# EVALUATION OF DIETARY PATTERN, ANTHROPOMETRIC CHARACTERISTICS AND MICRONUTRIENT STATUS OF ADOLESCENTS ATTENDING SECONDARY SCHOOLS IN JOS SOUTH LOCAL GOVERNMENT AREA, PLATEAU STATE

**BY**

**DRENKAT, MICHAEL NANPEN, B.Sc BIOCHEMISTRY (UNI-JOS) 2008**
**M.Sc/SCIE/42224/2012-2013**

**A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA**

**IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTER OF SCIENCE IN NUTRITION**

**DEPARTMENT OF BIOCHEMISTRY,**

**FACULTY OF SCIENCE,**

**AHMADU BELLO UNIVERSITY,**

**ZARIA, NIGERIA**

**FEBRUARY, 2016**

## DECLARATION

I declare that the work in this dissertation entitled 'EVALUATION OF DIETARY PATTERN, ANTHROPOMETRIC CHARACTERISTICS AND MICRONUTRIENT STATUS OF ADOLESCENTS ATTENDING SECONDARY SCHOOLS IN JOS SOUTH LOCAL GOVERNMENT AREA, PLATEAU STATE' has been carried out by me in the Department of Biochemistry, Faculty of Science. The information derived from the literature has been dully acknowledged in the text and a list of references provided. No part of this dissertation has previously been presented for another degree or diploma at this or any other institution.

| DRENKAT, MICHAEL NANPEN | | |
|---|---|---|
| Name of student | Signature | Date |

## CERTIFICATION

This dissertation entitled 'EVALUATION OF DIETARY PATTERN, ANTHROPOMETRIC CHARACTERISTICS AND MICRONUTRIENT STATUS OF ADOLESCENTS ATTENDING SECONDARY SCHOOLS IN JOS SOUTH LGA, PLATEAU STATE' by DRENKAT, MICHAEL NANPEN meets the regulations governing the award of the degree of Master of Science in Nutrition of the Ahmadu Bello University and is approved for its contribution to knowledge in literary presentation.

| | | |
|---|---|---|
| Prof K. M. Anigo | _____ | _____ |
| (Chairman Supervisory Committee) | Signature | Date |
| Dr M. A. Ibrahim | _____ | _____ |
| (Member Supervisory Committee) | Signature | Date |
| Prof. M. N. Shuaibu | _____ | _____ |
| (Head of Department) | Signature | Date |
| Prof K. Bala | _____ | _____ |
| (Dean School of Postgraduate Studies) | Signature | Date |

## ACKNOWLEDGMENTS

I wish to express my profound gratitude to God Almighty who in his infinite mercy granted me strength and wisdom through this programme despite the challenges. Despite my unfaithfulness, He has been faithful.

I wish to appreciate my supervisory team Prof. K. M. Anigo and Dr M. A. Ibrahim for the scholarly and psychological support they gave to me.

I also want to use this opportunity to thank My Mother, Mrs R. C. M. Dung; siblings Nanma, Emma, Neng, Kaneng and Godiya for the moral and financial support they gave me during the period of my studies. I remain indebted to you all and may the Lord Almighty richly reward and bless you.

I also want to use this opportunity to appreciate members of the Biochemistry research committee for their efforts in ensuring the successful completion of the defense of this dissertation. My profound gratitude also goes to the academic, non-academic and technical staff of the Department of Biochemistry.

I want to use this opportunity to also acknowledge Pharm. Davou Stephen, State ministry of Health, Plateau State, Mr. Abubakar and Mallam Ilo, Institute of Agricultural Research (IAR) for their assistance.

I sincerely acknowledge my friends Ceasar, Femi, Daniel, Panmun, Peter, Binda, Isaac, Faith, Aisha and many others too numerous to mention. Special thanks go to Alhaji M. A. Sani for his assistance and advice.

Finally, my appreciation goes to my colleagues for their moral support and encouragement during this programme may God richly reward you. THANK YOU ALL!!!

## ABSTRACT

Changes in the nutrient intake combined with increasing sedentary life style and urbanization contribute to the emergence of chronic disease as a major health risk. This study assessed nutritional status, physical activity, dietary pattern and micronutrient status of adolescents attending Secondary School in Jos South Local Government Area (LGA) of Plateau State. A cross-sectional study was conducted using 588 adolescents attending Private and Public Secondary Schools of Jos South LGA between September and December 2014. Data on demographic characteristics were collected using semi-structured, pretested questionnaires. Measurements of weight and height were made using standardized weighing scales and standiometer respectively. Adolescent Body Mass Index-for-Age was compared with WHO (2007) growth reference. Dietary pattern and micronutrient status were accessed using standard methods. Results obtained showed mean Age, BMI and Waist/ Hip ratio were 16.09 years, 21.05±2.65 and 0.81±0.06 respectively. General prevalence of Overweight was high (11.22 %), particularly among the Private Secondary School girls (19.01%). Majority of the adolescents (57.99 %) had a fairly low Physical Activity Level and Private Secondary School boys showed the highest frequency (64.23%). Dietary pattern of the adolescents showed weekly intake of all types of food from "4 to 6 times" to "7 or more times" below 50 percent, except for bread, cereals, tubers and other carbohydrate based foods. Mean PCV, serum iron, zinc and copper for the Private Secondary School Adolescents were 38.71 percent, 96.15µg /dl, 86.31µg /dl and 84.44 µg /dl respectively. A percentage of 9.68 %, 16.13 % and 19.35 % adolescents recorded low values for serum iron, zinc and copper respectively when compared to reference ranges for iron, zinc and copper. The results obtained showed a prevalence of overweight and a fairly low physical activity particularly among the Girls. Consumption of cereals, tubers, pasta and other carbohydrate based foods was high while mean serum values for Iron, Zinc and Copper for the Private Secondary School adolescents were within the normal ranges. Results of this study emphasize the need for educational interventions which should include increased exercise and Physical Activity at early ages involving the whole family that will promote optimal nutritional status and wellbeing.

## TABLE OF CONTENTS

## LIST OF TABLES

**Table** **Page**

## LIST OF FIGURES

**Figure** **Page**

## LIST OF APPENDICES

**Appendix** **Page**

## LIST OF ABBREVIATIONS

| | |
|---|---|
| ADA | American Dental Association |
| ANOVA | Analysis of Variance |
| BMI | Body Mass Index |
| CDC | Center for Disease Control |
| Cu | Copper |
| EDTA | Ethylenediaminetetraacetic Acid |
| EPP | Epythrocyte Protoporphyrin |
| FAO | Food and Agriculture Organization |
| Fe | Iron |
| HCl | Hydrogen Chloride |
| IFPRI | International Food Policy Research Institute |
| LBW | Low Birth Weight |
| mL | milliliter |
| NIH | National Institute of Health |
| NCF | Nature Conservation Foundation |
| nM | Nanometre |
| PAQ-A | Physical Activity Questionnaire for Adolescents |
| P/A | Physical Activity |
| PCV | Packed Cell Volume |
| SES | Socio-Economic Status |
| SD | Standard Deviation |
| SPSS | Statistical Package for Social Sciences |

| | |
|---|---|
| TIBC | Total Iron Binding Capacity |
| UNICEF | United Nations Children's Fund |
| WHO | World Health Organization |
| WHR | Waist Hip ratio |
| YRBS | Youth Risk Behavior Surveillance |
| Zn | Zinc |

# CHAPTER 1

# 1.0 INTRODUCTION

## 1.1 Malnutrition

Generally, malnutrition refers to both undernutrition and overnutrition (Blossner and De Onis, 2005). It is a state in which a deficiency or excess of energy, proteins, and other nutrients causes measurable adverse effects on body form and function, and clinical outcome. Although malnutrition refers to both under and over nutrition, it is often associated more to under-nutrition (Todorovic *et al., 2003*). Malnutrition has become an urgent global health issue, with under-nutrition killing or disabling millions of children each year. Malnutrition also prevents millions more from reaching their full potentials. In children, severe malnutrition accounts for approximately 1 million deaths annually, with 20 million children under the age of five suffering from severe malnutrition (Ismail and Suffia, 2013). Malnutrition is therefore a health outcome as well as a risk factor for disease and malnutrition.

Many factors can cause malnutrition, most of which relate to poor diet or severe and repeated infections (Blossner and De Onis, 2005). Causes of malnutrition include general low intake of food due to short supply, various diseases such as diabetes, cancer and infections, physical and psychological trauma, which increases cellular requirements for some nutrients, the use of pharmaceutical drugs, foreign bodies such as implants and various environmental factors (Niedzwiecki and Rath,2005)

Malnutrition can disrupt the functions of various immune system components. This weakens the immune defence, decreasing its effectiveness in the elimination of pathogens and making individuals vulnerable to disease which in turn causes the loss of many nutrients, which further aggravates already existing nutrient deficiency (Niedzwiecki and Rath, 2005).

Under-nutrition does the greatest damage early in life, marked by underweight, wasting and stunting, while over-nutrition degrades the body gradually with heart disease, cancer, and other chronic diseases striking typically in middle and old age. The effects of under-nutrition such as stunting and blindness are often irreversible, while the effects of over-nutrition can be tamed through changes in diet and lifestyle (Gardner *et al.*, 2000).

Adolescence is difficult to define in precise terms, for several reasons which include difference in the onset of puberty but generally it can be estimated from 10 years to 19 years, beginning with the onset of physiologically normal puberty, and ends when an adult identity and behaviour are accepted (Centre for Disease Control., 2014). Adolescent malnutrition not only impacts future adult physique and sense of self esteem, it also affects future metabolic and cardiovascular outcomes (Yusuf *et al.,* 2013). Adolescence is a period of intense physiological, psychological and social change. The main problems in adolescence are micronutrient deficiencies, and dietary inadequacies are likely more of a threat among adolescents because of unstable eating patterns (Delisle *et al.,* 2000). Changes in lifestyle are often more obvious among urban adolescents, as they are typically 'early adopters' (Delisle *et al.,* 2005).

**1.2 Statement of Problem**

Approximately 20% of the world's population are adolescents, 84% of whom live in developing countries (Montazerifar *et al.,* 2009). In adolescence, requirement for all nutrients increase as it is one of the most challenging periods of human development (Dapi *et al*., 2009).Aproximately 20% of final adult height and 50% of adult weight is attained and bones mass increases by 45% during adolescence and even red blood cell mass increases (Ronsen, 2004).

Adolescence is a very decisive period of development because it represents the transition between life as a child, and life as an adult (Ahmad *et al.,* 2009). Over the life course, there may be an accumulation of biological and social risks (Delisle, 2005). Adolescents make many more

choices for themselves than they do as children. At some time, social pressure makes them to make choices that can have lasting effects on their nutritional health. During this period, dietary intake patterns are set in place and these patterns can have vital impact on lifetime nutritional status and health of the individuals (Ahmad *et al.*, 2009).

Type 2 diabetes mellitus, hypertension, obesity, deficiencies and anaemia are partly related to Dietary habits (Dapi *et al*., 2005). Obesity in combination with certain developed lifestyles such as smoking and physical inactivity may increase the risk of chronic diseases (Yahia *et al.*, 2008).

### 1.3 Justification

Nearly 900 million people worldwide suffer from under-nutrition, 95% of whom live in the developing world. In Sub-Saharan Africa, about 27% of the population (250 million) is chronically under-nourished (World Health Organisation, 2007).

Adolescence is an important phase as shown in "malnutrition through life circle". Evidence shows that better nourishment encourages better growth. Furthermore, adolescence is an appropriate time for health promotion programmes based on documented relationship between behaviour in this age group, obesity, cardiovascular and other chronic disease risk factors (Delisle *et al.*, 2005).

Information from this study may help implement nutrition education programs for adolescents which could lead to better food consumption patterns, dietary habits, and routine exercise which also reduces the risk of nutritionally related diseases.

### 1.4 Aim

The aim of this study is to assess dietary intake pattern and nutritional status of adolescents attending secondary schools in Jos South Local Government Area, Plateau State.

### 1.5 Specific Objectives

(1) To document demographic characteristics of adolescents attending secondary schools in Jos South Local Government Area, Plateau State

(2) To determine nutritional status and Physical activity Levels of adolescents attending secondary schools in Jos South Local Government, Plateau State.

(3) To assess dietary pattern of the adolescents using Food Frequency Questionnaires.

(4) To determine serum iron, zinc and copper of adolescents attending Private secondary schools in Jos South Local Government, Plateau State.

## CHAPTER TWO

## 2.0 LITERATURE REVIEW

## 2.1 Nutrition

The most important nutritional problem in the world today is that of Protein Energy Malnutrition (WHO, 1983) which is caused by undernutrition (Latham, 2010). Protein-energy malnutrition represents a spectrum, with kwashiorkor and marasmus at the one extreme and stunting and underweight representing the more chronic and mild moderate forms of PEM (Neumann *et al.,* 2012). Obesity can now be described as a global epidemic as it is fast becoming a worldwide problem which can increase the risk of certain conditions such as cardiovascular diseases, osteoarthritis and certain types of cancers. It has been shown that obesity in young infants and children may be a predisposing factor for adult obesity and also a risk factor to morbidity and mortality (Beaton, 1975). In 2002, the World Health Organisation (WHO), reported that Non Communicable Diseases (NCDs) are the leading cause of death globally (Ramos and Stein, 2000; Al- Hazzaa *et al.*, 2011), accounting for 60 % of annual deaths worldwide (Sweet and Fortier, 2010). Five of the risk factors (high blood pressure, high cholesterol levels, inadequate intake of fruits and vegetables, overweight and obesity, physical activity and tobacco use) are nutritionally related (Al- Hazzaa *et al.*, 2011).

Five food groups have been recognised as important and should be eaten every day as obesity and chronic diseases have been clearly associated with modifiable health risk behaviours. These food groups include grains, vegetables, fruits, meat/fish/beans (including eggs and meat alternatives) and milk (including yogurt and cheese). Each food group provides its kind of nutritional benefit. Diets that are rich in fruits and vegetables, whole grains and higher amounts of fibre are associated to lower energy intakes and smaller gains in BMI, and thus lower risk of obesity (Sweet and Fortier, 2010).

At the moment, there is real concern about the increase of unhealthy dietary habits (which includes skipping breakfast and greater consumption of sweetened soft drinks) and sedentary

behaviours- a subject that has recently undergone intense research, which both have adverse health outcomes (Al- Hazzaa *et al.*, 2011). Association of dietary behaviours, physical activity and sedentary lifestyle with childhood obesity has been extensively explored among school- aged children globally (Choi *et al.*, 2008; Mushtaq *et al.*, 2011), and obesity has been clearly associated with improper food consumption and physical inactivity (Sweet and Fortier, 2010). The 2009 National Youth Risk Behaviour Survey (NYRBS) also states a negative association between physical inactivity, unhealthy dietary behaviours and academic achievement (Centre for Disease Control, 2008)

The development of eating behaviours (food preferences, patterns of food acceptance and rejection, and the type and amount of food a person eats is a complex process that begins in infancy and continues throughout life (Eliassen, 2011). There are a series of interrelated factors, internal or external to a person which influence the formation of such habits (Ramos and Stein, 2000).These factors include biological predisposition as provided by the parents (Choi *et al.*, 2008; Birch, and Fisher, 1998), family (Ramos and Stein, 2000), social context of eating (Birch and Fisher, 1998),psychological, environmental factors (Ganasegeran *et al.*,2012; Konttinen, 2012) and socio-demographic factors (Henningsen, 2011).

The transition from childhood to adulthood may extend over variable periods of time, depending on socio-cultural and economic factors (Delisle *et al.*, 2000). It is a period in which the weight can change due to nutritional behaviours and lifestyle habits and is usually affected by control of parents and by school meal programs (Toselli *et al.*, 2014). Between childhood and adolescence, the consumption of sugar-sweetened beverages, iron-deficiency anaemia and inadequate calcium intake increases. This has been attributed to poor eating habits (less consumption of milk /milk products, vegetables and grains) and physical inactivity (Ahmed and Blumberg, 2009).

Nutritional assessment is an integral part of medical diagnosis and it involves the collection of individual's history, physical examination, and laboratory tests to provide data to diagnose nutritional problems. Anthropometrics provide an excellent indication of nutritional status of vulnerable groups and individuals and are usually central components of the nutritional surveillance systems used for the past 25 years (Centre for Disease Control, 2014).

### 2.2 Adolescents and Nutrition

Good nutrition is a somewhat elusive concept not easily defined or determined but it is generally agreed that good nutrition involves the principle of sufficiency, variety, balance and moderation. The human body requires for health the intake of water, amino acids, vitamins, minerals, fatty acids, and a source of calories which may be from carbohydrates, fats or proteins. Eating healthy means getting the right balance of nutrients the body needs to perform every day (National Institute of Health, 2009).This is to maintain a healthy weight which when not checked increases the risk of heart diseases and diabetes (National Institute of Health, 2012). Good nutrition starts from infancy. Children who were not breastfed are at increased risk of overweight, asthma, and other childhood infections. In underdeveloped countries, the concern is for micronutrients deficiencies while that of developed countries is excess energy intake (Centre for Disease Control, 2008) with evidence that in the past 20 years, the proportion of adolescents aged 12 to 19 who are obese has increased from 5 percent to 18 percent (McNeely and Blanchard, 2010; National Institute of Health, 2009).

A healthy eating plan includes Fruits and vegetables, whole grains, fat-free or low fat milk and milk products, lean meat (including poultry and fish), dry beans and peas, and nuts. This intends to limit the intake of saturated fats, trans-fats, cholesterol, salt, added sugars and alcohol. It also involves the development of healthy habits such as eating breakfast every day, choosing of whole grains more often, taking fresh fruits, which has beneficial fibre more

often than fruit juice which has little or no fibre, reducing the use of fats and oils, and limiting foods and beverages that are high in sugar (National Institute of Health, 2012).

Nutritional status during adolescents plays an important role in the human life cycle because lifestyle habits formed at this stage in life may persist into adulthood and may delay or prevent some chronic diseases (Doustmohammadian *et al.*, 2009), and it correlates closely with biological maturity..Adolescence are relatively healthy compared to other lifecycle groups (Childhood and adulthood) and show roughly similar morbidity and mortality trends in developed and developing countries (Delisle *et al.*, 2000). This period of transition is usually characterized by important physiological, psychological and social changes. Nutritional needs of male and female adolescents of the same age are typically quite different because of factors that include differences in body composition and function but even adolescents of the same sex and age may have different nutritional needs because adolescents mature at different rates due to factors like genetic predisposition, environmental factors (e.g. Undernutrition) and sometimes special conditions like diabetes, thyroid conditions or pregnancy (Delisle, 2005).

### 2.3 Adolescent Nutritional Challenges in Developing Countries

About 85 percent adolescents live in developing countries (Delisle *et al.*, 2000, and WHO, 2007). Growth retardation is common in poorer countries, and it occurs primarily during the first three years of life. Diet is poor in many low and middle-income countries due to poverty, so food diversification and intake of meat/fish is limited because of unavailability (Thurham,

2013). Overall nutritional status has been shown to be very poor among adolescent girls of poor rural groups in India with a report of about 79 percent suffering from severe chronic energy deficiency, 74 percent from anaemia and 44 percent had signs of vitamin B complex deficiency (Delisle, 2005).

The burden of early marriage can have an adverse effect on the overall nutritional status of the adolescent girl. Early marriage is common in Sub-Saharan Africa and in several countries of South Asia (Thurham, 2013), and gender differences in nutrition become apparent in adolescence which is particularly striking in West and Central Africa (UNICEF, 2011). In the Nigerian health survey carried out on pregnant women, 40 percent of those with a low BMI, which indicates undernutrition, were less than 15 years at the time of their marriage (Thurham, 2013; Ronsen, 2004). These Adolescents are more likely to die or suffer complications during pregnancy or delivery. In most countries, however, an increasing proportion of young people are becoming sexually active at early ages. Lack of knowledge, skills and access to contraception and vulnerability to sexual abuse puts adolescents at high risk for unwanted pregnancies (Moukhyer, 2006).

Iron deficiency is one of the most common nutrition disorders in adolescents living in developing countries as the prevalence in children and women and adolescents of reproductive age is about 50 percent and about 25-30 percent in men (Neumann *et al.*, 2012; UNICEF, 2011). Adolescent females though are more prone to nutritional difficulties especially iron deficiency. Available international evidence suggests that differences in nutritional status between girls and boys are statistically negligible in all regions except south Asia. However, as the years pass, girls become at greater risk of anaemia. In nine countries, all in Africa except India, more than half of the girls, aged 15 to 19 are anaemic (UNICEF, 2011). In Bolivia, prevalence of moderate or severe anaemia clearly declined as income

rises. In Rajasthan, the poorest group of adolescent women has the highest rate of anaemia (Ronsen, 2004).

Contrary to what is expected in developing countries, recent trend has seen an increase in obesity, and it is emerging as an epidemic. Worldwide, disease profiles are transforming at a rapid pace. This has been reported in significant number from nations previously considered poor or developing. In Nigeria, as at 2003, 18 percent of children aged 5-15 years from relatively privileged homes were found to be obese (Chhatwal *et al.*, 2003). In Brazil, in two surveys carried out in 1974 to 1975 and 1996 to 1997, there was an increase in obesity from 4.1 percent to 13.9 percent among 18 year old adolescents (Gupta *et al.*, 2012). In developed countries, children of low socio-economic status are more affected than their affluent counterparts. This is not the case in developing countries; children of the upper socio-economic strata are more likely to be obese (Raj and Kumar, 2010). Most developing countries including Bolivia, Croatia, Dominican Republic, Egypt, Nigeria, Peru, and Senegal demonstrate a rising trend in overweight prevalence in school children, although in developed countries is about twice that of developing countries. The vast majority (about 35 million) of affected children live in developing countries though (Gupta *et al.*, 2012).

### 2.4 Demographic Factors Associated with Nutritional Status

The nutritional status of an individual involves interplay of genetic predisposition with environmental factors such as socio-demographic variables (Dupuy *et al.*, 2011). These socio-demographic factors include age, sex, education, occupation, income, ethnicity, and knowledge and attitude related to diet and health (Dunneram and Jeewon, 2013**).**

### 2.4.1 Age

Age is an important factor which can determine the nutritional status of an individual. Malnutrition commonly affects all groups in a community, but infants and young children are the most vulnerable because of their high nutritional requirements for growth and development. The infant is dependent on its parents for the nutrition it gets. In developing countries, poor prenatal conditions are responsible for approximately 23% of all deaths among children younger than five years old. These deaths are concentrated in the neonatal period (i.e. the first 28 days after birth), and most are attributable to LBW (Blossner and De Onis, 2005).

At adolescence, eating patterns are developed which may impact on lifetime nutrition. This is also a stage where eating disorders are developed. Disordered eating behaviours are associated with a number of harmful behaviours such as smoking, alcohol consumption, and drug use, as well as physical and psychosocial consequences like poorer dietary quality depressive symptoms, weight gain and onset of obesity, and finally the onset of eating disorders (Mallick *et al.*, 2014).

### 2.4.2 Gender

Gender is not just about women. It is about the socio-cultural roles assigned to men and women and the interplay between them (Yinger *et al.*, 2002). The socially constructed gender roles of men and women interact with their biological roles to affect the overall nutritional status of an individual. Women and girls are particularly more vulnerable because of their cyclical iron loss and childbearing. Both pregnancy and lactation considerably increase

nutritional needs in terms of dietary quantity, and quality. Furthermore, more inadequacies are inquired when pregnancy and lactation coincide with adolescence because nutritional needs at this stage in life competes with nutritional needs of the foetus (FAO, 2012).

Most societies restrict the availability of resources to women (Oniang and Mukudi, 2002). This is as a result of gender inequality, a cause and also an effect of hunger and malnutrition (FAO, 2012), which in turn may affect their nutritional status and that of their children (UNICEF, 2011).

2.4.3 Physical activity

WHO defines insufficient Physical Activity for adults as not meeting the following criteria:

(1) At least 30 minutes of moderate to intense activity or walking per day on at least five days in a typical week; or

(2) Atleast 20 minutes of vigorous-intense activity per day on at least three days in a week; or

(3) Five or more days of any combination of walking, moderate or vigorous intensity activities achieving a minimum of 600 metabolic equivalent (MET)- per week (WHO, 2013).

Physical activity is an effective way to maintain body composition and potentially prevent chronic diseases as it has been shown to induce health related benefits in males and females of all age groups through the reduction of blood pressure, body fat and the incidence of type II diabetes, leading to lower incidence of cardiovascular problems (Gearheart *et al.*, 2008). It has been reported to reduce Ischemic heart disease by 15-20%. About 1.9 million People die from the consequences of insufficient physical activity every year (Jovanovic *et al.*, 2010). Being physically active plays an essential role in ensuring health and well- being and

according to C3 Collaborating for Health (2011), it benefits the heart, skeletal muscles, bones, blood, immune system and the nervous system

All types of physical activities which include occupational, transport, domestic and recreational physical activities do or may protect against cancer. People living in industrialized or urban settlements are encouraged to increase their levels of physical activity as there is high tendency to live a sedentary lifestyle (Marmot *et al.*, 2007).

In younger people like adolescents and children, it improves strength and endurance, reduces anxiety and stress, increases self esteem, promotes psychological well being, and may help improve performance (Centre for Disease Control, 2014). Consequently, physically reduces mortality rates in populations as evidence shows people with high level of Physical activity or cardio-respiration fitness have a lower mortality rate as compared with sedentary habits or low cardio-respiratory fitness (United States Public Health Service, 1996)

The social importance of Physical activity among youths as recognised by the World Health Organisation includes the following:

(1) Youths who participate in organised sports at school or in their community are less likely to engage in risky health behaviours like cigarette smoking and drug use than non- sport participants

(2) Many studies show that youth involved in organised sports have lower rates of drug use. There is however evidence that sports participation can increase some harmful health behaviours like eating high fat foods, binge drinking, vomiting and use of laxatives to prevent weight gain. This is particular among males.

(3) Youths involved in organised sports have been associated with less antisocial behaviour, such as carrying weapons, or contemplating or attempting suicide. On the contrary, some sports such as ice hockey, football and rugby may promote violence

(4) Girls who play sports have lower pregnancy rates, engage in sexual intercourse less frequently, have fewer partners, and begin sexual activity later than those not involved with sports (WHO, 2013).

2.4.4 Socio-economic status

Socio-Economic Status (SES) is referred to as components of economic and social status that distinguish and characterize people. Many indicators of socio-economic status exist, even though there is little agreement to which are more useful (Doocy and Burnham, 2005). Income is an example of an indicator of socio-economic status. One direct Channel through which income may affect health is through nutrition (Jensen, 2004). A large body of epidemiologic data shows that diet quality depends on socioeconomic status. In developed countries, evidence shows that higher quality diet is associated with affluence while energy-dense diets, which are nutrient- poor, are consumed by people of low economic status (Darmon and Drewnowski, 2008), as shown by overwhelming evidence of higher obesity in lower income earners in the united states (Gearhart *et al.*,2008) . Mexico for example has a high percentage of overweight or obese men and women (50% for men and 60% for women). In Guatemala, obesity increased from 34.1% in 1995 to 44.9% in 2002 (Nagata *et al.*, 2009). In developing countries however, the level of obesity is greater in the higher income earners of the society. Evidence exists in Brazil, Cameroon, India, Jordan, and Madagascar (Gearhart *et al.*, 2008).

Education is linked to both understanding what healthy diet and healthy lifestyle means as well as how to implement them (Frederick *et al.*, 2014). This can be better explained by the

fact that good education leads to better health behaviours. For example, more highly educated mothers smoke less, drink less, take more vitamins and receive more prenatal medical care (Currie and Goodman, 2010). Those with a higher level of education, particularly greater than a grade school education are more likely to be exposed to information regarding nutritional requirements. Those with higher education may have more money, thereby having access to healthier foods (White, 2012).

## 2.5 Dietary Factors Associated with Nutritional Status

### 2.5.1 Effect of calcium and dairy foods

Calcium metabolism in childhood is complex with the degree of positive calcium balance necessary to achieve maximum peak bone mass not known. Supplementation significantly increases the percentage gain of bone mass (Cheng *et al.*, 2005). Recently, there have been studies that show that calcium intake is inversely related to body weight or body fat, which may be due to the reason that low calcium diet leads to increase in intracellular calcium which in turn promotes body fat deposition, reducing lipolysis and reducing thermogenesis. High calcium diets act in a reverse manner. Dairy products may be more effective than elemental calcium and other factors may also play a role in body fat regulation (Barr, 2003).

### 2.5.2 Effect of dietary fibre and whole grain

To date, there is no international whole grain definition and the definitions used vary between different countries (Anderson *et al.*, 2009). It is a divergent process and it depends on both nutritional and analytical concepts(Lattimer and Haub, 2010), but one thing is sure, whole grains provide complex carbohydrates, resistant starch, dietary fibres, minerals, vitamins, photochemical which serve as antioxidants and phytoestrogens and other substances(Anderson and Hanna, 1999). Whole grains contain germ, endosperm, and bran,

unlike refined grains that contain only the endosperm. The bran and germ contain various nutrients, which are removed during the refining process (Aune *et al.,* 2011).

There is increasing evidence that whole-grain cereal products protect against the development of chronic diseases like obesity, type II diabetes, cardiovascular disease and cancers. Evidence to prove this has been shown from the effect of consuming refined cereal products which have been associated with increased risk of digestive track, pharynx, larynx and thyroid cancers (Fardet, 2010; Anderson and Hanna , 1999). These problems may be attributed to the absence of dietary fibre. Dietary fibre intake provides many health benefits. A generous intake reduces the risk of chronic diseases. It also improves serum lipid concentration, lowers blood pressure, improves blood glucose control in diabetes, and promotes regularity, aids weight loss and may improve immune function (Anderson *et al.*, 2009).

Health aspects of whole grains have long been known. In the 14$^{th}$ century BC, Hippocrates, the father of medicine recognised the health benefits of wholegrain bread. Physicians and scientists recommended wholegrain to prevent constipation in the 1800s to the 1900s (Slavin, 2004). The beneficial effect of soluble fibres may be mediated through slow absorption and digestion of carbohydrates that leads to low demand for insulin while that of insoluble fibres can be shown in the short transit time through the intestine, which reduces time for carbohydrates to be absorbed (Montonen *et al.*, 2003).

Fibre in the diet can be gotten from several sources apart from whole grains. The major sources include fruits and vegetables. Fibres from fruits and vegetables have been associated with decreased risk of breast cancer. This effect was not seen in fibre from whole grains. This may suggest that the source of dietary fibre also matters (Warren and Devine, 2000).

### 2.5.3 Effect of fruits and vegetables

Just like wholegrain; epidemiological data has supported the association between high intake of vegetables and fruits with lowering the risk of chronic diseases. Vegetables and fruits are rich sources of nutrients which include vitamins and minerals, dietary fibre, and many other biologically active components which function in detoxification, stimulation of the immune system reduction of platelet aggregation, cholesterol synthesis modulation and hormone metabolism, lowering blood pressure, antioxidant, antibacterial and antiviral effects (Lampe, 1999). Based on such evidences, the World Health Organisation issued recommendations for a minimum daily intake of 400g of fruits and vegetables (Oyebode *et al.*, 2014). Surprisingly though, identification of specific compounds in fruits and vegetables that are responsible for anti-carcinogenetic activities has remained elusive to date (Boffetta, 2010; Dragsted *et al.*, 2006)

In recent years, there has been controversy about the relationship between fruits and vegetables and mortality. More uncertainty is in their association with reducing risk of cancer, but studies have shown that they are more associated with reducing risk of cancer of the mouth, pharynx, oesophagus, stomach and lung (Oyebode *et al.*, 2014).

2.5.4 Effect of dietary pattern

Even though a person may be food secured, he or she may not necessarily be nutrition secured. Individual nutritional status depends on the interaction between foods that are eaten. The effect of any individual nutrient may be too small to detect in trials (Appel *et al.*, 1997; Abiba *et al.*, 2012), and instead of isolated nutrients, people eat meals mixing different foods, giving several nutrients a chance to interact (Montonen *et al.*, 2005). Food preferences are developed early in life, and influenced by adult food preferences (Appel *et al.*, 1997).

Dietary pattern has been associated with the risk of developing many chronic diseases. For example, the risk of developing high blood pressure has been reported to be higher in non-

vegetarians than in vegetarian. This may be due to the high intake of fibres and minerals (such as potassium and magnesium), and their low fat content (Appel *et al.*, 1997). High intake of energy (carbohydrates and Fats especially) increases the chances of developing chronic diseases such as type 2 diabetes and high blood pressure. In addition, diets rich in fruits and vegetables have been shown to exert preventive effects on cancer, due to the presence of anti-oxidants (Montonen *et al.,* 2005).During adolescents, there is incidence of nutrition deficiencies and poor eating habits which expose them to many risk factors leading to the development of chronic diseases (Abiba *et al.,* 2012).

## 2.6 Role of Iron, Zinc and Copper in human metabolic processes

Metal ions are vital to life and participate in numerous metabolic processes in every living cell with considerable specificity and selectivity as components of enzymes and other molecular complexes (Nadadur *et al.,* 2008). Each of the nutritionally essential trace elements (and major elements) has its own unique combination of atomic characteristics that underlie their special individual roles in human biology (Costello and Grumstrup-Scott, 2000). Worthy of note are Iron, Zinc and Copper.

### 2.6.1 Iron

Iron is the most abundant element on earth, yet it is only required in trace amounts in biological cells (Arora and Kapoor, 2012). It is an important trace element required by living organisms and its daily intake in milligrams is adequate for normal health. Iron deficiency is a global problem though, despite the low dietary requirement (Nadadur *et al.,* 2008). Mammals obtain their iron exclusively from their diet, whereas absorption in the form of heam iron, from animal sources is very efficient (Nadadur *et al.*, 2008). Absorption may be affected by factors such as type of food eaten, vitamin C intake, and the presence of other compounds (such as phytate) in the food which may affect the bioavailability of iron. Iron is

needed greatly during growth or periods of blood loss. This is particularly true in young children, adolescents and pregnant women (Clifford *et al.*, 2015). Iron deficiency and iron overload are the two major disorders of iron metabolism. Iron deficiency anaemia is the most severe form of iron deficiency, with consequences such as poor pregnancy outcomes, reduced physical capacity, poor cognitive development among infants and adolescents and so on (Pfeiffer *et al.*, 2009).

2.6.1.1 Iron transport, metabolism and storage

The total body iron in an adult male is 3000 to 4000 mg whereas that in an average adult woman is 2000 to 3000 mg. This may be attributed to a much smaller reserve in women. The common oxidative states of iron are ferrous ($Fe^{2+}$), ferric ($Fe^{3+}$) or ferryl ($Fe^{4+}$). Iron has an affinity for electronegative atoms like oxygen, nitrogen and sulphur (Arora and Kapoor, 2012) and transport is primarily by binding to the transport protein, transferrin, which has two binding sites and can complex with a higher specific transferring receptor (TfR) located at the plasma membrane surfaces of cells. A second transporter, simulator of iron transport (SFT) has been identified as a transporter of both ferric and ferrous iron out of the endosome (Trumbo *et al.*, 2001).

Iron is stored in the form of ferritin or hemosiderin in the body. Ferritin is a protein produced by nearly every cell of the body and each molecule can hold about 4,500 atoms of iron as hydrous ferric oxide. It serves as the primary reservoir of iron from which iron can be mobilized. Serum ferritin is a good measure of iron stores; especially for someone who is iron defficient .Hemosiderin is a water insoluble degradation product of ferritin, with variable iron content that is generally higher than that of ferritin. The cells of liver, spleen, and bone marrow are the primary iron storage sites in humans (Trumbo *et al.*, 2001).

2.6.1.2 Excretion

Only small quantities of iron are excreted every day apart from losses due to bleeding (including menstruating) or pregnancy. Thus body iron is highly conserved. Loss is in the range of 0.9 to 1.02mg/day in non menstruating women. Losses from urine gastrointestinal track and skin are approximately 0.08, 0.6 and 0.2 to 0.3 mg/day respectively (Trumbo *et al.*, 2001).

2.6.1.3 Function

Four major classes of iron containing proteins exist in the mammalian system: iron containing haem proteins (haemoglobin, myoglobin, cytochromes), iron sulphur enzymes (flavoprotiens, haemflavoprotiens), proteins for iron storage and transport (transferring, lactoferrin, ferritin, haemosidering) and other iron containing or activated enzymes (sulphur, non haem enzymes) (Trumbo *et al.*, 2001).

About 65 to 70 percent of total body iron is found in heam group of haemoglobin which consists of iron held in a heterocyclic ring, known as aporphyrin. Haemoglobin is an oxygen transport molecule. Even though carbon dioxide is also transported by haemoglobin, it does not compete with oxygen. In the transport of oxygen, iron must be in the $Fe^{2+}$ state. Oxygen temporarily binds and oxidizes $Fe^{2+}$ to $Fe^{3+}$ (Arora and Kapoor, 2012). Myoglobin is located in the cytoplasm of muscles cells and increases the rate of diffusion of oxygen from capillary erythrocytes to the cytoplasm and mitochondria. Iron deficiency anaemia reduces its concentration. Cytocromes contain haem. They act as electron carriers. The 40 different proteins that constitute the respiratory chain contain six different haem proteins, six with iron sulphur centers (Trumbo *et al.*, 2001).

Iron is vital for almost all living organisms and a variety of metabolic processes so its concentration in body tissues must be tightly regulated (Gurzau *et al.*, 2003). Our body continually lose iron through everyday process such as urination, defication, sweating and

sloughing of skin cells. Bleeding contributes to further loss of iron from the body (Casiday and Frey, 1998). Furthermore, excess iron leads to tissue damage, an outcome of the formation of free radicals (Gurzau *et al.*, 2003).

When the body supply of available iron is low, a condition known as iron deficiency anaemia results. This condition is as a result of low production of haemoglobin to meet the oxygen-transport needs of that individual (Cassiday and Frey, 1998).

Iron overload occurs as a result of too much iron deposit in the body tissues. A severe state of iron overload is known as haemchromatosis. This condition can result to serious damage to the body tissues, including liver cirrhosis, heart failure, diabetes, abdominal pain and arthritis. This condition can further be enhanced by genetic disposition (Finberg, 2011).

Clinical laboratories typically use units for iron status indicators: serum iron, Total Iron-Binding Capacity (TIBC), and Erythrocyte Protoporphhyrin (EPP) (calculated in micrograms per decilitre, ferittin in nanograms per millimetre (nm/mL) (Pfeiffer *et al.*, 2009).

2.6.1.4 Dietary sources and intake of iron

Dietary sources of iron include meat (beef, pork, lamb, turkey, chicken etc.), bread, cereals, fruits and vegetables and dairy products. RDA is age dependant. It ranges from 0.27-11 mg/ day for infants and children aged 0-8 years, 8-11mg/ day for males aged 9 years and above and 8-18mg/day for females 9 years and above. About 18 mg/day is required by pregnant women and 9-10 mg/ day is required by lactating women. (Anderson and Fitzgerald, 2010).

2.6.2 Zinc

Zinc, ($Zn^{2+}$) is an essential part of more than 300 enzymes involved in synthesis, metabolism and turnover of proteins, carbohydrates lipids, nucleic acids and some of the vitamins like vitamin A (Blaszczyk *et al*,2014). It is estimated that about 10 percent of human proteins

potentially bind zinc, in addition to hundreds that transport and traffic zinc. It is required for the catalytic activity of more than 200 enzymes and it plays a role in immune function, wound healing, protein synthesis, taste and smell and normal growth and development during pregnancy, childhood and adolescence (Beshgetoor and Hambridge, 1998).

2.6.2.1 Zinc transport, metabolism and storage

Zinc homeostasis is maintained via the gastrointestinal system by absorption of exogenous zinc and excretion of endogenous zinc. Absorption of zinc is done through active transport as well as passive diffusion, (which is dependent on concentration gradient) (Molokwu and Li, 2006). Absorption is dependent on doze and mainly takes place at the upper part of the small intestine. Absorbed zinc is transported in the blood bound to albumin (about 60%), (Blaszczyk*et al.,* 2014) and transferin (about 10%) (Beshgetoor and Hambridge, 1998).

The zinc content of the adult human body ranges from 1.5 to 2.5g, with a higher content in men than in women. The non-fat tissues (skeletal muscles and bones) contain 83% of the total zinc in the body. Also, the concentration of zinc in various tissues is not uniform so is its depletion across all tissues, skeletal muscles, skin and heart (Hotz and Brown, 2004). Two thirds of the total body zinc is located in muscle tissues and 30 percent in the bone tissues. Plasma zinc only represents 0.1 percent of total body zinc. High concentrations are found in the eye and prostate liquid (Blaszczyk *et al.,* 2014) Greater than ten percent of the human genome codes for zinc- containing proteins. Zinc homeostasis is controlled by the coordinated actions of zinc transporters responsible for zinc influx and efflux and also contributes to cellular events at the molecular, biochemical and genetic levels (Josco, 2011).

There are no conventional tissue reserves of zinc that can be released or sequestered quickly in response to variations in dietary supply. Nevertheless, it has been proposed that bone may serve as a reserve because zinc may become available during normal turnover of osseous

tissue. Losses through the gastrointestinal track accounts for approximately half of all zinc eliminated from the body (Hotz and Brown, 2004).

2.6.2.2 Excretion

Zinc is lost in the body through the gastrointestinal track, which accounts for half of the zinc loss. Another route for zinc excretion includes urine, which accounts for about 15%. Epithelial cell desquamation, sweat, semen, hair, and menstrual blood account for about 17% of total zinc losses. Faecal losses account for less than 1mg/ day (Burch *et al.*, 1975).

2.6.2.3 Function

Zinc has multiple physiological and metabolic functions, such as physical growth, immune-competence, reproductive function, and neurobehavioral development. Clinical signs and biochemical abnormalities may develop when there is excess or inadequate zinc in the body of an individual (Hotz and Brown, 2004). Zinc has the following functions as listed below:

(1) Necessary to maintain normal serum testosterone

(2) Boost immune system as a component of thymic hormone which controls the maturation of lymphocytes

(3) Boost brain activity as a component of mossy fibre system found in the hippocampus

(4) Aids in the healing and protection of skin

(5) Stimulates tastes and smell

(6) Zinc improves appetite

(7) Zinc improves mood

(8) Aids in the treatment of premenstrual syndrome

(9) Reduces the risk of premature birth (Bhowmik and Chiranjib, 2010)

Notable among the importance of zinc is the fact that zinc is necessary for growth. The first recognized clinical presentations of zinc deficiency and the essential role of zinc in human nutrition were growth retardation and hypogonadism; impaired physical growth is one of the most studied physical features of zinc deficiency (Nriagu, 2007).

2.6.2.4 Dietary sources and intake of zinc

Good sources of zinc include meat, milk and milk products, and wholegrain. Nuts and legumes are other sources. Foods with a high fat content and sugar have a low content of zinc. The Recommended Daily Allowance (RDA) of zinc is 15 mg for a male adult. Women may need as much as 19mg per day (Bhowmik and Chiranjib, 2010).

2.6.3 Copper

Copper is an essential micronutrient required by all life forms. It is a transition metal involved in a variety of biological processes. It exists as Cu (II) and Cu (I). This attribute make copper an important catalytic co-factor for a variety of metabolic processes. In biological forms, copper is found mainly in the Cu (II) or $Cu^{2+}$ since in the presence of oxygen or other electron acceptors, Cu (I) or $Cu^{1+}$ is readily oxidized to $Cu^{2+}$ (Krupanidhi *et al*., 2008). Copper can be found in almost every cell of the human organism. The highest concentrations of copper are in the brain, liver, Central Nervous System (CNS) and the heart. About 50% of copper is stored in bones and muscles with skeletal muscles storing about 25%, skin having 15%, 8-15% in the liver and 8% in the brain (Angelova *et al*, 2011). An average adult body contains 80-120 mg of copper (Burch *et al*, 1975).

2.6.3.1 Copper transport, metabolism and storage

Copper is absorbed from the stomach and upper gut by at least 2 mechanisms; one, an energy dependant process facilitated by amino acids and which represents the absorption of copper complexes of amino acids. A larger portion of copper is absorbed by a second mechanism and is bound to two protein fractions in the intestinal mucosa (Burch *et al.*, 1975). Copper is absorbed and transported to the liver bound to albumin. It enters the bloodstream via the plasma protein, ceruloplasmin (about 90 %) (Josko, 2011), where its metabolism is controlled, and is excreted in bile. Ceruloplasmin is synthesized in the liver. The mechanism of the transport of copper to the liver is not yet known (Burch *et al.*, 1975).

2.6.3.2 Excretion

The major excretory route for copper is bile, for eventual loss in stool (Brewer and Askari, 2006) and the process is quite complex and also poorly understood. Normal urinary copper is little (20- 50µg/ day) and its source is unknown, whereas stool copper is in the order of 1.0mg/day (Brewer and Askari, 2006). Copper excretion is a slow process which may be a problem if copper is in excess. Also, there must be a proper balance between copper and minerals that compete for absorption, like zinc. Improper supplementation of zinc in excess may cause reduction in the absorption of copper leading to copper deficiency (Josko, 2011).

2.6.3.3 Function

Copper is an essential nutrient critical mostly at infancy because of rapid growth as rapid growth increases copper demands. Copper is an essential co-factor in a number of critical enzymes in metabolism including superoxide dismutase1 (Cu/ZN-SOD), an enzyme that detoxifies superoxides by converting it to oxygen and hydrogen peroxide, cytochrome c oxidase (COX), which is required for aerobic respiration, lysyl oxidase, which participates in cross-linking collagen and elastin, ceruloplasmin (CP) and feroxidase, 2-furoate-CoA dehydrogenase which oxidize $Fe^{2+}$ to $Fe^{3+}$ for connection to transferrin for transportation to

the Red Blood Cells (RBC) and Blood formation , amine oxidase, cetechol oxidase, dopamine beta-monooxygenase which catalalizes the convertion of the neurotransmitter dopamine into norepinephrine and many other enzymes (Angelova *et al.*, 2011). Copper is also necessary for the synthesis of phospholipids found in myelin sheaths of peripheral nerves, and the production of thyroid hormone, thyroxine (Josko, 2011)

During deficiency, iron transport in the body is affected and iron tends to accumulate in many tissues. Generally, copper deficiency is accompanied by a hypochromic microcytic anaemia similar to that produced by iron deficiency (Arredondo and Nunez, 2005). Also, because copper is involved in many functions, deficiency may result in a range of symptoms such as hernias, aneurysms, blood vessel breakage manifesting as bruises or nosebleeds, joint problems, osteoporosis, brain disturbances, abnormalities in glucose and cholesterol metabolism , increased susceptibility to diseases, fatigue, skin sores, irregular heart beat and low body temperature (Josko, 2011).

2.6.3.4 Dietary sources and intake of copper

Plants serve as a direct source of elemental copper for humans. Additionally, human breasts milk has the highest concentration of copper (0.25-6.0 mg/liter). Other sources include oysters and other sea foods, beef and organ meats (especially liver), dark green vegetables, enriched cereals, nuts and sunflower seeds, green olives, avocados, dried legumes chocolate, cocoa, and black pepper (Josko, 2011).

# CHAPTER 3

# 3.0 MATERIALS AND METHODS

## 3.1 Materials

### 3.1.1 Reagents and instruments

(1) Locally made Standiometer measuring up to 2 metres

(2) Digital personal weighing scale model 2003B measuring up to 150kg

(3) One (1) metre plastic tape

(4) Plain bottles for serum sample collection

(5) Heparized bottles

(6) 5ml syringes

(7) Atomic Absorption Spectrophotometer AA500

(8) $HClO_4$ ( perchloric Acid)

(9) $H_2SO_4$ (Tetraoxosulphate(vi) acid)

(10) $HNO_3$ (Trioxonitrate(v) acid)

(11) Distilled water

### 3.1.2 Study area

The study was conducted in public and private secondary schools of Jos South Local Government Area, Plateau State, Nigeria. Jos South local Government has a size of 510km$^2$ and population of about 311,392 (NPC, 2007). The LGA is located in the northern senatorial district of Plateau State and 15 kilometres south of the State capital. Jos South has 4 districts (Du, Gyel, Vwang and Kuru) (retrieved from http://www.plateaustate.gov.ng/).

Jos South local government has 20 wards ( Bukuru, Du A, Du B, Giring, Gyel A, Gyel B, Kuru A, Kuru B, Shen, Turu A, Turu B, Vwang, Zawang A, Zawang B, Sot, Kushe, Hwolshe, Dashnong, Tanchol, Chugwi).

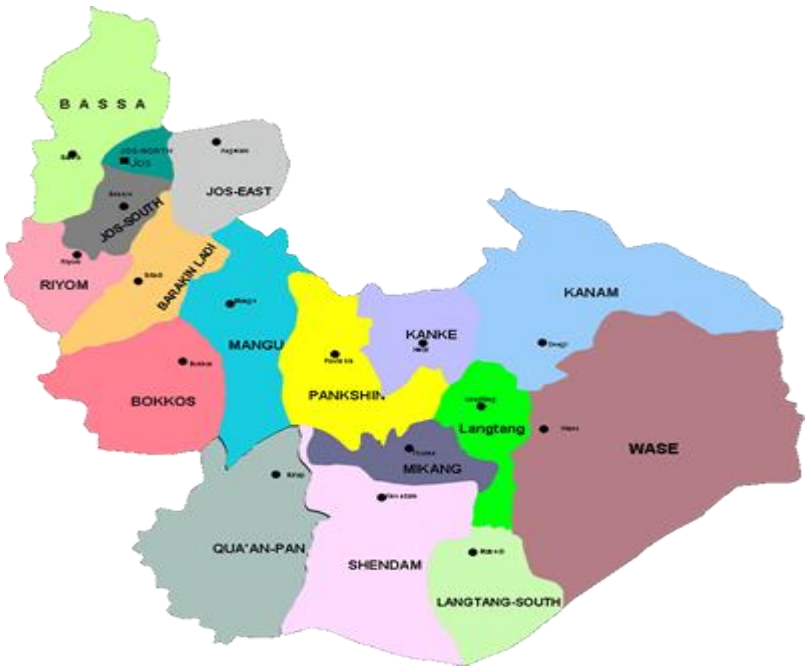


**Figure 3.1: Map of Plateau State showing Jos South Local Government (** Source: http://www.plateaustate.gov.ng/)

3.1.3 Study population

The study population were adolescents attending Private and Public Secondary Schools in Jos South Local Government Area of Plateau State.

3.1.4 Inclusion priteria

All mentally fit adolescents between the age of 13 to 19 years who attend Private and Public Secondary Schools in Jos South LGA of Plateau State and also not physically challenged.

### 3.1.5 Exclusion criteria

Adolescents attending Private and Public Secondary Schools in Jos South not within the age range of 13 to 19 years, and who are mentally and physically challenged.

### 3.1.6 Informed consent

Informed consent for inclusion into this study was sought from the students and their parents/ guardians using standard protocol (appendix I)

### 3.1.7 Ethical approval

Ethical approval was obtained from the Ministry of Health, Plateau State, in accordance with the Helsinki declaration. This is a code of ethics on human experimentation drafted by the World Medical Association in 1964. Application was submitted to the principals of selected secondary schools for permission to carry out the study (Appendix III).

### 3.1.8 Study design

A descriptive, comparative cross-sectional design was used to determine the association between nutrient intake, demographic factors and BMI in healthy adolescents attending selected secondary schools in Jos South, Plateau State.

Face to face questionnaire was administered to obtain information from the students. Information gathered included demographic, anthropometric and physical activity as well as their food and beverage intake (unquantified) every day (appendix II section 5).

3.1.9 Sampling technique

The research covered 12 wards of the Local government. A multistage cluster sampling technique was used to select samples. One school was chosen from each ward (alternating between Private and Public Schools), adding up to 12 Schools. Probability Proportional to Size Sampling Technique was then carried out within the various Secondary Schools.

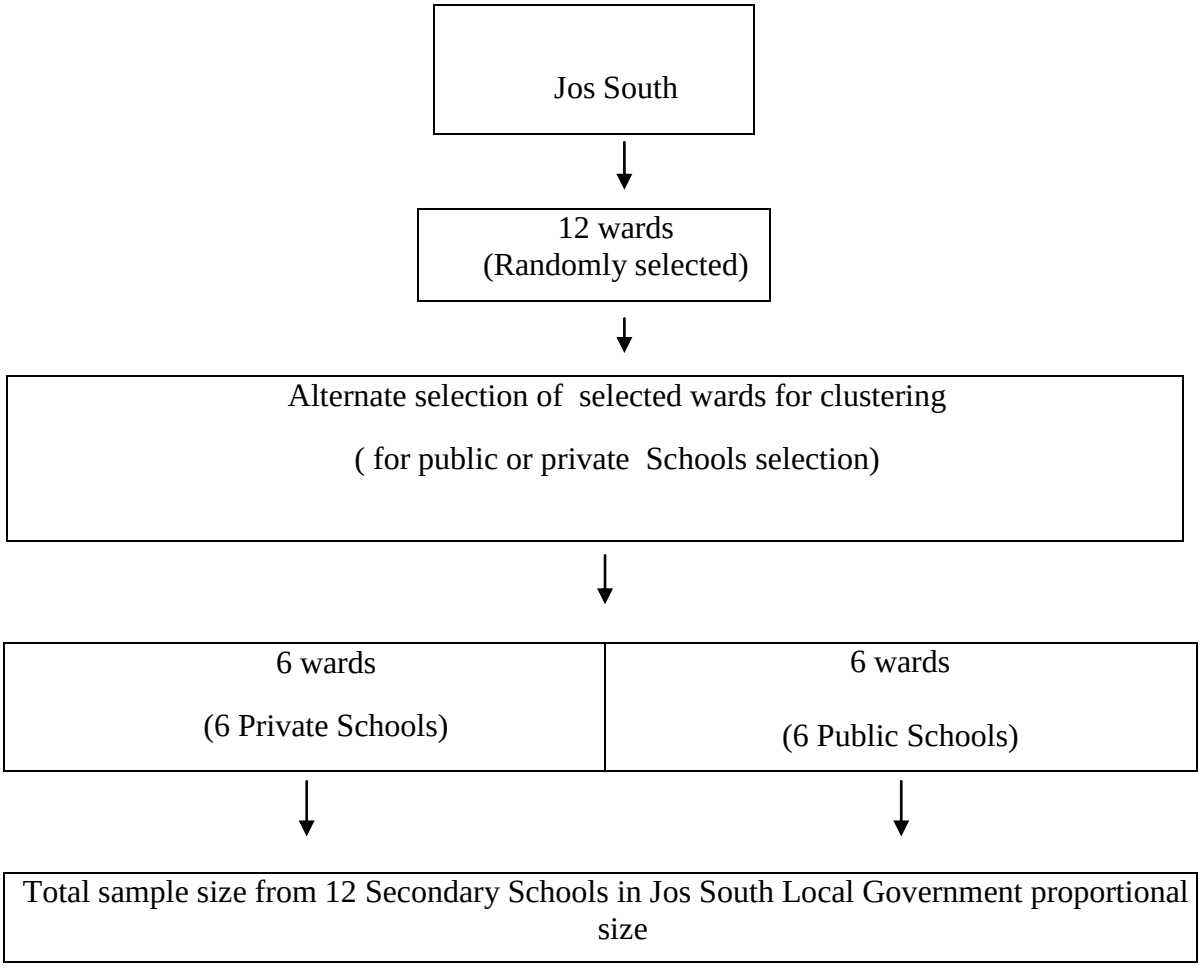


**Figure 3.2: Sampling Procedure for Selection of Adolescents**

3.1.10 Sample size

The sample size for this study was obtained using the formula:

$n = (z^2pq/d^2) \times 1.5$(design effect)

Where:

n= the desired sample size

z= the standard normal deviation, usually set at 1.96 (≈2.0)

p= the proportion in the target population having the particular trait or prevalence (44%).

q= 1.0-p

d= degree of accuracy desired, usually set at 0.05

Therefore, $n= (1.96)^2(0.44)\ (0.56)/\ (0.05)^2 = 379$

Design effect (n x 1.5) was considered in the calculation and 5% was allowed for null response.

(379 x 1.5) = 568.5

≈ 569

So final N was calculated as:

N = 569 + 5% (379)

N = 588

Total population size was 588.

## 3.2 Methods

### 3.2.1 Determination of weight and height

Weight and height measurements were obtained as described in the Food and Nutrition Technical Assistance Guide (Cogill, 2003). Weight measurements were taken with minimal number of clothes and no shoes on. A digital weighing scale was used. The height measurements taken to the nearest 0.1cm were obtained with the volunteers having no shoes on. A locally made manual standiometer with a maximum height of 2m was used.

### 3.2.2 Determination of body mass index for age (BMI for Age)

BMI for Age is a commonly accepted index for classifying nutritional status in adolescents. It is defined as body weight in kilograms divided by the square of the height, in meters squared (Kuczmarski *et al*, 2000).

$$\text{BMI} = \text{weight (kg)} / \text{height (m}^2\text{)}$$

Underweight, overweight and obesity was assessed using the WHO reference standards for adolescents with regard to age and sex.BMI for Age values < -2SD indicates Global Acute Malnutrition (thinness and severe thinness), ≥-1SD to <+2 SD as normal, ≥+2 to <+3SD as overweight and ≥ +3 as obesity (Cogill, 2003).

### 3.2.3 Determination of waist and hip circumference (WHR)

Waist circumference and measurements was taken to the nearest 0.1 cm, by measuring from the narrowest point between the lower borders of the rib cage and the iliac crest. The hip circumference was measured around the widest portion of the buttocks. Both measurements were

carried out in centimeters using a tape rule. The recommended sex specific cut off points are 0.9 for males and 0.85 for females (WHO, 2011).

### 3.2.4 Determination of demographic and physical activity characteristics

Demographic and Physical Activity was collected using questionnaire which asked for background, characteristics and Physical Activities of participant (appendix II, section 1- 3). A modified Physical Activity questionnaire for Adolescents (PAQ-A) was used to classify Physical activity into five Classes: Low (1.00-1.49), fairly low (1.50-2.49), moderate (2.50-3.49), fairly high (3.50-4.49) and high (4.50-5.00).

### 3.2.5 Dietary intake records

The dietary intake was assessed using an un-quantified Food Frequency Questionnaire (appendix II, Section 5).

### 3.2.6 Blood Sample Collection

Five (5) millilitres of blood was collected from peripheral vein of the lower arm by venipuncture using a sterile syringe. Four millilitres of the blood was placed in a sample bottle containing no anticoagulant and allowed for about 30-60 minutes for spontaneous blood clotting. The serum was separated from the cells by centrifuging at 3000 rpm for 10 minutes at room temperature. The decanted serum was used for the biochemical assays. The remaining One (1) millilitre of blood was collected in a sample bottle containing anticoagulant (heparin). This was used for Packed Cell Volme (PCV) determination.

### 3.2.7 Determination of Packed Cell Volume (PCV)

This was carried out using anti-coagulated blood with EDTA. Specimens were centrifuged within 6 hours of collection

Principle:

Hematocrit is the volume occupied by erythrocytes in a given volume of blood and is usually expressed as a percentage of the volume of the whole blood sample. PCV is determined by spinning blood filled capillary tube in a centrifuge.

3.2.8 Estimation of serum iron, zinc and copper

This was done using an Atomic Absorption Spectrophotometer AA500.

Principle:

Quantification is based on the measurement of light absorbed at different wavelengths, by ground-state atoms of Iron, zinc and copper from hollow-cathode lamp light sources. Specimens, standards, and quality control samples are diluted with n-butanol in 0.05 HCl. The diluted samples are aspirated directly into a flame and the concentration of Iron, zinc and copper measured using the Atomic Absorption Spectrophotometer.

Blood sample preparation:

Serum sample (0.5ml) was put into an Erlenmeyer flask which was washed with acid, and distilled water. Perchloric acid (4ml), concentrated $HNO_3$ (25ml) and H2SO4 (2ml) where then added under a fume hood. The content was mixed and heated gently at medium heat on a hot plate under perchloric fume hood until dense white fumes appear. The flask was allowed to cool before 2 ml of concentrated $HNO_3$ was added and the content digested again until fuming stage. The content was further heated strongly for 30 seconds, allowed to cool and then 50ml of distilled water was added. It was then boiled for 30 seconds on medium heat, cooled and the solution filtered (using a whatman No. 42 filter paper, 9cm) into a 100ml Pyrex volumetric flask.

The mark was then made up by adding distill water into the solution. This was then used for analysis. (Helrich, 1990; Perkin-Elmer, 1982; Piper, 1945)

### 3.2.9 Statistical Analysis

Data obtained from Public and Private School students were statistically analyzed and compared using SPSS for windows, version 20.0. Descriptive statistics was used to display data in means, frequencies, and percentages. Chi square analysis was used to compare dietary characteristics. Student's t-test was used to compare two groups. Correlation was used to detect the relationship between BMI, and other variables. One way ANOVA was used to compare means of more than two groups. P-values less than 0.05 were considered significant.

## CHAPTER 4

# RESULTS

## 4.1 Demographic Characteristics of Adolescents Attending Secondary Schools

Anthropometric and physical activity data were collected from a total of 588 adolescents aged 13-19. A total of 244(41.50%) adolescents were selected from private secondary schools, 121(49.59%) of which were girls and 123 (50.41%) were boys. A total of 344(58.50%) adolescents were chosen from Public Secondary Schools, out of which 178(51.74%) were girls and 166(48.26%) were boys. In total, 299 (50.85%) adolescents were girls and 289 (49.15%) were boys. The demographic characteristics of the selected adolescents are as shown in Table 4.1

**Table 4.1: Demographics of Adolescents in Secondary Schools**

| Characteristics | Private Schools n=244 | | Public Schools n=344 | | Total n=588 | |
|---|---|---|---|---|---|---|
| | frequency | % | Frequency | % | frequency | % |
| **Age** | | | | | | |
| 13-14 | 43 | 17.62 | 38 | 11.05 | 81 | 13.78 |
| 15-17 | 145 | 59.43 | 228 | 66.28 | 373 | 63.44 |
| 18-19 | 56 | 22.95 | 78 | 22.67 | 134 | 22.79 |
| **Sex** | | | | | | |
| Female | 121 | 49.59 | 178 | 51.74 | 299 | 50.85 |
| Male | 123 | 50.41 | 166 | 48.26 | 289 | 49.15 |
| **Grade** | | | | | | |
| Junior Secondary | 32 | 13.12 | 49 | 14.24 | 81 | 13.77 |
| Senior Secondary | 212 | 86.89 | 295 | 85.76 | 507 | 86.22 |
| **Ethnic Group** | | | | | | |
| Berom | 96 | 39.34 | 197 | 57.27 | 293 | 49.83 |
| Ngas | 26 | 10.66 | 34 | 9.88 | 60 | 10.20 |
| Taroh | 10 | 4.10 | 8 | 2.33 | 18 | 3.06 |
| Mwagavwul | 18 | 7.38 | 11 | 3.20 | 29 | 4.93 |
| Jarawa | 25 | 10.25 | 27 | 7.85 | 59 | 10.03 |
| Igbo | 13 | 5.32 | 7 | 2.03 | 24 | 4.08 |
| Hausa | 15 | 6.15 | 14 | 4.07 | 34 | 5.78 |
| Yoruba | 15 | 6.15 | 9 | 2.62 | 24 | 4.08 |
| Igala | 11 | 4.51 | 17 | 4.94 | 28 | 4.76 |
| Others | 15 | 6.15 | 20 | 5.81 | 19 | 3.23 |

## 4.2 Anthropometric and Physical Activity Characteristics of Adolescents

### 4.2.1 Mean anthropometric characteristics of adolescents

Overall mean anthropometric characteristics of adolescents attending secondary schools is shown in Table 4.2. Mean weight was 53.86kg, height was 1.60m, BMI was 21.05, and waist/hip ratio was 0.81.

### 4.2.2 Nutritional status distribution of adolescents

The Body Mass Index (BMI) for Age of adolescents attending secondary schools in Jos South Local Government was distributed into five (5) categories namely; Severe Thinness, Thinness, Normal, Overweight and Obesity, according to the WHO reference standard for BMI for Age.

The distribution of BMI for Age for adolescents attending secondary schools (Table 4.3) shows that 507 (86.22%) of the adolescents were within the normal range with the highest frequency seen in the public secondary school boys (93.38%) and the lowest in the private school girls (80.17%). Overweight had the highest frequency among the private school girls (19.01%), while the public secondary school boys had 3.61%. Severe thinness, moderate thinness and obese put together were less than 2.00%.

**Table 4.2: Anthropometric Characteristics of Adolescents attending Secondary Schools**

| Variable | Girls<br>N=299 | Boys<br>N=289 | Total<br>N=588 |
|---|---|---|---|
| **Weight (kg)** | 52.91± 7.89 | 54.85± 8.22 | 53.86± 8.10 |
| **Height (m)** | 1.57± 0.06 | 1.63 ± 0.07 | 1.60 ±0.08 |
| **BMI ($kg/m^2$)** | 21.52± 2.79 | 20.57 ± 2.42 | 21.05± 2.65 |
| **Waist/Hip ratio** | 0.80 ± 0.06 | 0.82 ± 0.06 | 0.81 ± 0.06 |

Values are Mean ±SD, BMI- Body Mass Index

**Table 4.3: Nutritional Status (BMI for Age) Distribution of Adolescents attending Secondary Schools,**

| | | BMI For Age Distribution | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Severe Thinness | | Thinness | | Normal | | Overweight | | Obese | |
| Schools | Gender | Frequency | % | frequency | % | frequency | % | frequency | % | frequency | % |
| Private Secondary Schools | Girls (121) | 1 | 0.83 | 1 | 0.83 | 97 | 80.17 | 22 | 19.01 | 0 | 0.00 |
| | Boys (123) | 0 | 0.00 | 5 | 4.06 | 105 | 85.36 | 13 | 10.57 | 0 | 0.00 |
| | Total (244) | 1 | 0.41 | 6 | 2.46 | 202 | 82.79 | 35 | 14.34 | 0 | 0.00 |
| Public Secondary Schools | Girls (178 | 0 | 0.00 | 2 | 1.12 | 150 | 84.27 | 25 | 14.04 | 1 | 0.56 |
| | Boys (166) | 0 | 0.00 | 3 | 1.81 | 155 | 93.38 | 6 | 3.61 | 2 | 1.20 |
| | Total (344) | 0 | 0.00 | 5 | 1.45 | 305 | 88.67 | 31 | 9.01 | 3 | 0.87 |
| Total | Girls (299) | 1 | 0.33 | 3 | 1.00 | 247 | 82.60 | 47 | 15.72 | 1 | 0.33 |
| | Boys (289) | 0 | 0.00 | 8 | 2.77 | 260 | 89.97 | 17 | 6.57 | 2 | 0.69 |
| | Overall (588) | 1 | 0.17 | 11 | 1.87 | 507 | 86.22 | 66 | 11.22 | 3 | 0.51 |

BMI- Body Mass Index. Distribution was based on WHO Reference for BMI for Age

### 4.2.3 Physical activity level of adolescents attending secondary schools

The Physical Activity (PA) level was classified using a modified Physical Activity Questionnaire for Adolescents (PAQ-A), as low (1.00-1.49), fairly low (1.50-2.49), moderate (2.50-3.49), fairly high (3.50-4.49) and high (4.49-5.00).

Presented in Table 4.4 is the Physical Activity distribution of the adolescents attending secondary schools in Jos south LGA which showed that 57.99% were within the fairly low category of classification with the highest seen in the private secondary school boys (64.23%), and the lowest frequency seen in the public secondary school boys (50.60%). The Low category had a frequency of 20%, with the public secondary school girls showing the highest frequency (25.84%) and the private secondary school boys showing the lowest frequency (8.13%) in that category. There was also an overall frequency of 20.58% in the moderate physical activity level category. The public secondary school boys showed the highest frequency (25.30%) while the public secondary school girls showed the lowest frequency in this category (11.24%).

**Table 4.4: Physical Activity Level Distribution of Adolescents attending Secondary Schools**

| Schools | Gender | Physical Activity Level Distribution | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | | Fairly low | | Moderate | | Fairly High | | High | |
| | | Frequency | % | frequency | % | frequency | % | Frequency | % | Frequency | % |
| **Private Secondary Schools** | Girls(121) | 24 | 19.83 | 66 | 54.55 | 29 | 23.97 | 2 | 1.65 | 0 | 0 |
| | Boys (123) | 10 | 8.13 | 79 | 64.23 | 30 | 24.39 | 4 | 3.25 | 0 | 0 |
| **n=244** | Total (244) | 34 | 13.93 | 145 | 59.43 | 59 | 24.18 | 6 | 2.46 | 0 | 0 |
| **Public Secondary Schools** | Girls(178) | 46 | 25.84 | 112 | 62.92 | 20 | 11.24 | 0 | 0.00 | 0 | 0 |
| | Boys (166) | 38 | 22.89 | 84 | 50.60 | 42 | 25.30 | 2 | 1.20 | 0 | 0 |
| **n=344** | Total (344) | 88 | 24.42 | 196 | 56.98 | 62 | 18.02 | 2 | 0.58 | 0 | 0 |
| **Total** | Girls(299) | 70 | 23.41 | 178 | 59.53 | 49 | 16.39 | 2 | 0.67 | 0 | 0 |
| **n=588** | Boys (289) | 48 | 16.61 | 163 | 56.40 | 72 | 24.91 | 6 | 2.08 | 0 | 0 |
| | Overall (588) | 188 | 20.07 | 341 | 57.99 | 121 | 20.58 | 8 | 1.36 | 0 | 0 |

Classification done according to the Physical Activity Questionnaire for Adolescents (PAQ-A) Grading where 1.00-1.49= low, 1.50-2.49= fairly low, 2.50-3.49= moderate, 3.50-4.49= fairly high, 4.50-5.00= high.

### 4.2.4 Correlation between age, anthropometric and physical activity characteristics of adolescents

Presented in Table 4.5 are correlation of Age, Anthropometric characteristics and physical activity level characteristics of adolescents in secondary schools in Jos South LGA. There was a positive significant ($p \leq 0.01$) correlation (0.260) between age and BMI whereas a negative significant ($P \leq 0.05$) correlation (-0.139) between age and physical activity for girls. There was only a positive significant ($P \leq 0.01$) correlation (0.306) between age and BMI for the boys. Overall, Age correlated positively (0.248) and significantly ($p \leq 0.01$) with BMI, and negatively (-0.101) but significantly ($p \leq 0.05$) with physical activity level. Waist/Hip ratio had a positively correlation (0.086) which was also significant ($p \leq 0.05$) with physical activity level.

**Table 4.5 Correlation of Age, Anthropometric Characteristics and Physical Activity of Adolescents**

| | Girls n=299 | | | | Boys n=289 | | | | Overall n=588 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **AGE** | **BMI** | **WHR** | **P/A** | **AGE** | **BMI** | **WHR** | **P/A** | **AGE** | **BMI** | **WHR** | **P/A** |
| **AGE** | - | **0.261**** | -0.089 | **-0.139*** | - | **0.306**** | -0.004 | -0.113 | - | **0.248**** | -0.034 | **-0.101*** |
| **BMI** | **0.261**** | - | 0.082 | 0.073 | **0.306**** | - | 0.042 | -0.079 | **0.248**** | - | 0.045 | -0.027 |
| **WHR** | -0.089 | 0.082 | - | 0.054 | -0.004 | 0.042 | - | 0.094 | -0.034 | 0.045 | - | **0.086*** |
| **P/A** | **-0.139*** | 0.073 | 0.054 | - | -0.113 | -0.079 | 0.094 | - | **-0.101*** | -0.027 | **0.086*** | - |

BMI-Body Mass Index, WHR- Waist-Hip Ratio, P/A- Physical Activity

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2- tailed)

### 4.2.5 Distribution by age of BMI and physical activity level of adolescents

Adolescents were categorized based on the stages of adolescence thus; early adolescence (13-14), middle adolescence (15-17), and late adolescence (18-19).

The mean BMI for Age of these age groups were compared within the respective types of School irrespective of Gender (Table 4.6). Overall, there were significant differences between these age groups within the various schools and in the general population of adolescents with the normal trend of BMI increasing as age increased. Anomalies in this trend include the private secondary school boys and the total for adolescents in the public secondary schools where the 15-17 age groups had higher BMI than the 18-19 age groups.

The general trend (Table 4.7) was a decrease in physical activity as age increased with the 13-14 age group having the highest physical activity Levels while the 18-19 age group having the lowest Physical Activity Level.

**Table 4.6 Distribution by Age of BMI for Age of Adolescents Attending Secondary Schools**

| Age groups (years) | Private Secondary Schools | | | Public Secondary Schools | | | Overall | | |
|---|---|---|---|---|---|---|---|---|---|
| | Girls N=121 | Boys N=123 | Total N=244 | Girls N=178 | Boys N=166 | Total N=344 | Girls N=299 | Boys N=289 | Total N=588 |
| 13-14 | 20.91±2.86[a] | 18.82±2.02[a] | 20.08±2.74[a] | 19.87±2.51[a] | 19.07±2.78[a] | 19.60±2.60[a] | 20.40±2.72[a] | 18.93±2.34[a] | 19.86±2.67[a] |
| 15-17 | 21.28±2.60[a] | 20.54±2.55[b] | 20.93±2.60[a] | 21.62±2.50[b] | 20.40±2.27[b] | 21.06±2.47[b] | 21.51±2.54[b] | 20.46±2.38[b] | 21.01±2.52[b] |
| 18-19 | 23.38±3.39[b] | 20.51±2.54[b] | 22.14±3.00[b] | 22.16±3.20[b] | 21.49±2.09[b] | 21.05±2.56[b] | 22.66±3.30[c] | 21.42±2.20[c] | 21.90±2.74[c] |

Values expressed as Mean±SD.BMI- Body Mass Index. BMI for age classification done using WHO reference standard for BMI for Age

Different subscripts along the same columns are significantly different based on one way ANOVA test at P≤0.05

**Table 4.7 Distribution by Age of Physical Activity Levels of Adolescents attending Secondary Schools**

| Age groups (years) | Private Secondary Schools | | | Public Secondary Schools | | | Overall | | |
|---|---|---|---|---|---|---|---|---|---|
| | Girls N=121 | Boys N=123 | Total N=244 | Girls N=178 | Boys N=166 | Total N=344 | Girls N=299 | Boys N=289 | Total N=588 |
| **13-14** | 2.58±0.52[a] | 2.90±0.79[a] | 2.70±0.65[a] | 2.44±0.52[a] | 2.61±0.71[a] | 2.50±0.59[a] | 2.51±0.52[a] | 2.77±0.76[a] | 2.61±0.63[a] |
| **15-17** | 2.56±0.67[a] | 2.74±0.59[a] | 2.66±0.64[a] | 2.33±0.55[a] | 2.56±0.66[a] | 2.44±0.62[a] | 2.43±0.61[a] | 2.64±0.64[ab] | 2.53±0.63[ab] |
| **18-19** | 2.43±0.72[a] | 2.62±0.49[a] | 2.52±0.59[a] | 2.25±0.45[a] | 2.39±0.64[a] | 2.34±0.57[a] | 2.31±0.56[a] | 2.48±0.59[b] | 2.42±0.58[b] |

Values are Mean±SD. Physical Activity classification done by PAQ-A grading.

Different subscripts along the same columns are significantly different based on one way ANOVA test at $P \leq 0.05$

### 4.2.6 Distribution by gender and type of school of BMI and physical activity level of adolescents

Several differences were observed in BMI for age and physical activity levels when the adolescents were compared based on gender and types of schools as seen in Table 4.8.

The private and public secondary school girls showed significant difference in physical activity ($p \leq 0.05$), with the private school girls having higher physical activity. The private and public secondary school boys also showed significant difference in physical activity ($p \leq 0.05$) with the private school boys having higher physical activity. The girls and boys showed significant difference in both BMI for age ($p \leq 0.01$) with the girls having higher BMI, and physical activity ($p \leq 0.01$) with the boys having higher values, whereas the private school adolescents and the public school adolescents showed significant difference in physical activity only ($p \leq 0.01$) with the private school adolescents having higher values.

### 4.2.7 Physical activity between overweight and normal adolescents

Table 4.9 compares between the normal and overweight adolescents. No significant difference was observed between the two groups as regards physical activity.

**Table 4.8 Distribution by Gender and Type of Schools in BMI and Physical Activity of Adolescents**

| Variable | BMI For Age | | | Physical Activity Level | | |
|---|---|---|---|---|---|---|
| | No | Mean | p-value | No | Mean | p-value |
| **Girls** | | | | | | |
| Private School | 121 | 21.62±2.93[a] | 0.56 | 121 | 2.54±0.64[a] | **0.03** |
| Public School | 178 | 21.45±2.69[a] | | 178 | 2.33±0.54[b] | |
| **Boys** | | | | | | |
| Private School | 123 | 20.51±2.54[a] | 0.715 | 123 | 2.62±2.34[a] | **0.004** |
| Public School | 166 | 2.73±0.60[a] | | 166 | 2.52±0.66[b] | |
| **Adolescent** | | | | | | |
| Girls | 299 | 21.52±2.79[a] | **0.000** | 299 | 2.42±0.59[a] | **0.000** |
| Boys | 289 | 20.57±2.42[b] | | 289 | 2.60±0.64[b] | |
| **Schools** | | | | | | |
| Private | 244 | 21.06±2.79[a] | 0.967 | 244 | 2.64±0.62[a] | **0.000** |
| Public | 344 | 21.05±2.55[a] | | 344 | 2.42±0.60[b] | |

Values are expressed as Mean±SD. BMI for Age classification done using WHO reference standard for BMI for Age. Physical activity classification was done by PAQ-A grading.

[a]Means with different superscripts are significantly different based on student t- test at $P \leq 0.05$

**Table 4.9 Physical Activity between Normal and Overweight Adolescents attending Secondary Schools**

| Schools | Mean Physical Activity | | P- Value |
|---|---|---|---|
| | Normal | Overweight | |
| **Private Schools** | 2.65±0.62 | 2.55±0.68 | 0.372 |
| **Public Schools** | 2.41±0.60 | 2.38±0.60 | 0.055 |
| **Overall** | 2.50±0.62 | 2.47±0.64 | 0.313 |

Values are expressed as Mean±SD. BMI for Age classification done using WHO reference standard for BMI for Age.

[a]Means with different superscripts are significantly different based on student t- test at P≤0.05

### 4.3 Dietary Patterns of Adolescents attending Secondary Schools

The frequency of eating different type of food was categorized into four groups (7 or more times, 4 to 6 times, 2 to 3 times and 1 or less time per week). Table 4.10, 4.11 and 4.12 show the dietary pattern of 519 adolescents attending secondary schools, Jos South Local Government Area. There was a general low frequency of intake from "4 to 6 times" and above for dairy/dairy products, eggs, legumes, alcohol and tea/coffee. Meat from all sources, fruits, high energy snacks and sugar sweetened drinks had moderate frequency of intake while cereals/tubers and all other carbohydrate based foods were taken in a high frequency.

**Table 4.10 Dietary Patterns of Adolescents attending Private Secondary Schools**

| Food type | Frequency of Intake n=220 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 7 or more times | | 4 to 6 times | | 2 to 3 times | | 1 or less times | |
| | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| Diary/diary product | 24 | 10.90 | 31 | 14.10 | 91 | 41.40 | 74 | 33.60 |
| Meat | 54 | 24.50 | 64 | 29.10 | 63 | 28.60 | 39 | 17.70 |
| Eggs | 27 | 12.30 | 28 | 12.70 | 91 | 30.00 | 74 | 45.00 |
| Legumes | 28 | 12.70 | 49 | 22.30 | 68 | 30.90 | 75 | 34.10 |
| Citrus, tomatoes, etc | 56 | 25.50 | 47 | 21.40 | 64 | 29.10 | 53 | 24.10 |
| Green vegetables, carrots etc | 51 | 23.20 | 45 | 20.20 | 77 | 35.00 | 47 | 21.40 |
| Cake, doughnuts, buns etc | 39 | 17.70 | 42 | 19.10 | 64 | 29.10 | 75 | 34.10 |
| Sugar sweetened drinks | 42 | 19.10 | 59 | 26.80 | 61 | 27.70 | 58 | 26.40 |
| Cereals, tubers, etc | 90 | 40.90 | 55 | 25.00 | 57 | 25.90 | 18 | 8.20 |
| Alcohol | 7 | 3.20 | 9 | 4.10 | 28 | 12.70 | 176 | 80.00 |
| Tea/coffee | 40 | 18.20 | 33 | 15.00 | 71 | 32.30 | 76 | 34.50 |

**Table 4.11 Dietary Patterns of Adolescents attending Public Secondary Schools**

| Food type | Frequency of Intake n=299 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 7 or more times | | 4 to 6 times | | 2 to 3 times | | 1 or less times | |
| | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| Diary/ dairy products | 34 | 11.40 | 41 | 13.70 | 86 | 28.80 | 138 | 46.20 |
| Meat | 63 | 21.10 | 53 | 17.70 | 122 | 40.80 | 61 | 20.40 |
| Eggs | 29 | 9.70 | 67 | 22.40 | 95 | 31.80 | 108 | 36.10 |
| Legumes | 27 | 9.00 | 53 | 17.70 | 128 | 42.80 | 91 | 30.40 |
| Citrus, tomatoes, etc | 70 | 23.40 | 77 | 25.80 | 104 | 34.80 | 48 | 16.10 |
| Green vegetables, carrots, etc | 65 | 21.70 | 70 | 23.40 | 102 | 34.10 | 62 | 20.70 |
| Cakes, doughnuts, buns, etc | 58 | 19.40 | 63 | 21.10 | 91 | 30.40 | 87 | 29.10 |
| Sugar sweetened drinks | 42 | 14.00 | 69 | 23.10 | 95 | 31.80 | 93 | 31.10 |
| Cereals, tubers | 94 | 31.40 | 101 | 33.80 | 71 | 23.70 | 33 | 11.00 |
| Alcohol | 6 | 2.00 | 13 | 4.40 | 21 | 7.10 | 256 | 86.50 |
| Tea/coffee | 56 | 18.70 | 38 | 12.70 | 112 | 37.50 | 93 | 31.10 |

**Table 4.12 Dietary Patterns of Adolescents attending Secondary Schools**

| Food type | Frequency of Intake n=519 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 7 or more times | | 4 to 6 times | | 2 to 3 times | | 1 or less times | |
| | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| Diary/ dairy products | 58 | 11.20 | 72 | 13.90 | 177 | 34.10 | 212 | 40.80 |
| Meat | 117 | 22.50 | 117 | 22.50 | 185 | 35.60 | 100 | 19.30 |
| Eggs | 56 | 10.80 | 95 | 18.30 | 161 | 31.00 | 207 | 39.90 |
| Legumes | 55 | 10.60 | 102 | 19.70 | 196 | 37.80 | 166 | 32.00 |
| Citrus, tomatoes, etc | 126 | 24.30 | 124 | 23.90 | 168 | 32.40 | 101 | 19.50 |
| Green vegetables, carrots, etc | 116 | 22.40 | 115 | 22.20 | 179 | 34.50 | 109 | 21.00 |
| Cakes, doughnuts, buns, etc | 97 | 18.70 | 105 | 20.20 | 155 | 29.90 | 162) | 31.20 |
| Sugar sweetened drinks | 84 | 16.20 | 128 | 24.70 | 156 | 30.10 | 151 | 29.10 |
| Cereals, tubers etc | 184 | 35.50 | 156 | 30.10 | 128 | 24.70 | 51 | 9.80 |
| Alcohol | 13 | 2.50 | 22 | 4.30 | 49 | 9.50 | 432 | 83.70 |
| Tea/coffee | 96 | 18.50 | 71 | 13.70 | 183 | 35.30 | 169 | 32.60 |

### 4.3.1 Dietary patterns between girls attending secondary schools

Significant differences were observed in Table 4.13 and 4.14 when private and public school girls were compared.

A significant difference ($p<0.024$) was observed between the girls in frequency of intake of meat from all sources. The private school girls had a higher frequency of intake (50.90%) from “4 to 6 times” and above than the public secondary school girls who had 35.00% intake at that level.

There was also significant difference ($p<0.003$) between the girls in intake of eggs. The public school girls showed higher frequency of intake (50.90%) from “4 to 6 times” and above than the private school girls (33.70%)

The girls also showed significant difference ($p<0.029$) in intake of citrus fruits/tomatoes. This could be seen as 45.20% of the private school girls took these fruits/ vegetables “4 to 6 times” and above while 45.30% of the public school girls took the fruits/ vegetables “4 to 6 times” and above.

**Table 4.13 Dietary Patterns with regard to Food from Animal Sources between Girls attending Secondary Schools**

| Food Items | Schools | No | Frequency of intake | | | | p- value |
|---|---|---|---|---|---|---|---|
| | | | 7 or more times (%) | 4 to 6 times (%) | 2 to 3 times (%) | 1 or less times (%) | |
| Diary/ dairy products | Private | 106 | 9.40 | 15.10 | 34.90 | 40.60 | 0.417 |
| | Public | 157 | 12.10 | 14.00 | 26.10 | 47.80 | |
| Meat from all sources | Private | 106 | 24.50 | 26.40 | 28.30 | 20.80 | **0.024*** |
| | Public | 157 | 17.80 | 17.20 | 46.50 | 18.50 | |
| Eggs | Private | 106 | 15.10 | 7.50 | 27.40 | 50.00 | **0.003*** |
| | Public | 157 | 8.90 | 24.80 | 25.50 | 40.80 | |

*Chi square test values significantly different at 0.05 level of significance.

**Table 4.14 Dietary Patterns with regards to Food from Plant Sources between Girls attending Secondary Schools**

| | | | Frequency of intake | | | | |
|---|---|---|---|---|---|---|---|
| **Food Item** | **Schools** | **No** | **7 or more times (%)** | **4 to 6 times (%)** | **2 to 3 times (%)** | **1 or less times (%)** | **p- value** |
| Legumes | Private | 106 | 8.50 | 27.40 | 34.00 | 30.20 | 0.285 |
| | Public | 157 | 7.60 | 17.80 | 41.40 | 33.10 | |
| Cereals, tubers, pasta, etc | Private | 106 | 37.70 | 23.60 | 29.20 | 9.30 | 0.615 |
| | Public | 157 | 31.80 | 28.00 | 27.40 | 12.70 | |
| Citrus fruits, tomatoes, etc | Private | 106 | 29.20 | 16.00 | 24.50 | 30.20 | **0.029*** |
| | Public | 157 | 21.70 | 23.60 | 35.70 | 19.10 | |
| Green leafy vegetables, carrots, etc | Private | 106 | 21.70 | 16.00 | 36.80 | 22.60 | 0.947 |
| | Public | 157 | 22.30 | 17.20 | 38.20 | 22.30 | |

***chi square testvalues significantly different at 0.05 level of significance.

4.3.2 Dietary patterns between boys attending secondary schools

In Table 4.15, There was a significant difference ($p<0.026$) observed when the frequency of intake of diary/dairy products of boys in secondary schools were compared. Private school boys showed higher frequency of intake (25.50%) from “4 to 6 times” and above than the public secondary school boys (24.00%).

In table 4.16, there was a significant difference ($p<0.039$) in the frequency of intake of legumes where private school boys showed higher intake (34.20%) from “4 to 6 times” and above than public school boys who had a frequency of 30.40%

**Table 4.15 Dietary Patterns with regard to Food from Animal Sources between Boys attending Secondary Schools**

| Food Item | Schools | No | Frequency of intake | | | | p- value |
|---|---|---|---|---|---|---|---|
| | | | 7 or more times (%) | 4 to 6 times (%) | 2 to 3 times (%) | 1 or less times (%) | |
| Diary/ dairy products | Private | 114 | 12.30 | 13.20 | 47.40 | 27.20 | **0.026*** |
| | Public | 142 | 10.60 | 13.40 | 31.70 | 44.40 | |
| Meat from all sources | Private | 114 | 24.60 | 31.60 | 28.90 | 14.90 | 0.068 |
| | Public | 142 | 24.60 | 18.30 | 34.50 | 22.50 | |
| Eggs | Private | 114 | 9.60 | 17.50 | 32.50 | 40.40 | 0.479 |
| | Public | 142 | 10.60 | 19.70 | 38.70 | 31.00 | |

*Chi square test values significantly different at 0.05 level of significance

**Table 4.16 Dietary Patterns with regards to Food from Plant Sources between Boys attending Secondary Schools**

| Food Item | School | No | Frequency of intake | | | | p- value |
|---|---|---|---|---|---|---|---|
| | | | 7 or more times (%) | 4 to 6 times (%) | 2 to 3 times (%) | 1 or less times (%) | |
| Legumes | Private | 114 | 16.70 | 17.50 | 28.10 | 37.70 | **0.039*** |
| | Public | 142 | 12.80 | 17.60 | 44.40 | 27.50 | |
| Cereals, tubers, pasta, etc | Private | 114 | 43.90 | 26.30 | 22.80 | 7.00 | 0.070 |
| | Public | 142 | 31.00 | 40.10 | 19.70 | 9.20 | |
| Citrus fruits, tomatoes, etc | Private | 114 | 21.90 | 26.30 | 33.30 | 18.40 | 0.623 |
| | Public | 142 | 25.40 | 28.20 | 33.80 | 12.70 | |
| Green leafy vegetables, carrots, etc | Private | 114 | 24.60 | 24.60 | 33.30 | 17.50 | 0.697 |
| | Public | 142 | 21.10 | 30.30 | 29.60 | 19.00 | |

*****chi square testvalues significantly different at 0.05 level of significance. PR Boys- Private Secondary School Boys, Pu Boys- Public Secondary School Boys

4.3.3 Dietary Patterns between girls and boys attending secondary schools,

Presented in Table 4.17 are results which indicate a significant difference ($P<0.016$) between girls and boys with regards to intake of vitamin A rich fruits and vegetable. Boys showed higher frequency of intake (50.40%) than the girls (38.80%) when observing from "4 to 6 times" and above.

There was also significant difference ($p<0.040$) with regards to frequency of intake of sugar sweetened drinks as seen in Table 4.8. Girls showed a higher frequency (42.20%) in the intake of these drinks than boys (39.40%) when considering intake from "4 to 6 times" and above.

**Table 4.17 Dietary Patterns with regards to Food from Plant Sources between Girls and Boys attending Secondary Schools**

| | | | Frequency of intake | | | | |
|---|---|---|---|---|---|---|---|
| **Food Item** | **Gender** | **No** | **7 or more times (%)** | **4 to 6 times (%)** | **2 to 3 times (%)** | **1 or less times (%)** | **p- value** |
| Legumes | Girls | 263 | 8.00 | 21.70 | 38.40 | 31.90 | 0.204 |
| | Boys | 256 | 13.30 | 17.60 | 37.10 | 32.00 | |
| Cereals, tubers, pasta, etc | Girls | 263 | 34.20 | 26.20 | 28.10 | 11.40 | 0.079 |
| | Boys | 256 | 36.70 | 34.00 | 21.10 | 8.20 | |
| Citrus fruits, tomatoes, etc | Girls | 263 | 24.70 | 20.50 | 31.20 | 23.60 | 0.059 |
| | Boys | 256 | 23.80 | 27.30 | 33.60 | 15.20 | |
| Green leafy vegetables, carrots, etc | Girls | 263 | 22.10 | 16.70 | 37.60 | 23.60 | **0.016*** |
| | Boys | 256 | 22.70 | 27.70 | 31.20 | 18.40 | |

***chi square test values significantly different at 0.05 level of significance

**Table 4.18 Dietary Patterns with regards to High Energy Foods between Girls and Boys attending Secondary Schools**

| | | | Frequency of intake | | | | |
|---|---|---|---|---|---|---|---|
| **Food Item** | **Gender** | **No** | **7 or more times (%)** | **4 to 6 times (%)** | **2 to 3 times (%)** | **1 or less times (%)** | **p- value** |
| Cakes, doughnuts, buns, etc | Girls | 263 | 17.10 | 17.50 | 32.30 | 33.10 | 0.225 |
| | Boys | 256 | 20.30 | 23.00 | 27.30 | 29.30 | |
| Sugar Sweetened Drinks | Girls | 263 | 17.10 | 25.10 | 24.70 | 33.10 | **0.040*** |
| | Boys | 256 | 15.20 | 24.20 | 35.50 | 25.00 | |
| Alcohol | Girls | 263 | 1.90 | 3.40 | 9.50 | 85.20 | 0.606 |
| | Boys | 256 | 3.20 | 5.10 | 9.50 | 82.20 | |

***** Chi square test values significantly different at 0.05 level of significant

4.3.4 Dietary patterns between adolescents attending secondary schools

Table 4.19 and 4.20 show significant differences in frequency of intake of 5 food types.

There was significant difference ($p<0.013$) between Secondary Schools in the intake of Dairy/dairy products. Public secondary school adolescents showed higher intake (25.10%) from "4 to 6 times" and above than private secondary school adolescents who had 25.00%

There was also a significant difference ($p<0.003$) between secondary schools with respect to the intake of meat as private secondary school adolescents showed higher intake (53.60%) from "4 to 6 times" and above than public secondary school adolescents (38.80%)

On intake of eggs, public secondary schools showed higher intake (32.10%) than private secondary school adolescents (25.00%) from "4 to 6 times" and above. A significant difference ($p<0.013$) was recorded.

A significant difference ($p<0.041$) was observed between secondary schools on intake of Legumes. Private secondary schools had higher intake (35.00%) from "4 to 6 times" and above than public secondary school adolescents (26.70%).

With regards to intake of cereals, tubers and other carbohydrate based foods, secondary schools showed an almost equal consumption when considering frequency of intake from "4 to 6 times" and above. However, there was significant difference ($p<0.052$) in pattern of intake between these two types of schools.

**Table 4.19 Dietary Patterns with regards to Food from Animal Sources between Adolescents attending Secondary School**

| Food Item | Schools | No | Frequency of intake | | | | p- value |
|---|---|---|---|---|---|---|---|
| | | | 7 or more times (%) | 4 to 6 times (%) | 2 to 3 times (%) | 1 or less times (%) | |
| Dairy/ dairy products | Private | 220 | 10.90 | 14.10 | 41.40 | 33.60 | **0.013*** |
| | Public | 299 | 11.40 | 13.70 | 28.80 | 46.20 | |
| Meat from all sources | Private | 220 | 24.50 | 29.10 | 28.60 | 17.70 | **0.003*** |
| | Public | 299 | 21.10 | 17.70 | 40.80 | 20.40 | |
| Eggs | Private | 220 | 12.30 | 12.70 | 30.00 | 45.00 | **0.013*** |
| | Public | 299 | 9.70 | 22.40 | 31.80 | 36.10 | |

*Chi square test values significantly different at 0.05 level of significance.

**Table 4.20 Dietary Patterns with regards to Food from Plant Sources between Adolescents attending Secondary School**

| | | | Frequency of intake | | | | |
|---|---|---|---|---|---|---|---|
| **Food Item** | **Schools** | **No** | **7 or more times (%)** | **4 to 6 times (%)** | **2 to 3 times (%)** | **1 or less times (%)** | **p- value** |
| Legumes | Private | 220 | 12.70 | 22.30 | 30.90 | 34.10 | **0.041*** |
| | Public | 299 | 9.00 | 17.70 | 42.80 | 30.40 | |
| Cereals,tubers, etc | Private | 220 | 40.90 | 25.00 | 25.90 | 8.20 | **0.052*** |
| | Public | 299 | 31.40 | 33.80 | 23.70 | 11.00 | |
| Citrus fruits, tomatoes, etc | Private | 220 | 25.50 | 21.40 | 29.10 | 24.10 | 0.082 |
| | Public | 299 | 23.40 | 25.80 | 34.80 | 16.10 | |
| Green leafy vegetables, carrots, etc | Private | 220 | 23.20 | 20.20 | 35.00 | 21.40 | 0.880 |
| | Public | 299 | 21.70 | 23.40 | 34.10 | 20.70 | |

***chi square testvalues significantly different at 0.05 level of significance

### 4.3.5 Dietary patterns between normal and overweight adolescents in secondary schools

There was no significant difference in any of the food types when normal BMI for Age and overweight adolescents were compared. However, overweight adolescents showed higher frequency of food intake from “4 to 6 times” and above for food types such as diary/products, meat from all sources, legumes, cereals/tubers/pasta, citrus fruits/ tomatoes, cakes/doughnuts/buns, and sugar sweetened drinks. The adolescents with normal BMI for Age only had higher frequency of intake from “4 to 6 times” and above than the overweight adolescents with intake of eggs and alcohol.

**Table 4.21 Dietary Pattern with regards to Food from Animal Sources between Normal and Overweight Adolescents attending Secondary School**

| Food Item | Status | No | Frequency of intake | | | | p- value |
|---|---|---|---|---|---|---|---|
| | | | 7 or more times (%) | 4 to 6 times (%) | 2 to 3 times (%) | 1 or less times (%) | |
| Diary/ dairy products | Normal | 449 | 11.80 | 12.00 | 37.00 | 39.20 | 0.222 |
| | Overweight | 55 | 7.30 | 20.00 | 29.10 | 43.60 | |
| Meat from all sources | Normal | 449 | 20.70 | 22.7 | 36.3 | 20.30 | 0.145 |
| | Overweight | 55 | 30.90 | 27.30 | 30.90 | 10.90 | |
| Eggs | Normal | 449 | 11.10 | 18.50 | 29.60 | 40.80 | 0.874 |
| | Overweight | 55 | 12.70 | 14.50 | 32.70 | 40.00 | |

*****chi square testvalues significantly different at 0.05 level of significance

**Table 4.22: Dietary Pattern with regards to Food from Plant Sources between Normal and Overweight Adolescents attending Secondary Schools**

| Food Item | Status | No | Frequency of intake | | | | p- value |
|---|---|---|---|---|---|---|---|
| | | | 7 or more times (%) | 4 to 6 times (%) | 2 to 3 times (%) | 1 or less times (%) | |
| Legumes | Normal | 449 | 10.70 | 18.70 | 37.20 | 33.40 | 0.950 |
| | Overweight | 55 | 10.9 | 21.80 | 36.40 | 30.90 | |
| Cereals, tubers, pasta, etc | Normal | 449 | 34.30 | 30.50 | 24.50 | 10.70 | 0.339 |
| | Overweight | 55 | 45.50 | 27.30 | 21.80 | 5.50 | |
| Citrus fruits, tomatoes, etc | Normal | 449 | 22.70 | 24.30 | 32.70 | 20.30 | 0.430 |
| | Overweight | 55 | 32.70 | 21.80 | 29.10 | 16.40 | |
| Green leafy vegetables, carrots, etc | Normal | 449 | 21.60 | 26.70 | 29.60 | 22.00 | 0.514 |
| | Overweight | 55 | 27.30 | 21.80 | 34.50 | 16.40 | |

*****chi square testvalues significantly different at 0.05 level of significance

**Table 4.23: Dietary Pattern with regard to High Energy Foods between Normal and Overweight Adolescents attending Secondary schools**

| Food Item | Status | No | Frequency of intake | | | | p- value |
|---|---|---|---|---|---|---|---|
| | | | 7 or more times (%) | 4 to 6 times (%) | 2 to 3 times (%) | 1 or less times (%) | |
| Cakes, doughnuts, buns, etc | Normal | 449 | 16.90 | 21.20 | 30.50 | 31.40 | 0.168 |
| | overweight | 55 | 21.80 | 27.30 | 16.40 | 34.50 | |
| Sugar Sweetened Drinks | Normal | 449 | 16.30 | 24.50 | 29.40 | 29.80 | 0.580 |
| | overweight | 55 | 12.70 | 32.70 | 25.50 | 29.10 | |
| Alcohol | Normal | 449 | 2.70 | 4.50 | 9.40 | 83.50 | 0.953 |
| | overweight | 55 | 1.80 | 3.60 | 10.90 | 83.60 | |

*****chi square test values significantly different at 0.05 level of significance

## 4.4 Micronutrients Status of Adolescents Attending Secondary Schools

### 4.4.1 Serum Micronutrient Distribution of Adolescents in Private Schools

Table 4.24 shows Mean PCV, serum iron, zinc and copper were 38.71%, 96.15µg /dl, 86.31µg /dl and 84.44µg /dl respectively.

Distribution of micronutrient status of adolescents is also presented in Table 4.25. Micronutrient concentration in serum was distributed into two groups, normal and low based on references for serum iron, zinc and copper. Values under the following ranges were considered deficient: Iron (50-170µg /dL for females and 65-175µg /dL for males), Zinc: (60-1.30µg /dL), and copper (80-155µg /dL for males and 70- 140µg /dL for females). Table 4.25 shows the distribution of serum micronutrient concentration.

### 4.4.2 Correlation of anthropometric characteristic, physical activity level and micronutrient status of students in private secondary schools

In Table 4.26 are correlation of anthropometric characteristics, Physical Activity and micronutrient status of adolescents in Secondary Schools of Plateau State. There was a positive significant correlation between PCV and iron, PCV and zinc, iron and zinc; and iron and copper.

**Table 4.24 PCV and Serum Micronutrient Concentrations of Adolescents attending Private Secondary Schools.**

| Variable | Girls<br>N=18 | Boys<br>N= 13 | Total<br>N= 31 |
|---|---|---|---|
| PCV (%) | 38.11±3.91 | 39.54±2.93 | 38.71±3.55 |
| F(µg /dl) | 88.00±28.11 | 104.30±31.78 | 96.15±29.94 |
| Zn (µg /dl) | 85.20±18.31 | 87.42±12.12 | 86.31±16.21 |
| Cu(µg /dl) | 80.42±17.23 | 88.45±18.90 | 84.44±18.05 |

Values are Mean±SD. PCV- Packed Cell Volume, Fe- Iron, Zn- Zinc, Cu- copper.

**Table 4.25: Serum Iron, Zinc and Copper Concentration in Adolescents attending Private Secondary Schools (µg/dl)**

| Micronutrient | Status | Girls N=18 | | Boys N= 13 | | Total N=31 | |
|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % |
| Fe | Normal | 16 | 88.89 | 12 | 92.31 | 28 | 90.32 |
| | Low | 2 | 5.56 | 1 | 7.69 | 3 | 9.68 |
| Zn | Normal | 15 | 83.33 | 11 | 84.62 | 26 | 83.87 |
| | Low | 3 | 16.67 | 2 | 15.38 | 5 | 16.13 |
| Cu | Normal | 14 | 77.78 | 11 | 84.62 | 25 | 80.65 |
| | Low | 4 | 22.22 | 2 | 15.38 | 6 | 19.35 |

Fe-Iron, Zn-Zinc, Cu-Copper. Serum Iron concentrations below 50-170µg /dL for females and 65-175µg /dL for male were considered low. Serum zinc concentrations below 60-130µg /dL were considered low. Serum copper concentrations below 70-140µg /dL for female and 80-155µg /dL for males were considered low ( Tietz, 1995, and Burtis and Tietz, 1999).

**Table 4.26 Correlation on BMI, Physical Activity, PCV and Serum Micronutrient Concentrations of Adolescents attending Private Secondary Schools**

| | BMI | P/A | PCV | Fe | Zn | Cu |
|---|---|---|---|---|---|---|
| **PCV** | -0.135 | -0.110 | - | **0.711**** | **0.356*** | 0.223 |
| **Fe** | -0.024 | 0.000 | **0.711**** | - | **0.533**** | **0.365*** |
| **Zn** | -0.209 | 0.030 | **0.356*** | **0.533**** | - | 0.305 |
| **Cu** | -0.340 | 0.198 | 0.223 | **0.365*** | 0.305 | - |

BMI-Body Mass Index, P/A- Physical Activity, PCV- Packed Cell Volume, Fe- Iron, Zn- Zinc, Cu- copper

** Correlation is significant at the 0.01 level (2-tailed)

*correlation is significant at the 0.05 level (2- tailed)

4.4.3 Serum iron, zinc and copper by age in adolescents attending private secondary schools.

In Table 4.27 are mean serum Iron Zinc and copper between the adolescents in private secondary schools in Jos South with regards to age. No significant difference was observed between the age groups though age group 15-17 showed higher values for these micronutrients.

4.4.4 Serum iron, zinc, and copper by gender in adolescents attending private secondary schools.

In Table 4.28 are serum iron zinc and copper concentrations of private secondary school adolescents classified by gender. There were no observed significant differences in serum iron, zinc and copper concentrations between the Girls and the Boys even though the Boys had higher mean values for these micronutrients.

**Table 4.27 Serum Iron, Zinc and Copper by age of Adolescents attending Private Secondary Schools**

| Age groups (years) | Micronutrients (µg /dl) | | |
|---|---|---|---|
| | **Iron** | **Zinc** | **Copper** |
| | **N=31** | **N=31** | **N=31** |
| 13-14 | 85.47±21[a] | 85.36±17[a] | 83.01±18[a] |
| 15-17 | 106.53±29[a] | 93.55±15[a] | 89.30±19[a] |
| 18-19 | 96.46±34[a] | 80.04±14[a] | 81.04±5[a] |

Values expressed as mean±SD. Different superscripts along the same column are considered significantly different

**Table 4.28 Serum Iron, Zinc and Copper by Gender of Adolescents attending Private Secondary Schools**

| | GIRLS (18) | BOYS (13) |
|---|---|---|
| Fe (µg /dl) | 88.00±28.11[a] | 104.30±31.78[a] |
| Zn(µg /dl) | 85.20±18.31[a] | 87.42±12.12[a] |
| Cu (µg /dl) | 80.42±17.23[a] | 88.45±18.90[a] |

Fe- Iron, Zn- Zinc, Cu- Copper. Values expressed as Mean±SD

[a]Means with different superscripts are significantly different based on t- test at P<0.05

# CHAPTER 5

# 5.0 DISCUSSIONS

## 5.1 Anthropometry and Physical Activity Characteristics of Adolescents

Distribution of adolescents attending schools in Jos South using BMI for Age as seen in Table 4.3 showed a large percentage of the adolescents were within the Normal range (86.22%). This supports the report that adolescence is a stage of less nutritional concerns when compared to childhood and adulthood as reported by Delisle *et al* (2000). Physical Activity was fairly low with a mean of 2.51. Van Sluijs *et al* (2007) reported Physical Activity among Children and Adolescents insufficient. Physical Activity Level of adolescents in Jos south further strengthens that conclusion. Prevalence of overweight (11.22%) was higher than those of moderate and severe thinness put together. This agrees with the recent concerns about the increase in overweight and obesity in developing countries as expressed by Gupta *et al* (2012) where it was estimated that in Brazil, there was an increase in obesity among 18 year olds from 4.1 percent to 13.9 percent. Further, 14.34 percent of private secondary school adolescents were overweight. This was more than that of public secondary schools where 9.01 percent were overweight. This strengthens findings that the affluent are more at risk of obesity in developing countries as reported by Chhatwal *et al* (2003), where it was estimated that in Nigeria, 18 percent of children aged 5-15 years from relatively privileged homes were found to be obese. Private schools are mostly attended by adolescents who have parents earning higher incomes. Groeneveld *et al* (2007) reported higher anthropometric measures for children with high socioeconomic status than those of low socioeconomic status when they assessed the Nutritional Status of urban school children in Quatzaltenango, Guatemala. Furthermore, Dapi *et al* (2009) reported a higher BMI

for age among adolescents with a higher Socio-economic status than those of medium and low Socio-economic status in urban Cameroon.

The higher percentage of overweight in the Private Secondary Schools may however not be attributed to less Physical Activity amongst the adolescents as they had a higher mean Physical Activity Level than the public school adolescents as seen in Table 4.8. Consumption of excess energy is common within the affluent in developing countries and may be the contributing factor to the higher incidence of overweight in the private school adolescents, even if the adolescents in the private schools had a higher mean Physical activity, it may not be sufficient enough to annul the effect of excess energy intake and thus leads to a higher BMI.

Overall, girls had a higher mean BMI for Age value than boys which was significantly different when compared as seen in Table 4.8. The difference may be as a result of the lower level of Physical activity shown by the girls as compared to that of the boys which was significantly different, or also as a result of excess consumption of energy. Fakhouri et al (2014) reported of the higher percentage of boys meeting the required amount of Physical Activity than girls in the U.S. Telama et al (2005) also had similar results when they assessed age and gender differences in objectively measured physical activity in youths.

Private school girls had a higher means BMI than that of the public secondary school girls though there was no significant difference. It may be expected that there will be a significantly higher BMI between the girls from the different schools with the private school girls having more tendency to consume more energy but that effect may have been balanced with the higher Physical Activity demonstrated by the private school girls which was significantly different from that of the public school girls. The same conditions may be applied to the boys from the different types of schools as the same situation was seen within them.

In Table 4.6, the lowest BMI for Age was recorded within age range 13-14 and the highest recorded within age group 18-19 of the general adolescent attending Secondary Schools, Jos South. This followed the trend as seen in the correlation that BMI increases as age increases. There was a gradual decrease in physical activity as age increased, as seen in the correlation, with the age range 13-14 having the highest physical activity and the age range 18-19 having the lowest physical activity level. Similar was recorded once again by Telama *et al* (2005), who reported a gradual decline in physical activity from childhood to adulthood, with the greatest decline during middle adolescence.

Undernutrition, which is a common concern in many developing countries cannot be said to be a problem with the general Population of adolescents attending secondary schools in Jos South, Plateau State as just about 2 percent of the sampled population had Global Acute Malnutrition (under -2 Z scores). Jos South is largely an urban area with so many settlements. According to reports by Yattinamani *et al* (2014), anthropometric measurements of urban adolescents were higher than those of their rural counterparts irrespective of age and gender. This they observed when they assessed the nutritional status of adolescents of Dharwadtaluk. Adolescents in Secondary Schools, Jos South follow this trend. The major problem may be increased risk of overweight and obesity which may have been due to other factors other than low physical activity.

A correlation between BMI for Age and Physical activity showed that BMI for Age was negatively correlated with Physical Activity as seen in Table 4.5 (i.e. as BMI for Age Increased, Physical Activity reduced). Within the girls, age correlated positively but weakly with BMI for Age and correlated with Physical activity negatively and also weakly. These correlations were significant. Within the boys, there was a positive significant correlation between age and BMI

but the correlation between age and Physical Activity was not significant. Increase in BMI has been related to decrease in Physical Activity in several studies. Jebb and Moore (1999) concluded that Physical Activity contributed to the etiology of overweight and obesity. Saris *et al* (2003) also talk about the importance of Physical Activity in the prevention of unhealthy weight gain.

### 5.2 Dietary Patterns of Adolescents

Adolescents in Jos South had low intake of diary, eggs, legumes, alcohol, and tea/coffee when considering from "4 to 6 times" and above, as seen in Table 4.12. This was reflected in the intake per week with majority of adolescents falling within the "2 to 3 times" and below. Intake of meat from all sources, fruits/ vegetables that contain vitamin C, fruits/ vegetables with Vitamin A, soft drinks, and snacks could be said to be moderate, with a seemingly fair distribution between "4 to 6 times" and above and "2 to 3 times" and below. Intake of cereals/tubers/ pasta and other carbohydrate based foods was at a high frequency (about 65%) when intake from "4 to 6 times" and above was considered.

When the dietary intake of girls and that of boys were compared, there were significant differences observed with the frequency of intake of green leafy vegetables/carrots etc., and sugar sweetened drinks. Boys showed higher intake of the green leafy vegetables/carrots etc., than girls when intake from "4 to 6 times" and above was considered. Similar results were reported when Alaffi *et al* (2014) assessed the Physical activity, sedentary behaviours and dietary habits among Kuwaiti adolescents with regards to gender differences. This was however contradicted when Skardal *et al*(2014) researched on socioeconomic differences in selected dietary habits among Norwegian 13-14 year olds and Maier *et al* (2013) who studied Dietary pattern and leisure time activity of overweight and normal weight children in Germany.

Rasmussen *et al* (2006) reported on studies that have been carried out on fruit consumption among adolescents and children. They mentioned that girls tend to have higher intake than boys. Not much difference was seen between the girls and the boys when intake of sugar sweetened drinks from "4 to 6 times" and above was considered. However, when considered from "2 to 3 times" and above, the boys showed higher intakes than the girls. Musaiger and Kalam (2014) reported that males were significantly more likely to consume sugar sweetened drinks than females when they assessed Dietary habits and lifestyle among adolescents in Damascus, Syria. Allafi *et al* (2014) also reported same when Physical activity, sedentary behaviours and dietary habits among Kuwaiti adolescents were assessed, as boys had higher intake of these drinks than girls.

In Tables 4.19 and 4.20, significant differences were seen between private and public school adolescents in intake of diary/dairy products, meat from all sources, eggs, legumes and cereals/tubers etc. Private school adolescents showed higher intake from "4 to 6 times" and above for meat from all sources and legumes than public school adolescents. However, public school adolescents had higher intake of eggs from "4 to 6 times and above than private school adolescents. There was an almost even percentage of intake for diary/dairy products and cereals/ tubers etc from "4 to 6 times" and above. However, this was not the case when intake from "2 to 3 times" and above was considered as private school adolescents showed higher intake of diary/dairy products and cereals/tubers/ pasta etc from "2 to 3 times" and above. The higher frequency of food consumption exhibited by private school adolescents may be attributed to the higher socio-economic status of the parents whose children attend private schools. This may have also contributed to the higher incidence of overweight observed in the private schools. Gebreyohannes et al (2014) also reported similar when they compared the Nutritional status of adolescents in selected government and private secondary schools of Addis Ababa, Ethiopia.

### 5.3 Micronutrient Status of Adolescents attending Private Secondary Schools

In Table 4.24 are mean PCV and serum micronutrient concentrations of adolescents in private schools of Jos South Local government, all of which were within the normal ranges. Boys however had better values for these micronutrients than girls as seen in Table 4.27 even though there was no significant difference between them as seen in Table 4.28. Girls are more prone to micronutrient deficiencies due to their monthly loss of Blood through menstruation as reported by UNICEF (2011)**,** however, boys may also be in increased demand for these micronutrients due to increase in muscle mass during this period of life. **.** The statistical difference in serum iron, zinc and copper which is insignificant agrees with findings by UNICEF (2011) where there were no gender differences in serum micronutrient status.

In Table 4.23, age group 15-17 had better values for these micronutrients than those of age group 13-14 and 18-19**.** Certain percentages (9.68, 16.13 and 19.35) of these adolescents had low serum values for iron, zinc and copper respectively. These values were actually better when compared to previous studies conducted on adolescents in various developing countries of the world. Hettiarachchi et al **(**2006**)** reported 51.5 percent and 58.3 percent of adolescent girls and boys respectively were deficient in zinc in a cross sectional studies carried out in Sri Lanka**.** *Leenstra et al* (2004) also found a prevalence of 19.80% for iron deficiency when the prevalence and severity of anaemia and iron deficiency in adolescent school girls in Kenya was assessed. Frequent intake of fruits and vegetables as well as intake of meat from all sources may have contributed to this better serum micronutrient status (as shown in table 4.11 where 21.00 percent took fruits once or less in a week and 19.30 percent took meat once or less times in a week). Fruits and vegetables are good sources of the micronutrients.

# CHAPTER 6

# 6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 6.1 Summary

The major findings of this study can be summarized as follows:

(i) In this study, 11.22% of adolescents in Secondary schools in Jos South LGA were overweight, with a higher prevalence in private secondary school adolescents (particularly the girls) and significant differences were seen as regards to age, Genders and types of schools.

(ii) Mean Physical Activity of the adolescents was fairly low (using the PAQ-A grading) with 57.99% of adolescents falling within the mentioned category and a significant difference seen between the genders.

(iii) Dietary pattern consists of a high intake (65.60%) from "4 to 6" times and above for cereals/ tubers/ pasta and other carbohydrate based foods.

(iv) The adolescents differed with regards to gender in the intake of green leafy vegetables and sugar sweetened drinks.

(v) There was Prevalence of low serum iron, zinc and copper for private secondary school adolescents (9.68%, 16.30% and 19.35% respectively).

## 6.2 Conclusion

There is prevalence of overweight among adolescents particularly adolescent girls in private secondary schools in Jos south, with a generally low Physical activity. The high consumption of energy dense foods may have also contributed to the observed prevalence.

There was also prevalence of serum micronutrient deficiencies (Fe, Zn and Cu). This however may have been low due to the moderate consumption of fruits and vegetables as seen in the food frequency distribution.

## 6.3 Recommendations

Based on the results of this research, the following recommendations are made:

(i) Nutritional education should be developed to target adolescents that would motivate more healthy food choices as well as increase in physical activity and reduction of sedentary lifestyle.

(ii) Nutritional education for male and female students especially as it relates to weight management is recommended. Interventions for the prevention and control of overweight and obesity must go much further than simply prompting nutrition knowledge but aim at the development of healthy lifestyle habits.

### 6.4 Limitations

The following limitations of this study are outlined thus:

(1) The inability to access the actual nutrient intake due to lack of a Food Composition Database and standardized measures.

(2) The inability to gain access to the public schools with regards to blood sample collection for serum micronutrient analysis.

## REFERENCES


Abiba, A., Grace, A. N. K., and Kubreziga, K. C. (2012). Effects of Dietary Patterns on the Nutritional Status of Upper Primary School Children in Tamale Metropolis. *Pakistan Journal of Nutrition*, *11*(7), 591-609.

Ahmad, H., Liaqat, P., Paracha, P. I., Qayyum, A., and Uppal, M. A. (2009). Assessment of Nutritional Status of Adolescents Versus Eating Practices in Islamabad City. *Pakistan Journal of Nutrition*, *8*(8), 1304-1308.

Ahmed, S., and Blumberg, J. (2009). Dietary guidelines for Americans 2010. *Nutritional Review*, *67*, 615-23.

Allafi, A., Al-Haifi, A. R., Al-Fayez, M. A., Al-Athari, B. I., Al-Ajmi, F. A., Al-Hazzaa, H. M., . and Ahmed, F. (2014). Physical activity, sedentary behaviours and dietary habits among Kuwaiti adolescents: gender differences. *Public Health Nutrition*, *17*(09), 2045-2052.

Angelova, M., Asenova, S., Nedkova, V., and Koleva-Kolarova, R. (2011). Copper in the human organism. *Trakia Journal of Sciences*, *9*(1), 88-98.

Al-Hazzaa, H. M., Abahussain, N. A., Al-Sobayel, H. I., Qahwaji, D. M., and Musaiger, A. O. (2011). Physical activity, sedentary behaviors and dietary habits among Saudi adolescents relative to age, gender and region. *International Journal of Behavior, Nutrition and Physical Activity*, *8*(1), 140.

Anderson, J., and Fitzgerald, C. (2010). Iron: an essential nutrient, Fact Sheet No 9.356. *Food and Nutrition Series/ Health, Colorado State University*.Pg 1-3

Anderson, J. W., and Hanna, T. J. (1999). Whole grains and protection against coronary heart disease: what are the active components and mechanisms?.*The American Journal of Clinical Nutrition*, *70*(3), 307-308.

Anderson, J. W., Baird, P., Davis Jr, R. H., Ferreri, S., Knudtson, M., Koraym, A., ...and Williams, C. L. (2009). Health benefits of dietary fiber. *Nutrition Reviews*, *67*(4), 188-205

Appel, L. J., Moore, T. J., Obarzanek, E., Vollmer, W. M., Svetkey, L. P., Sacks, F. M., ... andHarsha, D. W. (1997). A clinical trial of the effects of dietary patterns on blood pressure. *New England Journal of Medicine*, *336*(16), 1117-1124.

Arredondo, M., and Núñez, M. T. (2005). Iron and copper metabolism. *Molecular Aspects of Medicine*, *26*(4), 313-327.

Arora, S., and Kapoor, R. K. (2012). Iron Metabolism in Humans: An Overview. *Iron metabolism*, 1. Retrieved from cdn.intechopen.com/pdfs/37586/intech iron_ metabolism_ in_humans_an_overview.pdf. March 2015

Aune, D., Chan, D. S., Lau, R., Vieira, R., Greenwood, D. C., Kampman, E., and Norat, T. (2011). Dietary fibre, whole grains, and risk of colorectal cancer: systematic review and dose-response meta-analysis of prospective studies. *Bmj*, *343*, d6617.

Barr, S. I. (2003). Increased dairy product or calcium intake: is body weight or composition affected in humans?.*The Journal of Nutrition*, *133*(1), 245S-248S.

Beaton, G. H. (1975). Nutritional problems of affluence. *Monograph series. World Health Organization*, (62), 482-499.

Beshgetoor, D., and Hambidge, M. (1998). Clinical conditions altering copper metabolism in humans. *The American Journal of Clinical Nutrition*, *67*(5), 1017S-1021S

Bhowmik, D., and Chiranjib, K. P. (2010). A potential medicinal importance of zinc in human health and chronic. *International Journal of Pharmacy*, *1*(1), 05-11.

Birch, L. L., and Fisher, J. O. (1998). Development of eating behaviors among children and adolescents. *Pediatrics*, *101*(Supplement 2), 539-549.

Blaszczyk, M., Paluch, J., Binkowski, L. J., Rogozinski, P., and Stawarz, R.(2014) Differences in iron concentrations between lung tumor and adjacent tissues. *Animal Physiology*, 27.

Blossner, M. and De Onis, M. (2005). Malnutrition: quantifying the health impact at national and local levels.Geneva, *World Health Organisation (WHO Environmental Burden of Disease Series, No. 12).*

Boffetta, P., Couto, E., Wichmann, J., Ferrari, P., Trichopoulos, D., Bueno-de-Mesquita, H. B., and Norat, T. (2010). Fruit and vegetable intake and overall cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC). *Journal of the National Cancer Institute*, *102*(8), 529-537.

Brewer, J., Harris, D., and Askari, K. (2006). Normal copper metabolism and lowering copper to subnormal levels for therapeutic purposes. *Textbook of Hepatology: From basic science to clinical practice. Oxford, England: Blackwell Publishing, Expected publication*. Pg 226-233.

Burch, R. E., Hahn, H. K., and Sullivan, J. F. (1975). Newer aspects of the roles of zinc, manganese, and copper in human nutrition. *Clinical chemistry*, *21*(4), 501-520.

Burtis, A. and Tietz N. W. (1999). Textbook on clinical chemistry, 3rd edition AACC. *Philadelpia Saunders.*

Casiday, R., and Frey, R. (1998). Iron Use and Storage in the Body: Ferritin and Molecular Representations. *Department of Chemistry, Washington University, St. Louis. USA.*

CDC (2008). Physical activity and good nutrition: essential elements to prevent chronic diseases and obesity 2008. *Nutrition in clinical care 6*(3), 135

CDC (2014) . Body Mass Index: Considerations for Practitioners.retrieved September2, 2014 from www.cdc.gov/healthyweight/assessing/bmi/

Cheng, S., Lyytikäinen, A., Kröger, H., Lamberg-Allardt, C., Alén, M., Koistinen, A., and Tylavsky, F. (2005). Effects of calcium, dairy product, and vitamin D supplementation on bone mass accrual and body composition in 10-12-year-old girls: a 2-year randomized trial. *The American Journal of Clinical Nutrition*, *82*(5), 1115-1126.

Chhatwal, J., Verma, M., and Riar, S. K. (2003). Obesity among pre-adolescent and adolescents of a developing country (India). *Asia Pacific Journal of Clinical Nutrition*, *13*(3), 231-235.

Choi, E. S., Shin, N. R., Jung, E. I., Park, H. R., Lee, H. M., and Song, K. H. (2008). A study on nutrition knowledge and dietary behavior of elementary school children in Seoul. *Nutrition research and practice*, *2*(4), 308-316.

Clifford, J., Niebaum, K.,and Bellows, L. (2015) Iron: An Essential Nutrient. *Colorado State University.* Fact sheet no.9.356

Cogil, Bruce. (2003). Anthropometric Indicators Measurement Guide. *Washington, DC: Food and Nutrition Technical Assistance ( FANTA) Project, FHI 360*.

Costello, R. B., and Grumstrup-Scott, J. (2000). Zinc: what role might supplements play?.*Journal of the American Dietetic Association*, *100*(3), 371-375.

Currie, J., and Goodman, J. (2010). Parental socioeconomic status, child health, and human capital. *International Encyclopedia of Education*, *3*, 253-259.

Darmon, N., and Drewnowski, A. (2008). Does social class predict diet quality?.*The American Journal of Clinical Nutrition*, *87*(5), 1107-1117.

Dapi, L. N., Janlert, U., Nouedoui, C., Stenlund, H., and Håglin, L. (2009). Socioeconomic and gender differences in adolescents' nutritional status in urban Cameroon, Africa. *Nutrition research*, *29*(5), 313-319.

Delisle, H., Chandra-Mouli, V., and de Benoist, B. (2000). Should Adolescents Be Specifically Targeted for Nutrition in Developing Countries: To Address Which Problems, and How?.*World Health Organization/International Nutrition Foundation for Developing Countries.* Retrieved September 2, 2014 from http://www. who. int/childadolescent-health/New_Publications/NUTRITION/Adolescent_ nutrition_paper. pdf.

Delisle, H., Fawole, A. O., Obisesan, K. A., Ojengbede, O. A., Babarinsa, I. A., Cole, A. H., ... and Vyas, S. (2005). Nutrition in adolescence--issues and challenges for the health sector. Issues in adolescent health and development. *East African Medical Journal*, *82*(4), 198-202.

Doocy, S., and Burnham, G. (2005). Assessment of socio-economic status in the context of food insecurity: Implications for field research. *World health & population*, *8*(3), 32-42.

DoustmohammadianJr, A., Dorostymotlagh, A. R., Keshavarz, A., Sadrzadehyeganeh, H., and Mohammadpour-Ahrangani, B. (2009). Socio-demographic Factors Associated with Body Mass Index of Female Adolescent Students in Semnan City, Iran. *Malaysian journal of nutrition*, *15*(1), 27-35.

Dragsted, L. O., Krath, B., Ravn-Haren, G., Vogel, U. B., Vinggaard, A. M., Jensen, P. B., and Pedersen, A. (2006). Biological effects of fruit and vegetables. *Proceedings of the Nutrition Society*, *65*(01), 61-67.

Dunneram, Y., andJeewon, R. (2013). A scientific assessment of sociodemographic factors, physical activity level, and nutritional knowledge as determinants of dietary quality among indo-mauritian women. *Journal of nutrition and metabolism*, *2013*.

Dupuy, M., Godeau, E., Vignes, C., and Ahluwalia, N. (2011). Socio-demographic and lifestyle factors associated with overweight in a representative sample of 11-15 year olds in France: results from the WHO-Collaborative Health Behaviour in School-aged Children (HBSC) cross-sectional study. *BMC Public Health*, *11*(1), 442.

Eliassen, E. K. (2011). The Impact of Teachers and Families on Young Children's Eating Behaviors. *Young Children*, *2*, 66-84.

Elmer, P., and Conn, N. (1982). Analytical methods for atomic absorption spectrophotometry. *Perkin Elmer Corporation. Connecticut, USA*, 530.

Fakhouri, T. H., Hughes, J. P., Burt, V. L., Song, M., Fulton, J. E., and Ogden, C. L. (2014). Physical activity in US youth aged 12-15 years, 2012. *NCHS data brief*, (141), 1-8.

Fardet, A. (2010). New hypotheses for the health-protective mechanisms of whole-grain cereals: what is beyond fibre?.*Nutrition Research Reviews*, *23*(01), 65-134.

FAO (2012). Gender and Nutrition Draft. *Food and Agricultural Organisation (FAO).*pg 2-3.

Finberg, K. E. (2011). Unraveling mechanisms regulating systemic iron homeostasis. *ASH Education Program Book*, *2011*(1), 532-537.

Frederick, C. B., Snellman, K., and Putnam, R. D. (2014). Increasing socioeconomic disparities in adolescent obesity. *Proceedings of the National Academy of Sciences*, *111*(4), 1338-1342.

Ganasegeran, K., Al-Dubai, S. A., Qureshi, A. M., Al-abed, A. A. A., and Aljunid, S. M. (2012). Social and psychological factors affecting eating habits among university students in a Malaysian medical school: a cross-sectional study. *Nutrition journal*, *11*(1), 1-7.

Gardner, G., Halweil, B., and Peterson, J. A. (2000). *Underfed* and overfed: the global epidemic of malnutrition. *Washington, DC, USA: Worldwatch Institute.*

Gebreyohannes, Y., Shiferaw, S., Demtsu, B., and Bugssa, G. (2014). Nutritional status of adolescents in selected government and private secondary schools of Addis Ababa, Ethiopia. *Adolescence*, *10*, 11.

Gearhart, R. F., Gruber, D. M., and Vanata, D. F. (2008, March). Obesity in the lower socio-economic status segments of American society.*Forum in public policy. Ashland University, Ohio USA. Serie en internet*.1-21

Groeneveld, I. F., Solomons, N. W., and Doak, C. M. (2007). Nutritional status of urban schoolchildren of high and low socioeconomic status in Quetzaltenango, Guatemala. *RevistaPanamericana de Salud Pública*, *22*(3), 169-177.

Gupta, N., Goel, K., Shah, P., and Misra, A. (2012). Childhood obesity in developing countries: epidemiology, determinants, and prevention. *Endocrine Reviews*, *33*(1), 48-70.

Gurzau, E. S., Neagu, C., and Gurzau, A. E. (2003). Essential metals—case study on iron. *Ecotoxicology and environmental safety*, *56*(1), 190-200.

Helrich, K. C. (1990). *Official methods of Analysis of the AOAC. Volume 2* (No. Ed. 15). *Association of Official Analytical Chemists Inc*. pp. xvii - 1298 pp.

Henningsen, M. (2011). Dietary habits in adolescence related to sociodemographic factors, physical activity and self-esteem. Retrieved September 2, 2014 from: http://brage.bibsys.no/xmlui/handle/11250/267803.

Hettiarachchi, M., Liyanage, C., WickremasinghePhD, R., Hilmers, D. C., and Abrams, S. A. (2006). Prevalence and severity of micronutrient deficiency: a cross-sectional study among adolescents in Sri Lanka. *Asia Pacific Journal of Clinical Nutrition*, *15*(1), 56-63.

Hotz, C., and Brown, K. H. (2004). Assessment of the risk of zinc deficiency in populations and options for its control. *International Nutrition Foundation: For UNU*. pp. S96-203

Ismail, G., and Suffla, S. (2013). Child Malnutrition. Child Safety, Peace and Health Promotion. *MRC-UNISA Safty and Peace Promotion Research Uni*t. Retrieved from http//:www.mrc.ac.za/crime/crime.htm. September 2014

Jebb, S. A., and Moore, M. S. (1999). Contribution of a sedentary lifestyle and inactivity to the etiology of overweight and obesity: current evidence and research issues. *Medicine and science in sports and exercise*, *31*(11 Suppl), S534-41.

Jensen, R. T. (2004). Socioeconomic status, nutrition, and health among the elderly. In *Perspectives on the Economics of Aging* (pp. 313-332). University of Chicago Press.

Josko, O. (2011). Copper and zinc, biological role and significance of copper/zinc imbalance. *Journal of Clinical Toxicology*. S3:001. doi: 10.4172/2161- 0495.S3-001

Jovanović, R., Nikolovski, D., Radulović, O., and Novak, S. (2010). Physical activity influence on nutritional status of preschool children. *Acta Medica Medianae*, *49*(1), 17-21.

Konttinen, H. (2012). Dietary habits and obesity: the role of emotional and cognitive factors. *Department of Social Research, Helsinki*.ISSN 1798-9140. 1-103

Krupanidhi, S., Sreekumar, A., and Sanjeevi, C. B. (2008). Copper & biological health. *Indian Journal of Medical Research*, *128*(4), 448.

Lampe, J. W. (1999). Health effects of vegetables and fruit: assessing mechanisms of action in human experimental studies. *The American Journal of Clinical Nutrition*, *70*(3), 475s-490s

Latham, C. M., (2010). Perspectives on nutritional problems in developing countries: nutritional security through community agriculture (abstract). *Food based approaches for improving diets and raising levels of nutrition.* Retrieved September 2, 2014 from

http%3A%2F%2Fwww.fao.org%2Fag%2Fhumannutrition%2F24171-08e2260c85978797f1f5cea82c7353a4.pdf&ei=y4SfVcTWM-md7gbpz6ewBQ&usg=AFQjCNGvWtiw3XRhw5UyESU2UGIgW2XXVg.

Lattimer, J. M., and Haub, M. D. (2010). Effects of dietary fiber and its components on metabolic health. *Nutrients*, *2*(12), 1266-1289.

Leenstra, T., Kariuki, S. K., Kurtis, J. D., Oloo, A. J., Kager, P. A., and TerKuile, F. O. (2004). Prevalence and severity of anemia and iron deficiency: cross-sectional studies in adolescent schoolgirls in western Kenya. *European Journal of Clinical Nutrition*, *58*(4), 681-691.

Maier, I. B., Ozel, Y., Wagnerberger, S., Bischoff, S. C., and Bergheim, I. (2013). Dietary pattern and leisure time activity of overweight and normal weight children in Germany: sex-specific differences. *Nutrition Journal*, *12*(1), 14.

Mallick, N., Ray, S., and Mukhopadhyay, S. (2014). Eating behaviours and body weight concerns among adolescent girls. *Advances in Public Health*, *2014*.

Marmot, M., Atinmo, T., Byers, T., Chen, J., Hirohata, T., Jackson, A.,and Zeisel, S. (2007). Food, nutrition, physical activity, and the prevention of cancer: a global perspective. *World Cancer Research Fund / American Institute for Cancer Research: Washington DC, US.* ISBN 9780972252225.

McNeely, C., and Blanchard, J. (2010). The teen years explained: A guide to healthy adolescent development. *Jayne Blanchard*.

Montazerifar, F., Karajibani, M., Rakhshani, F., and Hashemi, M. (2009). Prevalence of underweight, overweight and obesity among high-school girls in Sistanva Baluchistan. *Eastern Mediterranean Health Journal*, *15*(5)

Montonen, J., Knekt, P., Härkänen, T., Järvinen, R., Heliövaara, M., Aromaa, A., and Reunanen, A. (2005). Dietary patterns and the incidence of type 2 diabetes. *American Journal of Epidemiology*, *161*(3), 219-227.

Montonen, J., Knekt, P., Järvinen, R., Aromaa, A., and Reunanen, A. (2003). Whole-grain and fiber intake and the incidence of type 2 diabetes. *The American Journal of Clinical Nutrition*, *77*(3), 622-629.

Moukhyer, M.,(2006).women and health Package: Adolescent Health. *TUFH Women and Health Taskforce, second edition*. Pg 6. Retrieved March 4, 2015 from http://www.the-networktuft.org.

Molokwu, C. O., and Li, Y. V. (2006). Zinc homeostasis and bone mineral density. *Ohio Research Clinical Review*, *15*, 7-15.

Musaiger, A., and Kalam, F. (2014). Dietary habits and lifestyle among adolescents in Damascus, Syria. *Annals of Agricultural and Environmental Medicin, 21*(2), 416-419.

Mushtaq, M. U., Gull, S., Mushtaq, K., Shahid, U., Shad, M. A., and Akram, J. (2011). Dietary behaviors, physical activity and sedentary lifestyle associated with overweight and obesity, and their socio-demographic correlates, among Pakistani primary school children. *International Journal of Behavior, Nutrition and Physical Activity*, *8*(1), 130.

Nadadur, S. S., Srirama, K., and Mudipalli, A. (2008). Iron transport & homeostasis mechanisms: their role in health & disease. *Indian Journal of Medical Research*, *128*(4), 533.

Nagata, J. M., Valeggia, C. R., Barg, F. K., and Bream, K. D. (2009). Body mass index, socio-economic status and socio-behavioral practices among Tz'utujil Maya women. *Economics & Human Biology*, *7*(1), 96-106.

National Population Commision. (2007). Population and Development Review.vol. *NPC Abuja.* 33, No 1, pp. 206-2106. Retrieved 2nd September from www.jstor.org/stable/25434601

Neumann, C. G., Gewa, C., and Bwibo, N. O. (2012). Child nutrition in developing countries: critical role in health. *UCLA Working Paper*. Retrieved from http://www. ph. ucla. edu/epi/faculty/detels/ph150/Neumann_Malnutrition. pdf.

Niedzwiecki, A.and Rath,M. (2005). Malnutrition: the leading cause of Immune Deficiency Diseases Worldwide.*DrRath Research Institute*. Retrieved September 2, 2014 from www.drrathresearch.org

NIH, (2009).Take charge of your Health: A guide for teenagers (2009). *US Department of Health and Human Services*. NIH Publication No. 09-4328.pg 4.

NIH (2012).Health and Physical Activity Across your Lifespan: Better health and you. *National Institute of Diabetes and Digestive and Kidney Disorders, and Weight- control Information* Network.NIH no. 08-4992. 2-9.

Nriagu, J. (2007). Zinc deficiency in human health. *School of Public Health, University of Michigan.*1-8

Oniang, R., and Mukudi, E. (2002). Nutrition and gender in *Nutrition: A foundation for development geneva.pg 1-4* Retrieved September 2, 2014 from http://acc.unsystem.org/scn/ or www.ifpri.org.

Oyebode, O., Gordon-Dseagu, V., Walker, A., and Mindell, J. S. (2014). Fruit and vegetable consumption and all-cause, cancer and CVD mortality: analysis of Health Survey for England data. *Journal of epidemiology and community health*. doi:10.1136/jech-2013-203500.1-7

Piper, C. S. (1945). Soil and Plant Analysis. *Soil Science*, *59*(3), 263.

Pfeiffer, C. M., Schleicher, R. L., Osterloh, J. D., Jain, R. B., Wong, L. Y., and Sampson, E. J. (2009). National Report on Biochemical Indicators of Diet and Nutrition in the US Population 1999-2002. *The FASEB Journal*, *23*, 551-526.

Raj, M., and Kumar, R. K. (2010). Obesity in children & adolescents. *The Indian Journal of Medical Research*, *132*(5), 598.

Ramos, M., and Stein, L. M. (2000). Development children's eating behavior. *Journal of Pediatrics (Rio J)*, *76*(Suppl 3), S229-37

Rasmussen, M., Krølner, R., Klepp, K. I., Lytle, L., Brug, J., Bere, E., and Due, P. (2006). Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. *International Journal of Behavioral Nutrition and Physical Activity*, *3*(1), 22.

Ronsen, J. E. (2004). Adolescent Health and development (AHD): A Resource Guide for World Bank Operations Staff and Government Counterparts.*The International Bank for Reconstruction and Development/ The World Bank*. ISBN 1-932126-91-0

Saris, W. H. M., Blair, S. N., Van Baak, M. A., Eaton, S. B., Davies, P. S. W., Di Pietro, L., and Wyatt, H. (2003). How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement. *Obesity reviews*, *4*(2), 101-114.

Skårdal, M., Western, I. M., Ask, A. M., and Overby, N. C. (2014). Socioeconomic differences in selected dietary habits among Norwegian 13–14 year-olds: a cross-sectional study. *Food & nutrition research*, *58*.1-8

Slavin, J. (2004). Whole grains and human health. *Nutrition Research Reviews*, *17*(01), 99-110.

Sweet, S. N., and Fortier, M. S. (2010). Improving physical activity and dietary behaviours with single or multiple health behaviour interventions? A synthesis of meta-analyses and reviews. *International Journal of Environmental Research and Public Health*, *7*(4), 1720-1743.

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., andRaitakari, O. (2005). Physical activity from childhood to adulthood: a 21-year tracking study. *American Journal of Preventive Medicine*, *28*(3), 267-273.

Tietz, N. W. (1995). Clinical guide to laboratory tests. 3rd edition AACC. *WB Saunders Co.*

Thurnham, D. I. (2013). Nutrition of Adolescent Girls in Low-and Middle-Income Countries.

Todorovic, V., Russell, C., Stratton, R., Ward, J., and Elia, M. (2003). The 'MUST'explanatory booklet. *Redditch: British Association for parenteral and enteral nutrition*.1-32 .Retrieved March 4, 2015 from http://www.bapen.org.uk/pdfs/must/must_explan.pdf.

Toselli, S., Brasili, P., Di Michele, R., and Spiga, F. (2014). Perception of fattening foods in Italian children and adolescents. *Springer International Publishing*, *3*(1), 1-7.

Trumbo, P., Yates, A. A., Schlicker, S., and Poos, M. (2001). Dietary reference intakes: vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. *Journal of the American Dietetic Association*, *101*(3), 294-301

UNICEF (2011). Gender influences on Child survival, Health and Nutrition: a narrative review. *United Nations Childrens Fund (UNICEF) and Liverpool School of Tropical medicine*.

UNICEF. (2011). The State of the World's Children 2011-Executive Summary: Adolescence an Age of Opportunity. *Unicef.*

United States. Public Health Service (1996). Office of the Surgeon General, Centers for Disease Control, National Center for Chronic Disease Prevention, Health Promotion (US), President's Council on Physical Fitness, and Sports (US). Physical activity and health: a report of the Surgeon General. *Jones and Bartlett Learning*.

Van Sluijs, E. M., McMinn, A. M., and Griffin, S. J. (2007). Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *Medical Research Council,Epidemiology Unit, Institute of Metabolic Sciences, Addenbrooke Hospital, Cambridge.*1-13

Warren, B. S., and Devine, C. (2000). Whole Grains, Fiber, And Breast Cancer Risk Fact Sheet No. 36. *Cornell University Program on Breast Cancer and Environmental Risk Factors in New York State.* 1-4 retrieved July 15, 2014 from http://envirocancer.cornell.edu/factsheet/diet/fs36.grain.pdf.

White, R. (2012). Examining the Effect of Socioeconomic Status on Access to Nutritional Food. *Perspectives (University Of New Hampshire)*, 114-120.

WHO (1983). Measuring change in nutritional status: guidelines for assessing the nutritional impact of supplementary feeding programmes for vulnerable groups. *World Health Organization.*ISBN 92 4 154 166 0. 11

WHO. (2007). Helping parents in developing countries improve adolescents' health. *WHO.37 p*

WHO (2011). Waist circumference and waist-hip ratio: *report of a WHO expert consultation, Geneva, 8-11 December 2008.*

Yattinamani, N. M., Bharati, P., and Ashalatha, K. V. (2014). Nutritionl status of adolescents of Dharwadtaluk. *Karnataka Journal of Agricultural Sciences, 27*(1).

Yahia, N., Achkar, A., Abdallah, A., and Rizk, S. (2008). Eating habits and obesity among Lebanese university students. *Nutritional Journal*, *7*(32), 1-6.

Yinger, N., Peterson, A., Avni, M., Gay, J., & Firestone, R. (2002). A framework to identify gender indicators for reproductive health and nutrition programming. *Washington, D.C., Population Reference Bureau.*

Yusuf, S. M., Mijinyawa, M. S., Musa, B. M., Gezawa, I. D., &Uloko, A. E. (2013). Overweight and Obesity among Adolescents in Kano, Nigeria. *Journal of Metabolic Syndrome, 2*, 126

# APPENDIX I

## CONSENT TO PARTICIPATE IN RESEARCH

## EVALUATION OF DIETARY PATTERN, ANTHROPOMETRIC CHARACTERISTICS AND MICRONUTRIENT STATUS OF ADOLESCENTS IN PUBLIC AND PRIVATE SECONDARY SCHOOLS, JOS SOUTH LOCAL GOVERNMENT AREA, PLATEAU STATE

### INTRODUCTION

You are kindly being asked to participate in a research study conducted by Drenkat Michael Nanpen for a Master of Science degree under the supervision of Prof. K. Anigo, from the Department of Biochemistry, Faculty of Sciences, Ahmadu Bello University, Zaria.

If you have any questions or concerns about the research, please feel free to contact: Drenkat Michael Nanpen, Faculty of sciences, Ahmadu Bello University, Tel: 07064859376; Prof. K. Anigo, Department of Biochemistry, Faculty of Sciences, Ahmadu Bello University, Tel: 08073197086

### PURPOSE OF THE STUDY

The purpose of this project is to study the Dietary intake and nutritional status of Adolescents in public and private secondary schools in plateau state. This study is in partial requirement for the award of M.Sc degree in Nutrition, Department of Biochemistry, Ahmadu Bello University, Zaria.

**WHY ARE YOU BEEN ASKED TO PARTICIPATE?**

You are being invited because you are a12 -19 year adolescent in either a public or private school in Jos North local Government of Plateau State.

**WHAT WILL HAPPEN DURING THIS STUDY?**

Information pertaining demographics (i.e. age, sex, etc.), and 24 hour dietary intake will be collected using a questionnaire. Your anthropometric measures will also be taken and sample of your blood will be collected.

**POTENTIAL RISKS AND DISCOMFORT**

This study does not pose any form of physical, emotional or psychological risks to you.

**POTENTIAL BENEFITS TO PARTICIPANTS**

The result of this study will help in assessing your nutritional status and factors that affect it. It can also help you make healthy choices pertaining to diet and health. This research work can also be used in planning, evaluation and advocacy in Plateau State and can lead to the implementation of interventions to improve adolescent health and survival.

**WILL THERE BE ANY COST FOR PARTICIPATING?**

Aside from your time, there are no costs in taking part in the study.

**REMUNERATION FOR PARTICIPATION**

Participation will not attract any financial benefit.

**CONFIDENTIALITY**

Every effort will be made to ensure confidentiality of any identifying information provided by participants in. You will not be identified in any reports or publications resulting from the study.

**PARTICIPATION AND WITHDRAWAL**

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. You may also refuse to answer any questions you don't want to answer

and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrants doing so.

**RIGHTS OF RESEARCH PARTICIPANTS**

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through Ahmadu Bello University Research Ethics Board.

**SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE**

I have read the information provided for the study "Evaluation of dietary pattern, anthropometric characteristics and micronutrient status of adolescents in public and private secondary schools of Jos south Local Government area of Plateau State, Nigeria" as described herein. I have been given a copy of this form.

_____

Name of Participant

_____ _____

Signature of Participant Date

**SIGNATURE OF PARENT/ GUADIAN**

_____

Name of parent/ guardian

_____ _____

Signature of parent/ guardian Date

**APPENDIX II**

**EVALUATION OF DIETARY PATTERN, ANTHROPOMETRIC CHARACTERISTICS AND MICRONUTRIENT STATUS OF ADOLESCENTS IN PUBLIC AND PRIVATE SECONDARY SCHOOLS, JOS SOUTH LOCAL GOVERNMENT AREA, PLATEAU STATE.**

**SURVEY QUESTIONNAIRE**

**SECTION 1: Background information**

| | |
|---|---|
| Date……/……/…… | Questionnaire No…… |
| LGA……..... Ward……. | Community……. |
| Interviewer's Name……. | Signature ……... |

**SECTION 2: Characteristics of adolescent**

(1) Date of Birth ……/……./……..

(2) Sex …….

(3) Ethnicity …….

(4) Type of school: Public [] Private []

(5) Grade…….

**SECTION 3: Physical Activity Level**

Before completing this Questionnaire, please note that:

**(A) This is not a test; there are no wrong or right answers.**

**(B) The interest is on your actual physical activity from the last 7 days. Please answer all questions as honestly and accurately as you can- this is very important.**

(1) Physical activity in your spare time: have you done any of the following activities in the past 7 days? If yes, how many times? (mark only one circle per row

| | No | 1-2 | 3-4 | 5-6 | 7 or more times |
|---|---|---|---|---|---|
| Skipping……..... | [] | [] | [] | [] | [] |

| | No | 1-2 | 3-4 | 5-6 | 7 or more times |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Rowing/canoeing……..... | [] | [] | [] | [] | [] |
| Walking for exercise…….. | [] | [] | [] | [] | [] |
| Bicycling……. | [] | [] | [] | [] | [] |
| Jogging/ running ……. | [] | [] | [] | [] | [] |
| Aerobics…….. | [] | [] | [] | [] | [] |
| Swimming……... | [] | [] | [] | [] | [] |
| Dance……....[] | | [] | [] | [] | [] |
| Football…….....[] | | [] | [] | [] | [] |
| Badminton……[] | | [] | [] | [] | [] |
| Volleyball…….[] | | [] | [] | [] | [] |
| Basketball…….[] | | [] | [] | [] | [] |
| Others: | | | | | |
| ……..[] | | [] | [] | [] | [] |
| ……..[] | | [] | [] | [] | [] |

(2) In the last 7 days, during your Physical Education classes, how often were you very active (playing hard, running, jumping, throwing)? (check one only)

I don't do PE……..…[]

Hardly ever…….....[]

Sometimes……..[]

Quit often…….....[]

Always……...[]

(3) In the last 7 days, what did you normally do at lunch break (besides eating lunch)? (check one only)

Sat down (talked, reading, doing school work……..[]

Stood around or walked around…….....….[]

Ran or played a little bit…….[]

Ran and played quite a bit……..[]

Ran and played hard most of the time……....[]

(4) In the last 7 days, on how many days, right after school did you do sports, dance or play games in which you were active in? (Check one only).

None……[]
1time last week……....[]
2 or 3 times last week…….….[]
4 times last week…….[]
5 times last week…….[]

(5) In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were active? (check one only)

None……[]
1 time last week……...[]
2 or 3 times last week……..[]
4 or five times last week……..[]
6 or seven times last week……...[]

(6) On the last weekend, how many times did you do sports, dance, or play games in which you were very active? (Check one only).

None……[]
One time……..[]
2 or 3 times……..[]
4 or 5 times……..[]
6 or more times……[]

(7) Which one of the following describes you best for the last 7 days? Read all five statements before deciding the **one** to answer.

a. All or most of my free time was spent doing things that involves little physical effort……[]
b. I sometimes (1-2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics)……....[]
c. I often (3-4 times last week) did physical things in my free time……[]

d. I often (5-6 times last week) did physical things in my free time……[]

e. I very often (7 or more times last week) did physical things in my free time…..[]

(8) Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

| | None | Little bit | Medium | Often | Very often |
|---|---|---|---|---|---|
| Monday…… | [] | [] | [] | [] | [] |
| Tuesday……..... | [] | [] | [] | [] | [] |
| Wednesday……... | [] | [] | [] | [] | [] |
| Thursday…….. | [] | [] | [] | [] | [] |
| Friday…….. | [] | [] | [] | [] | [] |
| Saturday……..... | [] | [] | [] | [] | [] |
| Sunday……..... | [] | [] | [] | [] | [] |

(9) Were you sick last week, or did anything prevent you from doing your normal physical activity? (Check one).

Yes…….[]

No…….[]

If yes, what prevented you?

.....

.....

**SECTION 4: Anthropometric measurements**

1. Weight _____ (Kg)
2. Height _____ (m)
3. BMI _____ ($Kg/m^2$)
4. Waist circumference _____ (cm)
5. Hip Circumference _____ (cm)
6. Waist-Hip ratio _____

## SECTION 5: Food Frequency Questionnaire

Please kindly fill in the questionnaire below as accurately as possible

How often to you eat the following? (Check inside the box)

| | 1 or less Times/week | 1-3 times per week | 4-6 times per week | 7 or more times/ week |
|---|---|---|---|---|
| (1) Milk, yogurt, dairy products…….....[] | [] | [] | [] | |
| (2) Meat fish, poultry……..……...[] | [] | [] | [] | |
| (3) Eggs……..……[] | [] | [] | [] | |
| (4) Dry beans, peas, soybeans, akara (kosai), Moimoi, groundnut, kulululi…….....[] | [] | [] | [] | |
| (5) Citrus fruits (oranges, grapefruits), Tomatoes etc…….[] | [] | [] | [] | |
| (6) Carrots, sweet potatoes, ugu, spinach Green leafy vegetables…….….[] | [] | [] | [] | |
| (7) Bread, cereals (guinea corn, maize, Wheat, semovita, etc), pasta (macaroni Spaghetti, noodles, etc), rice……..…[] | [] | [] | [] | |
| (8) Cakes, doughnuts, pies, sweets, Burns, Puff-puff……....[] | [] | [] | [] | |
| (9) Soft drinks (coke, fanta, malt, etc)……[] | [] | [] | [] | |
| (10) Alcohol (burkutu, pito, Gulder)……[] | [] | [] | [] | |
| (11) Coffee, tea…….[] | [] | [] | [] | |

**Thank you for your time and response**.

## APPENDIX 3:

## ETHICAL CLEARANCE FROM THE STATE MINISTRY OF HEALTH TO CONDUCT RESEARCH

# GOVERNMENT OF PLATEAU STATE

In replying quote reference and date
All correspondence should be directed to
the Hon. Commissioner

SECRET

Ref: HIS/RI/VOL.I/X
Ministry Of Health Headquarters,
J.D Gomwalk Secretariat
Private Mail Bag 2014,
Jos, Plateau State.
Date: 02/10/2014 20____

Mr. Drenkat Michael
Department of Biochemistry,
Ahmadu Bello University,
Zaria.

**APPLICATION FOR PERMISSION TO CONDUCT RESEARCH.**

Your letter dated 15th July, 2014, refers.

I have been directed to convey approval granted to you to conduct research on the dissertation Titled "Evaluation of Dietary Pattern, Anthropometric Characteristics and Micronutrients Status of Adolescents in Public and Private Secondary Schools, Jos South Local Government Area, Plateau State, Nigeria".

Kindly remember to submit to the Ministry a copy of your research findings as soon as the dissertation is completed.

**Paul D. Dwagas**
**Director Planning**
**For: Hon. Commissioner**

SECRET