, 2002; Dudeja, *et al;* 2001; and Seidell, *et al;* 2001). However, Values above these averages (for instance, WHR $\geq$ 1.0) raise the health risks for individuals of both sexes (McArdle, *et al;* 1991; Stamford, *et al;* 1991 in Plowman and Smith, 1997; Fox, 1996; and Christensen, *et al;* 2008).

3:4:4 Percent Body Fat

The proper anatomical sites for the three measurements: triceps, chest and subscapular for the males; and triceps, abdomen and suprailium for the females respectively were marked and read - off accordingly (Pollack, *et al;* 1980 in Maud and Foster, 1995; Dudeja, *et al;* 2001; and Smith and Rinderknecht, 2003). The millimetre values of the measurements were taken on the right side of the body with the subjects standing according to American Standardisation Reference Manual. The measurements were taken by a single trained specialist for the study using Harpenden spring-loaded callipers (Holtain Ltd., UK) which was constantly standardised for correct jaw tension (10g/mm2) and gap-width (Hoeger, 1988; Dudeja, *et al;* 2001; Musa, *et al;* 2001; Smith and Rinderknecht, 2003; and topendsports.com, 2008). The correct anatomical landmarks for the three sites of skinfolds for both adult and gender include: (1) Triceps: a vertical fold on the back of the upper arm half way between the shoulders, acromion process, and the olecranon process; (2) Subscapular skinfold: the fat-pad of the inferior angle of the scapular directly in the midaxillary line was measured; (3) Chest fold: a diagonal fold halfway between the shoulder crease and the nipple; (4) Abdomen: a vertical fold taken about one inch to the right of the umbilicus; and (5) Suprailium: a diagonal fold above the crest of the ilium, on the side of the hip (Hoeger, 1998; Dudeja, *et al*, 2001; Smith and Rinderknecht, 2003; and Sorensen, *et al*, 2006;). Two steps are involved in the conversion of skinfolds thickness into an estimate of percentage fat (Watson, 1980 in Gunen, 1997). The first step involves the conversion of skinfolds thickness to an estimate of Body Density (D_B). The three folds were added together and substituted in one of the following gender equations according to sex and age (Pollack, *et al;* 1980 in Maud and Foster, 1995).

Male: $D_B = 1.1125025 - 0.0013125(X2) + 0.0000055(X2)^2 - 0.0002440(X3)$
Where: X2=sum of triceps, chest, and subscapular skinfolds (mm);
X3 = age (years)

Female: $D_B = 1.0902369 - 0.0009379(x1) + 0.0000026(x1)^2 - 0.0001087(x3)$
Where: x1=sum of triceps, suprailium, and abdomen skinfolds (mm);
x3 =age (years)

The second step involves the conversion of body density scores to an estimate of percentage fat (Watson, 1990 in Gunen, 1997). The equation for the conversion is due to Siri (1956) and Watson, (1990) in Gunen, (1997). Both stressed that it is the same for all types of subjects and genders.

$$\%BF = [(4.95/D_B) - 4.5] \times 100$$

3:4:5 Methodology of the International Physical Activity Questionnaire

The International Physical Activity Questionnaire (IPAQ)-short consists of 7 items that identifies frequency and time spent in vigorous to moderate intensity physical activities and mild to sitting intensity prior to the questionnaire administration and counts only those sessions that lasted 10 minutes or more (Hagstromer, 2007). In this study, while active lifestyle consists of vigorous and moderate intensities, the inactive lifestyle encompasses mild intensity and/or continuous sitting for more than six hours per day with four major domains and their corresponding metabolic equivalent tasks (METs) as follows:

(i) Occupation – 8 METs (2 items)

(ii) Transportation – 6 METs (2 items)

(iii) Household chores -3 METs (2 items)

(iv) Leisure Time physical activity – 1.3 METs (1 item)
Compendium of Physical Activities (Ainsworth, *et al;* 1993)

In the IPAQ-short, a maximum of 240 minutes/day in any of the two levels in the four domains was allowed. Any higher values reported were truncated to 240 minutes. To quantify the amount of physical activity, the number of minutes spent participating in each activity multiplied by the number of days and then multiplied by the appropriated (MET) value as provided in the compendium of Physical Activities in MET – minutes or counts (Varo, *et al;* 2003, Ainsworth, *et al;* 2006 in Hagstromer, 2007, and Pollard, *et al;* 2008). Finally, IPAQ methodology was used to classify subjects as active and inactive (Pollard, *et al;* 2008) as shown in Table 3:2.

Table 3:2 Categorisation of subjects into Active and Inactive Lifestyles

	Active		Inactive		Total	
	N	%	N	%	N	%
Male	359	39.58	548	60.42	907	100
Female	212	54.36	178	45.64	390	100
Total	571		726		1,297	

3:5 Testing Protocol

A written letter for permission to conduct the study in the hostels was obtained from the University. At least two days notice preceded each visit and arrangements for a suitable venue was usually made following a Notification Letter. The subjects were briefed by the researcher in order to seek consent; thereafter, research assistants were introduced and this was followed by inspection of working instruments. Approximately 200 subjects were assessed in each of the hostels (within a maximum of one week each) in 2008.

3:6 Validation of Instruments:

Blood pressure apparatus and skinfolds calliper were checked by the Instrument Engineering Unit, Ahmadu Bello University Teaching Hospital, Shika, before the commencement of data collection to ensure that they were working correctly. The weighing scale was constantly tested with known measure (10Kg) to verify accuracy. The following instruments were used in the process of data collection:

3:7 Instrumentation

This section describes the instruments used in the process of data collection:

3:7:1 Blood Pressure Apparatus

Omron Automatic Digital Blood Pressure Monitor (endorsed by the American Heart Association) produced and marketed by Omron Health Care Inc. made in China (Model no. HEM 713C, Serial number 24259976 uses Duracell alkaline battery 4 * 1.5v = 6volts) was used to measure resting blood pressure. It has a maximum systolic capacity of 240 mm Hg with a least count of 1mm Hg. The instrument had a very high reliability coefficient r=0.90.

3:7:2 Bathroom Weighing Scale

Bathroom weighing scale (Hanson: Model H89DK Blue) with a capacity of 120kilogrammes or 264 Pounds (lbs) was used for the measurement of subjects in kilogrammes. The device had a reliability coefficient r=0.80.

3:7:3 Stadiometer

A wooden stadiometer two metres high with a platform was graduated from bottom to the top in centimetres (1% error) by a structural engineer and certified by a physicist. The instrument was used for the measurement of height in metres (m) to the nearest 0.1cm. The self-constructed device had an adjustable flat set-square placed above the head to reduce parallax error. The device had a reliability coefficient r=0.90.

3:7:4 Measuring Tape

A flexible measuring tape with a capacity of 150 centimetres, made in China was used for measuring the waist and hip circumferences of the subjects. The device had a reliability coefficient r=0.70.

3:7:5 Skinfold Calliper

Harpenden spring - loaded calipers (Holtain Ltd., Inc., UK) was used for the measurement of triceps, chest, subscapular (males) and triceps, abdomen, suprailiac (females) skinfolds of the subjects. To ascertain standard and reliability, the mean of two readings was used. The device had a reliability coefficient r=0.60.

3:8 Research Assistants

Four persons (2 males and 2 females) were recruited as research assistants (RAs) for data collection. The researcher provided induction training on how to use the instruments for uniformity.

3:9 Statistical Techniques

The data collected were fed into the system and analysed using the Statistical Package for Social Sciences (SPSS 14, Inc., Chicago IL) for Windows.

(a) Pearson Product Moment Correlation Coefficient (r) was used to determine the relationship of the variables studied and to test the hypotheses.

b) Decision to retain or reject the null hypothesis was made at $P \leq 0.05$ alfa level of significance.

CHAPTER FOUR

RESULTS AND DISCUSSION

4:0 Introduction

The purpose of this study was to investigate the relationship between blood pressure and body composition of active and inactive students of Ahmadu Bello University, Zaria. To achieve this purpose, the data collected was statistically analysed to test the hypotheses. The results obtained are presented and discussed in this chapter.

4:1 Results

Before the results are presented according to the hypotheses, it is important to state that, while blood pressure consists of systolic and diastolic blood pressures respectively, body composition was treated as having four different components, namely; body mass index, waist circumference, waist-to-hip ratio, and percent body fat. Therefore, the relationships of systolic and diastolic blood pressures with body mass index, waist circumference, waist-to-hip ratio, and percent body fat among active and inactive students were computed separately to test the hypotheses. The biodata characteristics of the subjects are shown in Table 4:1.

Table 4:1 Biodata Characteristics of the Subjects

Items	Responses	Respondent	Percentage	Mean	STD. Error
Gender	Male	907	69.90		
	Female	390	30.10		
Age (years)	20 – 29	1, 092	84.10	24.52	0.08
	30 – 39	100	7.70	35.01	0.10
	40 – 49	105	8.20	45.53	0.11
Status of Subjects					
	Active males	359	39.58		
	Inactive males	548	60.42		
	Active females	212	54.36		
	Inactive females	178	45.64		
Category of Students					
	Undergraduate males	15,130	84.30		
	Postgraduate males	2,818	15.70		
	Undergraduate females	6,754	86.49		
	Postgraduate females	1,055	13.51		

The above Table shows biodata characteristics of the subjects. There were 907 males and 390 females representing 69.90% and 30.10% respectively. Age (in years) was grouped into three intervals. Subjects between 20-29 years were 1092; 30-39 years were 100 and 40 – 49 years were 105 representing 84.10%, 7.70% and 8.20% respectively.

The subjects were further grouped into into four classes according to their fitness status. While the active males were 359, the inactive males were 548 representing 39.58 and 60.42 respectively. Similarly, while the active female were 212, the inactive female were 178 representing 54.36 and 45.64 respectively.

Finally, the subjects were again categorized according to their educational levels. The undergraduate and postgraduate males were 15130 and 2818 representing 84.30 and 15.70 respectively. Simlarly, the undergraduate and postgraduates females were 6754 and 1055 representing 86.49 and 13.51 respectively.

4:2 Hypotheses Testing

The major hypothesis states that there is no significant relationship between blood pressure and body Composition among active and inactive students of Ahmadu Bello University, Zaria. In this study, the major hypothesis was tested and discussed under the following sub-hypotheses:

Sub-Hypothesis 1

There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active students of Ahmadu Bello University, Zaria. To test this hypothesis, the Pearson Correlation Coefficient was computed between systolic and diastolic blood pressures and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active students of Ahmadu Bello University, Zaria. The results of which are shown in Table 4:2.

Table 4:2 Relationship between Blood Pressure and Body Composition of Active Subjects

Variables	SBP	DBP	WC	BMI	WHR	%BF
SBP (mmHg)	1					
DBP (mmHg)	0.544**	1				
WC (cm)	0.209**	0.277**	1			
BMI (kg/m^2)	0.203 **	0.204**	0.835**	1		
WHR	-0.054	-0.041	-0.048	0.054	1	
%BF	-0.046	-0.019	0.026	0.064	0.064	1

**Correlation is significant at the 0.05 level (2-tailed) $r(569) = 0.1946 \leq 0.05$

Table 4:2 shows significant correlation between systolic and diastolic blood pressure (r = 0.544) of active subjects of Ahmadu Bello University, Zaria. The two blood pressure components, systolic and diastolic blood pressures correlated significantly with body mass index (r = 0.203 and 0.204) and with waist circumference (r = 0.209 and 0.277). Interestingly, there was a significantly high association between body mass index and waist circumference (r = 0.835) at $p \leq 0.05$. The positive high correlation between body mass index and waist circumference suggests that both are proportional to each other in the active population. Sub-hypothesis one of no significant relationship is hereby rejected.

Sub-Hypothesis 2

There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of inactive students of Ahmadu Bello University, Zaria. To test this hypothesis, the Pearson Correlation Coefficient was computed between systolic and diastolic blood pressures and body mass index, waist circumference, waist-to-hip ratio and percent body fat of inactive students of Ahmadu Bello University, Zaria. The results of which are shown in Table 4:3.

Table 4:3 Relationship between Blood Pressure and Body Composition of inactive Subjects

Variables	SBP	DBP	WC	BMI	WHR	%BF
SBP (mmHg)	1					
DBP (mmHg)	0.606**	1				
WC (cm)	-0.001	0.036	1			
BMI (kg/m^2)	0.255**	0.309**	0.306**	1		
WHR	-0.063	-0.083	-0.019	-0.051	1	
%BF	-0.140	-0.076	0.070	-0.046	0.052	1

**Correlation is significant at the 0.05 level (2-tailed) $r(724) = 0.1946 \leq 0.05$

Table 4:3 shows significant correlation between systolic and diastolic blood pressure (r = 0.606) of inactive subjects of Ahmadu Bello University, Zaria. The two blood pressure components, systolic and diastolic blood pressures correlated significantly with body mass index (r = 0.255 and 0.309) respectively. Similarly, body mass index correlated significantly with waist circumference (r = 0.306) at $p \leq 0.05$ of inactive group in this study. This therefore suggests that body mass index and blood pressure were directly proportional in the inactive subjects in this population. Sub-hypothesis two of no significant relationship is hereby rejected.

Sub-Hypothesis 3

There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active male subjects of Ahmadu Bello University, Zaria. In this study, the Pearson Correlation Coefficient was computed between systolic and diastolic blood pressures and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active male subjects of Ahmadu Bello University, Zaria to test hypothesis three: The results of which are shown in Table 4:4.

Table 4:4 Relationship between Blood Pressure and Body Composition of Active Male Students

Variables	SBP	DBP	WC	BMI	WHR	%BF
SBP (mmHg)	1					
DBP (mmHg)	0.483**	1				
WC (cm)	0.208**	0.264**	1			
BMI (kg/m^2)	0.213**	0.181	0.841**	1		
WHR	0.166	0.218**	0.629**	0.345**	1	
%BF	0.029	-0.004	0.117	0.200**	-0.049	

**Correlation is significant at the 0.05 level (2-tailed) $r(357) = 0.1964 \leq 0.05$

Table 4:4 shows significant correlation between systolic and diastolic blood pressures (r = 0.483) of active males of Ahmadu Bello University, Zaria. The two blood pressure components, systolic and diastolic blood pressures had significant correlation with waist circumference(r=0.208 and 0.264) respectively. Similarly, there was a significant correlation between body mass index and systolic blood pressure (r=0.213) and with waist circumference (r = 0.841). There was also a significant relationship between waist-to-hip ratio with diastolic blood pressure (r=0.218); with waist circumference (r=0.629) and with body mass index (r =0.345). Finally, there was a significant association between percent body fat and body mass index (r=0.200) at $p \leq 0.05$. The positive high correlation between body mass index with waist circumference and between waist-to-hip ratio with waist circumference suggest that both were directly proportional to each other in the active male population. Sub-hypothesis three of no significant relationship is hereby rejected.

Sub-Hypothesis 4

There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active female subjects of Ahmadu Bello University, Zaria. In this study, the Pearson Correlation Coefficient was computed between systolic and diastolic blood pressures and body mass index, waist circumference, waist-to-hip ratio and percent body fat of the active female subjects of Ahmadu Bello University, Zaria to test hypothesis four: The results of which are shown in Table 4:5.

Table 4:5 Relationship between Blood Pressure and Body Composition of Active female Students

Variables	SBP	DBP	WC	BMI	WHR	%BF
SBP (mmHg)	1					

DBP (mmHg)	0.686**	1				
WC (cm)	0.183	0.290**	1			
BMI (kg/m^2)	0.149	0.235**	0.816**	1		
WHR	-0.081	-0.061	-0.068	0.116	1	
%BF	0.064	0.101	0.145	0.175	-0.026	1

**Correlation is significant at the 0.05 level (2-tailed) $r(210) = 0.1946 \leq 0.05$

Table 4:5 shows significant correlation between systolic and diastolic blood pressures (r = 0.686) of active female group of Ahmadu Bello University, Zaria. Waist circumference had a significant correlation with only diastolic blood pressure (r=0.290) and finally, body mass index had a significant association with diastolic blood pressures (r=0.235) and with a positive high correlation with waist circumference (r = 0.816) at $p \leq 0.05$. The positive high correlation between body mass index and waist circumference suggests that both are directly proportional to each other in the active female population. Sub-hypothesis four of no significant relationship is hereby rejected.

Sub-Hypothesis 5

There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of inactive male subjects of Ahmadu Bello University, Zaria. In this study, the Pearson Correlation Coefficient was computed between systolic and diastolic blood pressures and body mass index, waist circumference, waist-to-hip ratio and percent body fat of the inactive male subjects of Ahmadu Bello University, Zaria to test hypothesis four: The results of which are shown in Table 4:6

Table 4:6 Relationship between Blood Pressure and Body Composition of inactive Male Subjects

Variables	SBP	DBP	WC	BMI	WHR	%BF
SBP (mmHg)	1					
DBP (mmHg)	0.580**	1				
WC (cm)	0.210**	0.262**	1			
BMI (kg/m^2)	0.219**	0.274**	0.816**	1		
WHR	0.227**	0.230**	0.505**	0.247**	1	
%BF	-0.043	0.006	0.068	0.086	-0.002	1

**Correlation is significant at the 0.05 level (2-tailed) r(546) = 0.1964 ≤0.05

Table 4:6 shows significant correlation between systolic and diastolic blood pressures (r=0.580) at P≤0.05 alpha level in the inactive male subjects of Ahmadu Bello University, Zaria. The two blood pressure components, systolic and diastolic blood pressures had significant correlation with waist circumference (r=0.210 and 0.262) respectively. Similarly, body mass index correlated significantly with systolic blood pressure (r=0.219); diastolic blood pressure (r=0.274) and a positive high correlation with waist circumference (r=0.816) at P≤0.05 alpha level. Finally, waist-to-hip ratio also had significant correlation with systolic blood pressure (r=0.227); diastolic blood pressure (r=0.230); waist circumference (r=0.505) and with body mass index (r=0.247) at P≤0.05. The positive high correlation between body mass index and waist circumference suggests that both are directly proportional to each other in the active female population. Sub-hypothesis 5 of no significant relationship is hereby rejected.

Sub-Hypothesis 6

There is no significant relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of inactive female subjects of Ahmadu Bello University, Zaria. In this study, the Pearson Correlation Coefficient was computed between systolic and diastolic blood pressures and body mass index, waist circumference, waist-to-hip ratio and percent body fat of the inactive female subjects of

Ahmadu Bello University, Zaria to test hypothesis four: The results of which are shown in Table 4:7.

Table 4:7 Relationship between Blood Pressure and Body Composition of inactive Female Subjects

Variables	SBP	DBP	WC	BMI	WHR	%BF
SBP (mmHg)	1					
DBP (mmHg)	0.674**	1				
WC (cm)	-0.046	0.008	1			
BMI (kg/m^2)	0.321**	0.387**	0.377**	1		
WHR	-0.104	-0.157	-0.029	-0.081	1	
%BF	-0.034	-0.069	0.029	-0.107	-0.133	1

**Correlation is significant at the 0.05 level (2-tailed) $r(176) = 0.1964 \leq 0.05$

Table 4:7 shows significant correlation between systolic and diastolic blood pressures (r=0.674) in the inactive female group of Ahmadu Bello University, Zaria. Similarly, correlation of body mass index with systolic (r=0.321); diastolic blood pressure (r=0.387and with waist circumference (r=0.377) were all significant at P≤0.05. Since correlation of body mass index with diastolic blood pressure in the inactive female group was positive and highest among the independent variables, it further showed that as body mass index increased, diastolic blood pressure also increased. Sub-hypothesis 6 of no significant relationship is hereby rejected.

4:4 Discussion

The purpose of the study was to show how blood pressure changes with body composition among active and inactive subjects of Ahmadu Bello University, Zaria. This was mainly to infer from the relationship between blood pressure and the different independent risk factors that can be used as the basis for indicating exercise intervention to positively modify blood pressure. The relationship between the aforementioned, which is blood pressure with body mass index, waist circumference, waist-to-hip ratio and percent body fat among the subjects were reported in Tables 4:2 to 4:7 presented in the previous section and the findings are discussed below.

4:4:1 Reationship between Blood Pressure and Body Composition of Active and Inactive Subjects

The study of Table 4:2 showed significant correlation of systolic with diastolic blood pressures and percent body fat (r = 0.576; r = -0.077) among both active and inactive subjects of Ahmadu Bello University, Zaria. In separate studies conducted by White, *et al;* (1986); Santos, *et al;* (2008), and Mutikainen *et al;* (2009) it was held that correlations of body mass index, waist-to-hip ratio and skinfold measurements with diastolic blood pressure varied with age and sex. For men, high blood pressure was more highly correlated with body mass index than with percent body fat in all activity levels in both gender. The two blood pressure components, systolic and diastolic blood pressures had significant correlation with body mass index(r = 0.226; r = 0.256) and with waist-to-hip ratio (r = 0.320; = 0.219). This is in consonance with studies conducted by Durnin, (1994) in Plowman and Smith, (1997); Williams, (2002); Jeukendrup, (2005) and Otinwa, (2005) in Venkateswarlu, (2007). They opined that subjects with low body mass index in relation to height, expressed as the body mass index, have less difficulty moving their body during weight bearing activities like walking or stair climbing than subjects with a higher body mass index. They added that these individuals regularly have lower systolic and diastolic blood pressures in either active or inactive population. There was also a significant relationship between waist circumference and body mass index (r = 0.320) and between body mass index with waist-to-hip ratio (r = 0.320) in this study at $p \leq 0.05$. These suggest that there was a significant relationship between systolic and diastolic blood pressures with body mass index among the subjects. White, *et al;* 1986; Maud and Foster, (1995), Oladipo and Angba, (2006) and Santos, *et al;*

(2008) affirmed from surveys in California, Connecticut and Maryland and the nationwide Community Blood Pressure Evaluation Clinic Programme that in the United States, it all showed that the prevalence of blood pressure, body mass index and waist circumference were higher in active and inactive males than their female counterparts. Therefore, these results failed to support major hypothesis one.

4:4:2 Reationship between Blood Pressure and Body Composition of Active Subjects

The study of Table 4:3 shows significant correlation of systolic with diastolic blood pressures (r = 0.544) of active subjects of Ahmadu Bello University, Zaria. The two blood pressure components, systolic and diastolic blood pressures correlated significantly with body mass index (r = 0.203; r = 0.204) and with waist circumference (r = 0.209; = 0.277). Interestingly, there was a significant high association between body mass index and waist circumference (r = 0.835) at $p \leq 0.05$. White, *et al;* (1986); Brownell, *et al;* (1987) and Falson, *et al;* **(xx)** in Plowman and Smith, (1997) and SIRC, (2007) lend their support, adding that, there is a linear relationship between body mass index and Waist circumference and for any slight increase or decrease in somatotype, there would be a commensurate change in waist girth. McArdle, *et al;* 1991; Stamford, *et al;* 1991 in Plowman and Smith, 1997; Fox, 1996; and Christensen, *et al;* 2008 affirmed that the average values for the waist circumference for females ages 17 – 39 is 0.80, and this value increases with age to 0.90. Comparable averages for males range from 0.90 to 0.98. Values above these averages raise the health risks for individuals of both sexes (Seidell, *et al;* 1987 in Heyward, 1997). Generally, young adults with waist-to-hip ratio values in excess of 0.94 (Males) or 0.82 (Females) are at higher risk for adverse health consequences (Bray and Gray, 1986b in Heyward, 1997). While the males fall within desirable limits, the females were already at a critical level (WHR=0.83) which might of course affect their health adversely in the near future. The study is therefore in conformity with the position of Mayhew and Gross, (1974); Wilmore, (1974); Fox and Matthews, (1981); and Agwubike, (1992) in Mwisukha, *et al;* (2009) who supported a significant gain in lean body weight following appropriate aerobic training. Following advances in technology, transportation and a sedentary lifestyle, weight gain and increased fat deposition reach their peak within the second and third decades of life. This therefore suggests why early participation in exercise is encouraged to reduce cases of adiposity and associated health consequencies among the subjects. Since body mass index and waist circumference correlated highly with blood pressure in this study, therefore, the null hypothesis of no significant difference is hereby rejected.

4:4:3 Reationship between Blood Pressure and Body Composition of Inactive Subjects

The study of Table 4:4 shows significant correlation of systolic with diastolic blood pressures (r = 0.606) among the inactive subjects of Ahmadu Bello University, Zaria. Inactivity is an important risk factor for overweight (Gortmaker, et al; 1990 in Henry, et al; 2004); furthermore, exercise and physical activity with poor nutrition and or disease may lead to muscular atrophy (Henry, et al; 2004; Pollard, et al; 2008 and Mutikainen, et al; 2009). The two blood pressure components, systolic and diastolic blood pressures correlated significantly with body mass index (r = 0.255; r = 0.309). Similarly, body mass index correlated significantly with waist circumference (r = 0.306). Inactivity is an important risk factor for abdominal (or central) adiposity which proved overall to be more closely related to hypertension, glucose intolerance, hyperinsulinemia, type 2 diabetes and other metabolic and cardiovascular diseases (White, et al; 1986; American Standardization Reference Manual, (2000) in Hagstromer, 2007). In agreement with other investigations, older males and females were more frequently overweight and obese and tend to have lower levels of physical activity than young adults (Wang, 2004; and Sjostron, et al; 2006 in Santos, et al; 2008). This study therefore failed to support the null hypothesis of no significant difference.

4:4:4 Relationship between Blood Pressure and Body Composition of Active Male Subjects

The study of Table 4:5 shows significant correlation of systolic with diastolic blood pressures (r = 0.483) of active male subjects of Ahmadu Bello University, Zaria. The two blood pressure components, systolic and diastolic blood pressures had significant correlation with waist circumference (r = 0.208; 0.264); with body mass index (r = 0.213) and with waist-to-hip ratio (r =0.218) in the active male subjects. Thus, in line with Malina, *et al;* (1991); and Ogawa, *et al;* (1992) in Plowman and Smith, (1997) if a male and a female perform the same workout, the female will typically be stressing the cardiovascular system to a greater extent. Males and females display the same pattern of response for blood pressure; however, males tend to have a higher systolic blood pressure than females at the same relative workload. Similarly, body mass index correlated significantly with waist circumference (r = 0.841); and with waist-to-hip ratio (r =0.345). The trends indicated that the results were within desirable limit in this category of active individuals whose metabolic equivalent task was > 6.0mL/kg/min. who engaged in moderate intensity physical activity for at least 30 minutes each workout for not lessthan three times a week (Pate, *et al;* 1995 and Haskell, *et al;* 2007 in Hagstromer, 2007; Craig, *et al;* 2009), and reported in the International Physical Activity Questionnaire (www.ipaq.ki.se) significantly more total health-enhancing physical activity in the range of 960 to 1836 METs – minutes per week (Hagstromer, et al; 2007; Mutikainen, *et al;* 2009). And finally, there was a significant negative association between waist circumference and waist-to-hip ratio (r = -0.629) at $p \leq 0.05$. This therefore suggests that body mass index and waist circumference were better predictors of blood pressure in the male active group in this population. The study therefore failed to support null hypothesis three of no significant difference.

4:4:5 Relationship between Blood Pressure and Body Composition of Active Female Subjects

The study of Table 4:6 shows significant correlation of systolic with diastolic blood pressures (r = 0.686) of active female group of Ahmadu Bello University, Zaria. Diastolic blood pressure correlated significantly with waist circumference(r = 0.290); and with body mass index (r = 0.235). Similarly, body mass index correlated highly with waist circumference (r = 0.816) at $p \leq 0.05$. It has been suggested that physical activity might prevent weight gain and rise in blood pressure through increased energy expenditure or favourable changes in adipose tissue (Ross and Jansen, 2001 in Yang, *et al;* 2007). While the waist circumference is an indicator of adipose tissue in the waist and abdominal area; hip circumference is an indicator of adipose tissue over the buttocks and hips (Maud and Foster, 1995 and Henry, *et al;* 2004); which is used to determine body fat percent of the active populations (SIRC, 2007, Christensen, *et al;* 2008 and Mutikainen, *et al;* 2009). The ratio thus provides an index of relative fat distribution in adults, whereas; the higher the ratio the greater the proportion of abdominal fat. However, the validity of these circumferences as measure of fat distribution in youth is unknown (Mueller and Nalina, 1987 in Maud and Foster, 1995). In a study conducted by Pollard, *et al;* 2008 on Migrant and British Born British Pakistani women they ventured that, reported physical activity levels were highest in the European women and lowest among immigrant British Pakistani women, but this difference was significant for the MET – minutes measure of physical activity only. In another study conducted by Hagstromer, 2007, in Sweden, it was demonstrated that men were more active than women (Trost, et al; 2002, Socialstyrelsen, 2005 in Hagstromer, 2007). Blood pressure was more correlated with body mass index than percent body fat (Venkateswarlu, 2007). This therefore suggests that body mass index and waist circumference were better predictors of blood pressure in the female active group in this population. The study therefore failed to support null hypothesis three of no significant difference.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5:1 Summary

The purpose of this study was to investigate the relationship between blood pressure and body mass index, waist circumference, waist-to-hip ratio and percent body fat of active and inactive subjects of Ahmadu Bello University, Zaria. The ex-post facto research design was adopted because the information required by the researcher was available with the respondents. Resting systolic and diastolic blood pressures were assessed. Age of subjects (20 to 49 years) was recorded to the nearest birthday. Weight in kilogrammes and height in meters were measured with bathroom weighing scale and a stadiometre to determine body mass index in kilogrammes per metre square. Waist and hip circumferences were measured in centimeters to determine waist-to-hip ratio. Three skinfold thicknesses: triceps, chest and subscapular; and triceps, abdomen, and suprailiac crest were read-off from males and females respectively, summed, and used for determination of percent body fat from population specific prediction body density formula by Pollard, *et al;* (1980) in Maud and Foster, 1995:185). Informed consent was obtained and subjects completed the assessment and the questionnaire (IPAQ) between the early hours of 8.00 through 11.30am in 2008. The data were analysed using the Pearson Product Moment Correlation Coefficient analysis to test the hypotheses.

The results of the study showed that:

(i) Relationship between systolic and diastolic blood pressures was positively significant among the active and inactive subjects in this study. This showed that the two variables were directly proportional to each other; as systolic blood pressure increased, diastolic blood pressure also increased.

(ii) Relationship between systolic blood pressure and body mass index was positively significant among the active and inactive subjects in this study. This showed that the two variables were directly proportional to each other; as body mass index increased, systolic blood pressure also increased. However, there was insignificant relationship in the active female subjects.

(iii) Relationship between diastolic blood pressure and body mass index was positively significant among the active and inactive subjects in this study. This showed that the two variables were directly proportional to each other; as body mass index increased, diastolic blood pressure also increased. However, there was insignificant relationship in the active male subjects.

(iv) Relationship between waist circumference and body mass index was positively significant among the active and inactive subjects in this study. This showed that the two variables were directly proportional to each other; as body mass index increased, waist circumference also increased.

5:2 Conclusion

Based on the findings and in view of the limitations, the study therefore confirmed that:

(i) As systolic blood pressure increased, diastolic blood pressure also increased.

(ii) As body mass index increased, waist circumference and arterial blood pressure also increased. Therefore body mass index as a modifiable risk factor of elevated blood pressure can be the best predisposing risk factor for cardiovascular disease in the inactive group of Ahmadu Bello University, Zaria.

5:3 Recommendations

From the findings and conclusions of the study, the following recommendations were made:

(i) Since high blood pressure is a silent killer, adults should be encouraged to participate in at least moderate intensity physical activities three to five times per week throughout life.

(ii) Since body mass index has been identified as an important risk factor for a rise in blood pressure, conscious efforts should be made by adults to conduct regular check-up on their blood pressure and body composition.

(iii) Since body mass index and waist circumference complement each other, conscious efforts should be made by adults to reduce excessive intake of tobacco, sugar, salt unsaturated fats and oily foods.

5:4 Suggestion for Further Research:

Relationship between blood pressure and body composition of urban women (age 40+) and elite female athletes in Nigeria.

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