# ANTHROPOMETRY, BODY COMPOSITION AND REPRODUCTIVE CHARACTERISTICS OF WOMEN FROM KADUNA AND RIVERS STATES, NIGERIA

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DEPARTMENT OF HUMAN ANATOMY
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## DECLARATION

I, VICTOR, PROGRESS DAKURO, declare that the work in the thesis titled ‘‘**ANTHROPOMETRY, BODY COMPOSITION AND REPRODUCTIVE CHARACTERISTICS OF WOMEN FROM KADUNA AND RIVERS STATES, NIGERIA ’’** was carried out by me under the supervision of Dr. B. Danborno and Dr. S. S. Adebisi in the Department of Human Anatomy ,Faculty of Medicine, Ahmadu Bello University, Zaria . The information used for my literature review was fully acknowledged in the text and references. No part of this dissertation was previously presented for another degree or diploma at any University.

**PROGRESS DAKURO VICTOR** **DATE**

## CERTIFICATION

The project thesis titled **ANTHROPOMETRY, BODY COMPOSITION AND REPRODUCTIVE CHARACTERISTICS OF WOMEN FROM KADUNA AND RIVERS STATES, NIGERIA by VICTOR, Progress Dakuro** meets the regulations governing the award of degree of Masters of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literacy presentation.

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## DEDICATION

This work is dedicated to my beloved Mother, Mrs Victoria Tobin Owuso.

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## LIST OF ABBREVIATIONS

A = Age

AC = circumference

BF % = Percentage body fat

BMI = Body Mass Index

CAL= Daily calorie intake

CC = Chest circumference

FAC = Fore arm circumference

HC = Hip circumference

HT= Height

ISF = Iliac skinfold

LC = circumference

MA = Metabolic age

MM = Muscle mass

MtA = Metabolic age

PR = Physique rating

TBW = Total body water

TC = Thigh circumference

TSF = Triceps skinfold

VFR = Visceral fat rating

W/H = Waist hip ratio

WC =Waist circumference

WT= Weight

DS = depressive symptoms

SDM = symptoms experienced during menstruation

PMS = Prebvmenstrual symptoms

MC= menstrual cycle

## ABSTRACT

The relationship between anthropometry, body composition and reproductive characteristics in women has been a subject of interest currently for biological anthropologists. The study investigates the relationship between anthropometry, body composition and menstrual characteristics of women from Kaduna and Rivers State of Nigeria. Participants were non pregnant women randomly selected from four (4) tertiary schools: Kaduna (n=387) and Rivers (n=401). Data was analysed using Sigma Stat version. Data obtained showed that limb circumferences of Kaduna females are significantly higher than Rivers females ($p<0.05$) except for the thigh circumference. While, weight, height, iliac and tricep skinfold of Rivers state women was significantly higher than Kaduna females ($p<0.05$). Muscle mass, percentage body fat, basal metabolic rate and metabolic age of Rivers women was significantly higher than that of their Kaduna counterparts at a significant level of $p< 0.05$. This study showed the incidence of underweight, normal weight, overweight and obesity as (38) 9.8%, (249) 64.3%, (78) 20.2%, and (22) 5.7% respectively for women from Kaduna; (40) 10%, (253) 63.1%, (80) 20% and (28) 7.0% respectively for women from Rivers. Results also showed that age had a significant association with BMI **(**River: $\chi^2$=38.585, p=0.000; Kaduna: $\chi^2$=19.323, p=0.023). This study also demonstrates that the frequency of underweight and normal weight women from Rivers and Kaduna decreases beyond 20 to 23 years, while obesity was maximum within 24-26 years for both states, overweight was maximum within 23-26 years. Waist circumference (WC) showed the strongest significant ($p < 0.05$) partial correlation with BMI and PBF (0.83 and 0.83, respectively). Hip circumference (HC) was also found to be significantly correlated with BMI ($r = 0.72$; $p < 0.001$) and PBF ($r = 0.86$; $p < 0.001$). This study showed that body weight, BMI, biceps and iliac skinfold correlated positive with all body composition parameters except for total body water and physique rating which showed negative correlation. The study showed that the mean age at menarche was higher in Rivers women than Kaduna women, but no significant difference. The minimum and maximum menarcheal age for this study was ten (10) and nineteen (19) years respectively. Results showed that, 311 (80.4%) of Kaduna females and 288 (71.8%) of Rivers females experienced regular menstrual cycle; 245 (63.3%) of Kaduna females and 324 (80.8%) of Rivers females experienced a menstrual flow duration of four to six

days. Study participants experienced at least one PMS (Kaduna: 387; 100%; Rivers: 366; 91.3%) and SDM (Kaduna: 367; 95.1%; Rivers 397; 99%); comparison of PMS and SDM between subjects from the two states showed significant difference ($\chi^2$= 35.348, p=0.000 and $\chi^2$= 10.637 and p=0.001, respectively). This study showed the incidence of minimal, mild, moderate, and severe depression as 257 (66.4 %), 76 (19.6 %), 39 (10.1 %), 15 (3.9 %) respectively for women from Kaduna; 270 (67.3 %), 86 (21.4 %), 35 (8.7 %), 10 (2.5 %) respectively. Generally, Rivers women presented higher anthropometric variables and body composition but a lower arm, forearm, and calf circumference than their counterparts from Kaduna state. In Kaduna women, weight can be used to predict all body composition parameters except bone mass, BMI can be used to predict all body composition parameters except bone mass and physique rating, sum of skinfold can also be used to predict body composition parameters except for bone mass, muscle mass and Basal metabolic rate (BMR). In Rivers women, weight can be used to predict body composition parameters, BMI can also be used to predict body composition parameters except for total body water, sum of skinfold can also be used to predict body composition parameters except for bone mass. In women from Kaduna, there was significant association between calf, chest and waist circumference with DS. Percentage body fat also showed association with DS. In Rivers women, there was no significant association between anthropometric parameters and body composition parameters with DS.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the study

Anthropometry is the measurement of humans for the purposes of identification and understanding human physical variation. Anthropometry is a simple reliable method for quantifying body size and proportions by measuring body length, width, circumference and skinfold thickness (Wang *et al*., 2000). Pheasant, (1996) suggested that the variations of body dimensions of different groups can be observed in terms of overall body size and bodily proportions. The mean anthropometric dimensions, for example stature and sitting height, are the most typical distinctions among ethnic groups. Another significant ethnic difference lies in the ratios of body dimensions, i.e. bodily proportions (Liu *et al*., 2004). The bodily proportion is a scaling relation calculated with a ratio of one body dimension to a specific reference dimension. The most common reference dimension is mean stature (Roebuck *et al*., 1975). Changes in life styles, nutrition and ethnic composition of populations has also been shown to cause changes in distribution of body dimensions (Adebisi, 2008).

Body height has also been used as a societal level indicator of the standard of living. Living conditions during the growing year's especially in early child hood influence body height through their impact on net nutrition (Silventoinen, 2003; Steckel, 2009). Genetic factors are most important when explaining these geographic differences in height (Holden and Mace, 1999). Variation in the heritability estimates of body height was larger between the study populations in women compared to men.

Researchers have shown that anthropometric characteristics are closely related to reproductive characteristics and body composition (Lassek and Gaulin, 2006). Anthropometric characteristics predict higher productive success in women (Danborno and Oyibo, 2008), high waist hip ratio has been associated with decreased fertility and menstrual irregularities (Zaadstra *et al*., 1993; Wass *et al*., 1997). Female anthropometry reveals that, adiposity has a strong influence on female reproductive characteristics marked by age of menarche (Lassek and Gaulin, 2006). The age at menarche is investigated for several reasons because it is one of the major indices of a female's fertility (Kazem *et al*., 2005). The age at menarche is widely varied in different populations and is delayed especially in populations with poor nutrition (Thomas *et al*., 2001; Gluckman and Hanson, 2006).

A woman's first menstruation is termed menarche and it is an important maturity indicator used to assess the developmental status of a pubertal female (Cameron and Nadgdee, 1996; Blondell *et al*., 1999). It has been established that, menarche is influenced by factors such as socioeconomic class, sports and genetic factors (Diegton *et al*., 1993). The age at menarche seems to be decreasing in industrialized countries (Chodick *et al*., 2005). Before 1900, the average age at menarche in the United States was greater than 14 years (Drife and Magowan, 2004). This has been attributed to improvements in socioeconomic conditions, nutrition and general health (Drife and Magowan, 2004; Chodick *et al*, 2005). However, the average age at menarche has not changed during the last 20 to 30 years in the United Kingdom and is now 12.9 years (Whincup *et al*., 2001). Early menarche (before 12 years) is a risk factor for breast cancer (Hirshaut, 2000) and is associated with a risk of obesity in postmenopausal women with breast cancer (Wasserman *et al*., 2004).

Higher gluteofemoral adiposity has been associated with lower menarche age (Fredriks *et al*., 2005; Lassek *et al*., 2006). Female anthropometry reveals that, adiposity has shown a strong influence on female reproductive characteristics marked by age at menarche (Lassek and Gaulin, 2006). This was the basis for the hypothesis proposed by Frisch and McAuthor, (1974) that a female need to store a critical amount of fat to reach menarche, even though the theory generally failed (Lassek and Gaulin, 2006). It is now thought that the distribution of fats towards the gluteofemoral region tend to be more plausible (Fredriks, 2005; Lassek and Gaulin, 2006). Achieving a critical weight was necessary for timing of menses and that increases in childhood body weight over time may explain the secular decline in menarche (Frisch and Revelle, 1997).

Menstruation may be associated with various symptoms occurring before or during menstrual flow. A significant number of females complained of dysmenorrhea, and this was more common among older girls with longer bleeding periods (Franco *et al*., 2012). Female experiencing premenstrual syndrome (PMS) have depression symptoms and PMS has been linked to depressive disorders (Hallman, 1986). Sleep disturbances also form important component of PMS. Common sleep related complaints in patients with PMS include: insomnia, hypersonmia, fatigue, nightmares, lethargy and inability to concentrate.

A relationship has also been shown between early menarche and increasing severity of painful menstruation, and pregnancies at a younger age (Repke, 1989; Balbi *et al*., 2000). Ryan *et al*., (1999) reported that the mean age of menarche was 12.7 years in the United States; Whincup *et al.* (2001) also reported that the average menarche age of a

1982–86 birth cohort in England and Scotland was 12.9 years. In another study the mean age of menarche among 338 sporting women was 13.8 years (Malina *et al*., 1994).

## 1.2 Statement of the problem

Anthropometric study among the different geographical locations in Nigeria particularly Rivers and Kaduna is inadequate, hence, statistical data showing variations or similarities that exist between anthropometric variables, body composition parameters and reproductive characteristics of women from Kaduna and Rivers States to the best of our knowledge is not in existence.

Menstrual disorders like delayed menarche, premenstrual syndrome, irregular menstrual cycles and dysmenorrhoea create a great anxiety among women and their families. These disorders are a major source of gynaecological problems among women. Hence, the need to study the variation in menstrual pattern and its disorders among women from Kaduna and Rivers States.

Information on the menstrual pattern of Kaduna and Rivers States women will aid in clinical evaluation of gynaecological problems. The results of the present study will demonstrate if differences actually exist between the measured anthropometric parameters of women from Kaduna and Rivers States. This knowledge will enable anthropologists, biomedical scientists and clinicians to access the influence of environment and genetics on the anthropometry, body composition and reproductive characteristics of women from Rivers and Kaduna states of Nigeria.

The results of this study will also show the relationships between anthropometric parameters and menstrual characteristics of Rivers State and Kaduna State, which could be relevant in appreciating the reproductive status of the study population. This study would provide a reference data for the anthropometric, menstrual characteristics and prevalence of premenstrual syndrome of different geographical location especially Kaduna and Rivers States of Nigeria.

## 1.3 Aim and objectives of the study

### 1.3.1 Aim of the Study

The aim of the study is to investigate the relationship between anthropometric parameters, body composition and menstrual characteristics of women from Kaduna and Rivers States of Nigeria

### 1.3.2 Objective of the Study

The objectives of the study are to:

i. investigate the anthropometric indices, body composition parameters and menstrual characteristics of women from Kaduna and Rivers States women.
ii. investigate the relationship between anthropometric and menstrual characteristics of women from Kaduna and Rivers States women.
iii. compare the prevalence of depression between women from Kaduna and Rivers States during their menstruation.
iv. investigate the effect of menstrual pain on the daily activities of women from Kaduna and Rivers States.

## 1.4 Study hypothesis (alternate)

There will be differences in the anthropometric indices, body composition parameters and reproductive characteristics of women from Kaduna and Rivers States due to genetics and environmental factors.

## 1.5 Definition of Terms

i. **Basal metabolic rate:** Amount of energy expended while at rest in a neutrally temperate environment. Also known as the amount of calories required to keep the body functioning at rest.

ii. **Body fat percentage:** Body fat percentage is the amount of body fat as a proportion of body weight.

iii. **Body Mass Index:** An index that expresses adult weight in relation to height, it is calculated as weight in kilograms divided by height in meter square.

iv. **Bone Mass:** This feature indicates the amount of bone (bone mineral level, calcium or other minerals) in the body.

v. **Metabolic age:** Indicates the age at which the body is currently working. It's a reflection of physical health form of a calculation based on basal metabolic rate.

vi. **Muscle mass:** Weight of muscle in the body. This includes the skeletal and smooth muscles, the water in the muscles.

vii. **Physique rating:** This is the ratio of body fat to muscle mass. It changes with the level of physical activity.

viii. **Total Body Water Percentage:** Body Water Percentage is the total amount of fluid in the body expressed as a percentage of the total weight.

ix. **Visceral Fat:** Visceral fat is the fat that is in the internal abdominal cavity, surrounding the vital organs in the trunk (abdominal) area.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Body height

Body height is a classic example of a polygenic inherited trait, which is also substantially influenced by environmental factors during fetal life, childhood, and adolescence (Sinclair, 1989). Recently, interest in body height as an indicator of childhood living conditions has increased remarkably in the field of epidemiology. Body height has also been used as a societal level indicator of the standard of living. The important focus here is on the dramatic increase in body height throughout the world during the 20th century.

The increase in body height has been uniform with the possible exceptions of the two world wars, and it seems to be a universal process occurring worldwide in both affluent societies and in the developing world (Silventoinen, 2003). In Europe, mean body height has increased about 1 cm per decade during the 20th century (Cavelaars *et al.*, 2000). This increase is similar across European countries, and the differences in mean body height have generally remained stable over birth cohorts. Earlier research reported that the Dutch people are the tallest in Europe (Cavelaars *et al.*, 2000). Reasons for this geographic pattern are not fully understood, and both environmental and genetic differences between the populations offer potential explanations. However, since the increasing trends in body height during the last century have generally been very similar in European populations, it is probable that genetic factors are most important when explaining these geographic differences in height. Variation in the heritability estimates of body height was larger between the study populations in women compared to men.

Previous report have suggested that women are more resistant to environmental stress than that in men (Stini, 1969), in addition, heritability of body height is lower among women than in men and there is also greater geographic variation in the heritability estimates among women. This is probably due to unidentified environmental factors specific to women only, which may vary more in time and between populations (Silventoinen *et al.*, 2003).

Living conditions during the growing year's especially in early child hood influence body height through their impact on net nutrition, namely the balance between the supplies of nutrition and the demands of metabolism, physical exertion and disease (Silventoinen 2003; Steckel 2009). Generally, it is believed that some differences in stature between human societies have a genetic basis (Holden and Mace, 1999). Environment also influences the stature of an individual, lowered nutritional standard and health care conditions can cause the mean stature of a population to decrease (Komlos, 1998). Gustafsson *et al*. (2007) reported that the mean stature of a population varies with living conditions.

Differences in the mean height across countries indicate a high degree of continuity of differences between countries in childhood living conditions (Cavelaars *et al*., 2000). Similarly, the persistence of education-related height differences indicates continuity of socio-economic differences in childhood living conditions (Cavelaars *et al*., 2000). Vashisht *et al.* (2005) studied physical growth and nutritional status of Garhwali girls, they observed that well nourished Indian girls and American girls show better performance in physical growth parameter like Height, weight and chest circumference as compared to Garhwali girls at all ages (5-12 years).The present state of malnutrition

in the Garhwali girls may probably be attributed to their low middle socioeconomic background, lack of knowledge of the simplest facts of nutrition and due to poverty.

Mukharjee *et al.* (2008) compared fathers rank as a Marker for socioeconomic status. Three categories of fathers rank i.e. Officer's, Junior Commanding Officers(JCO) and Other Ranks (OR) was chosen with declining socioeconomic status and it was seen that children of OR'S had higher prevalence of stunting, wasting and underweight as compared to other categories. The socioeconomic factors and normal physical growth are interrelated. There are various socioeconomic factors which affect adversely the socioeconomic status of a person and hence the growth. These factors are large families, overcrowding, poor sanitation, poor recreation facilities, air pollution, recurrent acute infections, chronic infections, heavy parasitic infection, more demands, lack of breast feeding, breast addiction (Malegaonkar *et al*., 2011).

### 2.1.1 Body height, body weight, and Age at Menarche

Although mechanisms involved in the negative correlation between obesity and age at menarche is not fully understood, Van Lenthe *et al.* (1996) suggested that many endocrine factors affect the rate of sexual maturity and fat accumulation in the body. Firsch (1974; 1994) believe that a girl needs to attain a minimum weight of 47.8 kg for her to start menstruating and the required body fat percentage of a girl before the onset of menstruation is between 16 to 23.7 %.

A critical weight, or height is needed for the onset of menstruation, and changes in the dietary habits of girls may have led to the increase in weight and height (Oland-More *et*

*al*., 2005). Several studies have shown that girls with a higher body weight, high BMI, more body fat and greater height, have an early age at menarche (Petridou *et al*., 1996).

Girls which have menstruated are significantly taller than girls of the same age that have not menstruated (Khekbanzan *et al*., 2005; Goon *et al*., 2010; Kim *et al*., 2010; Akbar *et al*., 2011). A study carried out in California showed that taller girls (148.60cm) experience menstruation earlier than shorter girls (135cm) (Kaplowitz *et al*., 2001; Kaplowite, 2006). Akhavan-Karbasi and Bafghi, (1997) reported that tall but overweight girls had experienced menstruation much earlier (around age 12-5 years) than short, but slender girls. Among the Korean girls, a reduction of the age at menarche and an increase in height was seen between 1920 to 1986. The age at menarche has reduced from 16.8 years to 12.7 years and height increased from 147.2cm to 161.75cm (Cho *et al*., 2010). This was attributed to changes in the physical growth of girls. Biro *et al.* (2012) reported that girls with early age at menarche, experienced a speedy development and enjoy a taller height at puberty but will have a shorter height in adulthood in comparison with those with delayed puberty, and the reason for this according to Onland-Moret *et al.* (2005) is the early closure of epiphysical plates of girls that have early menarche due to the release of oestrogen from the ovary and they will experience a meager chance to increase height after puberty. Some data suggest that girls who experienced late menarche have deficit in areal bone mineral density before the onset of pubertal maturation with very mild increment during the whole period of pubertal maturation. This observation indicates that estrogen exposure is not the only key factor responsible for the influence of menarcheal age on peak bone mineral density and that other genetic determinants could be involved (Chevalley *et al.*, 2009). Ellison (1981) proposed that menarcheal age is related to height `rather than

weight, suggesting that skeletal maturation is more important than body fat accumulation for menarche and this finding was supported by a survey performed among school girls in Taiwan (Chang *et al.,* 2000).

Lower menarcheal age was related with an increase in adulthood BMI (Parsons *et al*., 1999). The Body Mass Index of girls that have started menstruating is higher than the BMI of girls that have not menstruated (Parson *et al.,* 1999; Khekbanzan *et al*., 2005; Kim *et al*., 2010; Goon *et al*., 2010; Akbar *et al*., 2011). From the research carried out by Wong *et al.* (1999) in Iran, it was reported that the menarcheal age of girls with higher BMI is lower than those with normal or lower BMI. Pierce and Leon (2005) also reported a negative correlation between menarcheal age and BMI, meaning that BMI has an important role in determining the menarcheal age of a girl. Significant positive correlation has been reported between the menarcheal age and height (Elizando, 1992 and Kabir *et al.,* 2007). Studies showing contradictory results regarding the effect of weight on menarcheal age have been documented (Khakbazan *et al.,* 2005). However, Meyer *et al.* (1990) and Kim *et al.* (2010) reported a positive relationship between weight and menarcheal age. Height, weight and body fat content continue to increase for 1-2 years after menarche and the cycles become regular within 2-3 years (Begum, 2009).

A female will experience late menarche (high menarcheal age) when she attains the critical weight needed to trigger menarche at a later age. This could be as a result of malnutrition (Dreizen *et al*., 1967; Frisch and Revelle, 1969). Frish and Revelle, (1971) proposed a direct relationship between a critical weight and menarche. They further explained that attainment of a critical weight causes a change in metabolic rate, which

in turn affects the hypothalamus – ovarian feedback by decreasing the sensitivity of the hypothalamus to oestrogen. This feedback is then reset at a level of gonadotrophins and gonadal hormones high enough to induce the ovarian and uterine maturation resulting in menarche.

The age at menarche is investigated for several reasons because it is one of the major indexes of a female's fertility (Kazem *et al*., 2005). The determining factor of puberty (ends with age at menarche) is hereditary, though other factors are also involved on the onset of puberty: geographical location, nutrition, health and wellbeing as well as socioeconomic factors (Ersoy *et al*., 2005). Some studies have shown the role of height, weight and body structure on menarcheal age, while other studies are in disagreement with these factors (Gharravi *et al*., 2008; Zhutt *et al*., 2010).

## 2.2 Body Mass Index (BMI)

BMI, an index that expresses adult weight in relation to height, it is calculated as weight in kilograms (kg) divided by height in meter square ($m^2$). WHO categorize BMI into levels as the following: low weight (BMI < 18.5), appropriate weight (18.5<BMI< 25), over weight (25.1< BMI< 29.9), and obese (BMI ≥ 30) (WHO, 1998). BMI values of 30.00-34.99 kg/$m^2$ as obese class I, BMI 35.00-39.00 kg/$m^2$ as obese class II "severe obesity," and BMI > 40 kg/$m^2$ as obese class III "morbid obesity" (WHO, 2010). Surgically, people with a BMI > 50 kg/$m^2$ are classified as "super obese" (Almogy *et al*., 2004) and BMI > 60 kg/$m^2$ are classified as "super-super obese" (Regan *et al*., 2003). Once obese, the higher the BMI, the more health threatening it is, such as cardiovascular diseases, high blood pressure, sleep apnea, and gallstone/cholecystectomy (NIH, 1998).

World Health Organisation (1998) defined obesity as the presence of excessive body fat, which is associated with a number of adverse health condition (Allision *et al*., 2002). BMI is the most common and convenient method used to measure obesity, it is readily available in most survey. Body Mass Index has been reported to be an imperfect surrogate for body fat (Romero-corral *et al*., 2006). Furthermore, a number of researchers reported that Body Mass Index provides misleading information about the level of body fat (Prentice and Jebb, 2001). Therefore, the World Health Organisation (1995) warned researchers that BMI must be carefully interpreted to avoid confusing muscularity with obesity.

The inability of Body Mass Index to properly distinguish body fat from non fat components of the body is responsible for most of the puzzles in the findings when the medical literatures on BMI and the total mortality for patients with coronary artery disease were reviewed. Romeocorral *et al.* (2006) reported that overweight patients had a better survival rate and lower cardiovascular events than did underweight patients, and obese patients had no increased risk for mortality. Also, the obesity paradox states that there is no association between obesity and mortality in patients with cardiovascular disease (Curtis *et al*., 2005).

Sarria *et al.* (2001) in Spain concluded that BMI predicted total fat content well in male children and adolescents. Khadivzadeh, (2002) reported that BMI strongly correlates with mid upper arm circumference and calf circumference, with calf circumference correlating more strongly to BMI. Abernathy *et al.* (1996) reported that BMI is more a measure of heaviness and cautioned against the use of BMI to quantify individuals

fatness. Garrow and Webster, (1985) reported that BMI increases are typically associated with increases in fat weight.

Presently, the most accepted anthropometric measure for assessing overweight and obesity is BMI (Caroli *et al*., 2007). While BMI is the standard for defining obesity in adults, the use of BMI for defining obesity in children and adolescents is not universally accepted. The main issue is that although BMI correlates moderately with body fat ($r \leq 0.7$), BMI is not a direct measure of body fat (Freedman *et al*., 2009). The National Institutes of Health (NIH) and the WHO utilize BMI to classify subjects into three categories of bodyweight (Gallagher *et al*., 2000). For adults, BMI values in excess of 25 and 30 indicate overweight and obese, respectively, while those less than 18.5 are considered low healthy (US DHHS, 1998; WHO, 1998).

### 2.2.1 BMI and Body Fat Percentage (BF %)

Some studies have shown that the relationship between BMI, body fat percentage (BF %) and body fat distribution differ across populations (Razak *et al*., 2005). BMI $\geq$ 25 kg/m$^2$ and BF% <25 % was not associated with more risk to Cardiovascular disease risk whereas a BMI <25kg/m$^2$ and BF% $\geq$25 % was correlated with Cardiovascular disease risk in Korean men (Cho *et al*., 2009), implying that the majority of human body weight comes from lean mass. Researchers have shown that obesity associated metabolic risk are greater in Asian people than in European descent population (WHO, 2004).

Zhu *et al.* (2003) reported a curvilinear relationship between percentage body fat and BMI which was similar to the findings of Gallgher *et al.* (2000).

### 2.2.2 BMI, Total Body Fat, Waist Hip Ratio and Waist Circumference

According to Gill *et al.* (2003), Body mass index, Waist hip ratio and waist circumference have been shown to play a significant role in the identification of obese and overweight individuals. Lean and Han, (1996) reported that waist circumference can be used to predict most closely the total body fat. Some authors reported that waist circumference can be used as the best method of assessing intra-abdominal fat in contrast to subcutaneous fat (Seidell *et al*., 1992).

Waist circumference has been found to be most correlated to BMI than WHR, and BMI explain the highest variability of waist circumference than WHR (Bose, 2006). From the study carried out by Neovious *et al.* (2005) among adolescents, BMI and waist circumference was identified as a diagnostic for fatness, waist circumference correlated better with BMI than WHR. Ghosh and Bandyopadhyay, (2007), Chakraborly and Bose, (2009) reported that waist circumference had the highest correlation with total body fat than WHR among the Bengalee population. Other authors reported that waist circumference had better certainity in detecting overweight than WHR (Moy and Atiya, 2003) and BMI (Molarius *et al*., 1999).

Sarria *et al.* (2001) in Spain concluded that BMI predicted total fat content well in male children and adolescents. Some studies have shown that the relationship between BMI, body fat percentage (BF %) and body fat distribution differ across populations (Razak *et al*., 2005). Widhalm *et al.* (2001) concluded that BMI might be parameter for epidemiological studies: however, it gives only a limited insight to the degree of obesity based on definition. Gallagher *et al.* (2000) and Zhu *et al.* (2003) reported a curvilinear relationship between percentage body fat and BMI.

Garrow and Webster, (1985) also reported that BMI increases are typically associated with increases in fat weight. Amber *et al.* (2000) also reported that BMI was more highly correlated to fat weight than with lean body mass. Abernathy *et al.* (1996) reported that BMI is more a measure of heaviness and cautioned against the use of BMI to quantify individuals fatness.

### 2.2.3 Body Mass Index and Menstrual Cycle

Several researchers have demonstrated that BMI was independently associated with the experience of irregular menstrual cycles that is the leaner students were more likely to experience irregular menstrual cycles. Studies carried out by Symons *et al.* (1997) and Williams, (2006) revealed that BMI above or below the normal range has been associated with irregular menstrual cycle, suggesting that the relation between BMI and menstrual cycle is not linear. Body fat is important for the maintenance of reproductive cycle (Symons *et al*., 1997).

### 2.2.4 Body Mass Index, Weight and Depression

For the past decades, the relationship between BMI and depression has been studied and the findings from these studies are not consistent (Atlantis and Baker, 2008; Luppino *et al*., 2010). Some researchers reported increased risk of depression among obese people (Roberts *et al*., 2003) while Kuriyama *et al.* (2006) reported fewer depressive symptoms among this population. Crisp and McGuiness (1976) and Crisp *et al.* (1980) proposed a hypothesis called a "jolly fat" hypothesis. This hypothesis states that obesity reduces the risk of depression. Depression was reported to be higher in underweight individuals than in individuals with normal weight (Wyatt *et al*., 2003; De Wit *et al*., 2009).

Depressive symptoms were reported to be higher in obese elderly than normal weight elderly in Hong Kong (Li *et al*., 2004). Nan-wen *et al.* (2011) reported that, underweight people may have low self-esteem and depressive symptoms because of their negative body image. In a survey carried out by Carpenter *et al.* (2000), it was reported that major depression is associated with men whose BMI level is below normal and females whose BMI level is above normal. Nan-wen *et al.* (2011) reported that obese women have a lower risk and that the risk of depressive symptoms is significantly higher in underweight men than men with normal weight. Depressive disorders were reported to be associated with weight loss treatment (McElroy *et al.*, 2004) and increase with weight gain (Fumham *et al*., 2002).

Through the appearance concern pathway, obese individuals experience more body image dissatisfaction, distress regarding repeated diet failures, and actual or perceived stigma related to obesity (Markowitz *et al*., 2008). Individuals with elevated depressive symptoms were less physically active than those without elevated depressive disorder (Golden *et al*., 2008; Golden *et al*., 2013). Depression is associated with enhanced neuroendocrine activity and elevated inflammatory markers that may alter eating behaviour and/or promote weight gain (Champaneri *et al*., 2010). A recent meta-analysis showed that elevated depressive symptoms might lead to development of overweight and/or obesity (Luppino *et al*., 2010), they also reported that overweight and obesity are at the risk of developing depression. In an earlier study of middle aged women, depressive symptoms at the baseline were associated with a greater likelyhood of weight gain over 6 years (Noppa and Hallstrom, 1981).

Some studies have shown significant association between depression and waist circumference: Akbaraly *et al*. (2009) who carried out this study in London using the 4-item depression subscale of the general health questionnaire among adults between the age range 35 – 55 years; Dunbar *et al.* (2008) in Australia using the Hospital Anxiety and Depression Scale and the participants aged 25 – 84 years; Takeuchi, *et al.*, 2009 among Japanese men aged 20-67 years using the Profile of Mood States of the Likert Scale questionnaire.

However, some studies conducted in Finland showed no significant association between waist circumference and depression: Herva *et al.* (2006) conducted this research using the Hopkins Symptom Checklist and Koponen *et al.* (2008) using the Beck's depression inventory. Moreover, studies conducted among middle aged women using the Center for Epidemiological Studies Depression Scale reported by Everson-Rose *et al.* (2008) and in overweight pre-menopausal women using the Zung's self-rating depression scale reported by Lee *et al*. (2008) showed that Central Obesity which was measured as visceral fat (but no subcutaneous fat) was significantly associated with an increase in likelihood of having depression.

Guixiang *et al.* (2011) conducted the similar studies on both men and non-pregnant female's women who were overweight and obese, and reported a significant association between waist circumference and abdominal obesity, and that, waist circumference were significantly associated to both major depressive symptoms and moderate to severe depressive symptoms. Waist circumference is an inexpensive measure of central obesity in a population based studies and has been shown to be associated with depression in

some studies (Katz *et al.*,2000; Moreira *et al*., 2007), but in other studies, no association was observed (Turley *et al*., 2006 and Ho *et al*.,2008).

Studies showed that social anxiety is associated with increased WHR in middle aged women (Landen *et al*., 2004). Strong relationships exist between elevated cortisol, depression and abdominal obesity (Brown *et al*., 2004). Rosmond, (1997) reported a significant association between abdominal fat and depressive symptoms in middle aged men. However, Hach *et al.* (2006) reported that, individuals with and without an unfavourable waist circumference seem to be at a similar risk of suffering from mental disorders and depressive disorders respectively. The findings of Hach *et al.* (2006) contradicted the theory stated by Bojer, (2000); Young *et al.* (2001); Tsigos, (2002) which states that, waist circumference might be a suitable measure for permanent mental strain and increased risk for mental disorders.

Studies have suggested that elevated depressive symptoms and clinical depression led to the development of overweight and obesity (Luppino *et al*., 2010). Clinical and subclinical depressions are associated with subclinical hypercortisolism and enhanced stress activity (Champaneri *et al*., 2010). Subclinical hypercortisolism promotes differentiation and proliferation of adipocytes, redistributes fat from peripheral to central depots thereby increasing the size and number of the adipocyte leading to accumulation of visceral fat (Anagnostic *et al*., 2009).

Luppino *et al.* (2010) in a recent meta analysis showed that elevated depressive symptoms might lead to development of overweight and/ or obesity. Noppa and Hallstrom, (1981) reported that depressive symptoms were associated with a greater

likelihood of weight gain over six years amongst middle age women. Some longitudinal studies also suggest that obesity can lead to the development of depressive disorders through biological and physiological mechanism (Luppino *et al*., 2010).

Two studies were conducted among middle aged women, Everson-Rose *et al.* (2009) used the center for epidemiological studies Depression scale, while Lee *et al.* (2005) used the zung's self Rating Depression scale and they both reported that central obesity which was measured as visceral fat was significantly associated with an increased likelihood of having depression. Zhao *et al.* (2011) used data from both men and non pregnant women who were overweight and obesed to further demonstrate that waist circumference and abdominal obesity were significantly associated with both major and moderate to severe depressive symptoms.

## 2.3 Waist Hip Ratio (WHR)

In most western cultures, females with low WHR are rated as more sexually attractive (Henss, 1995; Furnham *et al.*, 1997). This preference has ecologic validity because higher ratios (e.g. > 0.80) are associated with various adverse factors such as menstrual irregularities and decreased fertility. Several researchers have reported that, women with high WHR exhibit decreased fertility (Zaadstra *et al.*, 1993; Wass *et al*.,1997), more menstrual irregularities (Hartz *et al.*,1984) and cardiovascular disease risk factors (Hartz *et al.*, 1984; Marti *et al.*, 1991; Wing *et al*, 1991), less physical activity (Rosmond and Bjo¨rntorp, 1999), higher levels of anger, anxiety, depression, lower levels of social support (Wing *et al.*, 1991) and education (Rosmond and Bjo¨rntorp, 1999), more stress, a greater stress reactivity (Epel *et al.*, 2000).

The medical practioners argued that low WHR is ideal from the perspective of both health and fertility. Because of the benefits associated with low WHR (0.7) one might expect all women to have a low WHR, these benefits include greater fertility, health and attractiveness (Lassek and Gaulin, 2008). Higher fertility was reported in females with low Waist Hip Ratio (Jasienska *et al*., 2004; Kirchengast and Hubes, 2004). Jasienska *et al.* (2004) reported that females with low WHR and large breast have estradiol levels indicating a threefold increase in the probability of conception and these women are the most fecund quartile in their sample compared to the rest of the study sample. Similarly, Zaadstrat *et al.* (1993) reported that there was a decrease in the probability of conception per cycle by 30 when 0.1 increases in WHR were recorded. Young German women in higher quartiles for self-reported hip, thigh and leg circumferences had higher odds of menarche in cross-sectional bivariate analyses (Merzenich *et al.*, 1993).

Higher or lower level of cortisol and androgens are associated with high WHR in women. Exogenous androgens increases visceral fat in females (Elhers *et al*., 1997), and high level of free testosterone was seen in women with high WHR (Van Anders and Hampson, 2005). Santoro *et al.* (2005) reported that the concentration of the protein (SHBG) that binds to testosterone and keeps it biologically inactive is lesser in females with high Waist Hip Ratio. High level of cortisol increases WHR by increasing visceral fat. Women with high Waist Hip Ratio report more chronic stress and respond to a stressful situation with greater cortisol reactivity than do low WHR women (Epel *et al*., 2000). Visceral fat cells are said to be highly responsive to cortisol (Bjorntorp, 1996). Estrogen decreases WHR directly by increasing fat storage in the thigh and hip area and increases lipolysis in abdominal fat (Rebuffe-Scrive, 1986), and indirectly by mitigating the effects of androgen through an increase in Sex hormone binding globulin (SHBG),

which keeps circulating androgen protein bound and unavailable to tissues. Results from research work on female to male transsexual suggests that, testosterone treatment increases visceral fat in the abdomen but not hip (Elbers *et al*., 1997), which would lead to higher WHR. Testosterone levels in women exposed to chronic marital stress is high when compared with women who experience stable marriages (Powell *et al*., 2002). Van Ander *et al.* (2005) reported that there is a significant and highly positive correlation with WHR and bioavailable testosterone in healthy post-menopausal women.

WHR is a visible biomarker of bioavailable testosterone and there is a positive association between BMI and WHR. Some data suggest that Body Mass Index correlates negatively with a woman's sexual desire (Kirchengast *et al*., 1996). Females with higher BMIs feel more negative about their bodies. This overwhelms hormonal influences on sexual desire. Similarly, Van Anders *et al.* (2005) reported sexual desire to be negatively related with WHR and this was in agreement with the report of Kaplan and Owett, (1993). Variation in a female WHR exists between one population to the other. In societies where females get resources through direct productive work rather than through investing males, the females have a higher WHR (Pawlowski and Jasienska, 2008).

### 2.3.1 Waist Hip Ratio (WHR), and Thigh Circumference

Most authors agree that waist circumference is likely to be a better indicator of visceral fat than WHR and that waist circumference correlates more strongly with cardiovascular risk factors than WHR (Dobbelsteyn *et al*., 2001). Thigh circumference

was also reported to be a better indicator for leg muscle mass than hip circumference because it is less influenced by the pelvic width and gluteal fat.

Snijder *et al.* (2003) reported a strong positive association between waist circumference and markers of glucose metabolism. A decrease in hip or thigh circumference leads to an increase in WHR. Bjorntorp, (1991) and Despress *et al.* (1995) reported that there is an increased risk of unfavourable glucose level in subjects with higher WHR. Snijder *et al.* (2003) reported that thigh circumference was strongly and negatively associated with markers of glucose metabolism in women, not in men, while hip circumference was negatively associated with the markers of glucose metabolism in both sexes. Snijder *et al.* (2003) also reported a significant interaction between thigh circumference and waist circumference, indicating that individuals with large waist circumference and small thigh circumference experience worst glucose levels than women with smaller waist or larger thighs. Hip circumference was negatively associated with markers of glucose metabolism in both sexes.

It was speculated that the contribution of larger hip circumference to lower glucose levels is likely to be due to a higher muscle mass (Seidel *et al*., 1997). The main target of insulin as well as a site of insulin resistance is the skeletal muscle. A large thigh and hip circumference can also reflect increased femoral and gluteal subcutaneous fat respectively.

### 2.3.2 Waist Hip Ratio, Thigh Circumference and Depression

Studies showed that social anxiety is associated with increased WHR in middle aged women (Landen *et al*., 2004). Strong relationships exist between elevated cortisol, depression and abdominal obesity (Brown *et al*., 2004). Rosmond, (1997) reported a

significant association between abdominal fat and depressive symptoms in middle aged men. However, Hach *et al.* (2006) reported that, individuals with and without an unfavourable waist circumference seem to be at a similar risk of suffering from mental disorders and depressive disorders respectively. The findings of Hach *et al.* (2006) contradicted the theory stated by Young *et al.* (2001); Tsigos, (2002) which states that, waist circumference might be a suitable measure for permanent mental strain and increased risk for mental disorders.

Rosmond (1997) reported an association between abdominal fat and depression. Zhao *et al.* (2011) observed that waist circumference was associated with depressive symptoms among overweight and obesed adults.

## 2.4 Gluteofemoral Adiposity and Age of Menarche

Menarche may be related to fat distribution rather than total fat, and in particular to the relative amount of lower-body (gluteofemoral) versus upper-body fat. Menarche was positively related to hip circumference and negatively related to waist circumference (Fredriks *et al.,* 2005). Fat distribution was significantly related to menarche, particularly in young women who reached their reproductive landmark with unusual low levels of total body fat, suggesting that body fat distribution may influence the timing of menarche although, there may be a pubertal mechanism that increases lower-body fat deposition concurrent with or after menarche (Lassek and Gaulin, 2007). Stark *et al.* (1989) and Elizando, (1992) reported that the odds of menarche increase with increasing amounts of fat in the hips and decreases with increasing waist circumference and triceps skinfolds and that hip circumference is a more important factor than height.

Girls with low level of gluteofemoral fat can still experience early menarche than girls with higher level of gluteofemoral fat if they have much lower WHR (Stark *et al.,* 1989 and Elizando, 1992). On the other hand, late menarche is associated with osteoporosis, since studies including postmenopausal women suggest that those having late menstruation have lower mineral density at forearm, spine and proximal femur and increased risk of fractures as well (Fox *et al.,* 1993). Moreover, apart from older women, onset of menstruation is a determinant factor of peak bone mineral density in young women. According to a Japanese cohort study, late menarche (> 14 yrs) is associated with approximately two fold increased risk of low areal bone mineral density at the hip in women aged under 40 years (Ho *et al.,* 2005). Age at menarche correlates not only with bone mineral density but also with bone microstructure, since young healthy women with late menarche display lower total volumetric bone mineral density, cortical volumetric bone mineral density, and cortical thickness at forearm, a finding compatible with less endocortical accrual (Chevalley *et al.,* 2008).

Higher gluteofemoral adiposity has been associated with lower menarche age (Fredriks *et al*., 2005; Lassek and Gaulin 2006). Female anthropometry reveals that, adiposity has a strong influence on female reproductive characteristics marked by age at menarche (Lassek and Gaulin, 2006), the age at menarche is widely varied in different populations and is delayed especially in populations with poor nutrition (Thomas *et al*., 2001; Gluckman and Hanson, 2006). This was the basis for the hypothesis proposed by Frisch *et al.* (1974) that, a female need to store a critical amount of fat to reach menarche, even though the theory generally failed. It is now thought that the distribution of fats towards the gluteofemoral region tend to be more plausible (Fredriks *et al*., 2005). Achieving a critical weight was necessary for timing of menses and that

increases in childhood body weight over time may explain the secular decline in menarche (Frisch and Revelle, 1997).

## 2.5 Skinfold

The development of human skinfold thickness (subcutaneous fat) is affected by genetic factors, sex hormones and neuroendocrine activity. In addition, there are obvious regional difference, ethnic differences, eating habits, nutrition and physical exercise etc (Huang *et al*., 2007). The skinfold thickness provides an estimate of the thickness of subcutaneous fat (Onimawo and Cole, 2000). Onimawo *et al.* (2004) reported that skinfold thickness useful in assessing the degree of malnutrition. Jellife (1966) also reported that the triceps skinfold thickness can serve as an indicator of nutritional status in man. Borkan and Norris, (1997) reported that a decline in skinfold thickness at the biceps and triceps can be attributed to a decrease in subcutaneous fat as a result of reduced energy intake, as fat content is dependent on nutrition intake and energy expenditure of the individual. The differences in the value of the skinfold thickness in people of the same age would reflect the status of energy reserve (Bhardwaj and Kopoor, 2007). Ye *et al*. (2012) gave two possible reasons for the difference in skinfold thickness: agricultural based activities and high physical exertion reduces skinfold thickness while meat, egg and high fat to high protein in a diet increase skinfold thickness.

Another measure for assessing body fat is skinfold thickness. This technique estimates body fat based on measurements of subcutaneous fat at various sites throughout the body, most commonly the triceps and subscapular regions (Power *et al*., 1997). Rolland-Cachera, (1993) demonstrated that one can reasonably predict total body fat

from skinfold thickness at the triceps, and percent body fat from skinfold thickness at the subscapular site (Power *et al*., 1997). The sum of two skinfold thicknesses utilizes the two most common skinfold measurement sites, the triceps and subscapular skinfolds, while avoiding a compounding of measurement error that would be present if a ratio was used (Power *et al*., 1997).

Nooyen *et al*. (2007) reported that predicting high body fatness in adult hood is better accomplished via adolescent skinfold thickness than adolescent BMI. The thickness of a skin allows researchers to distinguish between an individual's body mass and body fat, which is critical in regards to the potential negative impact on health status (Himes and Dietz, 1994).

## 2.6 Body Composition

The body composition of individuals changes with age (Ley *et al*., 1992). In premenopausal women, the free-fat mass proved to be the most significant determinant of not only lumber bone mass but also the total body mass. Shaw *et al.* (1993) and Douche *et al.* (1996) reported that the free-fat mass is significantly higher in premenopausal women than in postmenopausal women, exercise increases the bone mass while having an opposite effect on adiposity (Forwood and Burr, 1993). From the findings of Douchi *et al*. (1997), it was reported that premenopausal bone mass has a stronger relationship with free-fat mass than fat mass.

However, Shaw *et al.* (1993) reported that only free-fat mass can be used to predict bone mass in premenopausal women. Furthermore, Slemenda *et al*. (1990) reported that both fat mass and fat-free mass contribute to the mass of a bone. The total fat mass

weighed less than the total free-fat mass in postmenopausal women. The total fat mass has a greater effect on bone mass than free fat mass on postmenopausal women (Douchi *et al*., 1997). Assessment of body composition, particularly the estimation of fat-free mass and total body fat forms part of the nutritional assessment process. It offers more information than body mass index, because changes in body weight may be as a result of changes in either the fat-free mass or total body fat. Researches on the body composition of individuals are very important because body fat is related to blood pressure and other cardiovascular risk (Berchtold *et al*., 1981), glucose intolerance (Wilson *et al*., 1981) and insulin resistance (Bonnadonna *et al*., 1990).

The body composition of an individual changes with age and menopause (Ley *et al*., 1992). The evaluation of body composition is used in several areas of health science to gain important information on the gross morphology (Komuya *et al*., 1995). Although to-date the most common technique used to estimate body composition have been skinfold thickness, isotope dilution and underwater weighing with exception of skinfold thickness. These techniques have not been easy to apply to many subjects due to the requirements of special equipment, technician's skill and subject discomfort.

### 2.6.1 Bone Mass

Bone is a living tissue which is constantly being absorbed and replaced. Osteoporosis occurs when the formation of new bones does not keep up with the removal of old bone, it causes the bones to become weak and brittle (so brittle that a fall or even mild stresses like cough or bending over causes fracture). Osteoporosis is the most common metabolic bone disease and it is a major cause of morbidity in elderly(Srivastava and Deal, 2002).This disease is characterised by a reduction in the mass of bone per unit

volume to a level below that required for adequate mechanical support function . Most bone fractures are as a result of the increased bone fragility of osteoporosis and these fractures are associated with higher health care cost, physical disability, impaired quality of life and increased mortality. Due to the fact that the incidence of osteoporotic fracture increase with advancing age, measures to diagnose and prevent osteoporosis and it complications assume a major public health concern.

Zamboni *et al*. (1992) reported that the body composition of human changes with advancing age, this is because with age the free fat mass decreases as the fat mass increases. It has been well established that central obesity is associated with several metabolic disturbances such as dyslipidemia, glucose intolerance, hypertension, peripheral hyperinsulinemia. Upper body fat measured by waist hip ratio is known to increase with aging in women as well as in men (Zamboni *et al*., 1992).

Bone mass was reported to be lower in women than in men, this is due to a decrease in the bone mass of both the trabecular (trunk) and compact (i.e legs plus arm) bone irrespective of the the age of the female (Horber *et al*., 1996). In addition, the bone mass of female subject was reported to be high before menopause, irrespective of the compartment analysed, however, in males the bone mass is similar at the spine for both younger and older males, whereas at other sites the bone mass is lower in older males. The bone mass was strongly correlated with fat mass in both males and females, the percentage body fat and bone mass was significantly higher in females with high fat mass when compared with females with low fat mass, however, in males differences was not observed (Choi and Pai , 2003). Premenopausal women were reported to have a higher bone mass than postmenopausal women. Bone mass was reported to be strongly

related with body fat in both males and females but not in older males (Fritz *et al*., 1996). The total body bone mass is the sum total of the bone mass at various sites. The bone mineral content of the leg is greater than that in the arms and trunk of both postmenopausal and premenopausal women (Douchi *et al*., 1997). Bone mass is the most important determinant of the strength of bone and it serves as the best predictor of variance in breaking strength (Turner and Burr, 1993; Kanis and Gluer, 2000). Osteoporotic fracture increases with advancing age, measures to diagnose and prevent osteoporosis and its complications assume a major public health concern.

In the population studied, seafood was a large dietary component and was significantly associated with increased BMD in women (Zalloua *et al*., 2007). These results can be attributed to the high content of essential fatty acid (EFA) present in fish and other seafood. Recent evidence has shown that similar to the lack of calcium and Vitamin D3, a deficiency in certain fatty acids in the diet may also contribute to bone loss (Terano, 2001; Albertazzi and Couland, 2002). EFAs are believed to enhance Vitamin D effects thus facilitating calcium absorption from the gut, which in turn leads to a reduction of calcium excretion in the urine. This process may result in increased calcium deposition in bone, enhanced synthesis of bone collagen and, improved bone health (Kruger and Horrobin, 1997). Coetzer *et al*. (1994) showed that the relative content of fish oil derived polyunsaturated fatty acids in the intestinal membranes may change fluidity and increase calcium absorption by enhancing the action of Vitamin D3.

Fernandes *et al*. (2003) found a significant bone loss reduction in ovariectomized mice when placed on a fish oil (FO) rich diet. No such reduction was observed when similar mice were fed corn oil or casein rich diets. It is, however, well established that FO

decreases urinary calcium loss (Zalloua *et al*., 2007). It is well known that genetic factors influence peak bone mass, but many environmental factors also play a role in altering genetic effects (Livshits *et al*., 2004; Prentice, 2001). Proper nutrition plays a role in the prevention and treatment of osteoporosis. One of the most important nutritional factors in prevention of osteoporosis is adequate intake of calcium and Vitamin D (Matkovic *et al*., 1990).

### 2.6.2 Basal Metabolic Rate

Recommended daily calorie intake varies from person to person, but there are guidelines for calorie requirements you can use as a starting point. Factors that affect your personal daily calorie needs include your age, height and weight, your basic level of daily activity, and your body composition. United Kingdom Department of Health Estimated Average Requirements (EAR) is a daily calorie intake of 1940 calories per day for women and 2550 for men. How many calories are needed each day can vary greatly depending on lifestyle and other factors.

Nutritional status of an individual or population is a feasible indicator of the standard of living, and it's a tool of vital importance in public health (Rebato *et al.,* 2001). The required caloric intake is the sum of the energy required to maintain both biological functions associated with digestion, assimilation of food and physical and intellectual activities. When the caloric intake is lower than the energy consumed, it results to a negative energy balance. The usual consequences of negative energy balance are loss of body weight and a decrease in energy reserve, if this continues for long the body functions and health of the individual will deteriorate eventually leading to death. However, when the caloric intake is higher than the energy expenditure, it leads to

overweight and obesity. The nutritional status of an individual or reputation is a feasible indicator of the standard of living, and it is a test of vital importance in public health (Rebato *et al*., 2001).The nutritional status of adults cannot be properly evaluated by exclusive measurement of height since height usually reflects better the accumulative effects of unfavourable circumstances during the period of growth. Body weight reveals an accurate short-term effect and alterations of body components. It is an indicator of nutritional status. Nutritional dysfunctions do not modify height in adults but have a direct influence on body components (body mass). Thus, establishing ranges of body mass index (BMI) as a diagnose for malnutrition is very important when analyzing the prevalence of malnutrition in a certain population.

### 2.6.3 Muscle Mass

Anthropometry has been used as a simple, non-invasive and inexpensive method for measuring skeletal muscle mass (Heymsfield *et al*., 1982). In a recent study, anthropometric indices have been validated for estimating total body skeletal muscle mass in humans (Lee *et al*., 2000). Janssen *et al*. (2000) determined skeletal muscle mass by using Bioimpedence analyser (BIA) and magnetic resonance imaging in a multiethnic sample of 388 men and women aged 18-86 years. They concluded that BIA provides valid estimates of skeletal muscle mass in healthy adults varying in age and adiposity. However, the prediction equation derived from data on Caucasians obtained using the whole BIA analysis overestimated the whole skeletal muscle mass in an Asian cohort. Kuriyan *et al.* (2008) compared total body muscle mass estimation using BIA and anthropometric measurements. The simple anthropometric methods have been validated against more sophisticated and relatively more accurate methods of estimation of body composition. De Lorenzo *et al.* (1998) evaluated fat mass and fat free mass

using different techniques, such as dualenergy X-ray absorptiometry and different impedance equations. While they found no differences in body fat percentage between dual-energy X-ray absorptiometry and the impedance equations, the mean value of fat free mass measured using dual-energy X-ray absorptiometry was significantly higher than that predicted by the impedance equations. Tanaka *et al*. (2007) compared BIA with magnetic resonance imaging in estimating skeletal muscle mass. BIA produced systematic errors and resulted in an overestimation of skeletal muscle mass determined by magnetic resonance imaging. Kyle *et al.* (2003) investigated 444 healthy volunteers between 22 and 94 years and estimated muscle mass using BIA and dual-energy X-ray absorptiometry. They concluded that the BIA method was a valid method for estimating skeletal muscle mass when compared with dual-energy X-ray absorptiometry.

Knechtle *et al.* (2011) reported an overestimation of both skeletal muscle mass and fat mass by using BIA. BIA is a body composition method that measures tissue conductivity and is based on the relationship between the volume of a conductor and its electrical resistance (Khaled *et al*., 1988). Because skeletal muscle mass is the largest tissue in the body and it is an Electrolyte-rich tissue with a low resistance, muscle is a dominant conductor (Foster *et al*., 1996).

Free fat mass is made up of non fat components of the Human Body. The reduction in free fat mass with aging and its associated physical impairment is termed sarcopenia. Sarcopenia results from the loss of appendicular skeletal muscle mass (ASMM) (Gallagher *et al*., 2000), and its features are loss of the motor unit number, an atropy of muscle fibres and a decline in protein synthesis. The origin of fat mass loss is associated with a risk of disability, balance disorders and falls, immune and muscular dysfunction

and impaired quality of life (Janssen *et al*., 2002). In contrast, an increase in fat mass is said to be related to overweight and obesity, which in turn increases the risk of cardiovascular disease, osteoporosis, liver and gall bladder disease. Also, a gain in abdominal fat which is evaluated by an increase in waist circumference or waist hip ratio increases the risk of functional limitation and disability (Houston *et al*., 2005). Thus, both gain in fat mass or loss in fat free mass is harmful. Total free fat mass has been proven to be the most significant determinant of bone mass in both premenopausal (20-49) and post menopausal women (50-79) (Douchi *et al*., 1997).

A decrease in free fat mass and Appendicular skeletal muscle mass (ASMM) with age was reported to be more in females than in males (Dey *et al*., 2009; Genton *et al*., 2011). Forbes *et al*. (1999) showed that the loss of free fat mass is also seen in younger subjects' i.e between ages 21-38, he described that there is a progressive loss of 1.5 kg of free fat mass per decade in subjects who maintained weight. The kinetic of fat mass in older subjects is variable and it depends on other parameters than aging i.e it depends on hormonal or nutritional status.

## 2.7 Age at Menarche

A woman's first menstruation is termed menarche and it is an important maturity indicator used to assess the developmental status of a pubertal female (Cameron and Nadgdee, 1996). Menarche correlates with age at onset of puberty with breast development. In girls with early onset of breast development, the interval to menarche is longer (3 years or more) than in girls with later onset (Llop-Vinolas *et al*., 2000).

According to Bayer and DeCherney, (1993), the most common menstrual disorders in early adolescents are irregular menstration and prolonged menstrual bleeding. Prolonged menstrual bleeding usually occurs early after menarche due to anovulatory cycles (estrogen unopposed by progesterone produces an unstable endometrial lining that eventually breaks down, and vasoconstriction and myocardial contractility do not occur). The probable cause of menarche is an increase in the frequency of the gonadotropin releasing hormone (GnRH) pulse generator in the hypothalamus, but the age at menarche varies widely and is delayed in populations with poor nutrition (Thomas *et al.*, 2001; Gluckman and Hanson, 2006).

Menarche occurs averagely at the age of 12 years. Diegton *et al.* (1993) established that menarche is influenced by such factors as socioeconomic class, sports and genetic factors. The age at menarche seems to be decreasing in industrialized countries (Chodick *et al*., 2005). Drife and Magowan (2004) and Chodick *et al.* (2005) reported that before 1900, the mean age at menarche in the United States was greater than 14 years but it's now lesser, and this was attributed to improvements in socioeconomic conditions, nutrition and general health. However, the average age at menarche has not changed during the last 20 to 30 years in the United Kingdom and is now 12.9 years (Whincup *et al*., 2001).

Early menarche is associated with a risk of obesity in postmenopausal women with breast cancer (Wasserman *et al*., 2004). Ryan *et al.* (1999) reported that the mean age of menarche was 12.7 years in the United States; Also Whincup *et al.* (2001) in their report observed that the average menarche age of a 1982–86 birth cohort in England and Scotland was 12.9 years. In a study carried out by Malina *et al.* (1994) the mean age of

menarche among 338 sporting women was 13.8 years. Furthermore, Begum *et al.* (2009) in their study reported the minimum age of menarche was 9 years, while the maximum age at menarche was 17 years with an average mean of 13 years. However, Desalegn *et al.* (2009) reported that the mean age at menarche is 15 years which might be due to poor nutritional status of the women in rural communities where the study was conducted. Ikaraoha *et al.* (2005), carried out a research work on urban secondary school girls in Rivers State of Nigeria (South-south zone of Nigeria), they reported the mean age of menarche to be 13.89 years, while from the research carried out by Jack *et al.* (2005) on secondary school girls in Maiduguri (North-east zone of Nigeria), the mean age of menarche was observed to be 13.6 years.

Most menarcheal age studies carried out in developing countries were girls grow under conditions of poverty showed delay in onset of maturation which is associated with a history of under nutrition throughout childhood. For example, Khan *et al.* (1996) found stunting by 3 years to be a significant predictor of later menarche among Guatemalan girls. Simondon *et al.* (1998) also reported delayed maturation among girls who were stunted during the preschool years. Prenatal environment is likely to influence the timing of menarche indirectly through postnatal growth (Adair, 2001).

Postnatal growth is related to size at birth. Intrauterine growth-restricted infants, particularly those with weight deficits relative to their length, are likely to have a very rapid postnatal growth rates (Adair and Popkin, 1988; Fall *et al*., 1995). Cebu girls who were relatively long and light at birth had the highest postnatal weight velocities of all the weight/length groups (Adair, 2001). Infants may grow faster because they are metabolically programmed to take maximum advantage of the energy and nutrients

likely to be provided by full breastfeeding in early infancy. The strongest relationship with age at menarche occurs among girls who were long but relatively light at birth (Adair, 2001).

Menarche varies from population to population according to different factors like nutritional, geographical and environmental conditions and most of the female experience it when they are 10 to 16 year old (Thomas *et al.,* 2001; Kaplowitz, 2006). This variability is mainly due to genetic, ethnic, environmental and nutritional factors (Kaprio *et al.,* 1995).

Menstrual disorders like delayed menarche, premenstrual symptoms and dysmenorrhoea create a great anxiety among the adolescent females and their families, thus it is very important to know menstrual cycle pattern and variation for clinical evaluation and patient education (Adam, 2002; Diaz *et al.,* 2006). Investigating the age of menarche and menstrual problems among adolescent is of much importance so as to provide health planners and care givers with fundamental data necessary for interventions. While much data concerning age of menarche and problems among adolescent are available in the other countries (Padez, 2003; Rebacz, 2009; Okusanya *et al.,* 2009), however there is paucity of such data available in Sudan (Attallah *et al.,* 1983).

The onset of puberty reflects numerous health aspects of a population, including the timing of sexual maturation, growth and nutritional status and environmental conditions, in well-nourished, healthy girls and menarche is largely dependent on genetics, as confirmed by studies on the menarcheal age of twins, sisters and mother-and-daughter pairs (Anderson *et al*., 2003; Tehrani *et al*., 2010). A relationship has also

been shown between early menarche and increasing severity of painful menstruation, and pregnancies at a younger age (Repke, 1989; Balbi *et al*., 2000). Ryan *et al.* (1999) reported that the mean age of menarche was 12.7 years in the United States; Whincup *et al.* (2001) also reported that the average menarche age of a 1982–86 birth cohort in England and Scotland was 12.9 years. In another study the mean age of menarche among 338 sporting women was 13.8 years (Malina *et al*., 1994).

### 2.7.1 Age at Menarche and BMI

Early age at menarche has been shown to be associated with increased adult BMI (Parsons *et al.,* 1999). Girls who experience a relatively early age at menarche tend to be more obese as adults (Biro *et al*., 2001; Laitinen *et al*., 2001; Okasha *et al*., 2001). Kim and Lee (2003) reported that obese girls grow faster and have earlier menarche. Several studies have found a negative relationship between age at menarche and adult weight-for-height (Power and Parsons, 2002). Wellens *et al.* (1992) showed no association between age at menarche and adult BMI.

Puberty starts earlier in girls whose BMI is 20 to 30 % above normal than girls who have a normal body BMI, while Thomas *et al.* (2001) reported that, malnourished girls will experience a delay in menstruation. Studies have shown that childhood obesity is a predictor of early puberty (Davison *et al.,* 2003). The weight of girls that have started menstruating is higher than the weight of girls that have not menstruated (Goon *et al*., 2010; Akbar *et al*., 2011). This increase in body fat mass causes the secretion of leptin, which stimulates the hypothalamus and causes an over secretion of GnRH. Gonadotropin Releasing Hormone, stimulates the hypophysis ovarian axis and initiates the speeding up of puberty (Cole, 2003).

### 2.7.2 Age at Menarche and Menstrual Cycle

From the research carried out by Lee *et al.* (2006) on Malaysian girls, "long menstrual cycle" was a common menstrual disorder among adolescent girls; this was said to be due to difference in their gynaecological age. WHO (1986) carried out a study on menstrual and ovulatory patterns in adolescent girls and reported the mean menstrual cycle length for the first cycle after menarche as 50 to 57 days and bleeding lasted for an average of 4 to 7 days. The female reproductive system usually requires approximately two years maturing before adolescent girls will have consistently regular ovulatory cycles (WHO, 1986). Prolonged menstrual bleeding usually occurs early after menarche due to anovulatory cycles. In anovulatory cycles, estrogen unopposed by progesterone produces an unstable endometrial lining that eventually breaks down and vasoconstriction and myocardial contractility do not occur (Bayer and DeCherney, 1993).

Henderson *et al.* (1981) in their study showed that women with early menarche and those with immediate establishment of regular cycles are at the risk factors of breast cancer. Based on these risk factors, Hosokawa *et al.* (2012) proposed that women who had menarche before ten years old and regular cycling within one year after the menarche are at high risk of breast cancer. The distribution of such high-risk group has been significantly increasing among younger generations of Japanese women, suggesting that estrogen dependent diseases may increase in the near future among Japanese women. Age at menarche before age 12 was moderately associated with increased odds of short cycles and inters menstrual bleeding after adjusting for covariate. Having a late age of menarche (age 15 or older) was associated with almost three times the odds of long cycles and about a doubling in the odds of irregular cycles

(Rowland *et al.*, 2002), also late age of menarche was associated with longer mean cycle length and increased menstrual cycle variability (Harlow *et al.*,1997).

## 2.8 Menstrual Cycle

Menstrual cycles are monthly processes of ovulation and menstruation which occurs between puberty and menopause in female primates that are not pregnant. The length of a menstrual cycle is a marker of reproductive function (Diaz *et al.,* 2006). It is used to assess the reproductive effects of environmental and occupational exposures such as organic solvents (Eskenazi *et al.*, 2002; Windham *et al*., 2003; Farr *et al.,* 2004).The length of a menstrual cycle has also been used as a predictor of health outcomes including breast cancer (Chavez-MacGregor *et al*., 2005; Terry *et al*., 2005) and cardiovascular disease risk factors (Matthews *et al.,* 1975). Variation in the length of a menstrual cycle in population studies was studied by Munster *et al.* (1992). Most commonly the length of menstrual cycle is 28 days.

Invariably, the menstrual cycle length is least variable in women between 20 and 45 years of age (Treloar *et al.,* 1970; Munster *et al.*, 1992). The length and regularity of the menstrual cycle is an indicator of cumulative exposure to ovarian steroids. The length of the menstrual cycle of an individual is determined by a variable follicular phase from one individual to another while the luteal phase is relatively constant in all women and lasts 13–14days (Mishell, 2001). Irregular menstruation with large variability in the cycle length indicates anovulatory cycles, which is associated with reduced production of ovarian steroid, while shorter regular cycles have been associated with increased cumulative exposure to ovarian steroid (Kato *et al.,* 1999).

Menstrual cycle is a determinant of a woman's reproductive health. At age 15, about 98 % of females must have experienced menarche (Marti-Henneberg and Vizmanos, 1997). Menstrual cycles are usually irregular during the first year of menarche due to anovulatory cycles. Disorders in cycles or its irregularities are the major gynaecological problem among female adults especially adolescents and a major source of anxiety to them and their family. Information on a woman's menstrual pattern will aid in clinical evaluation of gynaecological problems (Harlow and Campbell, 2004). Abnormalities in menstrual cycle are likely to be associated with psychological stress, strenuous physical exercise, low body weight and endocrine disturbance. By late adolescence, about 75 % of girls may experience some problem associated with menstruation, which includes: delayed, irregular, painful, and heavy menstrual bleeding (Arkutu, 1995).

The function of menstrual cycle is closely linked with a woman's fecundability (ability to get pregnant) and may affect her chronic disease risk (Harlow, 2000). Based on these reasons, clinicians and epidemiologists interested in women's health have proposed that menstrual cycle pattern can provide a view into female reproductive bodies.

Menstrual cycle patterns results from biological systems that depend upon a woman's hormonal status. Steroid hormones such as estrogens, androgens, and cortisol are highly sensitive to environmental condition. Estrogen level drops under conditions of negative energy balance, physical activity and dress (Jasienska *et al*., 2006). Thus, factors capable of disrupting the pattern of menstrual cycle will be able to disrupt the normal functioning of the females' reproductive system. A small increase in BMI affects menstrual function.

Menstrual cycle patterns result from biological systems that depend on a woman's hormonal status that are sensitive to environmental influences. Therefore, factors that disrupt menstruation are capable of disrupting normal reproductive function. Identifying differences in women's menstrual cycle characteristics, understanding more about the determinants of those differences and their association to other reproductive outcomes, gives an important insights into women's reproductive biology (Rowland *et al.*, 2002). A California study of urinary biomarkers and menstrual function reported that women with current anovulatory cycles were four times as likely to have had difficulty becoming pregnant in the past (Windham *et al.*, 1999). Also a Danish study of menstrual cycle patterns among diabetic women reported a four-fold increase in having menarche at age 17 or later (primary amenorrhea) and increased risk of secondary amenorrhea (6 months or longer without a period), long cycles, and irregular cycles (Kjær *et al.*,1992). Irregular menstrual cycles have a considerable effect on women's health (Yamamoto *et al.*, 2009), such as psychosocial stress (Yamamoto *et al.*, 2009), dysmenorrhoeal, infertility (Rowland *et al.*, 2002) and further cardiovascular disease in later life (Solomon *et al.*, 2002).

Each menstrual cycle is divided into a follicular phase and a luteal phase. In the follicular phase, progesterone levels are low and estrogen levels increase in anticipation of ovulation. In the luteal phase, both progesterone and estrogen are elevated. The length of the luteal phase remains relatively constant, whereas the length of the follicular phase can vary dramatically (Goldien and Ovaries, 2001). Therefore, women with longer menstrual cycles spend more time in the follicular phase than in women with shorter menstrual cycles. Because estrogen and progestin together increase breast cell proliferation, women who spend a smaller proportion of their menstrual cycle in the

luteal phase due to longer a follicular phase or anovulation may have a reduced risk of breast cancer.

In 1977, two groups found that breast cell proliferation is significantly higher in the luteal phase than the follicular phase (Masters *et al*., 1977; Meyer, 1977). Subsequently, epidemiologic evidence has indicated that the combination of exogenous estrogen plus progestin increases the risk of breast cancer beyond the effect of estrogen alone (Meyer *et al*., 2002). However, these studies were restricted to postmenopausal women, and whether the same exogenous hormone combinations alter premenopausal breast cancer risk is unknown.

Girls may have a poor understanding of what constitutes a normal menstruation; as a result some may perceive normal menstruation as scanty menses while others with excessive menstrual flow may view it as normal which will result in anaemia eventually. Prolonged menstrual bleeding can result in poor menstrual hygiene since many young girls may not be able to afford costly sanitary pads to take care of the extra days especially when they are on campus. They may resort to the use of toilet paper, cotton and old clothes or rugs resulting in poor menstrual hygiene and increased risk of infection (Gumanga and Kwame-Aryee , 2012). The mean duration of menstrual flow in this study was 4.9 days which compares with the mean duration 4.5 days that was found in Nigeria and 4.0 days in an Ethiopia (Zegeye *et al*., 2009).

The onset of puberty reflects numerous health aspects of a population, including the timing of sexual maturation, growth and nutritional status and environmental conditions, in well-nourished, healthy girls and menarche is largely dependent on

genetics, as confirmed by studies on the menarcheal age of twins, sisters and mother-and-daughter pairs (Ayatollahi *et al*., 2002; Anderson *et al*., 2003; Tehrani *et al*., 2010).

### 2.8.1 Menstrual cycle, Premenstrual syndrome (PMS) and Menstrual Pain

It has been shown that, about 75 % of women with regular menstrual cycles experience some premenstrual symptoms before the onset of menses (Steiner and Born, 2000). In a population based survey, 79 % of 18 years old girls were found to experience menstrual pains and 21 % of 16 years old girls had stayed at home due to menstrual pain (Teperi and Rimpela, 1989). It has also been observed that menstrual function has an enormous implication in a woman's health.

Irregular menstrual cycle can be a predictor of type 2 diabetes (Solomon *et al*., 2001), cardiovascular disease (Solomon *et al*., 2002), reduced fecundity (Jensen *et al*., 1999) and infertility (Rowland *et al*., 2002), while a cumulative number of regular ovulatory cycles was found to be related to the risk of breast cancer (Henderson *et al*., 1985). Although previous studies did not show any significant relation between irregular menstruation and premenstrual symptoms, female students with premenstrual symptoms also complained of higher intensity of menstrual pains (Tomoko and Rieko, 2007).

## 2.9 Dysmenorrhea

Severe pains or cramps in the lower abdomen during menstruation, can also be defined as pelvic pain directly related to menstruation, and is associated with symptoms ranging from headache and back pain to nausea, vomiting and diarrheal. The cause of menstrual

pain is excess production of prostaglandins ($PGF_2\alpha$) in the endometrium during the ovulatory cycle; this is because prostaglandin stimulates the myometrial contraction and local vasoconstriction that cause the menstrual effluent to be expelled from the uterine cavity. It was shown that women with dysmenorrhea have higher levels of PG in their plasma and menstrual effluent than women without dysmenorrhea (Durain, 2004).

Additionally, elevated serum vasopressin, nitric oxide and interleukin-6 levels have been reported in women with primary dysmenorrhea. Dysmenorrhea (menstrual pain) is the most common problem associated with females with a prevalence of 67.7 % (Lee *et al*., 2006). However, Amita *et al*. (2008) reported 63.29 %, 30.37 % and 6.32 % respondents suffered from mild, moderate and severe grades of pain respectively. This was contradictory to the findings of Jerry *et al*. (1981), who reported that 14 % severe, 38 % moderate and 49 % subjects were mild sufferers.

### 2.9.1 Menstrual Pain and Menstrual Flow

Dysmenorrheal has been reported to be influenced by a variety of physiological, environmental and behavioural factors. These factors have been referred frequently to include early menarche, low body mass index (BMI), prolonged menstrual flow and premenstrual somatic complaints. Genetic influence is also known to affect the prevalence and severity of dysmenorrheal (Tonnin, 2002; Lantthe *et al*., 2006). Women participating in moderate recreational activity experience longer and more variable cycles compared to sedentary women (Cooper *et al*., 1996)

There is a general believe that physical activities increase menstrual flow, therefore, women tend to reduce their levels of physical activity during menstruation (Hill, 2003; Lee *et al*., 2006; Chiou *et al*., 2007). Blood flow and length of flow appeared to be

significantly associated with dysmenorrheal, 50 % of dysmenorrheic women reported to experience heavy blood flow and 26.5 % had moderate flow as against the non-dysmenorrheic (20.3 and 23.9 %) females. Most dysmenorrheic females experienced more menstrual days of flow (5-6 and ≥ 7 days).

Ali *et al.* (2001) reported that dysmenorrheal and premenstrual symptoms had prevalence of 44.3 % and 59.8 % respectively and only 20.3 % of dysmenorrheic girls were reported to be absent. In Nigeria, the prevalence of dysmenorrheal was reported as 76.3 % and the normal activity of 35 % of undergraduate students was affected by dysmenorrheal (Okusanya *et al*., 2009). While in neighbouring Ethiopia, Zegeye *et al*. (2009) reported the prevalence of dysmenorrheal as 72.0 % and premenstrual symptoms as 75 %.

### 2.10 Effect of premenstrual syndrome (pms) on the daily activities of females

Premenstrual Syndrome (PMS) as defined by the American College of Obstetricians and Gynaecologists is a clinical condition characterized by the cyclic presence of physical and emotional symptoms unrelated to any organic disease, and appears during the luteal phase of the menstrual cycle but disappears after menstruation or within 48 hours of the onset of bleeding (ACOG, 1992). The World Health Organization (WHO) also classified PMS as a physical disorder (premenstrual tension syndrome). Adolescent girls experience recurrent psychological changes during their menstrual cycles. These changes are related to the late luteal phase and interfere with daily activities (Frye and Silverman, 2000). The most frequently reported premenstrual symptom are tension, irritability, depression, anxiety, mood swings, craving for carbohydrates rich food, sleep disturbances and bloating, peripheral oedema and breast tenderness. Nutritional

strategies (caffeine-free beverages, no alcohol and intake of calcium and magnesium) and pharmacological strategies (suppression of physical symptoms and signs) may be achieved by the suppression of ovulation (Parker, 1994).

Symptoms seem to worsen as menstruation approaches and subside at the onset or after several days of menstruation. A symptom-free phase usually occurs following menses. The exact causes of PMS are not clearly understood but have been attributed to hormonal changes, neurotransmitters, prostaglandins, diet, drugs, and lifestyle. The PMS symptoms reported in the literature fall into three domains: emotional, physical, and behavioral. The most common emotional and mood-related symptoms of PMS include depression, irritability, tension, crying, over sensitivity (hypersensitivity), and mood swings with alternating sadness and anger. Physical discomforts include abdominal cramps, fatigue, bloating and breast tenderness (mastalgia), acne and weight gain. Behaviourally, symptoms include food cravings, poor concentration, social withdrawal, forgetfulness and decreased motivation. Research studies have reported up to 200 premenstrual symptoms with varying degrees of severity (Henderson, 2000).

Premenstrual Syndrome is experienced by nearly 80 % of menstruating women. Dickerson *et al. (*2003) reported that 25 to 95% of women suffer from PMS and these symptoms vary from one woman to another and from cycle to cycle. Intensity of PMS ranges from mild to incapacitating. About 20 to 40 % of women who have PMS experience symptoms that make life difficult and 2.5 to 5 % experience PMS that is debilitating. Women have been reported to have argument with family and friends as well as absenteeism from work due to premenstrual symptoms (Endicott *et al*., 1999). Premenstrual Symptoms is more severe in females as they get older, especially between

ages 20 to 25 (Endicott *et al*., 1999) while Myint *et al*. (2006) reported that PMS is more severe between age 16 to 25 years. Younger women in our study were more likely to complain of breast pain and discomfort when compared to older women.

Studies showed that more than 98 % of the females reported one or more PMS symptoms (Myint *et al*., 2006) and only 28 % reported feeling of PMS symptoms before every period (Dickerson *et al.,* 2003; Myint *et al*., 2006) . Previous studies carried out by Dickerson *et al*. (2003) showed that 25 to 95 % of women suffer from PMS. Estimates of PMS vary substantially in the research literature because of the differences in instruments, symptom's patterns, the number of symptoms reported and the use of prospective or retrospective protocols. PMS interferes with daily functioning of about 6% of reproductive age females (Myint *et al*., 2006). A Previous research studies conducted in the United States, showed that 2 to10 % of the female population experience severe PMS (Bhatia and Bhatia, 2002).

### 2.11 Premenstrual syndrome and depression

Studies have shown that women with PMS have a higher percentage of past major depression than women without PMS (Bancroft *et al.*, 1994) was 14 % higher in women with a past psychological disorder, it was not increased in women who reported to suffer from a major depression in the past (Hurt *et al.,* 1992). There is no clear distinction between PMS and depression, some symptoms such as depressed mood, feelings of hopelessness, decreased interest in usual activities, concentration difficulties, lack of energy, change in appetite, hypersomnia or insomnia are included in measures for both disorders (Kessler *et al.,* 1998; Steiner *et al.,* 2003).

Irritability has been described as a more prominent symptom in women with PMS than depressed mood (Angst *et al.,* 2001; Hartlage *et al.,* 2001). Differences in the dysregulation in the stress axes in women with PMS and in women with current or past depressive disorders also suggest the two disorders to be distinct (Klatzkin *et al.,* 2010).

In a longitudinal population-based twin study, it was suggested that genetic and environmental risk factors of premenstrual symptoms and major depression are not closely associated (Kendler *et al.,* 1998). Premenstrual symptoms seem to be only to a small degree or not at all influenced by familial-environmental factors (Kendler *et al.,* 1998). Female experiencing premenstrual syndrome (PMS) have depression symptoms and PMS has been linked to depressive disorders (Hallman, 1986). Sleep disturbances also form important component of PMS. The incidence of depression among PMS patients is greater than that in the general population (Barnhart *et al*., 1995; Roca *et al*., 1999).

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Materials

The following Anthropometric Tools/ Equipments were used for this study: Stadiometer, Measuring Tape, and Skinfold Caliper. Inner Scan Body Composition Monitor (TANITA, JAPAN) was also used to obtain Body composition parameters. All body measurements were obtained with subjects in anatomical position, except otherwise specified. The Becks depression inventory was used to measure the level of depression during menstruation.

### 3.1.1. Measuring Tape

i.) **Arm circumference (cm)**: Tape was wrapped around the biceps, halfway between the shoulder and the elbow.

ii.) **Chest circumference (cm)**: Tape was wrapped around the chest at the level of the middle of the sternum (breast-bone), with the tape passing under the arms. The arms were relaxed by the side, and the measurement taken at the end of a normal expiration

iii.) **Forearm circumference (cm)**: the tape was wrapped tightly around the forearm, about halfway between the elbow and the wrist.

iv.) **Hip circumference (cm)**: the tape was wrapped over the maximum circumference of the buttocks.

v.) **Thigh circumference (cm)**: Tape was wrapped around the thigh at the level of the mid-point on the lateral (outter side) surface of the thigh,

midway between trochanterion (top of the thigh bone, femur) and tibiale laterale (top of the tibia bone).

vi.) **Waist circumference (cm)**: Tape was wrapped around the waist at the midpoint between the lowest rib and the iliac crest. The subject was asked to stand erect while measurements were taken.

**3.1.2. Body composition monitor**: This monitor was used to analyse body composition using a simple principle: it passes small alternating current flowing between two electrodes rapidly through hydrated fat free body tissues and extracellular water compared with fat or bone tissue because of greater electrolyte content of the fat free component. The following were obtained: body fat (%), total body water (%), muscle mass, bone mass, visceral fat rating, metabolic age and physique rating.

**3.1.3. Stadiometer:** The stadiometer was used to measure the height and weight of study subjects.

i.) **Height (cm)**: standing height was measured taking the maximum distance from the floor to the highest point on the head, when subjects were standing in anatomical position. Shoes were put off, feet together, and arms by the sides. Heels, buttocks and upper back should also be in contact with the wall when the measurement is made.

ii.) **Weight (kg):** Weight was measured to the nearest 0.1kg when the subject is standing and putting on light indoor clothes using stadiometer.

**3.1.4. Skin fold calliper (mm)**: The skinfold thickness was taken at the left side of the body (Moreno *et al*., 2002) to the nearest 0.1mm using a skinfold caliper. Once a firm

grip is placed on the skin fold, the caliper was applied perpendicular to the site. After the release of the trigger, the measurement was read.

i. **Triceps**: A vertical pinch of skin fold was taken on triceps midway between the shoulder and elbow.

ii. **Iliac skinfold**: Immediately above the iliac crest (top of hip bone), on the most lateral aspect (side).

**3.1.5. Becks depression inventory (BDI):** BDI was used to measure for the severity of depression during menstruation. It contains 21 items covering the major features of psychiatric settings. Each item consists of four statement presented in ordered sequence to reflect increasing intensity of experience. These symptoms include: sense of failure, guilt, crying, suicidal thought, dissatisfaction, social withdrawal, insomnia, loss of appetite, weight loss, self dislike/ accusation, indecisiveness, sadness, pessimism, loss of pleasure, punishment feelings, agitation, loss of interest in sex, loss of energy, irritability, and worthlessness.

## 3.2. Methods

### 3.2.1 Sampling Technique

The subjects who participated in the research were women randomly selected from Kaduna State (n= 387 and mean age 22.10 ± 2.62) and women from Rivers State (n= 401 and mean age 22.55± 3.78).

### 3.2.2 Sampling Size Determination

The sample size for this study was obtained using the formula, as described by Naing *et al.* (2006)

$$[n = z^2pq/d^2]$$

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

(When no estimate 50% is used; i.e. 0.50)

**q**= 1.0 - p

**d**= degree of accuracy desired, usually set at 0.05

Therefore, $\mathbf{n} = (1.96)^2(0.5)\ (0.5)/\ (0.05)^2 = 384$

For this study, a total number 788 females were used: these were indigenes of Kaduna (n=387) and Rivers (n=401).

### 3.3 Data Collection

This was a prospective study and data was collected through questionnaire. The following parameters were included in the questionnaire: age of menarche, duration of menstrual flow and length of menstrual cycle, experiences during the flow and that before the flow, and Beck's depression inventory. On completion of the questionnaire, anthropometric measurements of weight, height and waist, hip, chest, arm, forearm, thigh and leg circumferences were taken and recorded in their respective questionnaires using standard techniques as required by WHO, for anthropometric parameters. Body composition parameters (percentage body fat, total body water, physique rating, visceral fat, muscle mass, bone mass) were also taken using inner scan body composition monitor.

## 3.4 Study Location

The study locations in Kaduna State were KASU, Kaduna and NBP, Zaria, Kaduna State, while that of Rivers state were RSUOE and UNIPORT, Rivers State (Figure 3.1).

### 3.4.1 Geographical location of study population

Rivers State is one of the 36 states of Nigeria. Its capital is Port Harcourt; it is bounded on the South by the Atlantic Ocean, to the North by the Anambra, Imo and Abia States, to the East by Akwa Ibom State and to the West by the Bayelsa and Delta States. This State occupies an area of about 11,077 square Kilometres. The global location of Rivers state is between longitude 6°50'east of the Greenwich meridian and between latitude 4°45' north of the equator (Map locator of Nigeria, 2010). The population of Rivers people is 3,187,864 (Nigeria, 1991).

Kaduna State occupies almost the entire central position of the Northern part of Nigeria and shares common boundaries with Zamfara, Kastina, Kano, Bauchi, Plateau, Nassarawa and Niger State as well as the Federal Capital Territory. This State occupies an area of about 48,473.2 square Kilometres. The global location of Kaduna State is between longitude 0610 and 0900 east of the Greenwich meridian and between latitude 0910 and 1130 North of the equator (Map locator of Nigeria, 2010). The population of Kaduna State is 5,001,258 (Nigeria, 1991).

### 3.4.2 Climatic Condition

Rivers State is characterised by high rainfall, which decreases from south to north. The total annual rainfall decreases from about 4,700 mm on the coast to about 1,700 mm in

extreme north of the state. It is 4,698 mm at Bonny along the coast and 1,862 mm at Degema. The duration of wet season is not less than 330 days, of which a great number is rainy day (days with 250 mm or more of rain). The mean maximum monthly temperature of Rivers State ranges from 28 $^0$C to 33 $^0$C, while the minimum monthly temperature is in the range of 17 $^0$C to 24 $^0$C. The mean monthly temperature is 26 $^0$C. The hottest months are February to May. The temperature difference between the wet and dry season is only about 2 $^0$C. Relative humidity is high in the State throughout the year and decreases slightly in the dry season (Salawu, 1993).

There are two distinct seasons in Kaduna State, namely: wet and dry season. The wet season spans between April/May and September /October while the dry season spans the period between October/November and March/April. The lowest mean temperature is usually recorded during harmattan period, which occurs between November and February with the range from 18 $^0$C – 23 $^0$C. The total annual evaporation transpiration rates varies from 1,560mm in the Northern part to 1, 4900 in the Southern part of the State (Third National Fadama Project, 2012).

### 3.4.3 Vegetation

The ‘‘upland’’ area of Rivers State was originally occupied by rainforest which has been drastically modified by human activities. In most places, economic trees, particularly oil palm, have been preserved and thus, this vegetation is called oil palm bush. The riverine area is divisible into three main hydro vegetation zones namely: the beach ridge zones, the salt water zones and the fresh water zones. The beach ridge zones are vegetated mainly by fresh water swamp trees, palm and shrubs on the sandy ridges and mangrove in the intervening valley or tidal flats. The salt water zones, the tidal flat

or swamps vegetated by the red stilts rooted mangrove and two other species of mangrove. The fresh water zones mainly the upper and lower delta flood plains of the Niger, having fresh water forest trees which are the edaphic variant of the forest. The Abura trees, oil palm, raffia palm, shrubs, lianas, ferns and floating reeds are typical vegetation.

Kaduna State falls within the Northern Guinea Savannah Zone which comprises of two Savannah, namely: Guinea and Sudan Savannah. The Savannah is characterised by woodland with grasses of different species. Mainly undifferentiated complex igneous and metamorphic rocks underlie the states. The soil is developed from the above parent materials. The combination of topsoil and subsoil coupled with reasonable organic matter enhance the fertility status of the soil most especially in the southern part of the state (NFP, 2012).

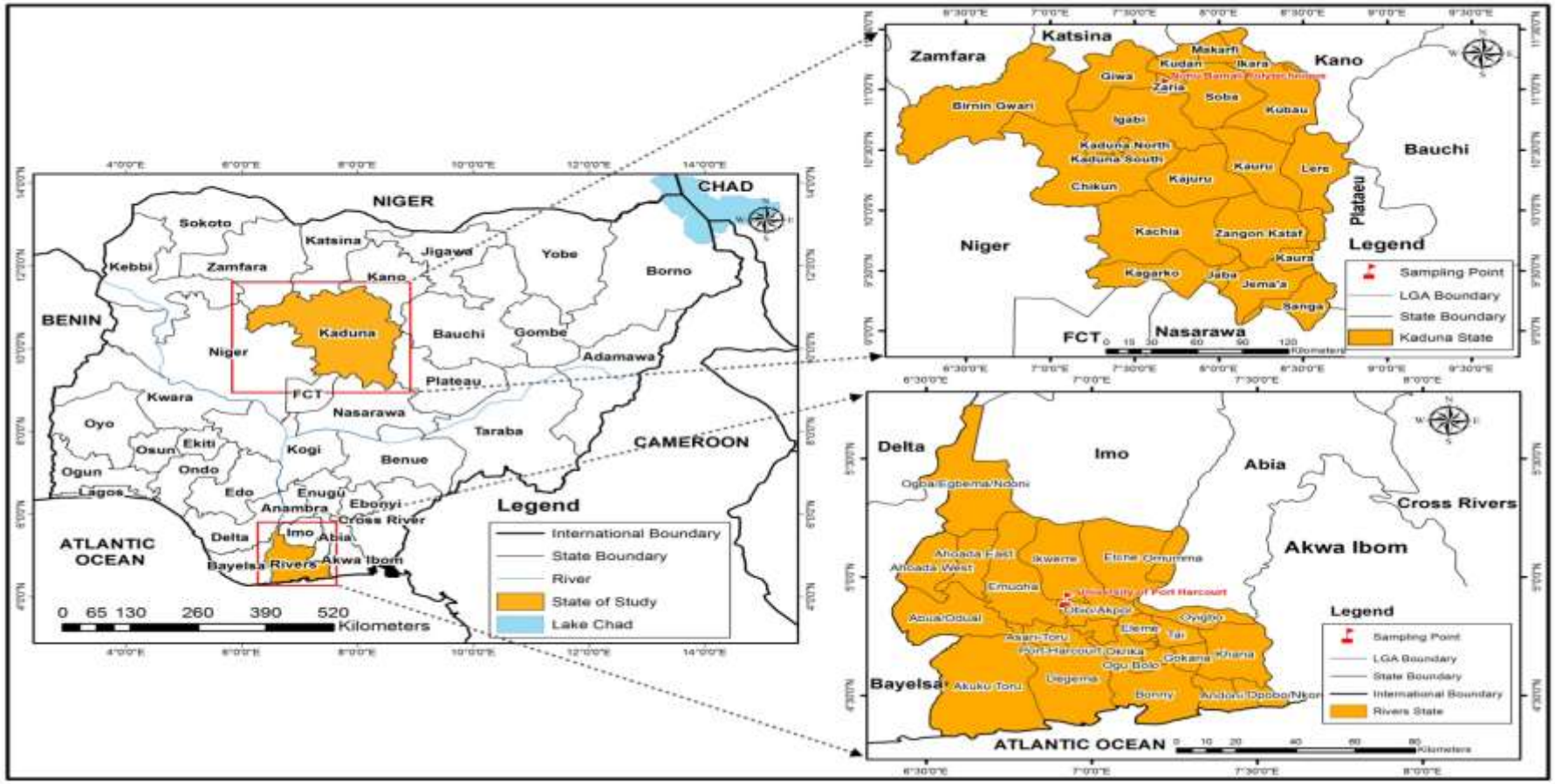



Figure 1: Map Nigeria showing the location of Sampling Points
Source: Adapted and Modified from the Administrative Map of Nigeria

## 3.5 INCLUSION AND EXCLUSION CRITERIA

### 3.5.1. Inclusion Criteria

The following were used as inclusion criteria

i. Women that are indigenes of Rivers State and Kaduna State aged 18-30
ii. Women that have not used contraceptives before
iii. Non pregnant women
iv. Women that have not given birth before

### 3.5.2. Exclusion Criteria

The following were used as exclusion criteria

i. Non-Rivers and non-Kaduna States indigenes.
ii. Pregnant women
iii. Women using contraceptives
iv. Women that have given birth before
v. Women with physical deformities
vi. Women who refused to give their consent

## 3.6 ETHICAL APPROVAL

Ethical approval was obtained from the Ahmadu Bello University Research Ethics Subcommittee and the Ahmadu Bello University Teaching Hospital Research Ethics (see Appendix IV) and permission to conduct this study was also obtained from the

Dean of Student Affairs of the participating schools. Only subjects who gave informed consent were included in this study.

### 3.7 Statistical Analyses

Data were expressed as mean ± standard deviation and percentages. Student's t-test was used to test for the mean difference between the anthropometric and body composition parameters of women from Kaduna and Rivers States. Chi square test was used to test for the association between menstrual characteristics of women from Kaduna and Rivers States. ANOVA was used to test for the mean difference between anthropometric parameters and reproductive characteristics; also between anthropometric parameters and depression categories. Pearson correlation was used to test for the relationship between measured anthropometric parameters and body composition parameters. Spearman's correlation coefficient was used to examine the associations of severity of menstrual pain with study variables.

# CHAPTER FOUR

# RESULTS

## 1.1. Descriptive statistics of study population

Seven hundred and eighty-eight (788) subjects, Kaduna (n=387) and Rivers (n=401) State women, aged 18 to 30 years participated in this study which are indigenes, born and brought up within the states.

Table 4.1 revealed the baseline characteristics of the study population. Majority of the study subject were within age 21-23 years for Kaduna subjects (166; 42.9 %) and age 18-20 years for Rivers subjects (141; 35.2 %). Normal BMI was observed among majority of the study subjects (Kaduna: 249, 64.3 %; Rivers: 253, 63.1 %); while the subjects in the class of obesity were few in this study (Kaduna: 22, 5.7 %; Rivers: 28, 7.0 %). Minimal depression during menstruation was observed among majority of the study subjects (Kaduna: 257, 66.4 %; Rivers: 270, 67.3 %). It was also observed that the father's (Kaduna: 305, 78.8 %; Rivers: 234, 58.4 %) and mother's (Kaduna: 263, 68 %; Rivers: 195, 48.8 %) of most of our participants have attained tertiary level of education. .

**Table 4.1: Demographic characteristics of study population**

| **CHARACTERISTICS** | | **Kaduna** n (%) | **Rivers** n (%) |
|---|---|---|---|
| Age | | | |
| | 18-20 | 114 (29.5) | 141(35.2) |
| | 21-23 | 166 (42.9) | 109 (27.2) |
| | 24-26 | 88(22.7) | 113 (28.2) |
| | 27- 30 | 19(4.9) | 38 (9.5) |
| BMI | | | |
| | Underweight | 38 (9.8) | 40 (10) |
| | Normal | 249 (64.3) | 253 (63.1) |
| | Overweight | 78 (20.2) | 80 (20) |
| | Obese | 22 (5.7) | 28 (7.0) |
| Category of Depression | | | |
| | Mild | 76 (19.6) | 86 (21.4) |
| | Moderate | 39 (10.1) | 35 (8.7) |
| | Minimal | 257 (66.4) | 270 (67.3) |
| | Severe | 15 (3.9) | 10 (2.5) |
| Fathers Educational Level | | | |
| | Primary | 19 (4.9) | 47 (11.7) |
| | Secondary | 63 (16.3) | 120 (29.9) |
| | Tertiary | 305 (78.8) | 234 (58.4) |
| Mothers Educational Level | | | |
| | Primary | 26 (6.7) | 64 (16) |
| | Secondary | 98 (25.3) | 142 (35.4) |
| | Tertiary | 263 (68) | 195 (48.6) |

## 4.2 Comparison between variables studied

### 4.2.1 Comparison of Anthropometric Variables

Comparison of the height of studied subjects showed that, Rivers women were significantly taller than their Kaduna counterparts ($p < 0.01$), (Figure 4.1).

Figure 4.2 shows the comparison between weight of Kaduna and Rivers States women. Rivers women were significantly weightier than their Kaduna counterparts ($p < 0.01$).

The skinfold thickness of subject studied were compared and shown in Figure 4.3. Rivers State women presented a significantly higher iliac skinfold ($p < 0.05$) and triceps skinfold ($p<0.01$) than their counterparts from Kaduna State.

When arm, forearm and calf circumferences were compared between Kaduna and Rivers State women, Kaduna state subjects presented with a significantly ($p<0.01$) higher arm, fore arm and calf circumferences (Figure 4.5). Rivers women presented higher hip and waist circumference, but a lower chest circumference ($89.74 \pm 7.29$ and $89.48 \pm 8.15$ for Kaduna and River women respectively) when compared to their Kaduna counterparts, there was no significant difference (Figure 4.6).

### 4.2.2 Body Composition Parameters

Body composition parameters of Kaduna and Rivers States women showed that, Rivers State women had significantly higher mean muscle mass($p<0.001$), body percentage fat($p<0.05$), metabolic age($p<0.05$) and calories ($p<0.001$) (Figures 4.8, 4.9, 4.10 and 4.11 respectively).

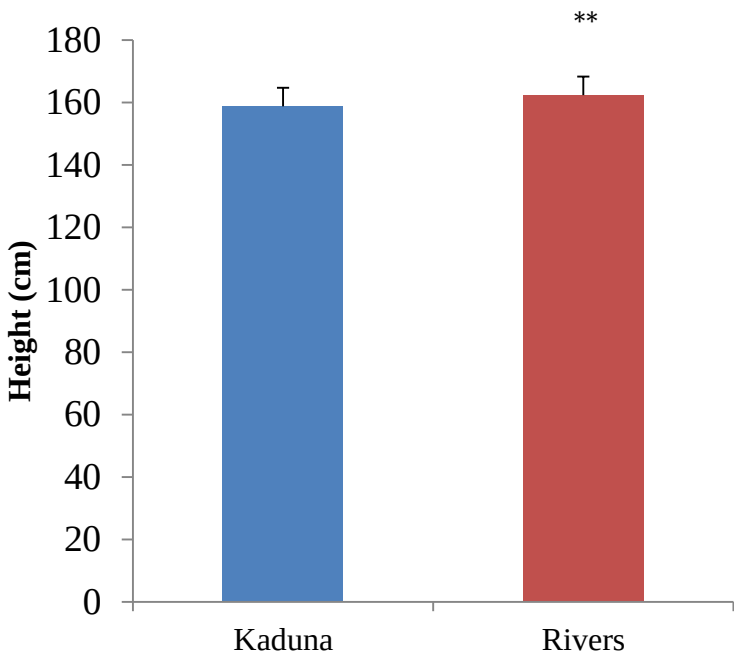



Fig 4.1: Comparison of the height of Kaduna and Rivers States women. Kaduna (n=387), Rivers (n=401); Independent sample t-test: **=p<0.01. Rivers women were taller than Kaduna women.

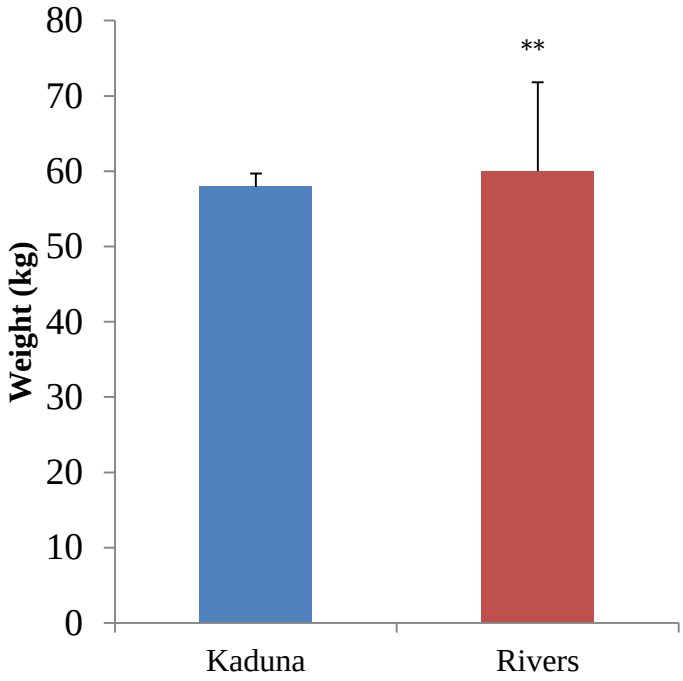



Fig 4.2: Comparison of the weight Kaduna and Rivers States women. Kaduna (n=387), Rivers (n=401); Independent sample t-test: **=p<0.01
Rivers women were weightier than Kaduna women.

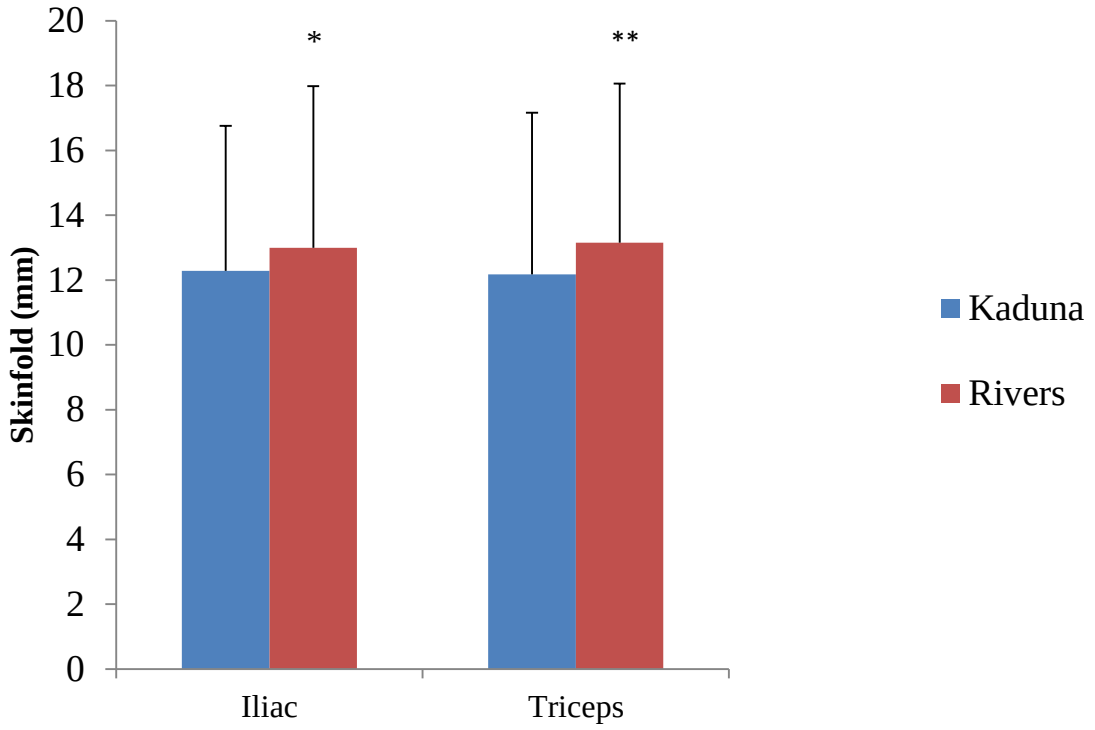



Fig 4.3: Comparison of skinfold thickness (iliac and triceps) in Kaduna and Rivers States Women. Kaduna (n=387), Rivers (n=401); Independent sample t-test *= $p<0.05$, **=$p<0.01$. The triceps and iliac skinfold of Rivers women was thicker than their Kaduna counterparts.

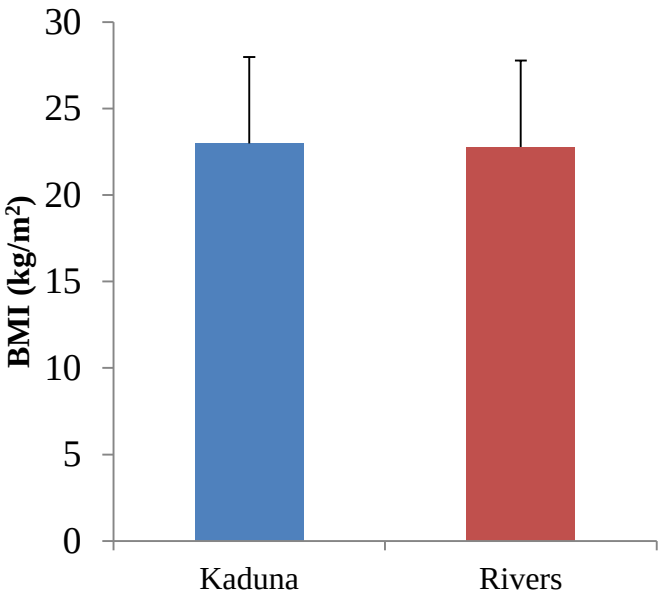



Fig 4.4: Comparison of BMI in Kaduna and Rivers States women. Kaduna (n=387), Rivers (n=401); Independent sample t-test. The BMI of Kaduna women was 0.2kg greater than that of the Rivers women but there was no significant difference.

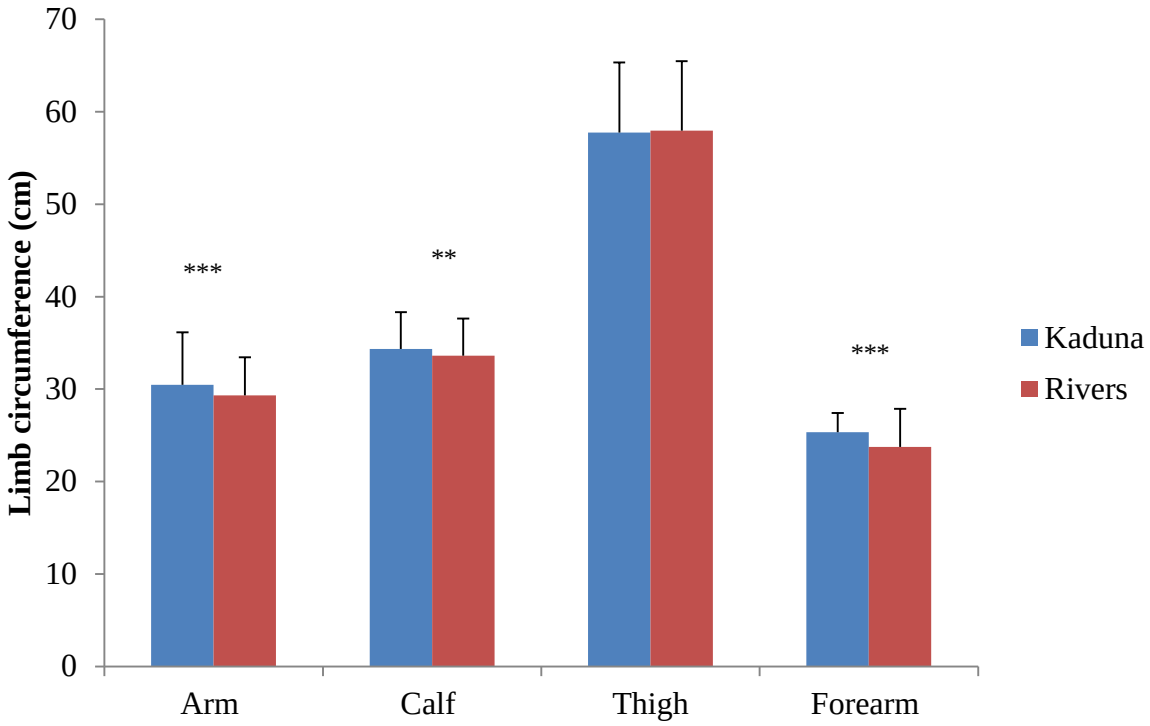



Fig 4.5: Comparison of limb circumferences of women from Kaduna and Rivers States. Kaduna (n=387), Rivers (n=401); Independent sample t-test: **=p<0.01, ***=p<0.001. The arm, forearm and calf circumference of Kaduna women was higher than that of the Rivers women, p<0.001, p<0.01, p>0.05 and p<0.001

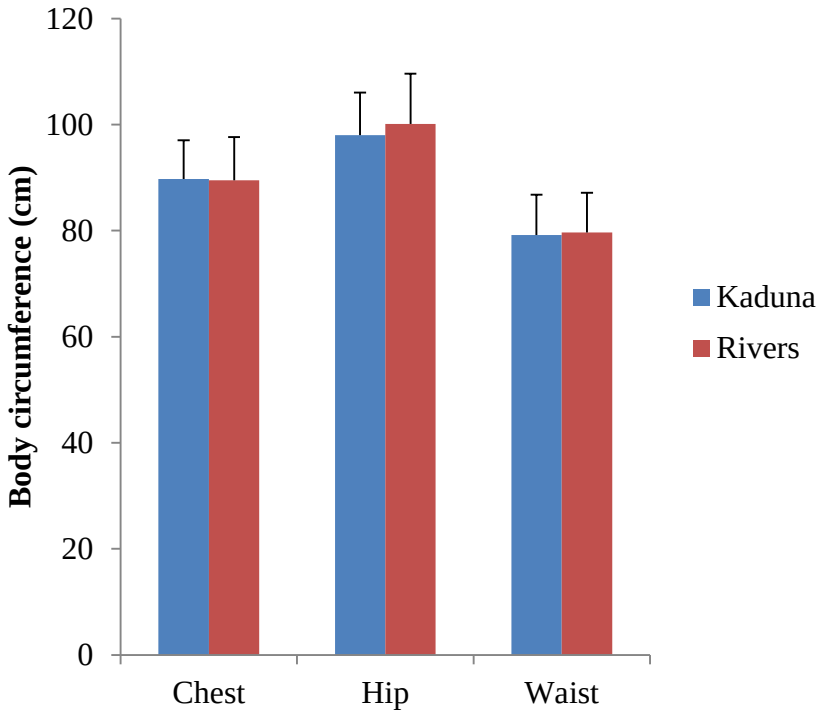



Fig 4.6: Comparison of body circumferences of women from Kaduna and Rivers States. Kaduna (n=387), Rivers (n=401); Independent sample t-test. Rivers women presented higher hip and waist circumference, but a lower chest circumference (89.74 ± 7.29 and 89.48 ± 8.15 for Kaduna and River women respectively) when compared to their Kaduna counterparts.

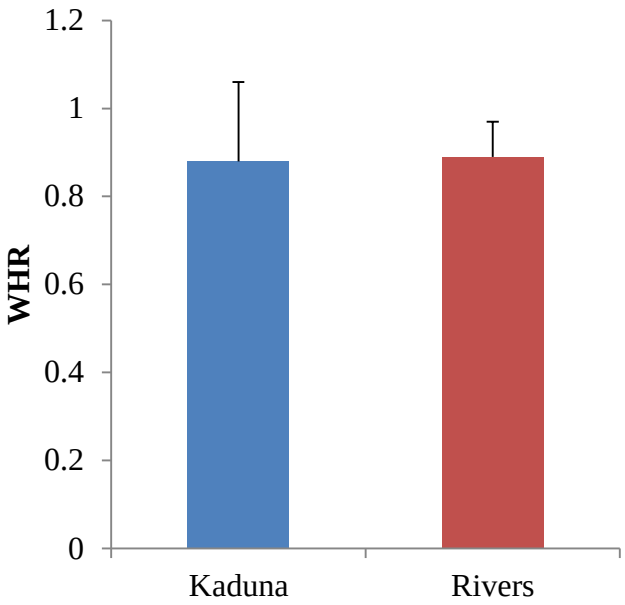



Fig 4.7: Comparison of waist hip ratio. Kaduna (n=387), Rivers (n=401); Mean ± SD; Independent sample t-test. There was no difference in the mean WHR of Kaduna women and Rivers women.

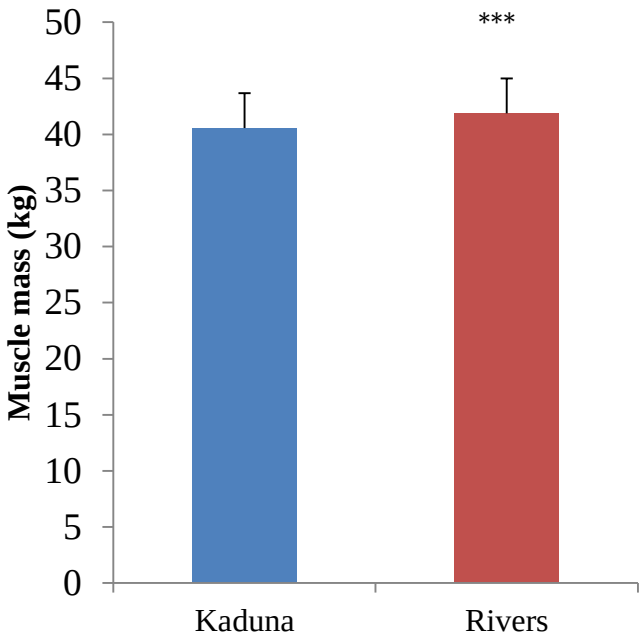



Fig 4.8: Muscle mass in women from Kaduna and Rivers States. Kaduna (n=387), Rivers (n=401); Independent sample t-test: ***=p<0.001. The muscle mass of Rivers women was higher than that of Kaduna women.

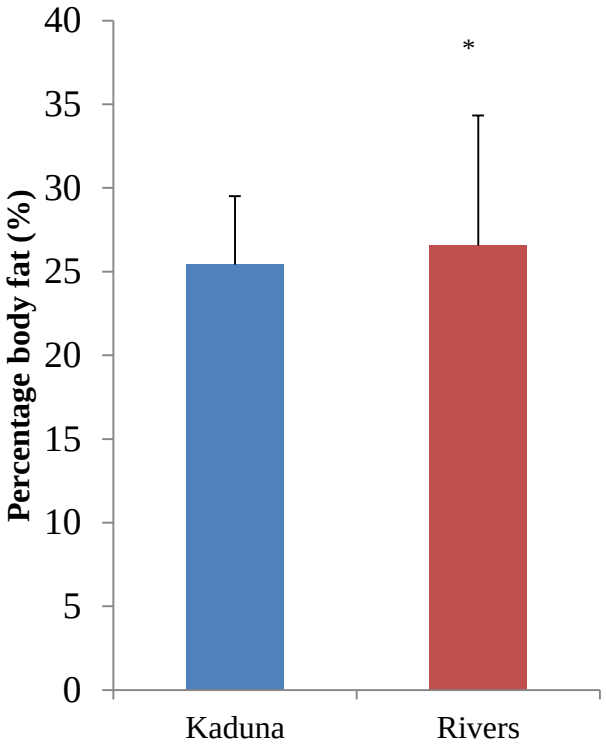



Fig 4.9: Percentage body fat in women from Kaduna and Rivers States. Kaduna (n=387), Rivers (n=401); Independent sample t-test *= $p<0.05$. Percentage body fat of Rivers women was higher than that of their Kaduna counterparts

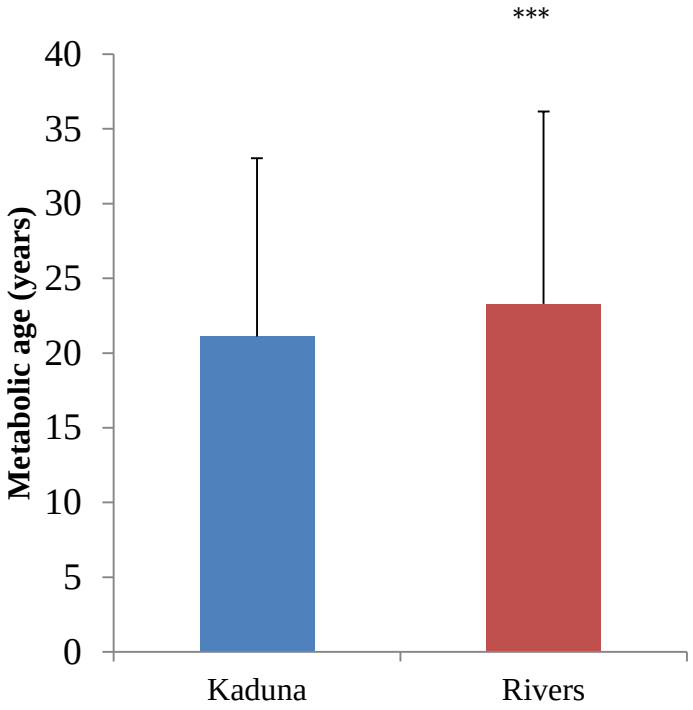



Fig 4.10: Metabolic age of women from Kaduna and Rivers state. Kaduna (n=387), Rivers (n=401); Independent sample t-test: **=p<0.01. Metabolic age of Rivers women was higher than that of their Kaduna counterparts.

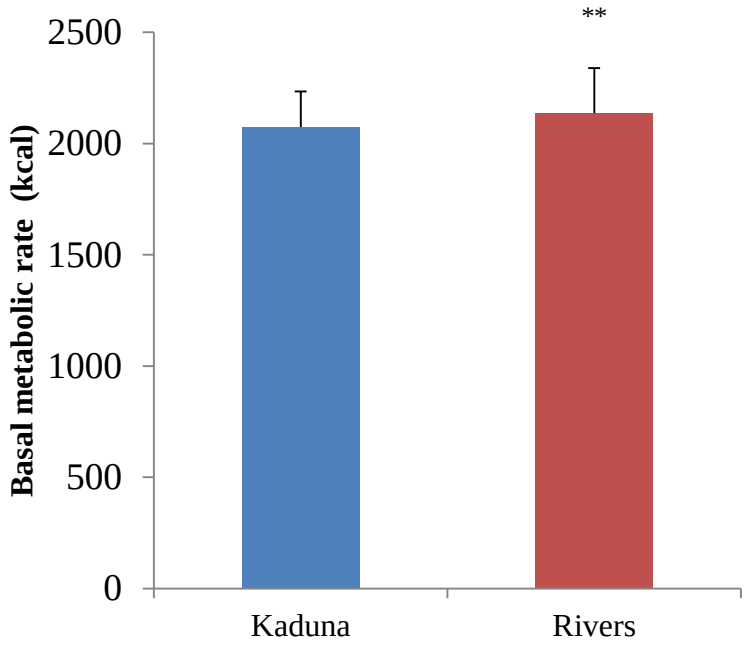



Fig 4.11: Relationship between the basal metabolic rate of women from Kaduna and Rivers state. Kaduna (n=387), Rivers (n=401); Independent sample t-test: **=p<0.01. The BMR of Rivers women was higher than that of Kaduna women.

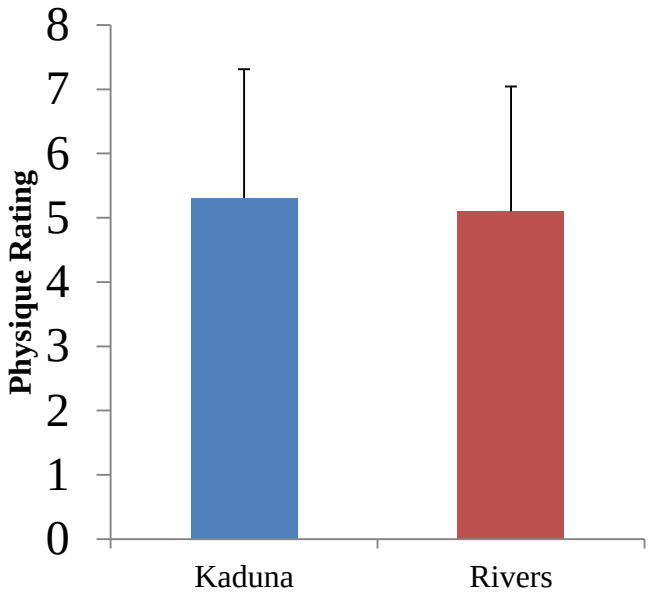



Fig 4.12: Comparison of Physique rating of women from Kaduna and Rivers state. Kaduna (n=387), Rivers (n=401); Independent sample t-test.

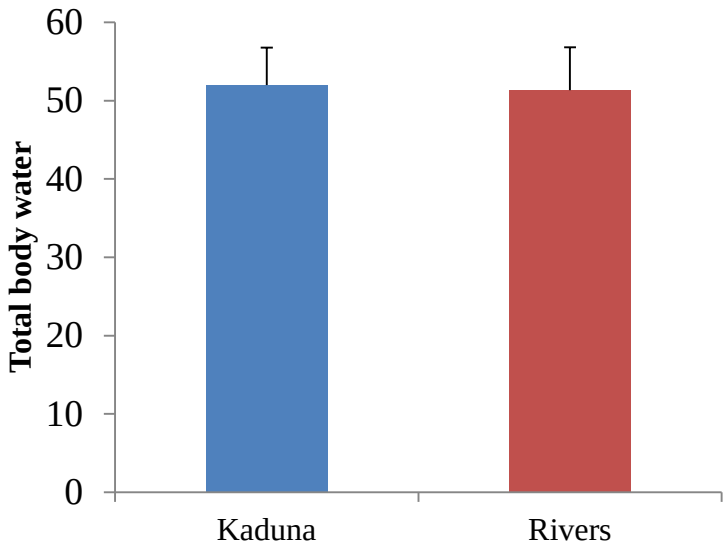



Fig 4.13: Comparison of total body water of women from Kaduna and Rivers state. Kaduna (n=387), Rivers (n=401); Independent sample t-test.

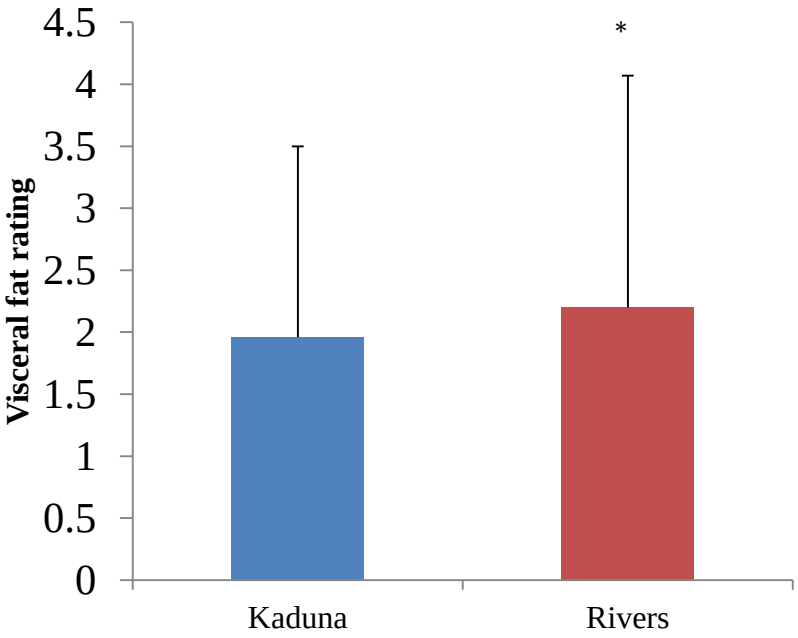



Fig 4.14: Comparison of visceral fat rating of women from Kaduna and Rivers state. Kaduna (n=387), Rivers (n=401); Independent sample t-test.

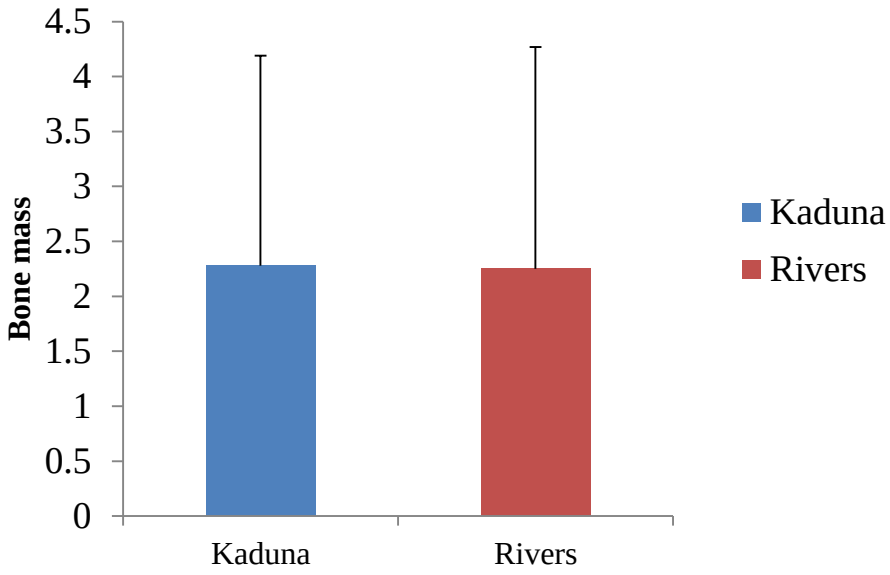



Fig 4.15: Comparison of bone mass of women from Kaduna and Rivers state. Kaduna (n=387), Rivers (n=401); Independent sample t-test.

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## 4.3 Relationship between studied variables

### 4.3.1 Relationship between Anthropometric Variables and depression categories during menstruation

Tables 4.2 and 4.3 show the relationship between anthropometric variables of subjects to categories of depression during menstruation in Kaduna state women. Significant differences ($p<0.05$) were observed between depression and the following anthropometric parameters: BMI, iliac skinfold, triceps skinfold, chest circumference, fore arm circumference and waist circumference.

Tables 4.4 and 4.5 show the relationship anthropometric variables and menstrual disorders. No association was found except for calf circumference ($p<0.05$).

**Table 4.2: Relationship between anthropometric variables and categories of depression in women from Kaduna**

| Variables | Minimal (n=256) Mean ± SD | Mild (n=76) Mean ± SD | Moderate (n=39) Mean ± SD | Severe (n=14) Mean ± SD | f | p value |
|---|---|---|---|---|---|---|
| Age (yrs) | 22.06±2.61 | 21.88±2.36 | 22.31±2.86 | 23.00±2.88 | 0.84 | 0.47 |
| Height (cm) | 159.10±6.13 | 157.97±5.40 | 158.35±5.76 | 157.07±5.30 | 1.18 | 0.32 |
| Weight (kg) | 57.45±9.65 | 59.26±9.58 | 57.11±10.31 | 61.33±3.92 | 1.34 | 0.26 |
| Body Mass Index (kg/m²) | 22.79±3.40 | 23.93±4.47[a] | 22.10±3.16[b] | 24.04±3.65 | 3.16 | 0.03 |
| Illaic Skinfold (mm) | 12.36±4.03[c] | 12.99±5.09[a] | 10.46±5.21[bd] | 12.29±5.93 | 2.83 | 0.04 |
| Triceps Skinfold (mm) | 12.15±4.49 | 13.11 ± 5.18[a] | 10.33±5.29[b] | 12.57±5.71 | 2.95 | 0.03 |
| Menarcheal age (yrs) | 13.74±1.83 | 13.37±1.48 | 13.54±1.97 | 13.61±1.98 | 0.88 | 0.45 |

n=387; one way ANOVA; Post Hoc test: 'a and b', c and d represents were the significance level lies. Means with similar superscripts are same while different superscripts are significantly different ($p<0.05$)

**Table 4.3: Relationship between body circumferences and categories of depression in women from Kaduna**

| Variables | Minimal (n=256) Mean ± SD | Mild (n=76) Mean ± SD | Moderate (n=39) Mean ± SD | Severe (n=14) Mean ± SD | f | p value |
|---|---|---|---|---|---|---|
| Arm circumference (cm) | 30.48 ± 6.17 | 31.80±4.22 | 30.38±5.69 | 30.30±2.72 | 1.13 | 0.34 |
| Calf circumference (cm) | 34.19 ± 4.14 | 34.95±3.58 | 34.29±4.01 | 34.47±3.84 | 0.75 | 0.52 |
| Chest circumference (cm) | 89.46 ±6.93[d] | 91.82±7.54[ac] | 87.15±8.36[b] | 91.08±7.11 | 4.07 | 0.01 |
| Forearm circumference (cm) | 25.22 ±1.96[b] | 25.98 ±2.49[a] | 25.17±1.96 | 25.04±1.96 | 2.83 | 0.04 |
| Hip circumference (cm) | 98.02±7.75 | 99.44±8.10 | 95.48 ± 8.26 | 97.61±11.23 | 2.10 | 0.10 |
| Thigh circumference (cm) | 57.79 ± 7.47 | 58.72 ±7.34 | 57.51±9.25 | 57.33 ±7.34 | 0.37 | 0.78 |
| Waist circumference (cm) | 79.12 ±8.08 | 80.57 ±8.69[a] | 29.83±3.49[b] | 31.86±3.39 | 3.11 | 0.03 |
| Waist chest ratio | 2.24 ±0.20 | 2.26 ± 0.13 | 2.21 ± 0.15 | 2.26 ± 0.13 | 0.73 | 0.53 |
| Waist hip ratio | 2.06 ± 0.13 | 2.6 ± 0.13 | 2.03 ± 0.18 | 2.11 ± 0.25 | 1.98 | 0.12 |

n=387; one way ANOVA; Post Hoc test: ‘a and b’, c and d represents were the significance level lies.

Means with similar superscripts are same while different superscripts are significantly different ($p<0.05$)

**Table 4.4: Relationship between anthropometric variables and categories of depression in women from Rivers State**

| Variables | Minimal (n=270) Mean ± SD | Mild (n=86) Mean ± SD | Moderate (n=35) Mean ± SD | Severe (n=10) Mean ± SD | f | p value |
|---|---|---|---|---|---|---|
| Age (yrs) | 22.60 ±3.79 | 22.28 ±2.92 | 22.71 ±5.54 | 22.30 ±2.54 | 0.20 | 0.90 |
| Height (cm) | 162.34 ± 6.06 | 162.20 ± 5.46 | 163.43 ±6.59 | 159.45 ±6.59 | 1.17 | 0.32 |
| Weight (kg) | 60.05 ± 11.84 | 59.44 ± 12.18 | 61.48 ±11.56 | 59.44 ± 8.88 | 0.28 | 0.84 |
| Body Mass Index (kg/m²) | 22.77 ±4.36 | 22.62 ±4.73 | 23.12 ± 4.54 | 23.35 ± 2.93 | 0.16 | 0.92 |
| Illaic Skinfold (mm) | 12.97 ±4.97 | 13.05 ±5.13 | 13.49 ±5.01 | 11.40 ±4.62 | 0.46 | 0.71 |
| Triceps Skinfold (mm) | 13.16 ± 4.96 | 13.08 ± 4.89 | 13.71 ± 4.86 | 11.70 ± 3.95 | 0.45 | 0.92 |
| Menarcheal age (yrs) | 13.65 ± 2.01 | 13.93 ± 2.16 | 13.63 ± 2.17 | 14.10 ± 1.91 | 0.53 | 0.66 |

n=401; one way ANOVA

**Table 4.5: Relationship between body circumference and categories of depression in women from Rivers**

| Variables | Minimal (n=270) Mean ± SD | Mild (n=86) Mean ± SD | Moderate (n=35) Mean ± SD | Severe (n=10) Mean ± SD | f | p value |
|---|---|---|---|---|---|---|
| Arm circumference (cm) | 29.33 ± 4.17 | 29.40 ± 4.03 | 29.72 ± 3.72 | 29.72 ± 3.40 | 0.12 | 0.95 |
| Calf circumference (cm) | 32.94 ± 5.33 | 34.07 ± 3.86 | 34.65 ± 3.57 | 35.18 ± 3.60 | 2.54 | 0.05 |
| Chest circumference (cm) | 89.51 ± 8.00 | 89.14 ± 9.29 | 90.13 ± 7.12 | 89.79 ± 6.50 | 0.13 | 0.94 |
| Forearm circumference (cm) | 23.63 ± 4.49 | 23.95 ± 3.42 | 23.11 ± 4.91 | 25.40 ± 1.04 | 0.87 | 0.46 |
| Hip circumference (cm) | 100.97 ± 59.94 | 97.01 ± 13.89 | 98.99 ±8.23 | 98.93 ± 8.80 | 0.14 | 0.93 |
| Thigh circumference (cm) | 57.66 ± 7.72 | 57.70 ± 7.23 | 58.62 ± 6.87 | 56.52 ± 8.28 | 0.25 | 0.86 |
| Waist circumference (cm) | 79.15 ± 10.48 | 80.35 ± 10.29 | 81.28 ± 9.14 | 80.39 ± 8.55 | 0.65 | 0.58 |
| Waist chest ratio | 0.88 ± 0.08 | 0.90 ± 0.09 | 0.90 ± 0.09 | 0.89 ± 0.05 | 1.67 | 0.17 |
| Waist hip ratio | 0.81 ± 0.09 | 0.82 ± 0.06 | 0.82 ± 0.08 | 0.81 ± 0.03 | 0.32 | 0.81 |

n=401; one way ANOVA

### 4.3.2 Body composition and depression categories during menstruation

Table 4.6 shows the relationship between body composition and menstrual disorders. Association ($p<0.05$) were observed between menstrual disorders and the following body composition parameters: percentage body fat, physique rating, total body water and visceral fat of subjects from Kaduna state.

Significant differences were not observed between body composition parameters and categories of depression in Rivers State subject implying that there was no relationship (Table 4.7).

**Table 4.6: Relationship between body composition and categories of depression in women from Kaduna**

| Variables | Minimal (n =256) Mean ± SD | Mild (n=76) Mean ± SD | Moderate (n=39) Mean ± SD | Severe (n=14) Mean ± SD | f | p value |
|---|---|---|---|---|---|---|
| Body Fat Percentage (%) | 25.33±7.47 | 26.91±7.16[a] | 22.53±6.81[b] | 27.06±7.21 | 3.31 | 0.02 |
| Bone Mass (kg) | 2.18±0.24 | 2.68 ± 4.28 | 2.16±0.15 | 2.18±0.18 | 1.43 | 0.24 |
| Calories (kcal) | 2070.52± 157.37 | 2104.67±158.50 | 2047±156.40 | 2081.29±50.23 | 1.34 | 0.26 |
| Metabolic Age (yrs) | 21.04 ± 11.80 | 23.17±12.99 | 17.10±9.51 | 23.36±3.40 | 2.41 | 0.07 |
| Muscle Mass (kg) | 40.50 ± 3.18 | 41.00±2.97 | 40.21±3.01 | 40.56±3.39 | 0.69 | 0.56 |
| Physique Rating | 5.21±1.97 | 5.21 ± 1.99 | 6.21±1.91 | 5.07±2.27 | 2.95 | 0.03 |
| Total Body Water (%) | 52.01±4.92 | 51.13±4.46[a] | 53.83± 4.25[b] | 50.94±4.36 | 3.02 | 0.03 |
| Visceral Fat Rating | 1.91±1.42 | 2.33±1.94 | 1.54±1.30 | 2.14±1.61 | 2.60 | 0.05 |

one way ANOVA; Post Hoc test: 'a and b', c and d represents were the significance level lies.

Means with similar superscripts are same while different superscripts are significantly different ($p<0.05$)

**Table 4.7: Relationship between body composition and categories of depression in women from Rivers**

| Variables | Minimal (n=256) Mean ± SD | Mild (n=76) Mean ± SD | Moderate (n=14) Mean ± SD | Severe (n=14) Mean ± SD | f | p value |
|---|---|---|---|---|---|---|
| Body Fat Percentage (%) | 26.42 ±7.68 | 26.91 ±7.50 | 27.35 ±6.97 | 25.10 ±7.45 | 0.34 | 0.80 |
| Bone Mass (kg) | 2.25 ± 3.40 | 2.25 ± 0.21 | 2.27 ± 0.18 | 2.25 ± 0.15 | 0.06 | 0.98 |
| Calories (kcal) | 2126 ±196.37 | 2151.84 ±227.25 | 175.40 ±191.16 | 2126.70 ±147.19 | 0.81 | 0.49 |
| Metabolic Age (yrs) | 23.37 ±12.93 | 23.15 ±13.22 | 23.66 ±11.49 | 21.30 ±14.34 | 0.10 | 0.96 |
| Muscle Mass (kg) | 41.82 ±3.95 | 42.17 ± 4.45 | 41.53 ± 7.73 | 41.77 ± 2.89 | 0.21 | 0.89 |
| Physique Rating | 5.06 ±2.01 | 5.22 ±1.76 | 4.94 ±1.61 | 5.60 ±2.63 | 0.45 | 0.72 |
| Total Body Water (%) | 51.46 ± 5.78 | 50.99 ± 4.97 | 50.99 ± 4.35 | 52.38 ± 4.78 | 0.21 | 0.89 |
| Visceral Fat Rating | 2.18 ± 1.83 | 2.25 ± 2.04 | 2.26 ± 1.93 | 2.00 ± 1.63 | 0.07 | 0.97 |

one way ANOVA

## 4.4 Correlation between variables studied

### 4.4.1 Correlation between Anthropometric Variables and body composition (Kaduna women)

Table 4.8 showed that menarcheal age correlated positively with anthropometric variables and body composition parameters but not of statistical significance. However, there was a strong positive correlation between anthropometric variables and body composition parameters except for Total Body Water which showed negative correlation and Bone Mass (BM) which showed no correlation. A strong positive correlation was observed between all the body composition parameters except for Total Body Water (TBW) and Physique Rating (PR) that correlated negatively and bone mass which showed no correlation except with physique rating. A strong positive correlation was observed between anthropometric variables except with height which showed negative correlation.

Weight correlated significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for total body water and physique rating which correlated negatively with weight. BMI correlated significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for total body water and physique rating which correlated negatively with BMI and arm circumference which was significant at $p<0.05$. No significant correlation was observed between BMI and Bone mass.

Chest, Waist and Chest circumference correlated significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for total body water and physique rating which correlated negatively. Visceral fat rating and height were significant at $p<0.01$ and $p<0.05$ respectively. No significant correlation was observed with Bone mass except for hip circumference. Arm, forearm, thigh and leg circumference correlated

significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for total body water and physique rating which correlated negatively and visceral fat rating which was significant at $p<0.05$. No significant correlation was observed with Bone mass and height (leg circumference).

TBW and PR correlated significantly ($p<0.001$) and negatively with all anthropometric and other body composition parameters except for physique rating which correlated with muscle mass at $p<0.05$ and total body water which correlated with height at $p<0.05$. TBW had positive correlation with PR. Percentage body fat, muscle mass, daily calorie intake and metabolic age correlated significantly ($p<0.001$) and positively with all anthropometric and other body composition parameters except for total body water and physique rating which correlates negatively with them. Visceral fat rating (VFR) correlated significantly ($p<0.05$) with arm, fore arm, thigh and calf circumference. VFR correlates significantly ($p<0.01$) with other anthropometric and body composition parameters except for weight which was significant at $p<0.001$.

**Table 4.8: Correlation matrix of anthropometric and body composition variables in Kaduna State women (n= 387)**

| | A | WT | HT | BMI | TSF | ISF | CC | WC | HC | W/H | AC | FAC | TC | LC | %BF | TBW | VFR | MM | PR | BM | BMR | MtA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | - | 0.09 | -0.08 | 0.13[b] | 0.13[a] | 0.12[a] | 0.08 | 0.11[a] | 0.09 | 0.07 | -0.02 | -0.02 | 0.09 | -0.02 | 0.17[a] | -0.16[a] | 0.24[d] | -0.02 | -0.13[a] | 0.02 | -0.10 | 0.21[d] |
| **WT** | | - | 0.34[d] | 0.90[d] | 0.61[d] | 0.61[d] | 0.80[d] | 0.84[d] | 0.85[d] | 0.26[d] | 0.49[d] | 0.68[d] | 0.61[d] | 0.54[d] | 0.87[d] | -0.84[d] | 0.81[d] | 0.90[d] | -0.71[d] | 0.09 | 0.90[d] | 0.87[d] |
| **HT** | | | - | -0.01[a] | -0.06 | -0.09 | 0.11[a] | 0.12[a] | 0.13[a] | -0.02 | 0.06 | 0.08 | 0.04 | 0.11[a] | 0.15[b] | -0.13[a] | 0.05 | 0.47[d] | -0.17[d] | 0.00 | 0.45[d] | 0.16[b] |
| **BMI** | | | | - | 0.68[d] | 0.68[d] | 0.79[d] | 0.83[d] | 0.72[d] | 0.28[d] | 0.49[a] | 0.61[d] | 0.63[d] | 0.51[d] | 0.85[d] | -0.82[d] | 0.84[b] | 0.63[d] | -0.67[d] | 0.09 | 0.74[d] | 0.84[d] |
| **TSF** | | | | | - | 0.83[d] | 0.59[d] | 0.66[d] | 0.55[d] | 0.26[d] | 0.32[d] | 0.46[d] | 0.46[d] | 0.32[d] | 0.68[d] | -0.66[d] | 0.63[b] | 0.40[d] | -0.56[d] | 0.04 | 0.48[d] | 0.65[d] |
| **ISF** | | | | | | - | 0.58[d] | 0.67[d] | 0.60[d] | 0.29[d] | 0.38[d] | 0.48[d] | 0.48[d] | 0.37[d] | 0.68[d] | -0.69[d] | 0.63[b] | 0.38[d] | -0.56[d] | 0.07 | 0.48[d] | 0.66[d] |
| **CC** | | | | | | | - | 0.79[d] | 0.77[d] | 0.28[d] | 0.24[d] | 0.57[d] | 0.63[d] | 0.31[d] | 0.81[d] | -0.70[d] | 0.75[b] | 0.61[d] | -0.60[d] | 0.06 | 0.70[d] | 0.77[d] |
| **WC** | | | | | | | | - | 0.80[d] | 0.59[d] | 0.48[d] | 0.62[d] | 0.58[d] | 0.51[d] | 0.83[d] | -0.81[d] | 0.80[b] | 0.61[d] | -0.68[d] | 0.08 | 0.73[d] | 0.83[d] |
| **HC** | | | | | | | | | - | -0.00 | 0.35[d] | 0.60[d] | 0.65[d] | 0.41[d] | 0.86[d] | -0.80[d] | 0.76[b] | 0.66[d] | -0.60[d] | 0.09[d] | 0.66[d] | 0.71[d] |
| **W/H** | | | | | | | | | | - | 0.35[d] | 0.20[a] | 0.12[a] | 0.26[d] | 0.23[d] | -0.30[d] | 0.30 | 0.14[d] | -0.25[d] | 0.01 | 0.20[d] | 0.30[d] |
| **AC** | | | | | | | | | | | - | 0.49[d] | 0.08 | 0.52[d] | 0.40[d] | -0.57[d] | 0.42[a] | 0.40[d] | -0.40[d] | 0.03 | 0.45[d] | 0.46[d] |
| **FAC** | | | | | | | | | | | | - | 0.42[d] | 0.29[d] | 0.59[d] | -0.59[d] | 0.56[a] | 0.56[d] | -0.35[d] | 0.05 | 0.67[d] | 0.58[d] |
| **TC** | | | | | | | | | | | | | - | 0.15[a] | 0.65[d] | -0.57[d] | 0.59[a] | 0.47[d] | -0.45[d] | 0.08 | 0.55[d] | 0.62[d] |
| **LC** | | | | | | | | | | | | | | - | 0.42[d] | -0.52[d] | 0.44[a] | 0.48[d] | -0.43[d] | 0.09 | 0.53[d] | 0.48[d] |
| **%BF** | | | | | | | | | | | | | | | - | -0.96[d] | 0.81[b] | 0.55[d] | -0.80[d] | 0.09 | 0.69[d] | 0.89[d] |
| **TBW** | | | | | | | | | | | | | | | | - | -0.79[d] | -0.51[d] | 0.79[d] | -0.09 | -0.64[d] | -0.87[d] |
| **VFR** | | | | | | | | | | | | | | | | | - | 0.54[d] | -0.65[d] | 0.08 | 0.65[d] | 0.93[d] |
| **MM** | | | | | | | | | | | | | | | | | | - | -0.45[a] | 0.06 | 0.95[d] | 0.60[d] |
| **PR** | | | | | | | | | | | | | | | | | | | - | -0.10[a] | -0.56[d] | -0.74[d] |
| **BM** | | | | | | | | | | | | | | | | | | | | - | 0.07 | 0.09 |
| **CAL** | | | | | | | | | | | | | | | | | | | | | - | 0.71[d] |
| **MtA** | | | | | | | | | | | | | | | | | | | | | | - |

A=Age;WT=Weight; HT=Height; BMI=Body Mass Index; TSF= Triceps Skinfold; ISF= Iliac Skinfold; CC= Chest Circumference; WC=Waist Circumference; HC= Hip Circumference; W/H= Waist Hip Ratio; AC= Arm Circumference; FAC=Forearm Circumference; TC= Thigh Circumference; LC =Leg Circumference; %BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = basal metabolic rate; MtA= Metabolic Age, PR=Physique rating.

a $p<0.05$; b $p<0.01$, c $p<0.001$; d $p<0.000$

### 4.4.2 Correlation between Anthropometric variables and Body composition (Rivers women)

Table 4.9 shows that menarcheal age of girls from Rivers state correlated negatively with both anthropometric variables and body composition parameter with only waist chest ratio to be of statistical significance. The relationships between all the body composition parameters were positive except for physique rating and total body water which showed negative correlations. A significant positive relationship was observed between anthropometric variables and body composition parameters except for total body water and physique rating which showed negative association. Positive associations were also observed between all anthropometric parameter except for height.

Weight correlated significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for TBW and PR which correlated negatively with weight. Weight correlated with calf circumference and metabolic age at $p<0.01$. BMI correlated significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for total body water and physique rating which correlated negatively with BMI and hip circumference which was significant at $p<0.05$.

Chest, Waist and Chest circumference correlated significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for total body water and physique rating which correlated negatively. No significant correlation was observed with Bone mass except for hip circumference. Height showed no correlation. Arm, forearm, thigh and leg circumference correlated significantly ($p<0.000$) and positively with all studied anthropometric and body composition parameters except for total body water and physique rating which correlated negatively and visceral fat rating which was significant at $p<0.05$.

Also, forearm circumference correlated with BM, daily calorie intake and metabolic age at $p<0.05$, and muscle mass at $p<0.01$.

TBW and PR correlated significantly ($p<0.001$) and negatively with all anthropometric and other body composition parameters except for total body water which correlated with weight, arm, forearm and leg circumference at $p<0.05$. TBW had positive correlation with PR. Percentage body fat, visceral fat rating, muscle mass, daily calorie intake and metabolic age correlated significantly ($p<0.001$) and positively with all anthropometric and other body composition parameters except for total body water and physique rating which correlates negatively with them. Metabolic age correlates with weight and height at $p<0.01$ and with fore arm circumference at $p<0.05$.

**Table 4.9: Correlation matrix of anthropometric and body composition variables in River State women (n=401)**

| | A | WT | HT | BMI | TSF | ISF | CC | WC | HC | W/H | AC | FAC | TC | LC | %BF | TBW | VFR | MM | PR | BM | BMR | MtA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | - | 0.28[d] | -0.10[a] | 0.31[d] | 0.26[d] | 0.20[d] | 0.28[d] | 0.35[d] | 0.09 | 0.18[d] | 0.23[d] | 0.14 | 0.22[d] | 0.13[a] | 0.30[d] | -0.30[d] | 0.47[d] | 0.10[d] | -0.27 | 0.04 | 0.06 | 0.38[d] |
| **WT** | | - | 0.21[d] | 0.93[d] | 0.62[d] | 0.63[d] | 0.77[d] | 0.69[d] | 0.18[d] | 0.19 | 0.66[d] | 0.20[d] | 0.73[d] | 0.34[b] | 0.79[d] | -0.68[b] | 0.74[d] | 0.54[d] | -0.57[d] | 0.36[d] | 0.72[d] | 0.79[b] |
| **HT** | | | - | -0.17[d] | -0.03 | 0.03 | 0.07 | 0.03 | 0.05 | -0.02 | 0.05 | -0.07 | 0.15[b] | -0.04 | 0.15 | -0.08 | 0.04 | 0.33[d] | -0.17[d] | 0.25[d] | 0.39[d] | 0.14[b] |
| **BMI** | | | | - | 0.65[d] | 0.63[d] | 0.76[d] | 0.68[d] | 0.16[a] | 0.19[d] | 0.64[d] | 0.23[d] | 0.68[d] | 0.36[d] | 0.75[d] | -0.66[d] | 0.74[d] | 0.42[d] | -0.51[d] | 0.27[d] | 0.58[d] | 0.75[d] |
| **TSF** | | | | | - | 0.85[d] | 0.67[d] | 0.60[d] | 0.18[d] | 0.15[d] | 0.61[d] | 0.17[d] | 0.61[d] | 0.31[c] | 0.71[d] | -0.62[d] | 0.70[d] | 0.38[d] | -0.53[d] | 0.23[d] | 0.53[d] | 0.70[d] |
| **ISF** | | | | | | - | 0.64[d] | 0.58[d] | 0.20[d] | 0.13[d] | 0.55[d] | 0.21[d] | 0.56[d] | 0.30[c] | 0.69[d] | -0.63[d] | 0.64[d] | 0.40[d] | -0.51[d] | 0.21[d] | 0.54[d] | 0.67[d] |
| **CC** | | | | | | | - | 0.74[d] | 0.19[d] | 0.21[d] | 0.73[d] | 0.28[d] | 0.68[d] | 0.36[d] | 0.82[d] | -0.72[d] | 0.81[d] | 0.50[d] | -0.58[d] | 0.32[d] | 0.67[d] | 0.81[d] |
| **WC** | | | | | | | | - | 0.15[a] | 0.60[d] | 0.65[d] | 0.33[d] | 0.58[d] | 0.38[d] | 0.74[d] | -0.66[d] | 0.74[d] | 0.39[d] | -0.54[d] | 0.25[d] | 0.56[d] | 0.74[d] |
| **HC** | | | | | | | | | - | 0.45[a] | 0.20[d] | 0.04 | 0.24[d] | 0.02 | 0.19 | -0.16 | 0.19 | 0.11[a] | -0.18[d] | 0.08 | 0.15[b] | 0.18[d] |
| **W/H** | | | | | | | | | | - | 0.16[a] | 0.13 | 0.01 | 0.11 | 0.19[d] | -0.19 | 0.21[d] | 0.02 | -0.12 | 0.03 | 0.06 | 0.20[d] |
| **AC** | | | | | | | | | | | - | 0.40[d] | 0.64[d] | 0.37[d] | 0.73[d] | -0.63[b] | 0.69[d] | 0.42[d] | -0.53[d] | 0.29[d] | 0.57[d] | 0.74[d] |
| **FAC** | | | | | | | | | | | | - | 0.00 | 0.28[d] | 0.27[d] | -0.25 | 0.27[d] | 0.16[b] | -0.17[d] | 0.12[a] | 0.20[a] | 0.29[a] |
| **TC** | | | | | | | | | | | | | - | 0.37[d] | 0.74[d] | -0.62[b] | 0.68[d] | 0.42[d] | -0.54[d] | 0.29[d] | 0.62[d] | 0.70[d] |
| **LC** | | | | | | | | | | | | | | - | 0.36[d] | -0.31 | 0.35[d] | 0.27[d] | -0.25[d] | 0.18[d] | 0.35[d] | 0.31[d] |
| **%BF** | | | | | | | | | | | | | | | - | -0.88[b] | 0.81[d] | 0.40[d] | -0.77[d] | 0.25[d] | 0.63[d] | 0.89[d] |
| **TBW** | | | | | | | | | | | | | | | | - | -0.71[d] | -0.31[d] | 0.65[d] | -0.20[d] | -0.51[d] | -0.78[d] |
| **VFR** | | | | | | | | | | | | | | | | | - | 0.46[d] | -0.56[d] | 0.30 | 0.62[d] | 0.87[d] |
| **MM** | | | | | | | | | | | | | | | | | | - | -0.31[d] | 0.42[b] | 0.72[d] | 0.44[d] |
| **PR** | | | | | | | | | | | | | | | | | | | - | -0.14 | -0.40[d] | -0.68[d] |
| **BM** | | | | | | | | | | | | | | | | | | | | - | 0.49[d] | 0.29[d] |
| **CAL** | | | | | | | | | | | | | | | | | | | | | - | 0.63[d] |
| **MtA** | | | | | | | | | | | | | | | | | | | | | | - |

A=Age; WT=Weight; HT=Height; BMI=Body Mass Index; TSF= Triceps Skinfold; ISF= Iliac Skinfold; CC= Chest Circumference; WC=Waist Circumference; HC= Hip Circumference; W/H= Waist Hip Ratio; AC= Arm Circumference; FAC=Forearm Circumference; TC= Thigh Circumference; LC =Leg Circumference; %BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = basal metabolic rate; MtA= Metabolic Age, PR=Physique rating.

a $p<0.05$; b $p<0.01$, c $p<0.001$; d $p<0.000$

### 4.4.3 Linear regression of body composition parameters from weight, BMI and sum of skinfold studied in women

Linear regression was used to relate body composition parameters to potential predictor variables weight, BMI, and sum of skinfold. Body composition parameters significantly related to weight, BMI and sum of skinfold in study subjects, except for sum of skinfold that did not correlate significantly with daily calorie intake in Kaduna women (Table 4.10 and 4.11). These population specific equations were then tested, used to generate the respective equation.

### 4.4.4 Linear Regression Showing the Central Adiposity measure that better Predicts Percentage body fat (%BF) and BMI

Table 4.12 showed that, statistical significance was observed between HC and BMI, %BF in Kaduna women, implying that HC can be used to predict percentage body fat (%BF) and body mass index. However, in Rivers women WC, HC and WHR can be used to predict both BMI and %BF, since significant difference was observed between these central adiposity measures and BMI, %BF.

**Table 4.10: Linear Regression of Body composition parameters from weight, BMI and sum of skinfold studied in Kaduna women**

| Parameters | | Predictive equation | P value |
|---|---|---|---|
| %BF | WT | %BF = (-12.704) + 0.422 × WT | 0.000 |
| | BMI | %BF = (-12.704) + 0.418 × BMI | 0.000 |
| | SSF | %BF = (-12.704) + 0.167 × SSF | 0.000 |
| TBW | WT | TBW = (75.778) + (-0.246) × WT | 0.000 |
| | BMI | TBW = (75.778) + (-0.294) × BMI | 0.002 |
| | SSF | TBW= 77.778 + (-0.114) × SSF | 0.000 |
| Bone mass (Kg) | WT | BM = 1.124 + 0.005 × WT | 0.818 |
| | BMI | BM= 1.124 + 0.040 × BMI | 0.546 |
| | SSF | BM= 1.124 +(-0.003) × SSF | 0.170 |
| Muscle mass (Kg) | WT | MM= 26.608 + 0.397 × WT | 0.000 |
| | BMI | MM= 26.608 + (-0.365) × BMI | 0.000 |
| | SSF | MM= 26.608 + (-0.027) × SSF | 0.049 |
| Physique rating | WT | PR=13.469 + (-0.117) × WT | 0.000 |
| | BMI | PR= 13.469 + (-0.017) × BMI | 0.721 |
| | SSF | PR= 13.469 + (-0.042) × SSF | 0.000 |
| Visceral fat rating | WT | VFR= (-5.963) + 0.052 × WT | 0.000 |
| | BMI | VFR= (-5.963) + 0.191 × BMI | 0.000 |
| | SSF | VFR = (-5.963) + 0.022 × SSF | 0.001 |
| Basal metabolic rate (Kcal) | WT | BMR= 1271.628 + (19.820) × WT | 0.000 |
| | BMI | BMR= 1271.628 + (14.321) × BMI | 0.000 |
| | SSF | BMR= 1271.628 + (-0.639) × SSF | 0.220 |
| Metabolic age (yrs) | WT | MA= (-41.048) + 0.727 × WT | 0.000 |
| | BMI | MA= (-41.048) + 0.652 × BMI | 0.001 |
| | SSF | MA= (-41.048) + (0.209) ×SSF | 0.000 |

%BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = basal metabolic rate; MtA= Metabolic Age, PR=Physique rating.

**Table 4.11: Linear Regression of Body composition parameters from weight, BMI and sum of skinfold studied in Rivers women**

| Parameters | | Predictive equation | P value |
|---|---|---|---|
| %BF | WT | %BF = (-2.262) + 0.381 × WT | 0.042 |
| | BMI | %BF = (-2.262) + (-0.075) × BMI | 0.000 |
| | SSF | %BF = (-2.262) + 0.294 × SSF | 0.000 |
| TBW | WT | TBW = 69.44 + (-0.184) × WT | 0.000 |
| | BMI | TBW = 69.44 + (-0.078) × BMI | 0.497 |
| | SSF | TBW= 69.44 + (-0.202) × SSF | 0.000 |
| Bone mass (Kg) | WT | BM = 1.697 + 0.022 × WT | 0.000 |
| | BMI | BM= 1.697 + (-0.036) ×BMI | 0.000 |
| | SSF | BM= 1.697 + 0.002 × SSF | 0.490 |
| Muscle mass (Kg) | WT | MM= 31.196 + 0.388 × WT | 0.000 |
| | BMI | MM= 31.196 + (-0.638) × BMI | 0.000 |
| | SSF | MM= 31.196 + 0.074 ×SSF | 0.004 |
| Physique rating | WT | PR=10.112+ (-0.098) × WT | 0.000 |
| | BMI | PR= 10.112 + (0.116) × BMI | 0.015 |
| | SSF | PR= 10.112 + (-0.067) × SSF | 0.000 |
| Visceral fat rating | WT | VFR= (-4.707) + 0.048 × WT | 0.000 |
| | BMI | VFR= (-4.707) + 0.098 × BMI | 0.005 |
| | SSF | VFR = (-4.707) + 0.068 × SSF | 0.000 |
| Basal metabolic rate (Kcal) | WT | BMR= 1488.534 + 20.610 × WT | 0.000 |
| | BMI | BMR= 1488.534 + (-31.471) ×BMI | 0.000 |
| | SSF | BMR= 1488.534 + 4.922 × SSF | 0.000 |
| Metabolic age (yrs) | WT | MA= (-25.835) + 0.681 × WT | 0.000 |
| | BMI | MA= (-25.835) + (-0.169) × BMI | 0.001 |
| | SSF | MA= (-25.835) + 0.464 × SSF | 0.000 |

%BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = basal metabolic rate; MtA= Metabolic Age, PR=Physique rating.

**Table 4.12: Linear regression of percentage body fat (%BF) and BMI from central adiposity measures**

| Parameters | Equation | P value |
|---|---|---|
| **Kaduna** | | |
| BMI | BMI = (-26.783) + (0.036) WC | 0.816 |
| | BMI = (-26.783) + (0.345) HC | 0.008 |
| | BMI = (-26.783) + (16.256) WHR | 0.266 |
| %BF | %BF = (-88.424) + (-0.125) WC | 0.664 |
| | % BF = (-88.424) + (0.901) HC | 0.000 |
| | %BF = (-88.424) + (43.950) WHR | 0.104 |
| **Rivers** | | |
| BMI | BMI = 14.319 + (0.466) WC | 0.000 |
| | BMI = 14.319 + (-0.024) HC | 0.000 |
| | BMI = 14.319 + (-32.224) WHR | 0.000 |
| %BF | %BF = 12.591 + (0.466) WC | 0.000 |
| | % BF = 12.591 + (-0.024) HC | 0.000 |
| | %BF = 12.591 + (-64.102) WHR | 0.000 |

BMI=Body mass index, %BF= percentage body fat, WC= waist circumference, HC= hip circumference, WHR= waist hip ratio

## 4.5 Association with body mass index

### 4.5.1 Association between Body Mass Index (BMI) and Age

This study also demonstrates that the frequency of underweight and normal weight women from Rivers and Kaduna decreases beyond 20 to 23 years, while obesity was maximum within 24-26 years for both states, overweight was maximum within 23-26 years (Table 4.13).

### 4.5.2 Association between BMI and Depression during Menstruation

It was observed that in both geographical regions, majority of the participants experienced minimal depression (0-13). And the maximum number of women with depression during menstruation had normal BMI (Table 4.14).

**Table 4.13: Association between Body Mass Index (BMI) and Age**

| AGE | BMI | | | | $\chi^2$ | P |
|---|---|---|---|---|---|---|
| | Underweight n (%) | Normal n (%) | Overweight n(%) | Obesity n(%) | | |
| Rivers | | | | | | |
| 18-20 | 20(50) | 98 (38.74) | 15 (18.75) | 8(28.57) | 38.585 | 0.000 |
| 21-23 | 13(32.5) | 71 (28.06) | 20 (25) | 5(17.86) | | |
| 24-26 | 7(17.5) | 69 (27.27) | 29 (36.25) | 8(28.57) | | |
| 27 -30 | 0 | 15 (5.93) | 16 (20) | 7 (25) | | |
| Kaduna | | | | | | |
| 18-20 | 15(39.47) | 73(29.32) | 21(26.92) | 5 (22.73) | 19.323 | 0.023 |
| 21-23 | 16(42.11) | 114(45.78) | 31 (39.74) | 5 (22.73) | | |
| 24-26 | 6(15.79) | 50(20.08) | 24 (30.77) | 8 (36.36) | | |
| 27 -30 | 1(2.63) | 12(4.82) | 2 (2.56) | 4 (18.18) | | |

**Table 4.14: Association between BMI and Categories of depression**

| BMI | CATEGORY OF DEPRESSION | | | | $\chi^2$ | p |
|---|---|---|---|---|---|---|
| | Minimal (0-13) | Mild (14-19) | Moderate (20-28) | Severe (29-63) | | |
| | n (%) | n (%) | n (%) | n (%) | | |
| **Rivers** | | | | | | |
| Underweight | 26 (9.63) | 11(12.79) | 3(8.57) | 0 (0) | 5.04 | 0.83 |
| Normal | 168 (62.22) | 55 (63.95) | 22(62.86) | 8 (80) | | |
| Overweight | 58 (21.48) | 14 (16.28) | 6(17.14) | 2 (20) | | |
| Obese | 18 (6.67) | 6(6.98) | 4(11.43) | 0 (0) | | |
| Total | 270(100) | 86(100) | 35(100) | 10 (100) | | |
| **Kaduna** | | | | | | |
| Underweight | 29 (11.28) | 6 (7.89) | 2 (5.13) | 1 (6.67) | 11.63 | 0.24 |
| Normal | 163 (63.42) | 46(60.53) | 31 (79.49) | 9 (60.00) | | |
| Overweight | 54 (21.01) | 15 (19.74) | 5 (12.82) | 4 (26.67) | | |
| Obese | 11 (4.28) | 9 (11.84) | 1 (2.56) | 1 (6.67) | | |

## 4.6 Descriptive statistics of reproductive characteristics

Table 4.15 revealed the reproductive characteristics of study population. Majority of the subject (Kaduna: 253, 65.3 %; Rivers: 270, 67.3 %) had normal menstrual cycle (24-29 days). Menstrual cycle length of less than 23 days (Kaduna: 90, 23.3%; Rivers: 85, 21.2 %) and more than 30 days (Kaduna: 44, 11.4 %; Rivers: 46, 11.5 %) menstrual cycle were relatively less. Menstrual cycle was regular in 80.4 % (311) of the respondents from Kaduna state, whereas 19.6 % (76) had irregular period. However, 71.8 % (288) of the respondents from Rivers State experienced regular menstrual cycle, whereas 113 % (28.2) had irregular period. A good number of women experienced period between 4 to 6 days (Rivers: 324, 80.8 %; Kaduna: 245, 63.3 %), while relatively lesser number of women had more/or 7 days period.

At age 15, about 80% of women from this study have experienced first menstruation. Women that reached their age at menarche at 10 (Rivers: 9, 2.2%; Kaduna: 2, 0.6 %) and 19 (Rivers: 12, 2.9 %; Kaduna: 2, 0.5%) years were relatively less. The most common age at menarche of study participants was 12 years (Rivers: 113, 28.2 %; Kaduna: 93, 24.4 %), which was followed by 13(Rivers: 68, 17 %;) and 14 years (Rivers: 66, 16.5%; Kaduna: 81, 20.9 %). However, for Kaduna women the most common was followed by14 years and then 13 years (Kaduna: 71, 18.3 %) (Table 4.16).

**Table 4.15: Descriptive statistics of reproductive characteristics of women from Rivers and Kaduna State**

| Reproductive Characteristics | | Kaduna n (%) | Rivers n (%) | $\chi^2$ | P value |
|---|---|---|---|---|---|
| Regular menstrual cycle | Yes | 311 (80.4) | 288 (71.8) | 7.88 | 0.01 |
| | No | 76 (19.6) | 113 (28.2) | | |
| Duration of menses | ≤3days | 113 (29.2) | 61 (15.2) | 30.02 | 0.000 |
| | 4-6 days | 245 (63.3) | 324 (80.8) | | |
| | ≥7 days | 29 (7.5) | 16 (4.0) | | |
| Average menstrual cycle | Short (≤23 days) | 90 (23.3) | 85 (21.2) | 0.49 | 0.78 |
| | Normal (24-29 days) | 253 (65.4) | 270 (67.3) | | |
| | Long (≥30 days) | 44 (11.4) | 46 (11.5) | | |
| Peak discharge | 1st day of flow | 72 (20.16%) | 158 (39.5%) | 42.01 | 0.000 |
| | 2nd day of flow | 309 (79.85%) | 242 (60.5%) | | |
| Pains during menstruation | Often | 125 (32.3) | 111 (27.7) | 2.04 | 0.36 |
| | Sometimes | 228 (58.9) | 254 (63.3) | | |
| | Never | 34 (8.8) | 36 (9.0) | | |

**Table 4.16: Descriptive statistics of menarcheal Age**

| Age at menarche (years) | Kaduna n (%) | Rivers n (%) |
|---|---|---|
| 10 | 2 (0.6) | 9 (2.2) |
| 11 | 22 (5.7) | 19 (4.7) |
| 12 | 93 (24.4) | 113 (28.2) |
| 13 | 71 (18.3) | 68 (17) |
| 14 | 81 (20.9) | 66 (16.5) |
| 15 | 63 (16.3) | 46 (11.5) |
| 16 | 30 (7.8) | 44(11) |
| 17 | 13 (3.4) | 11 (2.7) |
| 18 | 8 (2.1) | 11 (2.7) |
| 19 | 2 (0.5) | 12 (2.9) |

## 4.7 Comparison between the menstrual characteristics of Kaduna and Rivers state women

Regarding pains during menstruation (dysmenorrhoea), it was found that a substantial number of respondents complained of experiencing pains sometimes, while relatively lesser number of women reported that they had never experienced pain or experienced pains often (Fig 4.9). However, there was no statistical significance.

Fig 4.10 and 4.11 showed Menstrual pain had effect on the daily activity of women from Rivers and Kaduna origin, since a good number of women who complained of menstrual pain were absent from school during menstruation, ($\chi^2$= 53.147, p<0.000) and ($\chi^2$= 20.10 and p<0.000) for Rivers and Kaduna women respectively.

The most common category of depression experienced by study participants was minimal depression, the number of students who experienced severe depression were relatively less (Fig 4.12). Our results show that the distribution of the sample across depression categories differed between Kaduna and Rivers state women. The prevalence of severe was higher among Kaduna women than Rivers women (3.9 % versus 2.5 %).

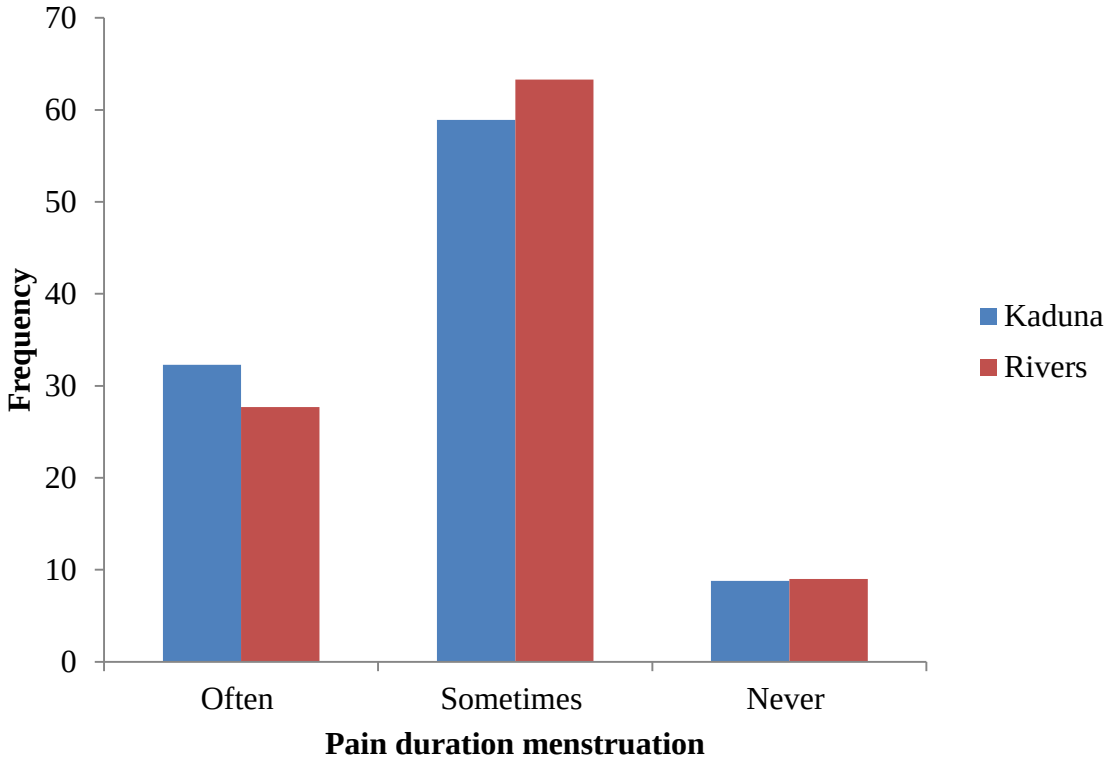



Fig 4.16: Frequency of women suffering from menstrual pains

From this study, the number of Kaduna women who experienced menstrual pains in every cycle was more than their counterparts from Rivers State. However, there was no statistical significance ($\chi^2$=2.36, p> 0.05).

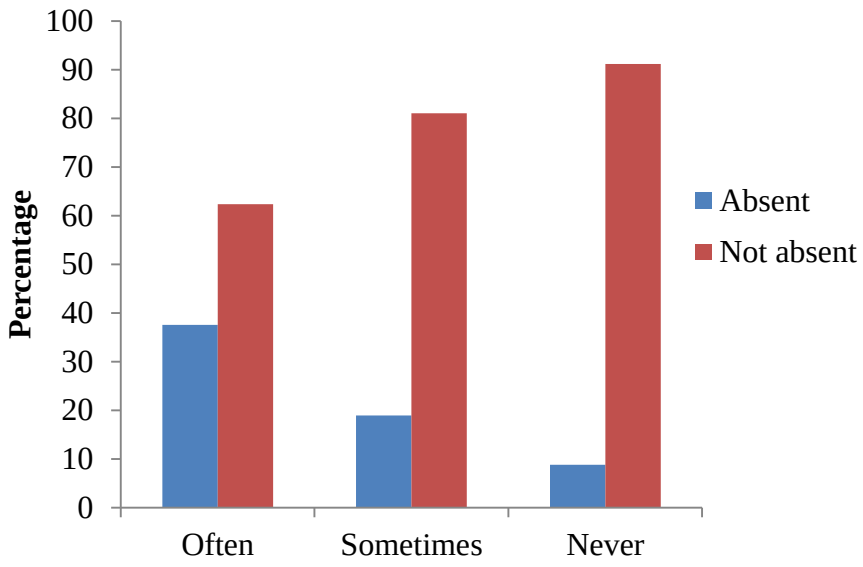



Fig 4.17: Menstruation related school absenteeism among Kaduna State undergraduate women. Majority of the women who were absent from studies during menstruation experienced menstrual pain.$\chi 2=20.10$, $p< 0.000$

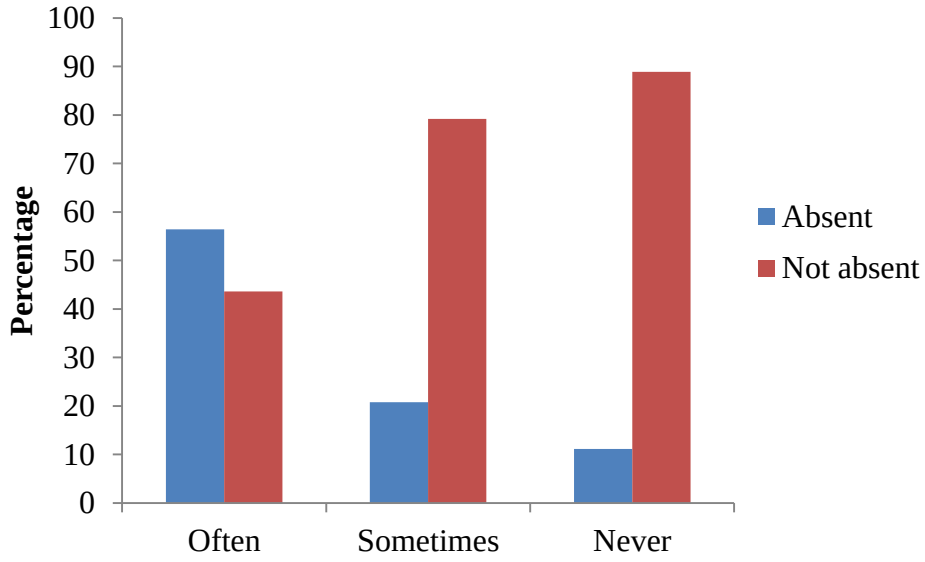



Fig 4.18: Menstruation related school absenteeism among Rivers State students. Majority of the women who were absent from studies during menstruation experienced menstrual pain. $\chi 2=53.147$, $p< 0.000$

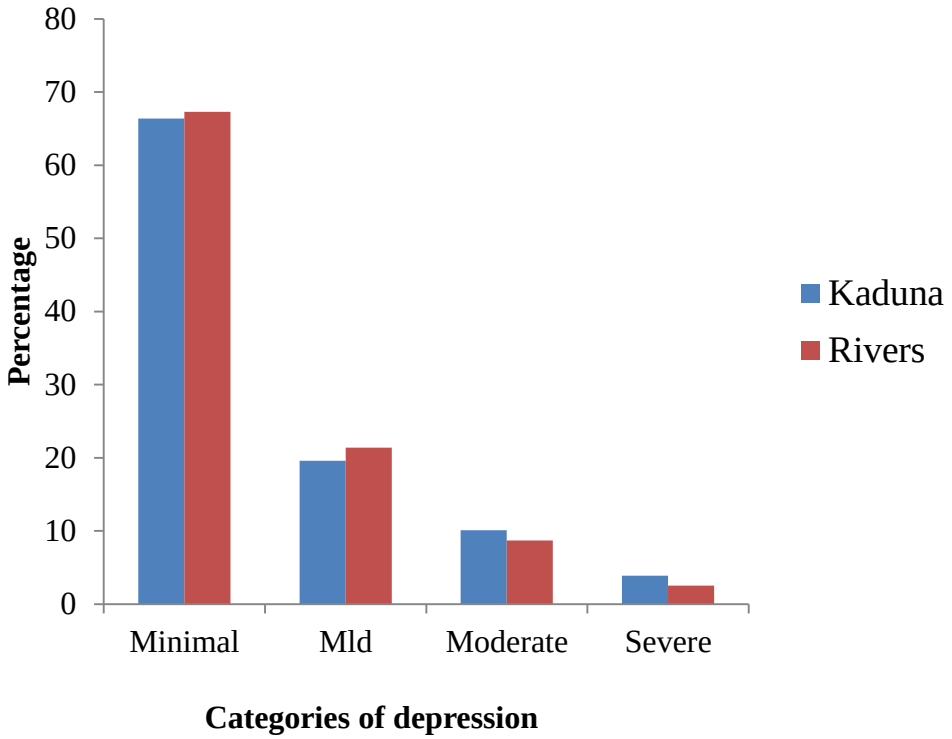



Fig 4.19: Prevalence of depression during menstruation in Kaduna and Rivers States women. The most common category of depression experienced by study participants was minimal depression, the number of students who experienced severe depression were relatively less.

### 4.8 Comparisons between premenstrual syndrome and symptoms experienced during menstruation of women from Kaduna and Rivers state

The prevalence premenstrual syndrome and menstrual symptoms in both populations were shown in Table 4.17 and 4.18. Menstrual symptoms showed significant ($p<0.01$) association in increased breast size in women from Kaduna and Rivers States (Table 4.18).

Figure 4.13 Shows the cross tabulation premenstrual symptoms experienced by women from Kaduna and Rivers origin. Majority of the study participants experienced at least one premenstrual symptom and symptoms during menstruation (Figure 4.17 and 4.18). The results showed that 95 % of Rivers women suffered from PMS, and 97 % from discomforts during menstruation.

Chi square validated the significant difference ($\chi^2= 35.348$, $p<0.001$) and ($\chi^2= 10.637$ and $p<0.001$) for PMS and SDM respectively.

**Table 4.17: Comparison between the prevalence of premenstrual syndrome In Kaduna and Rivers subjects (women)**

| Premenstrual syndrome symptoms | Kaduna women n (%) | Rivers women n (%) | $\chi^2$ | P value |
|---|---|---|---|---|
| Act aggressively | 37 (9.6) | 29 (7.2) | 1.25 | 0.23 |
| Increased appetite | 2 (0.5) | 40 (10) | 0.23 | 0.60 |
| Pimples and puffy face | 192 (49.6) | 180 (44.9) | 1.94 | 0.16 |
| Painful breast | 126 (32.6) | 108 (26.9) | 2.28 | 0.11 |
| Joint pain | 43 (11.1) | 22 (5.5) | 0.03 | 0.87 |
| Lower abdominal discomfort | 157 (40.6) | 168 (41.9) | 0.13 | 0.72 |

**Table 4.18: Comparison between the prevalence of menstrual symptoms in Kaduna and Rivers subjects (women)**

| Menstrual symptoms | Kaduna women n (%) | Rivers women n (%) | $\chi^2$ | P value |
|---|---|---|---|---|
| Lower abdominal pain | 185 (47.8) | 168 (41.9) | 0.11 | 0.74 |
| Depression | 36 (9.3) | 21 (5.2) | 0.01 | 0.91 |
| Anxiety | 9 (2.3) | 10 (2.5) | 0.24 | 0.62 |
| Nausea | 32 (8.3) | 13 (3.2) | 0.90 | 0.34 |
| Painful breast | 158 (40.8) | 143 (35.7) | 0.04 | 0.84 |
| Weakness/ Tiredness | 128 (33.1) | 109 (27.2) | 1.62 | 0.20 |
| Feeling heavy | 56 (14.5) | 57 (14.2) | 0.01 | 0.94 |
| Increased breast size | 191 (49.4) | 182 (45.4) | 7.52 | 0.01 |
| Back pain | 132 (34.1) | 37 (9.2) | 0.53 | 0.47 |
| Headache | 31 (8.0) | 44 (11) | 0.61 | 0.44 |

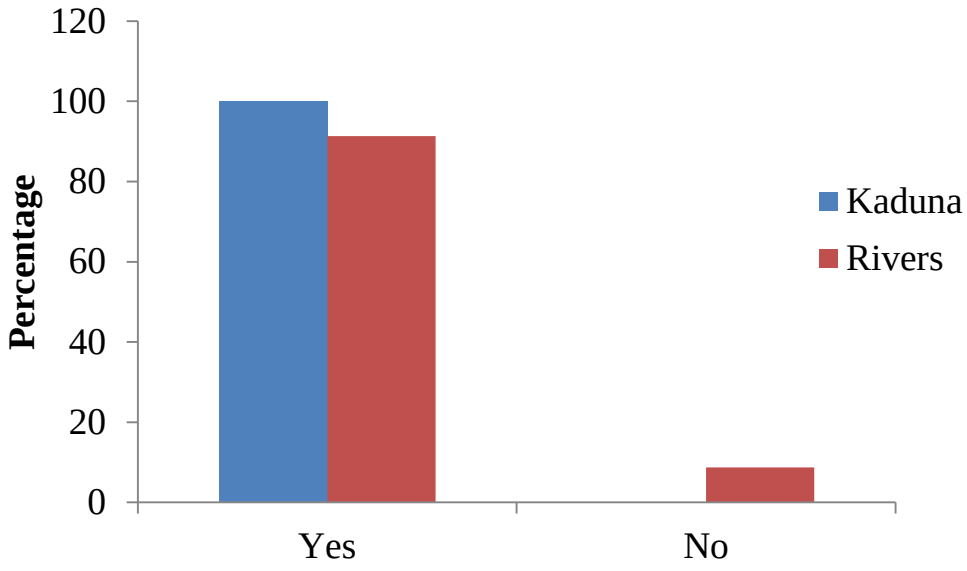



Fig 4.20: Frequency of women experiencing premenstrual symptoms. All Kaduna women reported at least one PMS symptom in every cycle, while 91% of Rivers women complained of PMS. $\chi 2= 35.348$, $p<0.000$

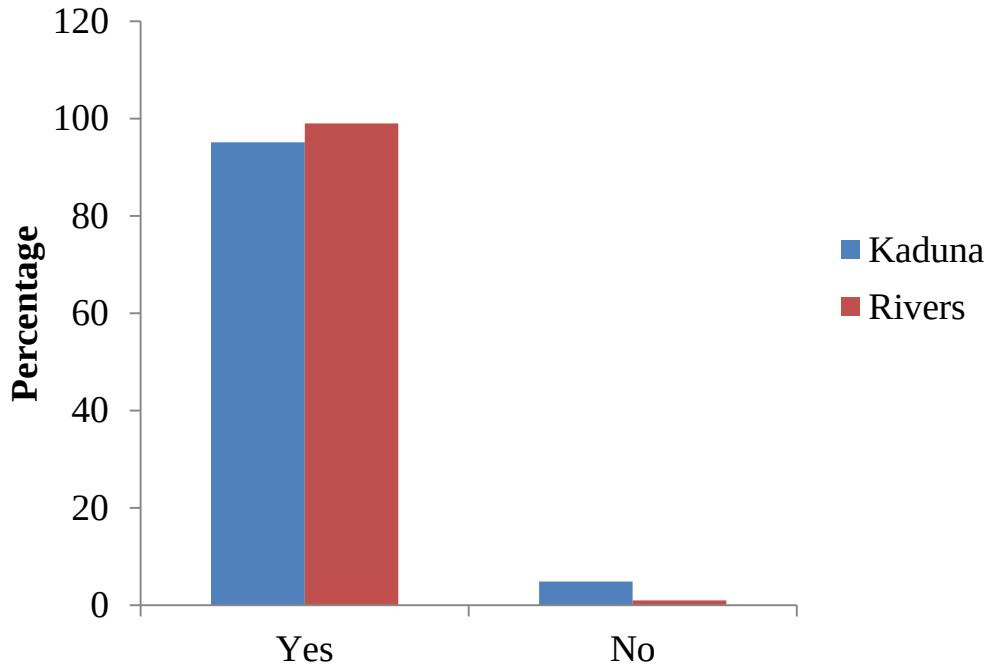



Fig 4.21: Frequency of women experiencing menstrual symptoms. Majority of the women suffered from one discomfort during menstruation, which was more in Rivers women. $\chi^2$=10.637, p<0.001

## 4.9 Association between anthropometry and menstrual characteristics

### 4.9.1 Age and Menstrual Characteristics

Table 4. 19 show the association between length of a menstrual cycle and age interval with the aim of studying the distribution of premenopausal women according to their menstrual cycle. Maximum Kaduna women (46.2 %) with the length of their menstrual cycle between 24-29 days were of the age range 21-23years, followed by 40% between ≤23 days within the age group 21–23 years. It is observed that in all the age groups of this study, maximum women experienced menstrual cycle of duration 24-29 days. Maximum women from Rivers state (47.8%) with the length of their menstrual cycle between ≥30 days were of the age range 18-20 years, followed by 45.9 % between ≤23 days within the age group 18-20 years. It was also observed that in all the age groups of this study, maximum women experienced menstrual cycle of duration 24-29 days (Table 4.19). It was observed that in all the age groups of this study, maximum number of girls experienced menstrual cycle duration of 24-29 days. After adjusting the covariates (Long menstrual cycle and age interval of 27-30), there was a likelihood for women within the age range of 24-26 years to experience normal menstrual cycle (24-29 days), however, there was no significance. In addition, Rivers subjects within the age range of 21- 23 years had twice the likelihood to experience normal menstrual cycle (Table 4.20), but there was no significance.

**Table 4.19: Association between length of a menstrual cycle and age interval**

| AGE INTERVAL (years) | AVERAGE MENSTRUAL CYCLE | | | $\chi^2$ | p |
|---|---|---|---|---|---|
| | Short (≤ 23 days) n (%) | Normal (24-29 days) n (%) | Long (≥30 days) n (%) | | |
| Kaduna | | | | | |
| 18-20 | 30 (33.3) | 69 (27.3) | 15 (34.1) | 6.42 | 0.38 |
| 21-23 | 36 (40) | 117 (46.2) | 13 (29.5) | | |
| 24-26 | 18 (20) | 57 (22.5) | 13 (29.5) | | |
| 27-30 | 6 (6.7) | 10 (4.0) | 3 (6.8) | | |
| Rivers | | | | | |
| 18-20 | 39 (45.9) | 80 (29.6) | 22 (47.8) | 17.70 | 0.07 |
| 21-23 | 19 (22.4) | 75 (27.8) | 15 (32.6) | | |
| 24-26 | 17 (20) | 90 (33.3) | 6 (13) | | |
| 27-30 | 10 (11.8) | 25 (9.3) | 3 (6.5) | | |

**Table 4.20: Logistic regression showing the association between distribution of length of a menstrual cycle and age group**

| Age Intervals (Years) | Average Length Menstrual Cycle (days) | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 23 | | 24-29 | | 30 | |
| | OR | 95%CI | OR | 95%CI | OR | 95%CI |
| **Kaduna** | | | | | | |
| 18-20 | 1.00 | 0.22-4.56 | 1.38 | 0.34-5.63 | - | - |
| 21-23 | 1.39 | 0.30-6.36 | 2.70 | 0.66- 11.08 | - | - |
| 24-26 | 0.69 | 0.15-3.29 | 1.32 | 0.32-5.46 | - | - |
| **Rivers** | | | | | | |
| 18-20 | 0.53 | 0.13-2.14 | 0.38 | 0.12-1.58 | - | - |
| 21-23 | 0.38 | 0.09-1.63 | 0.60 | 0.16 – 2.25 | - | - |
| 24-26 | 0.85 | 0.17-4.17 | 1.80 | 0.42 -7.71 | - | - |

aOR indicates adjusted odds ratio; CI, confidence interval. *p<0.05; **p<0.01. [#]Reference group: Long menstrual cycle, age interval of 27-30 years.

### 4.9.2 Association between anthropometric parameters and regularity of menstruation

Tables 4.21 and 4.22 show the association between anthropometry and regularity of menstruation. Among the Kaduna women regularity of menstruation associated with weight and forearm circumference (Table 4.21). Associated was observed between regularity and weight, triceps and iliac skinfold, waist circumference and BMI (Table 4.22) among Rivers women.

### 4.9.3 Association between body composition parameters and regularity of menstruation

Tables 4.23 and 4.24 show the association between body composition and regularity of menstruation. Among the Kaduna women regularity of menstruation associated with percentage body fat, total body water, basal metabolic rate, muscle mass, metabolic rate, and visceral fat rating (Table 4.23). No association was observed between regularity and body composition parameters (Table 4.24) among Rivers women.

**Table 4.21: Association between anthropometry and regularity of menstruation among Kaduna women**

| Variables | Regularity of menstrual cycle | | | |
|---|---|---|---|---|
| | Regular (n=311) Mean ± SD | Irregular (n=76) Mean ± SD | t | p value |
| Height | 159.01± 6.07 | 157.68 ± 5.27 | 3.10 | 0.08 |
| Weight | 58.52 ± 9.92 | 55.43 ±8.65 | 6.21 | 0.01 |
| Triceps | 12.38 ±4.79 | 11.28 ±4.72 | 3.29 | 0.07 |
| Iliac | 12.48 ± 4.53 | 11.45 ± 4.19 | 3.27 | 0.07 |
| Chest circumference | 90.00 ±7.35 | 88.67 ±6.94 | 2.05 | 0.15 |
| Waist circumference | 79.63 ± 8.43 | 76.97 ±7.72 | 6.31 | 0.12 |
| Hip circumference | 98.11 ± 9.87 | 96.29 ±7.29 | 2.28 | 0.13 |
| BMI | 23.15 ± 3.73 | 22.27 ± 3.20 | 3.29 | 0.07 |
| Leg circumference | 34.49±4.05 | 33.74 ± 3.69 | 2.19 | 0.14 |
| Thigh circumference | 57.84 ± 7.55 | 58.29 ± 7.85 | 0.21 | 0.64 |
| Fore arm circumference | 25.42 ± 2.63 | 24.77±1.44 | 4.44 | 0.04 |
| Arm circumference | 30.90± 5.98 | 29.95 ± 4.27 | 1.72 | 0.19 |
| WHR | 0.81± 0.05 | 0.80 ± 0.06 | 1.75 | 0.19 |

**Table 4.22: Association between anthropometry and regularity of menstruation among Rivers women**

| Variables | Regularity of menstrual cycle | | | |
|---|---|---|---|---|
| | Regular (n=288) Mean ± SD | Irregular (n=113) Mean ± SD | t | p value |
| Height | 162.37 ± 5.99 | 162.21 ± 6.05 | 0.06 | 0.81 |
| Weight | 60.07 ± 11.97 | 59.84 ± 11.41 | 0.03 | 0.86 |
| Triceps | 13.13 ± 4.82 | 13.21 ± 5.14 | 0.02 | 0.88 |
| Iliac | 12.96 ± 4.90 | 13.04 ± 5.22 | 0.02 | 0.89 |
| Chest circumference | 89.59 ± 8.34 | 89.24 ± 7.71 | 0.15 | 0.70 |
| Waist circumference | 79.61 ± 10.52 | 79.67 ± 9.66 | 0.00 | 0.96 |
| Hip circumference | 97.85 ± 8.80 | 105.11 ± 92.61 | 1.73 | 0.19 |
| BMI | 22.81 ± 4.46 | 22.76 ± 4.32 | 0.01 | 0.91 |
| Calf circumference | 33.56 ± 4.14 | 33.75 ± 3.56 | 0.18 | 0.67 |
| Thigh circumference | 58.05 ± 7.40 | 56.90 ± 7.84 | 1.88 | 0.17 |
| Fore arm circumference | 23.39 ± 3.52 | 24.12 ± 5.29 | 1.19 | 0.28 |
| Arm circumference | 29.57 ± 3.99 | 28.94 ± 4.27 | 1.92 | 0.17 |
| WHR | 0.81 ± 0.07 | 0.81 ± 0.09 | 0.18 | 0.67 |

**Table 4.23: Association between body composition and regularity of menstruation among Kaduna women**

| Variables | Regularity of menstrual cycle | | | |
|---|---|---|---|---|
| | Regular (n=311) Mean ± SD | Irregular (n=76) Mean ± SD | **t** | **p value** |
| % Body fat | 25.71 ± 7.60 | 24.18 ± 6.36 | 4.78 | 0.03 |
| Total body water | 51.82 ± 4.96 | 52.68 ± 3.90 | 4.84 | 0.03 |
| Bone mass | 2.31 ±1.2.13 | 2.13 ± 0.13 | 0.73 | 0.39 |
| Basal metabolic rate | 2085.44 ± 162.54 | 2031.62 ±135.56 | 8.77 | 0.003 |
| Muscle mass | 40.76 ±3.18 | 39.76 ± 2.71 | 6.30 | 0.01 |
| Visceral fat rating | 2.05 ±1.61 | 1.61 ±1.13 | 9.73 | 0.002 |
| Physique rating | 5.24 ± 2.05 | 5.62 ±1.75 | 1.56 | 0.21 |
| Metabolic age | 21.80 ± 12.35 | 18.30 ± 9.51 | 13.58 | 0.000 |

**Table 4.24: Association between body composition and regularity of menstruation among Rivers women**

| Variables | Regularity of menstrual cycle | | | |
|---|---|---|---|---|
| | Regular (n=288) Mean ± SD | Irregular (n=113) Mean ± SD | t | p value |
| % Body fat | 26.71 ± 7.63 | 26.24 ± 7.39 | 0.05 | 0.82 |
| Total body water | 51.24 ± 5.77 | 51.58 ± 4.62 | 0.93 | 0.34 |
| Bone mass | 2.24 ± 0.20 | 2.28 ± 0.57 | 1.38 | 0.24 |
| Basal metabolic rate | 2141.59 ± 195.87 | 2123.44 ± 216.74 | 0.01 | 0.94 |
| Muscle mass | 41.92 ± 4.83 | 41.74 ± 3.40 | 2.71 | 0.10 |
| Visceral fat rating | 2.23 ± 1.85 | 2.11 ± 1.93 | 0.00 | 0.96 |
| Physique rating | 5.11 ± 1.90 | 5.05 ± 2.05 | 0.42 | 0.52 |
| Metabolic age | 23.61 ± 12.91 | 22.50 ± 12.76 | 0.02 | 0.88 |

### 4.9.4 Association between Anthropometric parameters and duration of flow

Tables 4.25 and 4.26 show the association between anthropometry and duration of flow of study subjects. Hip and forearm circumference showed significant association with duration of flow among Rivers women (Table 4.26).

### 4.8.5 Association between Anthropometric parameters and dysmenorrhoea

No significant association was observed between anthropometry and pains in Kaduna women, except for waist hip ratio which showed statistical significance $p<0.05$ (Table 4.31). An association ($p<0.05$) was observed between body circumferences (chest, forearm, thigh and calf) and pains during menstruation among Rivers women (Table 4.32).

**Table 4.25: Association between Anthropometry and duration of flow among Kaduna women**

| Variables | Duration of flow | | | | |
|---|---|---|---|---|---|
| | ≤3 (n=113) Mean ±SD | 4-6 (n=245) Mean ±SD | ≥7 (n=29) Mean ±SD | f value | p value |
| Height (m) | 1.58 ± 0.06 | 1.59 ± 0.06 | 1.58 ± 0.06 | 0.88 | 0.42 |
| Weight (kg) | 57.08 ± 0.06 | 58.58 ± 9.63 | 55.51 ± 13.58 | 1.88 | 0.15 |
| BMI ($kg/m^2$) | 22.76 ± 3.31 | 23.16 ± 3.56 | 22.27 ± 5.32 | 1.06 | 0.35 |
| Triceps skinfold ($mm^2$) | 12.12 ± 4.65 | 12.30 ± 4.87 | 11.17 ± 4.61 | 0.73 | 0.48 |
| Iliac skinfold ($mm^2$) | 11.96 ± 4.04 | 12.56 ± 4.65 | 11.10 ± 4.43 | 1.77 | 0.17 |
| Chest circumference (cm) | 89.22 ± 6.54 | 89.96 ± 7.37 | 89.86 ± 9.19 | 0.39 | 0.68 |
| Waist circumference (cm) | 78.59 ± 7.33 | 79.45 ± 8.54 | 78.30 ± 10.34 | 0.55 | 0.58 |
| Hip circumference (cm) | 96.52 ± 11.90 | 98.52 ± 8.01 | 96.08 ± 9.40 | 2.23 | 0.11 |
| Arm circumference (cm) | 30.36 ± 3.21 | 30.98 ± 6.67 | 29.82 ± 4.02 | 0.83 | 0.44 |
| Forearm circumference (cm) | 25.20 ± 1.59 | 25.38 ± 2.79 | 24.96 ± 2.26 | 0.50 | 0.61 |
| Thigh circumference (cm) | 57.90 ± 6.27 | 58.12 ± 8.17 | 56.32 ± 7.31 | 0.73 | 0.48 |
| Calf circumference (cm) | 34.16 ± 3.27 | 34.57 ± 4.35 | 33.20 ±3.18 | 1.72 | 0.18 |

**Table 4.26: Association between anthropometry and duration of menstruation among Rivers women**

| Variables | Duration of flow | | | | |
|---|---|---|---|---|---|
| | ≤3 days (n=61) Mean ±SD | 4-6 days (n=324) Mean ±SD | ≥7 days (n=16) Mean ±SD | f value | p value |
| Height (m) | 1.63 ± 0.06 | 1.62 ± 0.06 | 1.63 ±0.07 | 0.33 | 0.72 |
| Weight (kg) | 60.55 ± 12.11 | 59.71 ± 11.57 | 63.93 ± 14.99 | 1.05 | 0.35 |
| BMI ($kg/m^2$) | 22.83 ± 4.53 | 22.73 ± 4.37 | 24.10 ± 4.99 | 0.74 | 0.48 |
| Triceps skinfold (mm) | 13.61 ± 4.75 | 13.09 ± 4.91 | 12.75 ± 5.48 | 0.34 | 0.71 |
| Iliac skinfold (mm) | 13.44 ± 5.38 | 12.90 ± 4.90 | 13.19 ± 5.24 | 0.32 | 0.73 |
| Chest circumference (cm) | 89.52 ± 7.87 | 89.38 ± 8.10 | 91.60 ± 10.55 | 0.56 | 0.57 |
| Waist circumference (cm) | 80.20 ± 9.25 | 79.42 ± 10.31 | 81.60 ± 13.40 | 0.45 | 0.64 |
| Hip circumference (cm) | 114.47 ± 24.86 | 97.14 ± 10.33 | 100.17 ± 10.89 | 3.16 | 0.04 |
| Arm circumference (cm) | 29.50 ± 3.92 | 29.34 ± 4.05 | 30.00 ± 5.26 | 0.23 | 0.80 |
| Forearm circumference (cm) | 24.92 ± 6.20 | 23.55 ± 3.60 | 23.57 ± 3.14 | 2.90 | 0.05 |
| Thigh circumference (cm) | 58.11 ± 9.08 | 57.59 ± 7.18 | 58.90 ± 8.41 | 0.32 | 0.27 |
| Calf circumference (cm) | 32.87 ± 4.19 | 33.73 ± 3.95 | 34.13 ± 3.70 | 1.32 | 0.27 |

**Table 4.27: Association between anthropometry and dysmenorrhoea among Kaduna women**

| Variables | Pains during menstruation | | | | |
|---|---|---|---|---|---|
| | Often (n=125) Mean ±SD | Sometimes (n=228) Mean ±SD | Never (n=34) Mean ±SD | f value | p value |
| Height (m) | 1.59 ± 0.06 | 1.58 ± 0.06 | 1.59 ± 0.07 | 1.86 | 0.16 |
| Weight (kg) | 58.06 ± 9.96 | 57.69 ± 9.76 | 58.86 ± 9.04 | 0.23 | 0.79 |
| BMI ($kg/m^2$) | 22.85 ± 3.90 | 23.01 ± 3.54 | 23.20 ± 3.46 | 0.15 | 0.86 |
| Triceps skinfold (mm) | 12.79 ± 5.42 | 11.84 ± 4.44 | 12.03 ± 4.47 | 1.61 | 0.20 |
| Iliac skinfold (mm) | 12.68 ± 5.12 | 12.10 ± 4.10 | 11.97 ± 4.45 | 0.76 | 0.47 |
| Chest circumference (cm) | 89.69 ± 7.04 | 89.78 ± 7.46 | 89.57 ± 7.11 | 0.02 | 0.98 |
| Waist circumference (cm) | 78.91 ± 8.56 | 79.30 ± 8.30 | 78.59 ± 8.10 | 0.16 | 0.86 |
| Hip circumference (cm) | 98.51 ± 7.51 | 97.13 ± 10.55 | 99.13 ± 7.65 | 1.27 | 0.28 |
| Waist hip ratio | 0.80 ± 0.05 | 0.81 ± 0.06 | 0.79 ± 0.05 | 3.93 | 0.02 |
| Arm circumference (cm) | 30.11 ± 4.74 | 31.05 ± 6.43 | 30.63 ± 2.81 | 1.10 | 0.33 |
| Forearm circumference (cm) | 25.20 ± 1.99 | 25.36 ± 2.78 | 25.18 ± 1.58 | 0.20 | 0.82 |
| Thigh circumference (cm) | 57.35 ± 7.18 | 58.09 ± 8.08 | 58.94 ± 5.44 | 0.71 | 0.49 |
| Calf circumference (cm) | 33.95 ± 2.86 | 34.67 ± 4.56 | 33.62 ± 3.31 | 1.92 | 0.15 |

**Table 4.28: Association between anthropometry and pains during menstruation among Rivers women**

| Variables | Pains during menstruation | | | | |
|---|---|---|---|---|---|
| | Often (n=111) Mean ±SD | Sometimes (n=254) Mean ±SD | Never (n=36) Mean ±SD | f value | p value |
| Height (m) | 1.62 ± 0.06 | 1.63 ± 0.06 | 1.61 ± 0.06 | 1.01 | 0.37 |
| Weight (kg) | 60.97 ± 10.63 | 59.78 ± 12.65 | 58.63 ± 8.67 | 0.66 | 0.52 |
| BMI ($kg/m^2$) | 23.19 ± 4.05 | 22.65 ± 4.71 | 22.62 ± 3.21 | 0.61 | 0.55 |
| Triceps skinfold (mm) | 12.83 ± 4.41 | 13.43 ± 5.17 | 12.17 ± 4.31 | 1.39 | 0.25 |
| Iliac skinfold (mm) | 12.70 ± 4.67 | 13.23 ± 5.31 | 12.14 ± 3.22 | 1.02 | 0.36 |
| Chest circumference (cm) | 90.46 ± 7.74 | 89.56 ± 8.09 | 86.04 ± 9.22 | 4.05 | 0.02 |
| Waist circumference (cm) | 80.88 ± 9.16 | 79.08 ± 10.92 | 79.66 ± 8.56 | 1.19 | 0.31 |
| Hip circumference (cm) | 98.63 ± 8.28 | 101.49 ± 8.28 | 92.60 ± 18.53 | 0.55 | 0.58 |
| Waist hip ratio | 0.82 ± 0.05 | 0.81± 0.09 | 0.83 ± 0.07 | 2.44 | 0.09 |
| Arm circumference (cm) | 29.69 ± 3.84 | 29.38 ± 4.23 | 28.53 ± 3.52 | 1.09 | 0.34 |
| Forearm circumference (cm) | 24.55 ± 2.77 | 23.29 ± 4.63 | 24.66 ± 2.84 | 4.69 | 0.01 |
| Thigh circumference (cm) | 57.96 ± 7.03 | 58.06 ± 7.80 | 54.62 ± 6.59 | 3.39 | 0.04 |
| Calf circumference (cm) | 34.12 ± 3.14 | 33.24 ± 4.41 | 34.71 ± 2.63 | 3.42 | 0.03 |

### 4.10 Association between anthropometric variables and parental education

Tables 4.29 - 4.32 show the association between anthropometric variables and parental education. Age at menarche, arm and fore arm circumference of Rivers subjects were observed to be significantly associated with fathers educational level (Table 4.31), while mothers level of education associated significantly with age at menarche, BMI,WC, WHR, arm, fore arm and calf circumference (Table 4.32). However, no association was observed between anthropometric parameters and parental education in Kaduna subjects (Table 4.29 and4.30).

**Table 4.29: Relationship between anthropometry of Kaduna subjects and fathers education**

| Variables | Primary n=19 Mean ±SD | Secondary n=63 Mean ±SD | Tertiary n=305 Mean ±SD | f value | p value |
|---|---|---|---|---|---|
| Age at menarche (years) | 13.63 ± 1.42 | 13.87 ± 1.60 | 13.60 ± 1.84 | 0.62 | 0.54 |
| Height (cm) | 160.68 ± 0.05 | 158.35 ± 0.06 | 158.72 ± 0.06 | 0.65 | 0.52 |
| Weight (kg) | 58.12 ± 6.83 | 58.35 ± 10.97 | 57.81 ± 9.66 | 1.16 | 0.32 |
| BMI ($kg/m^2$) | 22.57 ± 2.87 | 23.22 ± 3.86 | 22.95 ± 3.65 | 0.09 | 0.92 |
| Triceps skinfold (mm) | 10.89 ± 4.04 | 12.37 ± 4.88 | 12.20 ± 4.81 | 0.73 | 0.48 |
| Iliac skinfold (mm) | 11.32 ± 3.46 | 12.62 ± 4.49 | 12.27 ± 4.53 | 0.62 | 0.53 |
| Chest circumference | 90.64 ± 3.79 | 89.02 ± 10.33 | 89.83 ± 6.67 | 0.47 | 0.62 |
| Waist circumference | 79.68 ± 5.16 | 79.10 ± 10.11 | 79.08 ± 8.12 | 0.05 | 0.96 |
| Hip circumference | 98.12 ± 6.00 | 96.90 ± 8.73 | 97.90 ± 9.77 | 0.31 | 0.74 |
| Waist hip ratio | 0.81 ± 0.04 | 0.81 ± 0.07 | 0.81 ± 0.05 | 1.18 | 0.31 |
| Arm circumference | 30.74 ± 2.22 | 32.09 ± 10.64 | 30.43 ± 4.16 | 2.25 | 0.11 |
| Forearm circumference | 25.27 ± 1.57 | 25.44 ± 2.23 | 25.27 ± 2.54 | 0.13 | 0.88 |
| Thigh circumference | 57.48 ± 5.23 | 58.02 ± 8.17 | 57.93 ± 7.62 | 0.04 | 0.96 |
| Calf circumference | 34.35 ± 2.85 | 34.71 ± 5.38 | 34.27 ± 3.72 | 0.32 | 0.73 |

**Table 4.30: Relationship between anthropometry of Kaduna subjects and mothers education**

| Variables | Primary n= 26 Mean ±SD | Secondary n= 98 Mean ±SD | Tertiary n= 261 Mean ±SD | f value | p value |
|---|---|---|---|---|---|
| Age at menarche (years) | 13.46 ± 1.61 | 13.90 ± 1.76 | 13.57 ± 1.81 | 1.32 | 0.27 |
| Height (cm) | 159.65 ± 5.58 | 157.76 ± 5.81 | 159.65 ± 5.99 | 2.00 | 0.14 |
| Weight (kg) | 56.69 ± 9.26 | 57.49 ± 9.97 | 58.19 ± 9.73 | 0.40 | 0.67 |
| BMI ($kg/m^2$) | 22.23 ± 3.31 | 23.07 ± 3.58 | 23.01 ± 3.71 | 0.59 | 0.56 |
| Triceps skinfold (mm) | 10.81 ± 3.83 | 12.85 ± 4.69 | 12.05 ± 4.88 | 2.13 | 0.12 |
| Iliac skinfold (mm) | 11.12 ± 3.89 | 12.59 ± 4.27 | 12.27 ± 4.60 | 1.12 | 0.33 |
| Chest circumference | 89.88 ± 5.75 | 89.15 ± 8.66 | 89.64 ± 6.86 | 0.43 | 0.65 |
| Waist circumference | 79.72 ± 7.08 | 78.43 ± 8.66 | 79.31 ± 8.36 | 0.47 | 0.63 |
| Hip circumference | 96.91 ± 6.37 | 96.90 ± 7.99 | 98.15 ± 10.16 | 0.74 | 0.48 |
| Waist hip ratio | 0.82 ± 0.06 | 0.81 ± 0.06 | 0.80 ± 0.05 | 1.44 | 0.24 |
| Arm circumference | 30.38 ± 2.83 | 31.61 ± 9.03 | 30.41 ± 4.06 | 1.62 | 0.20 |
| Forearm circumference | 24.91 ± 1.90 | 25.24 ± 1.90 | 25.35 ± 2.68 | 0.41 | 0.67 |
| Thigh circumference | 57.35 ± 5.48 | 57.54 ± 7.74 | 58.13 ± 7.75 | 0.29 | 0.75 |
| Calf circumference | 34.00 ± 2.97 | 34.61 ± 4.89 | 34.28 ± 3.71 | 0.35 | 0.70 |

**Table 4.31: Relationship between anthropometry of Rivers subjects and fathers education**

| Variables | Primary n=47 Mean ±SD | Secondary n=120 Mean ±SD | Tertiary n=234 Mean ±SD | f value | p value |
|---|---|---|---|---|---|
| Age at menarche (years) | 13.47 ± 1.74 | 13.40 ± 1.86 | 13.94 ± 2.17 | 3.26 | 0.04 |
| Height (cm) | 163.81 ± 6.17 | 162.10 ± 6.41 | 162.15 ± 5.71 | 1.63 | 0.20 |
| Weight (kg) | 58.15 ± 6.83 | 58.34 ± 10.96 | 57.81 ± 9.66 | 0.09 | 0.92 |
| BMI ($kg/m^2$) | 22.57 ± 2.87 | 23.22 ± 3.86 | 22.95 ± 3.65 | 0.27 | 0.77 |
| Triceps skinfold (mm) | 13.57 ± 6.30 | 13.75 ± 4.89 | 12.76 ± 4.57 | 1.82 | 0.16 |
| Iliac skinfold (mm) | 13.94 ± 5.93 | 13.28 ± 5.18 | 12.65 ± 4.66 | 1.60 | 0.20 |
| Chest circumference | 88.44 ± 7.45 | 90.13 ± 8.49 | 89.38 ± 8.13 | 0.78 | 0.46 |
| Waist circumference | 77.55 ± 9.60 | 80.17 ± 10.51 | 79.77 ± 10.28 | 1.15 | 0.32 |
| Hip circumference | 97.28 ± 8.97 | 98.20 ± 8.93 | 101.29 ± 14.61 | 0.23 | 0.80 |
| Waist hip ratio | 0.80 ± 0.05 | 0.82 ± 0.06 | 0.81 ± 0.09 | 1.12 | 0.33 |
| Arm circumference | 27.99 ± 3.69 | 30.01 ± 4.01 | 29.35 ± 4.13 | 4.24 | 0.02 |
| Forearm circumference | 21.51 ± 3.99 | 24.32 ± 5.21 | 23.93 ± 3.26 | 8.72 | 0.000 |
| Thigh circumference | 58.12 ± 9.48 | 58.47 ± 7.68 | 57.26 ± 7.01 | 1.10 | 0.33 |
| Leg circumference | 33.37 ± 4.45 | 34.04 ± 34.04 | 33.45 ± 3.64 | 0.96 | 0.38 |

**Table 4. 32: Relationship between anthropometry of Rivers subjects and mothers education**

| Variables | Primary n=64 Mean ±SD | Secondary n=142 Mean ±SD | Tertiary n=195 Mean ±SD | f value | p value |
|---|---|---|---|---|---|
| Age at menarche (years) | 13.27 ± 1.67 | 13.27 ± 2.00 | 13.60 ± 2.16 | 3.21 | 0.04 |
| Height (cm) | 163.39 ± 6.23 | 162.52 ± 6.50 | 161.84 ± 5.49 | 1.73 | 0.18 |
| Weight (kg) | 57.17 ± 13.90 | 60.91 ± 11.01 | 60.28 ± 11.53 | 2.33 | 0.10 |
| BMI ($kg/m^2$) | 21.45 ± 5.09 | 23.07 ± 3.98 | 23.04 ± 4.43 | 3.58 | 0.03 |
| Triceps skinfold (mm) | 13.34 ± 5.85 | 13.77 ± 4.69 | 12.64 ± 4.69 | 2.24 | 0.11 |
| Iliac skinfold (mm) | 13.39 ± 5.40 | 13.43 ± 5.17 | 12.54 ± 4.69 | 1.56 | 0.21 |
| Chest circumference | 87.31 ± 7.07 | 90.07 ± 7.73 | 89.81 ± 8.71 | 2.77 | 0.06 |
| Waist circumference | 76.76 ± 9.01 | 78.95 ± 10.98 | 81.07 ± 9.93 | 4.81 | 0.01 |
| Hip circumference | 95.92 ± 8.24 | 104.62 ± 12.18 | 97.76 ± 11.46 | 1.03 | 0.36 |
| Waist hip ratio | 0.80 ± 0.06 | 0.80 ± 0.10 | 0.82 ± 0.06 | 4.10 | 0.02 |
| Arm circumference | 27.86 ± 3.79 | 30.07 ± 4.46 | 29.39 ± 3.74 | 6.71 | 0.001 |
| Forearm circumference | 21.35 ± 3.77 | 23.50 ± 5.26 | 24.74 ± 2.65 | 18.36 | 0.000 |
| Thigh circumference | 57.27 ± 8.44 | 58.68 ± 7.58 | 57.18 ± 7.15 | 1.78 | 0.17 |
| Calf circumference | 33.38 ± 3.41 | 32.49 ± 4.93 | 34.51 ± 3.09 | 11.23 | 0.000 |

# CHAPTER FIVE

# DISCUSSION

## 5.1 Description of anthropometric variables

Body mass index is the anthropometric variable frequently used in clinical research to investigate the relationship between weight excess and psychopathology. In this present study, the mean Body mass index (BMI) was 22.98 kg/$m^2$ and 22.78 kg/$m^2$ for Kaduna and Rivers States respectively. The mean BMI value of study subjects corresponds to normal BMI on the BMI reference data (Ferro-Luzzi *et al*., 1992). Results revealed that over 64.3 % of Kaduna and 63.1 % of Rivers women had normal weight. About 20 % were overweight, while 5.7 % and 7.0 % of Kaduna and Rivers women respectively were obese. The prevalence of obesity obtained in the present study was lower than those reported in USA (15 %) in females 20-65 years old, United Kingdom (9 %) in females 20-65 years and higher than that of Itally (3.9 %) in females 15-44 years old (Epstein and Higgins, 1992). However, the prevalence obtained in this study was higher than reported by Izuora (2007) in Lagos. It is assumed that areas with low prevalence of obesity may also have decrease health problems, cardiovascular diseases high blood pressure and sleep apnea (Cunningham and Mackerras, 1998; NIH, 1998).

Prevalence of underweight females in this study was lower than those reported by Madriaga *et al.* (1998) in Philippines. The differences in the prevalence of underweight obtained in the study from previous reports could be due to the age range of individuals and sample size used. Madriaga *et al.* (1998) used a larger sample size (6,079). Moreso, prevalence of overweight females in the present study (25 < BMI > 29.9) was higher than those reported by

Madriaga *et al.* (1998) and Ukegbu *et al.* (2007) in the Philippines and Nigeria respectively. However, the result of overweight females in this study is similar to that reported by Al-Sheed *et al.* (2007) in Saudi Arabia. It is presumed that the difference in overweight females obtained in both studies could be due to the methodology used, sample location and ages of individual sampled (Heald and Gong, 1999). Ukegbu *et al.* (2007) sampled secondary school boarding students, while Al-Sheed *et al.* (2007) sampled females within the age range of 6-17 years. Pre-adolescent, according Heald and Gong (1999) have been reported to have higher overweight rate.

Body height is a polygenic trait which is substantially influenced by environmental factors during fetal life, childhood and adolescence (Sinclair, 1989). Results from this study indicate that, Kaduna women were shorter than their Rivers counterparts. The possible reason for this variation in body height could be tied to both environmental and genetic difference between the two populations (Silventoinen *et al*., 2003). However, Silventoinen *et al.* (2001) have argued that, genetic factor are the most important factor contributing to geographical difference in height. In addition, some authors have reported that the standard of living during childhood influences height (Silventoinen, 2003; Steckel, 2009), women from Rivers State are believed to have access to sea food rich in protein than those from Kaduna State.

In the present study, it was observed that Rivers women were heavier than Kaduna women. The difference in weight between two populations portrays their distinctiveness and genetic potentials (Sampei *et al*., 2008). Family Socioeconomic status (SES) is an important predictor of children's overweight (Kleier *et al.*, 2009; Andgiorgish *et al*., 2012; Zadzinska *et al*., 2012). The mean weight obtained in this study is similar to that reported by Akinyemi

and Ibrahim (2009) for women in Rivers state but higher than that obtained for women in Kaduna state.

Skin fold thickness measurements are said to provide an estimate of the size of the subcutaneous fat deposit, which in turn provides an estimate of total body fat (Durnin and Rahaman, 1967). Skinfold thickness of Rivers women was observed to be higher than those from Kaduna state in this study. This implies that the average thickness of the entire subcutaneous tissue and the total body fat of Rivers women are higher than that of their Kaduna counterparts (Lukaski, 1987). Piers *et al.* (2003) argued that difference in subcutaneous fat deposit in women could result in difference in skinfold thickness. The reason for the greater skinfold thickness in women from Rivers as compared to those from Kaduna State, may not be unconnected to their less involvement in physical activities that may be strenuous and exertive in nature and also their high fat diet. Ye *et al.* (2012) and Borkan and Norris (1997), suggests that agricultural based activities and high physical exertion reduces skinfold thickness, while diet rich in protein and fat increases skinfold thickness. Variations in the distribution of subcutaneous fat occur with sex, age, ethnicity (Robson *et al.*, 1971; Durnin and Womersley, 1974; Knechtle *et al*., 2011). Huang *et al.* (2007) added that obvious difference in skinfold could be as a result of regional difference, ethnic differences, eating habits, nutrition and physical exercise.

The arm, forearm and calf circumferences of the Kaduna women was higher than that of Rivers women, while the chest, waist, hip and thigh circumference of the Kaduna women was higher than that of the Rivers women. This difference could be tied to difference in fat distribution as described by earlier investigators (Ross *et al*., 1993; Rolland-cachera *et al*.,

1997; Goran *et al*., 1998). In addition, nutrition and ethnic composition of populations has also been shown to cause changes in distribution of body dimensions (Adebisi, 2008).

In this study, the hip (HC) and waist circumferences (WC) of women from Rivers State was observed to be greater than those from Kaduna State. The WC of women in this study is lower than that reported by Akarolo-Anthony *et al.* (2013). Fat deposit in women differs across ethnic groups (Lear *et al*., 2007), it has been presumed that hormones influence fat deposit and distribution in this study subjects. Besides, hip circumferences are associated with varied disease conditions especially cardiovascular diseases in women (Lissner *et al*., 2001; Heitmann *et al*., 2004; Yusuf *et al*., 2005; Canoy *et al*., 2007; Parker *et al*., 2009). According to Marwick (1991), women with WHR of 1.0 are obese. However, the waist hip ratio of women in this study is 0.80. This indicates that, these women are not obese, and may likely have increased fertility rate (Wass *et al*., 1997; Kirchengast and Hubes, 2004), less menstrual irregularities (Hartz *et al*., 1984) and higher concentration of sex hormone binding globulin, which binds to testosterone and keeps it inactive biologically (Santoro *et al*., 2005).

Muscle mass of women from Rivers State was higher than that of Kaduna women, implying that Rivers women are likely to be healthier than Kaduna women, since increased muscle mass is a protective factor for depression and anxiety (Wallymahmed, 1997; Wagner, 1998; Gubata *et al*., 2013). Barlett *et al.* (1991) tied difference in muscle mass to be associated with race, physical activity and genetics. The mean muscle mass from women in this study was higher than that reported by Akarolo-Anthony *et al.* (2013), while their visceral fat was higher than that observed in this present study.

Besides, a higher body fat percentage at low BMI in adult Rivers women compared with Kaduna women was observed in this present study. This difference could be as a result of differences in body build (Swinburn *et al*., 1996; Luke *et al.*, 1997; Deurenberg *et al*., 2000), more specifically, differences in relative leg length and differences in slenderness and level of physical activity (WHO, 2004). Some authors have also reported a higher body fat percentage at a lower BMI (Deurenberg *et al*., 1999). The percentage body fat of Rivers women is significantly higher than of Kaduna women, implying that the total body water of Rivers women will be lower than that of the Kaduna women (Wang *et al*., 1999).

In the present study, the physique rating of Kaduna and Rivers women was 5.31 and 5.10 respectively, implying that these women have average body fat and average muscle mass, but there was no significant difference. In addition, the visceral fat (fat in the abdominal cavity surrounding vital organs of the trunk/abdominal region) of women from Rivers state was higher than their Kaduna state counterparts. This difference could be tied to genetics (Hamdy *et al*., 2006), besides genetic factor, environmental factors, lack of physical activity, excessive intake of sucrose and saturated fat could also be a possible reason (Hamdy *et al*., 2006).

The bone mass value obtained from women in Rivers State in this study was slightly lower than those obtained from women from Kaduna State. The observed difference in bone mass ratio observed from women in these two states depicts the type of diet available in these states. According to Macdonald *et al.* (2004), dietary choices and nutrition are associated

with major modulators of bone mass density (BMD). Likewise genetics and environmental factors have been shown to influence bone mass (Prentice, 2001; Livshits *et al*., 2004; Zalloua *et al*., 2007). Therefore, it is assumed that the higher bone mass obtained in women from Kaduna state may be due to the consumption of milk from animal origins as compared to women in Rivers State were sea food predominates. Ortiz *et al.* (1992) reported that population with greater skeletal muscle have higher bone mass density than population with lesser skeletal muscle mass, while Wagner and Heyward (2000) reported that an increase in circulation of oestrogen may contribute to greater secretion of growth hormone which in turn led to an increase in bone mass. This implies that Kaduna women probably have a greater skeletal muscle mass and more circulating oestrogen than their Rivers counterparts. Langsetmo *et al.* (2008) reported that the possible explanation for the geographic variation in bone mass include genetic determinants, differences in sun exposure and water fluoridation, differences in demographic and lifestyle variables.

## 5.2 Relationship between anthropometric variables, body composition and depression during menstruation

This study also examined if anthropometric parameters could predict existence of depressive symptoms during menstruation in the study population. Results have demonstrated an association between anthropometric parameters and depression in Kaduna women during menstruation, implying that the level of prostaglandins E1 which is meant to be highest during menstruation is low. The biological cause of depression has been reported to be a genetic inability to manufacture enough prostaglandin E1 (PGE 1), an important brain

metabolite derived from essential fatty acid (Manouchehr, 2009). This may be as a result of an inborn deficiency in omega-6- essential fatty acids.

However, association between anthropometry and depression does not exist except for calf circumference in Rivers women. The possible reason for this could be that the Rivers women are more exposed to sea food which is rich in essential fatty acids from which prostaglandin is derived, implying that the level of prostaglandins (PGE1) is likely to be higher in Rivers women than their Kaduna counterparts. Hoffmire *et al.* (2012) argued that, diet rich in fish, which is the major source of omega-3-poly saturated fatty acid EPA and DHA, reduces depressive symptoms in clinical trials. Probably, the cortisol level is higher in Kaduna women than the Rivers women, knowing that depressed persons experience dysregulation of the hypothalamic –pituitary-adrenal axis which leads to high cortisol level ( Deuschle *et al*., 1998).

BMI associated with different categories of depression in Kaduna women only. This difference in results could be as a result of culture and diet (Kheirouri *et al*., 2014), and diet. Cultural aspect of a community contributes to the risk of depression, in communities were overweight is considered as a positive norm, the risk for depressive symptom is low (Li *et al*., 2004; Yu *et al*., 2011), most of the tribes in Rivers State see overweight as a positive norm, thus, the risk of depression will be low. Interestingly, several surveys have observed positive association between obesity and depression (Onyike *et al*., 2003; Simon *et al*., 2006; Pan *et al*., 2012), which is in agreement with results obtained in Kaduna women and no association in other surveys (Guedes *et al*., 2013; Hammerton *et al*., 2014), which is in agreement with that of Rivers women.

Waist Circumference (WC), an indirect measurement of adiposity in clinical practise (Preiss *et al*., 2013; Luppino *et al*., 2010), associated significantly with categories of depression in Kaduna women, but showed no association with depression in Rivers women, in the present study. There are controversies concerning the association between WC and depression. Although some authors reported association (Katz *et al.,* 2000; Moreira *et al*., 2007), which was consistent with result obtained in Kaduna women; some authors (Turley *et al*., 2006 and Ho *et al*., 2008), reported no association which was also consistent with result obtained in Rivers women.

Weight is an anthropometric measure of the degree of heaviness, showed no association with depression. This finding is not in agreement with earlier findings (Han e*t al*., 1998 and Carpenter *et al*., 2000). In their studies, Han e*t al.* (1998) and Carpenter *et al.* (2000), an association between relative body weight and major depression among women, implying that the muscle mass of their study population is lower than that of this study. This difference could be attributed to difference in muscle mass of study population.

In the current study, no association was observed between height and depressive symptoms which is in harmony with some finding (Bjerkeset *et al* ., 2008; Kheirouri *et al*., 2014).

### 5.3. Correlation between anthropometric variables and body composition

Relationships between various anthropometric parameters indicated correlations between some of anthropometric variables. Association ($p<0.001$) was observed between weight and

arm circumference; weight and height; which indicates that these variables are likely dependent on each other, this finding is consistent with the report of Nwokoro *et al.* (2006) in Benin City. Nwokoro *et al.* (2006) also reported a correlation between age and height, age and arm circumference, and height and arm circumference, this is similar to the results obtained for Rivers state women in the present study, but no correlation was observed between age and height, age and arm circumference among Kaduna State, this may be due to ethnic differences (Danborno and Oyibo, 2008), since women from Rivers and Benin are predominantly Ijaws while Kaduna women are predominantly Hausa. Results from this study indicates that chest circumference and arm circumference correlated significantly with weight. This is similar to the findings of Khadivzadeh (2002) among women in Iran.

The present study showed that BMI, an anthropometric index for measuring obesity had a significant negative correlation with total body water and physique rating. The implication of these results is that individuals with high BMI are likely to have low total body water and physique rating. It was also observed that, BMI correlated significantly with triceps and iliac skinfold. This implies that triceps and iliac skinfold can be used as measures for predicting BMI. This was consistent with the finding of Kapoor *et al.* (2012). Moreso, BMI significantly correlated with weight. This agrees with previous reports (Garrow and Websters, 1985; Amber *et al.*, 2000) and disagrees with Abernathy *et al.* (1996). In addition, BMI also correlated with body circumferences like calf and upper arm circumference. This result was similar to that reported by Khadivzadeh (2000). This implies that any of the following parameters (triceps and iliac skinfold, calf and upper arm circumference) can likely serve as a predictor of BMI.

Percentage body fat (% BF) has been observed to correlate strongly with muscle mass, iliac and triceps skinfold in this study, which implies that, iliac and triceps skinfold are better predictors of obesity than weight alone as a suitable measure of obesity. This was consistent with several other authors (Sarria *et al*., 2001;Razak *et al* ., 2005; El-masry and Hassan, 2010), and also with some authors in Nigeria Cole *et al* (1997) in Ibadan, Osisanya *et al* (2002) in Lagos, Onimawo *et al* (2004), and Ogechi *et al* (2006) is South East Nigeria. In addition, Rolland- Cachera (1993); Nooyens *et al*. (2007); Freedman *et al*. (2009) argued that, triceps skinfold can be used as a measure of total body fat.

Besides, it was also observed that a significant positive correlation exits between % BF and age. This implies that, the % BF of an individual is likely to increase with age. This was in agreement with earlier studies on percentage body fat and age (Gallagher *et al*., 2000; Kyle *et al*., 2001). % BF was also observed to have significant positive correlation with muscle mass, implying that as muscle mass increases, % BF increases (Forbes, 1987). In addition, a positive correlation was observed between WHR, % BF and BMI. This implies that, an individual with a high WHR is likely to have a high BMI and high % BF. This finding was consistent with earlier report (Ogechi *et al*., 2007). Gill *et al* (2003) went further to buttress the fact that BMI, WHR and % BF have a significant role in the identification of an obese or overweight individual.

According to Gill *et al.* (2003), BMI, WHR and WC have been shown to have a significant role in the identification of obese and overweight individuals. Results from this study, revealed relationship between weight, BMI, WHR and WC. Lean and Han (1996) reported that, WC can be used to predict most closely the total body fat, which was similar to the

result obtained in Rivers women. WC correlated significantly with WHR, BMI and % BF, the strength of correlation was higher with % BF, which was in agreement with previous reports in India Ghosh and Bandyopadhyay, (2007); Charkraborty and Bose, (2009). The strength of correlation between waist circumference and BMI was higher than that between waist circumference and waist hip ratio. This is in agreement with the report of Kurpad *et al.* (2003). Molarius *et al.* (1999) argued that WC had a better efficacy in detecting overweight than BMI, while Moy and Atiya (2003) argued that WC had a better efficacy in detecting overweight than WHR. However, from the present studies, BMI correlated more with weight than WHR, which was similar to the report of Bose (2006).

Snijder *et al.* (2003) reported a negative association between thigh circumference and waist circumference, while from the present study a positive correlation was observed, implying that the thigh circumference of Kaduna and Rivers women increases with increasing WC. WC correlated significantly with visceral fat rating and WHR, the strength of correlation observed was higher between waist circumference and visceral fat rating than WHR, implying that waist circumference can predict visceral fat rating. This was in agreement with the reports of Pouliot *et al.* (1994) and Dobbelsteyn *et al.* (2001).

Results obtained from this study demonstrated that menarcheal age had no significant positive correlation with height, WC and WHR, but was significantly correlated with waist chest ratio at a significant level of $p<0.05$, which was in contrast with the findings of Kim *et al* (2010) and Farahman *et al.* (2012) . Other studies in Nigeria, Nwokocha (2005); Raji *et al.* (2006); Goon *et al.* (2010) and, Bagga and Kulkarni (2000) in India, have reported an inverse relationship between height and age at menarche. However, Elizando (1992) and

Kabir *et al.* (2007) reported a positive association which was similar to that obtained from this study.

Stark *et al.* (1989) and Elizando (1992) reported a positive correlation between menarche and hip circumference, a negative correlation between menarche, WC and triceps skinfold, which was in agreement with the reports of women from Rivers state except for WC which correlated positively with menarcheal age.

Several studies have shown that women with heavy body weight, high BMI, more body fat and greater height experienced early in menarche, which is a negative correlation (Kaplowitz *et al*., 2001; Freedman *et al*., 2003; Pierce and Leon, 2005). The present study clearly demonstrated that menarcheal age had a negative relationship with BMI and %BF, however, a positive association was observed between height, weight and menarcheal age among Kaduna state women. Raji *et al.* (2006); Danborno and Oyibo (2008) and Goon *et al.* (2010) have reported a negative correlation between BMI and menarcheal age. Among Rivers State women, menarcheal age had a positive correlation with height and negative correlation with weight and BMI. Onland moret *et al.* (2005); Biro *et al.* (2012) reported positive correlation between menarcheal age and height. Meyer *et al.* (1990) and Kim *et al.* (2010) reported positive correlation between weight and menarcheal age, which was in agreement with the finding of this study.

**5.4 Descriptions of reproductive characteristics**

The most striking event in the whole process of female puberty is the onset of menstruation (Chukwujekwu *et al*., 2014). Oduntan *et al.* (1976) reported the age at menarche for urban girls in Nigeria as 13.7 years. In Rivers State of Nigeria (South-South Nigeria), Ikaraoha *et*

*al.* (2005) also reported a mean age at menarche of 13.89 years for the urban secondary school girls; in Maiduguri (North-East Nigeria), Jacks *et al*. (2005) reported a mean age of 13.6 years for secondary school girls. From this study, the mean menarcheal age of Kaduna and Rivers women is 13.7. Kaprio *et al*. (1995) reported that the variability of age at menarche is mainly due to genetics, ethnic affiliation, environmental and nutritional factors.

At age 15, about 86% of Kaduna women and 80% of Rivers women have reached their age at menarche. An inverse relationship was reported between milk consumption and menarcheal age (Potdar and Raji, 2012), Kaduna women feed more on cow milk than Rivers women, which could be the possible reason for this difference. In addition, Danborno and Oyibo (2008) posited that, tribal difference may contribute to difference in age at menarche. Therefore, it could be presumed that, the difference in menarcheal age observed in Kaduna and Rivers States women in this study could be due to tribal differences, ethnic affiliation and nutrition of studied subjects (Kaprio *et al* ., 1995; Danborno and Oyibo, 2008; Potdar and Raji, 2012).

This study found large population differences in the menstrual bleeding, more specifically in the duration, regularity and length of menstrual cycle and pains during menstruation. Bleed length and bleed amount is presumed to reflect the characteristics of the preceding ovarian cycle (Harlow and Campbell, 1996). In this study, women experienced menstrual flow of ≤3 to ≥7 days, with 65.4 % of the Kaduna women and 80.8 % of Rivers women experiencing a flow of about four to six days. Harlow and Campbell (1996) posited that, the difference in the duration of menstrual bleeding in different ethnic groups could be as a result of variation in any of these factors: uterine size and structure, steroid hormone production, uterine sex

steroid receptors, and prostaglandin production and sensitivity. McMahon (1973) argued that ethnic difference in the timing of pubertal maturation has nothing to do with duration of bleeding or probability of heavy bleeding. It has been speculated that, variation in menstrual bleeding pattern reflects differences in the ratio of prostaglandins $PGE_2$ and $PGF_2$ (McLanchlan *et al.,* 1987; Poyser, 1995). In addition, Hornsby *et al.* (1994) reported that women experiencing shorter and lighter bleed were exposed prenatally to diethylstilbestrol, while some authors reported that a womans duration of menstrual bleeding is dependent on her geographical location (Belsey and Peregoudov, 1988; WHO, 1981; 1986).

Besides, some authors have reported that majority of their subject experienced bleeding duration of 3-5 days in Portugal (Padez and Rocha, 2003) and 4-8 days (Harlow and Ephross 1995; Cleckner-Smith *et al.,* 1998). Padez and Rocha (2003) have argued that this difference could be as a result of the difference in methodology.

A regional difference in menstrual bleeding characteristics was observed in this study. Data obtained revealed that, Kaduna women experienced shorter and longer bleeding episodes than their Rivers counterparts. This marked difference in the length of bleeding episodes could be as a result of significant shift in population distribution of bleed characteristics (Sioban and Halow, 1995). WHO (1983) have attributed this difference in bleed characteristics to difference in the timing of follicular growth, because some women have a significantly shorter follicular phase and a significantly longer luteal phase. Regional differences in hormone metabolism have been reported by some authors (Williams and Goldzieher, 1980), which may be cause of the differences seen in the present study.

In addition, association between circumferences and menstrual flow duration was observed. Rivers women with larger hip circumference and forearm circumferences had a menstrual flow of ≤ 3 days; women with smaller hip circumference and forearm circumferences experienced a menstrual flow of 4-6 days. Some authors have also reported an association between anthropometry and menstrual flow: Janssen *et al.* (1997) and Shapley *et al.* (2004) reported an association with age and duration of flow; Harlow and Campbell, (1999) reported an association between weight, diet and stress with heavy bleeding; Van voorhis *et al.* (2008) reported an association between BMI and duration of flow.

Differences in menstrual cycle were observed between Kaduna women and Rivers women. Majority of Kaduna women (65.4 %) and Rivers women (67.3 %) experienced a menstrual cycle of 24 to 29 days. Variability in the menstrual cycle length is determined largely by variation in follicular phase length (Waller *et al*., 1998; Fehring *et al*., 2006), with shorter cycles reflecting shorter follicular phase. In this study, fewer women (23.3 % Kaduna and 21.2 % Rivers) reported a menstrual cycle of less than or equal to 23 days, implying that the number of women with anovulatory cycle in this study was less. Harlow (2000) have argued that women with a menstrual cycle less than or more than 25-35 days are more likely to have anovulatory cycles, and reduced fecundity (Kolstad *et al*., 1997). In addition, Wise *et al* (2011) reported an inverse relationship between short cycle and fecundity.

In a study by Vicdan *et al.* (1996), majority of the subjects experienced a menstrual cycle of 20 and 35 days in Turkey, while Padez and Rocha (2003) reported that majority of their subjects experienced a menstrual cycle of 29 days in Portugal. Harlow *et al.* (2002) attributed the cause of this difference in menstrual cycle length to variation in the length of the

follicular phase and that the follicular phase length depends on a process of maturation and selection of primary follicles. Harlow and Ephross (1995) argued that stress influences the length of a woman menstrual cycle, since it is able to affect ovarian function.

In this study, menstruation was regular in 80.4 % Kaduna women and 71.8 % of Rivers women. This implies that majority of the subjects have normal ovulatory cycles and are four times likely to become pregnant than those with irregular menstrual cycle (Windham *et al.*, 1999). Kaduna women are likely to have a higher reproductive success than Rivers women, since the number of women with regular menstrual cycle in Kaduna was more than that of Kaduna. Cycle irregularity in adulthood has been associated with anovulation and infertility (Jessen *et al*., 1999; Rowland *et al*., 2002). Results have also shown that, the number of subjects who suffered from irregular menstruation is relatively few (19.6 % Kaduna women and 28.2 % Rivers women).

Numerous studies have indicated that a considerable proportion of women of reproductive age suffer from menses associated health problems such as irregular menstrual cycle, premenstrual symptom (PMS) and dysmenorrhoea (Dawood, 1990; Bloch *et al*., 1997; Dickerson *et al*., 2003). In the present study, 91 % of subjects experienced dysmenorrhoea, 100 % Kaduna women and 95 % of Rivers women suffered from PMS. The possible reason for the in menstrual disorders between the two geographical regions could be as a result of regional differences in hormone metabolism (William and Goldzieher, 1980). Painful menstruation was serious enough to affect the daily activities or academic attendance in 24.3% of Kaduna and 29.7 % of Rivers undergraduate women, thus making these women

to skip lectures. This is similar to a study which reported 75 % of girls experience some problems associated with menstruation (Lee *et al*., 2006).

Dysmenorrhoea, sometimes referred to as a broad panorama of symptomatology, is appropriately defined as menstrual pain, cramping or backache associated with menstrual bleeding. In this study, about 91 % of the subjects experienced menstrual pains; some experienced this pains monthly, while others sometimes. According to Pickles (1957), patients with primary dymenorrhea have higher $PGF_{2\alpha,}$ since $PGF_{2\alpha}$ is the menstrual stimulant that causes uterine contraction. Dysmenorrhoea was observed to be the major cause of school absenteeism among undergraduate women in this study. About 24.3 % of Kaduna and 29.7 % of Rivers undergraduate women experienced menstrual pain that lead to momentary withdrawal from academic work. Studies have reported an association between severe menstrual pain and absenteeism from academic work (Svanberg and Ulmsten, 1981; Andersch and Milsom, 1982, Thomas *et al*., 1990).

In addition, Kaduna women with WHR < 0.80 do not experience dysmenorrhea, while those with WHR ≥ 0.80 experienced menstrual pain. Haidari *et al.* (2011) also reported an association between WHR and primary dysmenorrhea. However, Rivers women with large calf and forearm, smaller thigh and chest circumference do not experience menstrual pain.

PMS is a common disorder in young and middle aged women characterised by cyclic occurrence in the luteal phase of the menstrual cycle (Antai *et al*., 2004). 100 % of Kaduna women and 95 % of Rivers women reported at least one PMS symptom in every menstrual cycle, which was higher than a study in Nigeria (72 % as reported by Thomas *et al*., 1990

and Odujinrin Ekinwe, 1991 and; 85.5 % by Antai *et al*., 2004 in Calabar) and in Ethiopa 72 % (Sule and Ukwenya, 2007), in India which reported a prevalence of PMS as 67 % (Anandha *et al*., 2011). Variation in the prevalence rates in PMS studies could be attributed to difference in diagnostic criteria (Bakhshani *et al*., 2009).

The prevalence of PMS among the Kaduna and Rivers women were more comparable than the report of Danborno and Oyibo, (2008). The prevalence of PMS decreased from pimples and puffy face to increased appetite, while Danborno and Oyibo, (2008) reported the prevalence of PMS to decrease from lower abdominal discomfort to increased appetite. Comparing the different prevalence of PMS, Kaduna women tend to suffer more from symptoms of PMS than the Rivers women. The prevalence of discomforts experienced during menstruation decreases from increased breast size to anxiety. Comparing the different prevalence of discomforts experienced during menstruation, Kaduna women tend to suffer more than their Rivers counterparts.

### 5.5. Association between anthropometric variables and parental education

Age at menarche of Rivers women is significantly associated with parental education, and the possible reason for this association could be tied to the fact that maternal education is a good proxy for standard of living (Orden *et al*., 2011). Also, the socio-economic status is a strong predictor of menarche (Chavarro *et al*., 2004). Abioye-Kuteyi *et al.* (1997) reported that age at menarche was lowest in girls from high socio-economic households and school girls from the upper socio-economic class reached menarche 11 months earlier than their lower socio-economic counterparts. In the present study, the anthropometric parameters of Kaduna women showed no significant association with parental education.

Age at menarche, BMI, waist circumference, WHR, arm, forearm and calf circumference of Rivers women showed association with maternal education. BMI and WC were reported to be associated to parental education (Gurzkowska *et al*., 2014).

# CHAPTER SIX

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 6.1 Summary

Rivers State women presented higher anthropometric variables than their Kaduna State counterparts, except for arm, forearm and calf circumference. Rivers women are taller, weightier and have thicker skinfold than the Kaduna women. No difference was observed between the chest, hip, waist and thigh circumference of Kaduna and Rivers women.

Rivers women also presented higher body composition parameters than their Kaduna State counterparts, except for total body water, physique rating and bone mass. The amount of calorie needed to meet the energy requirement in Rivers women was higher than that of the Kaduna women. Muscle mass of Rivers women was higher than that of Kaduna women, implying that Rivers women are less prone to depression.

Difference was also observed in menstrual characteristics of Kaduna and Rivers women except for average menstrual cycle. Normal ovulatory cycle (regular menstruation) was higher in Kaduna women, implying that Kaduna women are likely to have higher reproductive success than Rivers women.

Relationship between body circumferences and menstrual characteristics was observed. Rivers women with smaller hip circumference experienced menstrual flow of 4-6 days, while those with larger hip and forearm circumference experienced a menstrual flow of ≤ 3days. Kaduna women with WHR ≤ 0.80 do not experience dysmenorrhea, while those with WHR ≥ 0.80 do experience dysmenorrhea. Rivers women with larger calf and forearm circumference do not experience dysmenorrhea. In addition, Rivers women with smaller chest and forearm circumference do not experience dysmenorrhea.

The prevalence of severe depression was higher among Kaduna women. Minimal, moderate and mild depression was higher among Rivers women than their Kaduna counterparts. A relatively larger number of women who experienced menstrual pain often were absent from studies during menstruation.

## 6.2 Conclusions

There are differences between anthropometric parameters, body composition parameters and menstrual characteristics of women from Kaduna and Rivers States. There are relationships between anthropometric parameters and body composition, anthropometric parameters and menstrual characteristics, body composition and menstrual characteristics.

## 6.3 Recommendations

In the light of the findings of this study, the following recommendations are made:

I. Further studies are required to find out if menstrual cycle becomes normal within the first six months or a year after menarche.

II. Further investigation to determine if menstrual pain exceed the first, second or third day of menstruation.

III. Further work to be carried out to ascertain if premenstrual symptom can be experienced in every menstrual cycle.

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## Appendix I

**Questionnaire for Anthropometric and Menstrual Characteristics of girls from Kaduna and Rivers State of Nigeria**

**Biodata of Respondent**

i. Research ID--------
ii. Sex----------
iii. Age ----------
iv. Date of Birth----------
v. Birth Weight ----------
vi. State of Origin----------
vii. Tribe----------
viii. Marital Status----------
ix. Birth Order (e.g 2nd, 3rd etc)---------
x. Number of Siblings: Males ----- Females------

**Socioeconomic Background**

i. Father`s Occupation: Working/business/others----------
ii. Mother`s Occupation : Working/business/others----------
iii. Father`s level of education : Below Secondary/Secondary/Above Secondary-----
iv. Mother`s level of education: Below Secondary/Secondary/Above Secondary----

**Anthropometric Parameter Measurements**

i. Age of Menarche ------
ii. Weight (kg)----------
iii. Height (cm)----------
iv. BMI ($Kg/m^2$)----------
v. Skinfold Thickness(mm) ----------
vi. Chest Circumference----------
vii. Waist Circumference (cm) ----------
viii. Hip Circumference (cm) ----------
ix. Upper arm Circumference (cm) ---------
x. Fore arm Circumference----------
xi. Thigh Circumference (cm)----------

**Body Composition Parameters Measurements**

i. FFM (kg) ---------
ii. Fat Mass (kg) ------
iii. Muscle Mass (kg)---------
iv. Fat% (%) ----------
v. TBW (%)----------
vi. Bone Mass (kg) -------
vii. BMR (KJ)----------
viii. Metabolic Age--------
ix. Visceral Fat Rating-------
x. Physique Rating--------

| MENSTRUAL HISTORY |
|---|
| At what age did you experience your first menses |
| Do you use contraceptive? Yes/ No |
| Is your menstrual cycle Regular? Yes/ No |
| Does your of menstrual cycle Skip? Yes/ No |
| Nature of menstrual discharge : Fluid or Fluid + clot |
| Have you been absent from school due to menstrual discomfort ? Yes or No |
| Duration of peak menstrual discharge (days) : 1 or 2 |

| WHAT IS THE AVERAGE LENGTH OF MENSTRUAL CYCLE (in days) |
|---|
| 21-23 |
| 24-26 |
| 27-29 |
| 30-32 |

| DURATION OF MENSTRUAL FLOW (in days) | |
|---|---|
| i | Less than 2 days |
| ii | 2 |
| iii | 3 |
| iv | 4 |

| | |
|---|---|
| v | 5 |
| vi | 6 |
| vii | 7 |
| viii | More than 7 |

| MODE OF CLEANING THE GENITALS DURING MENSTRUAL FLOW | |
|---|---|
| i | With Water |
| ii | With Water and toilet soap |
| iii | With Water and antiseptic soap |

| WHICH OF THE FOLLOWING HAVE YOU OBSERVED DURING MENSTRUATION? | | | |
|---|---|---|---|
| i | White Discharge | iv | Burning Sensation |
| ii | Itching around the genitals | v | Continuous linkage of Urine |
| iii | Vaginal Odour | vi | Blisters |

| DO YOU EXPERIENCED DYSMENORRHEA( pains during menstruation)? | |
|---|---|
| i | Sometimes |
| ii | Often |
| Iii | Never |

| WHICH OF THE FOLLOWING SYMPTOMS DO YOU EXPERIENCE DURING MENSTRUATION? | | | |
|---|---|---|---|
| A. | Increase in breast size | F. | Anxiety |
| B. | Feeling heavy | G. | Depression |
| C. | Weakness | H. | Lower abdominal pain |
| D. | Painful breast | I. | Headache |
| E. | Nausea | j. | Back pain |

| WHICH OF THE FOLLOWING SYMPTOMS DO YOU EXPERIENCE BEFORE MENSTRUATION (PREMENSTRUATION)? | | | |
|---|---|---|---|
| A. | Lower Abdominal Discomfort | E. | Muscle Or Joint Pain |
| B. | Pimples And Puffy Face | F. | Increased Appetite |
| C. | Tender Or Painful Breast | G. | Feverish Feeling |
| D. | Act Aggressively | | |

**HOW DO YOU FEEL DURING MENSTRUATION?**

**A. Sadness**

0. I do not feel sad

1. I feel sad much of the time.

2. I am sad all the time.

3. I am so sad or unhappy that I can't stand it.

**B. Pessimism**

0. I am not discouraged about my future.

1. I feel more discouraged about my future than I used to be.

2. I do not expect things to work out for me.

3. I feel my future is hopeless and will only get worse.

**C. Past Failure**

0. I do not feel like a failure.

1. I have failed more than I should have.

2. As I look back I see a lot of failures.

3. I feel I am a total failure as a person.

**D. Loss of Pleasure**

0. I get as much pleasure as I ever did from the things I enjoy.

1. I don't enjoy things as much as I used to.

2. I get very little pleasure from the things I used to enjoy.

3. I can't get any pleasure from the things I used to enjoy.

**E. Guilty Feelings**

0. I don't feel particularly guilty.

1. I feel guilty over many things I have done or should have done.

2. I feel guilty most of the time.

3. I feel guilty all the time

**F. Punishment Feelings**

0. I don't feel I am being punished.

1. I feel I may be punished.

2. I expect to be punished.

3. I feel I am being punished.

**G. Self-Dislike**

0. I feel the same about myself as ever.

1. I have lost confidence in myself.

2. I am disappointed in myself.

3. I dislike myself.

**H. Self-Criticalness**

0. I don't criticize or blame myself more than usual.

1. I am more critical of myself than I used to be.

2. I criticize myself for all of my faults.

3. I blame myself for everything bad than happens.

**I. Suicidal Thoughts or Wishes**

0. I don't have any thoughts of killing myself.

1. I have thoughts of killing myself, but I would not carry them out.

2. I would like to kill myself.

3. I would kill myself if I had the chance

**J. Crying**

0. I don't cry anymore than I used to.

1. I cry more than I used to.

2. I cry over every little thing.

3. I feel like crying, but I can't.

**K. Agitation**

0. I am no more restless or wound up than usual.

1. I feel more restless or wound up than usual.

2. I am so restless or agitated that it's hard to stay still.

3. I am so restless or agitated that I have to keep moving or doing something.

**L. Loss of Interest**

0. I have not lost interest in other people or activities.

1. I am less interested in other people or things than before.

2. I have lost most of my interest in other people or things.

3. It's hard to get interested in anything.

**O. Loss of Energy**

0. I have as much energy as ever.

1. I have less energy than I used to have.

2. I don't have enough energy to do very much.

3. I don't have enough energy to do anything.

**P. Changes in Sleeping Pattern**

0. I have not experienced any change in my sleeping pattern.

1. I sleep somewhat less than usual. –or– I sleep somewhat more than usual.

2. I sleep a lot less than usual. –or– I sleep a lot more than usual.

3. I sleep most of the day. –or– I wake up 1-2 hours early and can't get back to sleep.

**Q. Irritability**

0. I am no more irritable than usual.

1. I am more irritable than usual.

2. I am much more irritable than usual.

3. I am irritable all the time.

**R. Changes in Appetite**

0. I have not experienced any change in my appetite.

1. My appetite is somewhat less than usual. –or– My appetite is somewhat greater than usual.

2. My appetite is much less than usual. –or– My appetite is much greater than usual.

3. I have no appetite at all. –or– I crave food all the time.

**S. Worthlessness**
0. I do not feel I am worthless.
1. I don't consider myself as worthwhile and useful as I used to.
2. I feel more worthless as compare to other people.
3. I feel utterly worthless.

T. **Indecisiveness**
0. I make decisions about as well as ever.
1. I find it is more difficult to make decisions than usual.
2. I have much greater difficulty in making decisions than I used to.

3. I have trouble making any decisions

**U. Loss of Interest in Sex**

0. I have not noticed any recent change in my interest in sex.

1. I am less interested in sex than I used to be.

2. I am much less interested in sex now.

3. I have lost interest in sex completely.

**V. Concentration Difficulty**

0. I can concentrate as well as ever.

1. I can't concentrate as well as usual.

2. It's hard to keep my mind on anything for very long.

3. I find I can't concentrate on anything.

**W. Tiredness or Fatigue**

0. I am no more tired or fatigued than usual.

1. I get more tired or fatigued more easily than usual.

2. I am too tired or fatigued to do a lot of the things I used to do.

3. I am too tired or fatigued to do most of the things I used to do

## Appendix II

## CONSENT TO PARTICIPATE IN RESEARCH

## ANTHROPOMETRY, BODY COMPOSITION AND REPRODUCTIVE CHARACTERISTICS OF WOMEN FROM KADUNA AND RIVERS STATE (Aged 18-30 years)

### INTRODUCTION

You are kindly being asked to participate in a research study conducted by Victor, Progress Dakuro for a Master of Science degree under the supervision of Dr. B. Danborno, and Dr. S.S Adebisi, from the Department of Human Anatomy, Faculty of medicine, Ahmadu Bello University, Zaria.

If you have any questions or concerns about the research, please feel free to contact: Victor, Progress Dakuro, Faculty of Medicine, Tel: 08064823793, Dr. B. Danborno, Faculty of Medicine, Tel: 08139429300

### PURPOSE OF THE STUDY

The purpose of this preliminary study is primarily to establish a reference data for anthropometric variables, body composition and reproductive characteristics of women from Kaduna and Rivers state (Aged 18-30 years). However, it is also expected that the results might implicate certain anthropometric indices, ethnicity, demography, and socio-economic factors that affect the menstrual characteristics within these designated geographical locations. This study is a partial requirement for the award of M.Sc. degree in Department of Human Anatomy in Ahmadu Bello University, Zaria.

You are being invited because you are a 18-30 years old female secondary school stude

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

**What will happen during this study?**

Information pertaining to menstrual characteristics (age at menarche, duration of menstrual flow, average menstrual cycle, peak menstrual flow and regularity of menstruation), demographics (i.e. age, ethnicity, etc.), and premenststrual symptoms will be collected using a questionnaire. Your anthropometric measurement will also be taken.

**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, when published will help in establishing reference data for anthropometric variables, body composition and reproductive characteristics between the two geographical locations; and how it is influenced by anthropometric indices, ethnicity, environment, demography, and parental level of education. This knowledge will enable anthropologist, biomedical scientist and clinicians to access the influence of environment and genetics.

**WILL THERE BE ANY COSTS TO ME?**

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

**PAYMENT 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 this study. 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 do not want to answer and still remain in the study. The investigator may withdraw you from this research, if circumstances arise that warrant 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. This study has been reviewed and received ethical clearance through Ahmadu Bello University Research Ethics Board. If you have any questions regarding your rights as a research participant, you can obtain further information about the research or voice your concerns to:

Dr. B. Danborno,
Department of Anatomy,
Faculty of Medicine,
Ahmadu Bello University.
Tel: 08139429300
E-mail: sbdanborno@yahoo.com

**SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE**

I have read the information provided for the study "**Anthropometry, body composition and reproductive characteristics of women from Kaduna and Rivers state (aged 18-30 years)**" as described herein. I have been given a copy of this form.

_____

Name of Participant

_____ _____

Signature of Participant Date

**SIGNATURE OF WITNESS**

_____

Name of Witness

_____ _____

Signature of Witness Date

**Appendix III**

## Anthropometry, body composition and reproductive characteristics of women from Kaduna and Rivers state (aged 18-30 years)

**Name**: VICTOR, PROGRESS DAKURO

**Position:** MSc Student

**Contact Address:** Department of Anatomy, Faculty of Medicine, Ahmadu Bello University, Zaria

1. I confirm that I have read and understood the information sheet for the above st and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. ☐
3. I agree to take part in the above study. ☐
4. I agree to the use of anonymised quotes in the publications. ☐

| _____ | _____ | _____ |
|---|---|---|
| Name of Participant | Date | Signature |
| _____ | _____ | _____ |
| Name of Researcher | Date | Signature |

## APPENDIX IV


**Ahmadu Bello University Teaching Hospital**

P.M.B. 06, Shika - Zaria, Kaduna State, Nigeria. 069-876305

website: www.abuth.org abuthshika@yahoo.com Abuthshika@gmail.com

Chairman of Board:

Chief Medical Director: **DR. LAWAL KHALID,** *MBBS, FMCS, FWACS, FRCS(ED) mni*

Chairman, Medical Advisory Committee: **DR. ABDULLAHI MOHAMMED,** *MBBS, FWACP FICS*

Director of Administration: **BARR. ISHAK BELLO,** *LL.B, BL, LL.M, PGDM, AHAN, FCAI*


***Our Ref:*** ABUTH/HREC/TRG /36 25th September, 2013

***ABUTH HREC FULL ETHICAL CLEARANCE CERTIFICATE***

Re: ***"Anthropometric and menstrual characteristics of girls from Kaduna and Rivers States on Nigeria."***

| | | |
|---|---|---|
| **ABUTH Ethics Committee assigned number:** | - | ABUTH/HREC/GO8/2013 |
| **Name of the principal Investigator:** | - | **Progress Dokuro Victor** |
| **Address of the Principal Investigator:** | - | Dept. of Human Anatomy, ABU Zaria |
| **Date of receipt of valid application:** | - | 20th August, 2013 |
| **Date of meeting when final determination on ethical approval was made:** | - | **25th September, 2013** |

This is to inform you that the research described in the submitted protocol, the consent forms, and other participant information materials have been reviewed and ***given full approval by the ABUTH Ethics Committee.***

Please note: this approval dates from **2nd *October, 2013* to 2nd *October, 2014.***

No participant recruitment into this research may be conducted outside these dates.

All informed consent forms in this study must carry the ABUTH HREC number assigned to this research and the duration of ABUTH HREC approval of the study.

This HREC expects that you submit your application as well as an annual report for ethical clearance renewal 3 months prior to expiration of study dates. This is to enable you obtain renewal of your approval and avoid interruption of your research.

If there is delay in starting the research, please inform the ABUTH HREC so that starting dates can be adjusted accordingly.

No changes are permitted in the research without prior approval by ABUTH HREC, except in circumstances outlined in national code for Health Research Ethics: http://www.nhrec.net.

ABUTH HREC reserves the right to conduct compliance assessment visits to your research site without prior notification.

**Prof. A. I. Mamman**
**Chairman, ABUTH HREC**

**APPENDIX V**



**APPENDIX VI**



## APPENDIX VII

