Comparison of Menarcheal Age, Socio-demographics and Anthropometrics of Hausa and Igbo Schoolgirls from Enugu and Kaduna States of Nigeria

By

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DEPARTMENT OF HUMAN ANATOMY FACULTY OF MEDICINE AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

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DECLARATION

I, NWANKWO, MONDAY declare that the work in the thesis titled ‘‘**Comparison of Menarcheal Age, Socio-demographics and Anthropometrics of Hausa and Igbo Schoolgirls from Enugu and Kaduna States of Nigeria”** was carried out by me 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. This thesis has not been presented in any scientific gathering, neither has it been presented for another degree or diploma at any University.

MONDAY NWANKWO **SIGNATURE** **DATE**

CERTIFICATION

The project thesis titled **Comparison of Menarcheal Age, Socio-demographics and Anthropometrics of Hausa and Igbo Schoolgirls from Enugu and Kaduna States of Nigeria by Monday NWANKWO** meets the regulations governing the award of degree of Master of Science in Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literacy presentation.

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DEDICATION

This thesis is dedicated to the memory of my late mother, MrsChinyereNwankwo. May this work stand as a small gesture of my abiding gratitude.

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ABSTRACT

The onset of menarche signals the start of women's reproductive life and is determined by genetics, race, environmental, nutritional habits, socioeconomic status, and exercise. The present study is primarily aimed at determining the mean menarcheal age of adolescent girls from Hausa and Igbo ethnic groups living in rural and urban regions. The study also compared the mean anthropometric dimensions of menstruating and non-menstruating girls. The study also examined the prevalence of premenstrual syndromes among these designated ethnic groups. A total of 800 secondary school girls participated in the study. Four hundred are from Hausa and four hundred from Igbo ethnic groups. One hundred and fifty out of the four hundred from each ethnic group reside in the rural region while another one hundred and fifty from each ethnic group reside in the urban region. The remaining two hundred subjects will constitute the non-menstruating group with hundred from each ethnic group of which fifty are residents of rural region and the remaining fifty from urban region. This cross-sectional study was conducted on girls aged 11-18 years old. Relevant data were collected through a self-administered questionnaire after which certain anthropometric measurements including weight, height, mid upper arm, waist, hip, chest, neck, thigh circumferences, waist-hip, waist-chest and waist-height ratios. There is statistical significant difference in the mean age at menarche of adolescent girls from Hausa and Igbo ethnic groups. The mean age at menarche was 13.54 ± 0.90 years, the mean menarcheal age of school girls from Hausa ethnic group was 13.65 ± 0.92 years while that of school girls from Igbo ethnic group was 13.44 ± 0.87 years. Similarly, the mean menarcheal age of girls from Hausa (rural, urban) and Igbo (rural, urban) ethnic groups were respectively (13.83 ± 0.95, 13.48 ± 0.86, t = -3.33, p <

0.01) years and (13.52 ± 0.87, 13.35 ± 0.88, t = -1.66, p > 0.05) years. The mean of the various anthropometric dimensions were significantly higher among the menstruating girls than the non-menstruating students (p < 0.001). Concerning birth order, first born girls reach menarche earlier than later born for girls from Hausa and Igbo ethnicity (F = 16.73, p < 0.01) and (F = 26.90, p < 0.01) respectively. Also, girls from small family size reach menarche earlier than their counterparts from large family size for girls from Hausa and Igbo ethnic groups (F = 12.13, p < 0.01) and (F = 37.72, p < 0.01) respectively.

Parents' educational background also showed statistical significant influence on mean age at menarche. Girls whose any or both parents has tertiary educational background reach menarche earlier than girls whom neither of their parents has any form of formal education. Though paternal education showed statistical significant influence (F = 2.81, p = 0.04) while maternal educational background did not show statistical significant influence (F = 2.24, p = 0.08). Menarcheal age showed statistical significant inverse correlation with weight, BMI, chest and hip circumference (p < 0.05). Linear regression models for estimating menarcheal age from anthropometric and socio-demographic variables of girls from each ethnic group were generated. All subjects in this study reported at least one premenstrual syndrome or the other with varying degree of severity. There is however, no predilection in the incidence and severity of premenstrual syndrome based on ethnicity. The mean menstrual cycle length of most participants is 24 – 29 days (χ^2 = 7.75, p = 0.02) while most participants reported a mean length of menstrual flow of

4 – 5 days (χ^2 = 49.22, p < 0.01).

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

The onset of puberty is marked by the development of breast tissue, and menarche is a late event in puberty. The age that menarche occurs varies and is dependent on the interaction between genetic and environmental factors. In the 19th century factors that were thought to exert an influence on the physical maturation of girls were climate (particularly the mean annual temperature), ethnic origin, social status, urban or rural residence, physical activity, education, sexual stimulation, housing, inheritance, and health status (Heidi, 1986). Studies carried out in the 20th century documented other factors associated with the age at menarche, e.g. season and month at birth, physique, birth order, family income, occupation and education of parents and family size (Heidi, 1986).

It is considered that during the 20th century the dramatic improvement of socioeconomic conditions and general health of the populations in the industrialized countries resulted in an earlier onset of puberty in children. The most reliable marker of the positive secular changes in pubertal development was the fall of the age at menarche. It has been estimated that during most of the 20th century age at menarche has been fallen by about 3 months per decade (Tanner, 1989), although there are reports from industrialized countries that it has been leveling off or that it shows an upward trend (Lindgren *et al.*, 1991; Dann and Roberts, 1993). Whatever the factors that

influence pubertal maturation and age at menarche are, they interrelate and thus the onset of menarche cannot be attributed to a single factor.

Menarche heralds the beginning of a female's reproductive life and its timing is an indicator of the start of regular exposure to endogenous oestrogen and other hormones. It is the onset of menstruation and is one of the milestones in women's lives. Although it is a late marker of puberty, it is a well validated indicator and an easily remembered event when compared to other events in the process of female sexual maturity (Herman-Giddens *et al.,* 1997;Parent *et al.,* 2003). Adolescence is a transition period from childhood to adult life during which pubertal development and sexual maturation takes place. During puberty, hormonal, psychological, cognitive and physical changes occur simultaneously and interactively making physiological development a challenge adolescents have to face, with emotional, social and behavioral dimensions.

Mean age at menarche varies from population to population according to different factors like nutritional status, socio-economic status, geographical and environmental conditions and most of the females experience it when they are 10 to 16 year old **(**Frédéric *et al*., 2001; Kaplowitz, 2006). Genetic factors perhaps account for approximately 10-15% variation in age at menarche (Gray, 1993). Generally, better nourished girls have been found to attain menarche earlier than undernourished girls (WHO, 2003).

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 caregivers with fundamental data necessary for interventions.

Studying age at menarche is not derived by academic interest, but rather by the huge public health implications which might be caused by changes in the mean age at menarche. Early age at menarche has been linked to several adverse health effects during childhood such as eating disorders (Striegel-Moore *et al.,* 2001) and depression (Kaltiala-Heino *et al.*,2003); and during adulthood such as type 2 diabetes (Lakshman *et al.,* 2008; Dreyfus *et al.,* 2012; Stockl *et al.,* 2012), metabolic syndrome (Stockl *et al.,* 2011), breast cancer (Petridou *et al.*,1996; Hadjisavvas *et al*., 2010), cardiovascular disease and overall mortality (Jacobsen *et al.,* 2007; Jacobsen *et al.,* 2009; Lakshman *et al.,* 2009) and rheumatoid arthritis (Karlson *et al.,* 2004). It is therefore a clinically relevant and widely used measure in anthropological and epidemiological studies, considered as an outcome, predictor, effect modifier or mediator. Estimating age at menarche is also critical for patient education and may guide the clinical evaluation to identify deviations from normal (Diaz *et al.,* 2006). Age at menarche appears to have been declining in recent decades in western industrialized countries (Whincup *et al.,* 2001; Parent *et al.,* 2003;Herman-Giddens, 2007;Cabanes *et al.,* 2009; Lehmann *et al.,* 2010) because of several plausible factors one of which is the increasing rates of childhood obesity which has been postulated to be the prime factor (Kaplowitz *et al.,* 2001; Ahmed *et al.*, 2009; Walvoord, 2010).

Menarcheal age is the most widely used indicator of sexual maturation and can be used as an indicator of female health, growth and development, and the capacity to reproduce (Rees 1993;Aksglaede *et al.,* 2009; Gohlke and Woelfle, 2009; Biro *et al.,* 2010; Gaudineau *et al*., 2010). Onset of maturation and age at menarche, are influenced by several factors, e.g. genetics, ethnicity, height, weight, body mass index (BMI), and socioeconomic circumstances (Mul *et al.,* 2001; Fredriks *et al.,* 2000; Anderson and Must, 2011; Aksglaede*et al.,* 2009; Gohlke and Woelfle, 2009). Several studies from various developed countries worldwide have shown a systematic decrease in median age at menarche in the past 160 years (Rees, 1993; Fredriks *et al.,* 2000). In Europe the median age at menarche decreased with 2 to 3 months per decade from 16.5years in 1840 to about 13.0 years in the 1960s, with 0.5 years variation between countries (Cabanes *et al.,* 2009; Gohlke and Woelfle,2009). In Scandinavian countries the secular trend in age at menarche and stature has stopped, and possibly even reversed in the past three decades (Liestol and Rosenberg, 1995; Gaudineau *et al.,* 2010).

1.2 STATEMENT OF RESEARCH PROBLEM

To our knowledge as at the time of writing this thesis, no previous study has been conducted to compare the menarchecal age of rural and urban girls between the Igbo and Hausa ethnic groups in Nigeria.There is no previous study with adequate methodology to compare and ascertain whether age at menarche has declined over the last few decades between the Hausa and Igbo ethnic groups in Nigeria due to the influence of variation in anthropometric parameters, ethnicity, and socio-demographic factors. The present study attempts to answer the following questions. What is the mean age of menarche among rural and urban girls of Hausa and Igbo ethnic groups, girls

from which ethnic group have lower or higher age at menarche with regard to selected anthropometric parameters,geographical location and social background.

1.3 JUSTIFICATION

The increasing breast cancer incidence worldwide follows trends toward earlier age at menarche and higher rates of obesity. Age at menarche and obesity has been identified as risk factors for breast cancer. For each 1-year delay in menarche, the risk of breast cancer decreases by around 5%, and this menarcheal effect may be stronger in premenopausal than in postmenopausal women, indicating a time dependent effect. Menarche is a clinically relevant and widely used measure in anthropological and epidemiological studies, considered as an outcome, predictor, effect modifier or mediator. Several studies have indicated that women who have an early menarche are at increased risk for breast cancer (Walvoord, 2010). According to Steingraber (2007), researchers have speculated that with early menarche a woman's lifetime exposure to oestrogen is increased, and exposure to oestrogen increases the risk of breast carcinogenesis.

1.4 SIGNIFICANCE OF STUDY

Menstrual disorders like delayed or early menarche, premenstrual symptoms and dysmenorrhoea create a great anxiety among adolescent girls and their families, thus it is of enormous significant to know the age at menarche for girls' clinical evaluation, education and identification of deviations from normal. Investigating the age of menarche and menstrual problems among adolescent is also important so as to provide health planners and caregivers with fundamental data necessary for interventions. The

knowledge of age at menarche in a given population is a pressing need of the society as no law about the age at marriage, consensual sex, abortion, family planning, rape and other aspects of female reproductive life can be made without it. With emergence of acquired immune deficiency syndrome as one of major threat to mankind and teenage pregnancies as one of the major social problems, an urgent need is felt, in developed as well as developing countries to make the adolescents aware of it.

1.5 STUDY HYPOTHESES

This study sets out to test the following hypotheses:

i. There will be difference in age at menarche due to anthropometric variables, ethnicity, and socio-demographic factors.
ii. There will be difference in anthropometric variables between menstruating and non-menstruating girls.
iii. There will be no difference in the incidence of premenstrual syndrome between girls from both ethnic groups.

1.6 AIMS AND OBJECTIVES OF STUDY

1.6.1 Aims of Study

The present cross-sectional study is primarily aimed to investigate the influence of socio-demographic factors on average age at menarche among Nigerian secondary schoolgirls from Enugu and Kaduna States of Nigeria.

1.6.2 Objectives of Study

The present study is designed to achieve the following objectives:

i. Determine the mean age at menarche of girls from the Igbo and Hausa ethnic groups of Nigeria;

ii. compare the mean age at menarche of girls based on ethnicity and socio-demographic factors;

iii. investigate the influence of certain anthropometric variables on menarche;

iv. investigate the relationship between BMI and age at menarche;

v. compare anthropometric variables of menstruating and non-menstruating girls;

vi. determine the prevalence of premenstrual syndrome in girls from these ethnic groups;

vii. investigate the effect of settlement (urban and rural) on age at menarche and anthropometric variables and indices;

viii. to generate predictive equations for the estimation of menarcheal age and other anthropometric variables.

1.7 ENUGU STATE

Enugu State is one of the 36 States in Nigeria, apart from the Federal Capital Territory, located between latitude 5° $56^{'}$ N and 7º 00' N and longitude 7º 00' E and $7^{\circ}55^{'}$ E of the Greenwich meridian (fig. 3.1). The State is bounded in the northeast by Ebonyi State, on the north by Benue and Kogi States and to the west by Anambra State from which it was carved out in 1991. In the south it borders with Abia State. Enugu State has a total land area of 7660.166 sq. kilometres with a population of 3,267,837 persons (National population census, 2006) and therefore a population density of 427 persons per square kilometre with an area code of 042. Administratively, Enugu State is divided into 19 Local Government Areas. But politically, there are three zones, namely: Enugu North, Enugu South and Enugu Central. About 85% of the rural population are engaged

in the agricultural sector, characterized largely by smallholding of less than one hectare. Predominant food crops include cassava, yam, maize, rice, pigeon pea, bambara nuts, cocoyam and cowpea. The major perennial tree crops grown are oil palm, citrus, pear and cashew. These are supplemented with small-scale livestock farming such as poultry, small ruminants and indigenous cattle. The State capital is located at the hilly city of Enugu. An old seat of government, Enugu was the capital of the former East Central State from which present Anambra, Enugu, Imo, Abia, and Ebonyi States were carved out. Highly cosmopolitan, Enugu boasts of a couple of industries. The state is called the Coal City State because of the discovery of coal in commercial quantity in Enugu urban in 1909 (Enete and Alabi, 2012).

1.7.1 Climate and vegetation of Enugu State

Enugu state falls within the humid tropical rain forest belt of South-eastern Nigeria. It has two seasons, the raining season and the dry season. The rainy season which is characterized by heavy thunderstorms lasts from April to October with the South Westerly moisture accompanied by air mass moving northwards into the city. The turbulent runoff result in leaching, sheet erosion and eventually gullies (Akabuike, 1990). The mean temperature varies from about 20.30 ºC to about 32.16 ºC in the dry season and rainy season respectively, (Akabuike, 1990). During the dry season the humidity is lower than in the rainy season. Temperature is most often high during the day and low during the night. This results in high evaporation rate during the day. Harmatten which occurs between the months of November and February is always

accompanied by poor visibility mostly at night and early in the morning (Enete and Alabi, 2012).

1.7.2 Nsukka

Nsukka area lies between latitude 6° 18' and 7° 06' N and longitudes 6° 52' and 7º 54' E, and covers a total surface area of approximately 3,961 square kilometers (Noble, 2002). However, the Nsukka urban community is one of the two major urban centres of Enugu State recognized by the state government. It has a population of about 254,422.

Before 1960, Nsukka was a relatively unknown town, overshadowed by the then more prosperous Ogurugu, which became a major exporting centre (on account of its location along the River Niger coast) and Ibagwa, which had a flourishing horse market. After 1960, all these changed with the establishment of the University of Nigeria. (Noble, 2002). Nsukka has grown *pari pasu* with development of the University. A casual look at the settlements will reveal two distinct patterns, namely: one predominantly rural, where indigenes live; and another, essentially cosmopolitan, and mostly inhabited by nonindigenes. The University dominates the landscape of Nsukka, offering employment to most of the inhabitants and constituting its main economic base or its main industry (Noble, J. N. 2002).

1.8 KADUNA STATE

Kaduna metropolis (fig. 3.1) is located at latitude 11º 3' N and longitude 7º 25' E. It is the capital city of Kaduna State, a state that shares boundaries with Kano, Zamfara, Katsina, Niger and Bauchi states in northern Nigeria. The town is largely a heterogeneous town, with major ethnic groups being of Hausa, Fulani, Kataf, Gbagyi, Jabba and Kagoro extractions, among many other minor groups (Akinbabijo, 2012).

Kaduna State has a total land area of 45,711.188 sq. kilometres with a population of 6,113,503 persons (National population census, 2006) and therefore a population density of 134 persons per sq. kilometer. Kaduna State is divided into 19 Local Government Areas Birni-Gwari, Chikun, Giwa, Igabi, Kajuru, Ikara, Jaba, Kachia, Jema'a, Kaduna North, Kaduna South, Kagarko, Kaura, Kauru, Kubau, Kudan, Lere, Makarfi, Sabon-Gari, Sanga, Soba, Zango-Kataf, and Zaria.

1.8.1 Zaria

Zaria is a Hausa land in northern Kaduna State, in the northern part of Nigeria and is located on latitude 11º04' north and longitude 7º 43' east. It is defined by a 15 Km radius from the PZ post office and is well connected by roads and rail with other regions of the country. Distances from Kaduna, Kano, Jos and Sokoto are approximately; 75 Km, 176 Km, 387 Km and 404 km respectively. Zaria is the second principal town in Kaduna state after Kaduna and home to the Ahmadu Bello University, established in 1962 and a host to several other federal government institutions like Federal Institute for Chemical andLeather Research, Federal College of Aviation and Industrial Development Corporation.

The population of Zaria is approximately 975,153 (projections from 2006 national census).It is made up of two Local Government Councils, Zaria Local Government, consisting of two districts; Zaria walled city and Tudun Wada, and Sabon gari Local Government which consists of three districts; Sabon Gari, Samaru, and the Government Reservation Area (Olamdimeji and Ojibo, 2012).

1.8.2 Drainage

The Kubanni River has its source from the Kampagi hill in Shika near Zaria. It flows in a Southeast direction through the premises of Ahmadu Bello University. The Samaru stream which is one of the tributaries of Kubanni River has a stream length of 1.05km within an area of 2.28km2 and has drainage density of 0.4605 km/km^2 (Yusuf and Shuaib, 2012).

1.8.3 The climate of Zaria

The climate of the study area is a tropical savanna climate, with distinct wet and dry seasons (Aw climate Koppens classification). Zaria experiences six (6) months of rainy season and six (6) months of dry season. The rainy season is from May to late October, while the dry season is from early November to April, this is as a result of the interplay of the two dominant air masses within the region i.e. the tropical continental air messes (cT) and Tropical maritime air masses (mT) (Iguisi and Abubakar, 1998). Climate is an important factor that determines the form of any architecture. In Nigeria the Hausa live in northern Savannah type of climate (Moughtin, 1985). The rainfall intensity is very high between the months of July and August. As a result though the environment is generally dry, crops are frequently lost through too much rain. It also results in

rapid surface run-off, soil erosion and water-logging (Udo, 1970). Dry season is the period of harmattan: a transition period between the wet and the hot seasons. It is a period when there is little or no rainfall (Ati, 2002). Daytime temperatures fluctuate between 16 and 32ºC in November with clear sky of sunshine hours of between 8.9 and 9.5 (DURP, 1979). December to January in Zaria is characterized by the suspension of fine dust particles in the air, due to Harmattan winds which cause surface turbulence. Visibility is poor, disrupting air navigation while sun's rays barely reach ground surface. This action reduces night temperatures to 14ºC, with sunshine hours between 8.7 and 9.5. Daytime temperature may drop to 31ºC, giving a variation of 17ºC, and the highest in the year. This extreme diurnal temperature range is another characteristic of the Savanna type of climate (Areola *et al.,* 2006).

1.8.4 Natural vegetation

Nigeria has six Climatic Zones (Bureau for Public Enterprises, 2003-2007); The Mangrove Swamp, Swamp Forest, Rain Forest, Guinea Savanna, Sudan Savanna and Sahel Savanna. The Sudan Savanna approximates in a belt from Latitude 8º north to Latitude 12º north of the Equator, in Nigeria (Anuforom and Okpara, 2004). This region definitely includes Zaria, which is located at latitude 11º 3' N and longitude 7º 25' E. The Sudan Savanna is typified by tall tropical 'savanna' grass (Ati, 2002); the elephant grass (Areola *et al*., 2006). Trees are scattered, typical of wet dry climate. This vegetation is mixed with scrubs and thorny bushes, adapting itself to the climatic rhythm of longer water-drought and shorter summer rain. They are mostly deciduous, shedding their leaves in the dry

season to conserve water which would have been lost by transpiration; lying dormant and searching for ground water. Tallest trees in Zaria are the baobab ‘gingiya’, palm and cotton trees (Anselem and Ojonigu, 2010).

CHAPTERTWO

2.0 LITERATURE REVIEW

2.1 ASSESSMENT OF MENARCHEAL AGE

Menarche is defined as the first menstrual period. There are three methods for assessing age at menarche, a) the status quo, b) the recall or retrospective, and c) the prospective methods (Cameron, 2002). In the status quo method data regarding menarcheal age can be obtained by asking a girl (or her parent) of her "current status", i.e. whether she has had her first menses by the time of assessment, and her birth date. In the status quo method the sample must be large, representative of the population, and in the developed countries the age range should be from 8 to 16 years old. In the recall method menarcheal data are obtained by asking post-menarcheal females (or their mothers) to recall their age at first menses. The recall method may be less valid and its accuracy is decreased with greater time elapsed between menarche and asking for the date, because it is fraud with poor memory (Karapanou and Papadimitriou, 2010).

Furthermore, all girls included must be at an age that they normally should be if they have already started menstruating. The prospective method is more accurate, however such studies are not easy to perform as they should be longitudinal having pre-menarcheal girls followed regularly, ideally every 3 months, and asked at each visit whether they have begun to menstruate. Therefore, most studies on menarcheal age have employed the status quo or the recall methods. There are numerous studies examining the secular trend of age at menarche in various populations (Karapanou and Papadimitriou, 2010). The exact causes of a secular trend toward a changing age at

menarche are elusive and multifaceted. Age at menarche is the result of complicated interplay between environmental and social experiences and genetics. If age at menarche was solely biologically determined, young girls everywhere would reach menarche around the same age. However, it is clear this is not the case. Thus, environment and culture influence when a girl begins menstruating (Proos *et al*., 1991).

2.2 NEUROENDOCRINOLOGY OF PUBERTY

The brain is the driving force that controls thelarche and menarche through the secretion of gonadotropin-releasing hormone (GnRH) from the hypothalamus. The GnRH-secreting neurons (of which there are about 1,000) are themselves regulated by a plethora of chemical cues. Some of these are hormones, some are enzymes and some are neurotransmitters. Hormones that play a role in stimulating GnRH neurons include leptin, which is produced by body fat, and kisspeptin, which is produced by neurons in the forebrain and appears to act as the central processor. Leptin and kisspeptin appear to interact. Melatonin is an inhibitory signal that responds to light and dark cycles and may also interact with kisspeptin. Also modulating the hormonal drumbeat of the hypothalamus are many neurotransmitters. Two of the most important are gamma-amino butyric acid (GABA), which is an inhibitory signal, and glutamate, which is an excitatory signal (Terasawa and Fernandez, 2001).

2.3 FACTORS ASSOCIATED WITH MENARCHEAL AGE

2.3.1 Urban Versus Rural Environment

Whether because of better nutrition, improved hygiene, increased social or sexual stimulation, some genetic factor that instigates migration to cities or other unidentified influences, residence in a town appears to predispose to early sexual maturation. This phenomenon has been observed in many parts of the world and over a long period of time. As early as 1610, Quarinonius, (1610) noted that Austrian peasant girls menstruated much later than the daughter of the townsfolk or the aristocrats. Wilson and Sutherland(1950), reported that the mean age at menarche for girls in urban Ceylon was (12.84± 1.24) years whereas in rural areas it was (14.39±1.73) years. Girls in urban Southern India were found to mature earlier than rural girls(12.76 years for urban and 14.16 years for rural) Madhavan (1965).

The influence of urbanization on menarche has been studied by many other researchers. Factors influencing the mean age at menarche (MAM) have been studied by a number of workers in Sri Lanka. Rural-urban differences were observed by Wilson and Sutherland (1950), and by Godarvatta and Wikramanayake (1988). Influence of ethnicity was observed by Arumugam and Jayawardena (1957) but Balasuriya and Fernando (1983) could find no difference between Jaffna Tamil girls and Sinhalese girls from Kandy. Most of the above studies were conducted in small geographical areas, the only two which compared two or three areas being the WHO Multi-centre Study (1986) and that of Balasuriya and Fernando (1983).

Girls raised in urban environments have earlier menarcheal ages than those raised in rural environments (PasquetandDucros,1980; Hulanicka and Waliszko, 1991; Barnes-

Josiah and Augustin, 1995; Graham *etal*.,1999; Pasquet*etal*., 1999; Padez, 2003). Third World girls adopted in Western European countries present the pattern of early menarche, which indicates the role of transition from an underprivileged to a privileged environment as determinant of menarche (Proos *et al.,* 1991). It has been suggested that the premature sexual maturation may be triggered by the catch-up growth that these children present (Virdis *et al.,* 1998). Other stresses like acute/chronic illnesses (Van *et al.*, 1998) or war conditions (Tahirovie, 2000) suppress the hypothalamic- pituitary-gonadal axis and delay pubertal onset.

2.3.2 Ethnic/Racial Differences in the Timing of Menarche

It is virtually impossible to isolate the effects of racial factors on sexual development. In the first place, very few populations exist that are racially pure; most commonly, many constitutional types are present in each person. Secondly, racial factors, like climate, cannot be separated from socioeconomic influences such as habitat and nutrition (Wu *et al.*, 2002).

Studies of people of very different racial and ethnic characteristic such as African Americans by Michelson (1943), tropical Africans by Ellis (1950), Japanese by Ito (1942), and Alaskan Eskimos by Levine (1953) have demonstrated that although hereditary influences exist, they are far outweighed by environmental circumstances, regardless of race.

Several studies performed, especially in the USA, have shown ethnic-racial differences in pubertal maturation and menarche. African American girls were younger than white girls at the same stage of breast development, pubic hair development and menarche.

The Bogalusa Heart Study included data from 7 cross-sectional examinations of school-aged children, which were used for both cross-sectional and longitudinal analyses (Freedman *et al.,* 2002). According to the study, African American girls experienced menarche, on average, 3 months earlier than did white girls (12.3 vs. 12.6 years) and during a 20 year study period, the median menarcheal age decreased by approximately 9.5 months among black girls (Wong *et al.,* 1999).

Secular trend among white girls was smaller and less consistent, since a two month decrease was recorded. Anthropometric dimension differences between black and white girls, such as weight, height, and skin fold thickness, could be a confounding factor; however, controlling for height and either BMI or weight, the rate of early menarche remained significantly higher among black girls, suggesting that race is an independent factor of pubertal/menarcheal timing. The racial difference in pubertal maturation may reflect genetic factors. Black girls present higher insulin response to a glucose challenge, and subsequently increased levels of free IGF1, which is associated with skeletal and sexual maturation compared to white girls (Wong *et al.,* 1999).

Moreover, another US study performed using data from the Third National Health and Nutrition Examination Survey, demonstrated that the mean age at onset of pubic hair, breast development and menarche was 9.5, 9.5, and 12.1 years for black girls; 10.3, 9.8, and 12.2 for Mexican American girls; and 10.5, 10.3 and 12.7 for white girls. The racial/ethnic differences remained even after adjustment for current body mass index and several social and economic variables (Wu *et al.,* 2002). Girls in South Europe experience menarche earlier than girls in North Europe. Mean menarcheal age in France and other Mediterranean countries is lower than in other Western European countries

(Parent *et al.,* 2002), which points to a geographical difference that reflects both genetic or ethnic and environmental factors. Geographical differences might involve altitude, temperature, humidity and lighting. Of special interest is that lighting signals on hypothalamus-pituitary-gonadal axis are supposed to be mediated through melanotonin circuit (Nanao and Hasegawa, 2000).

According to several studies, menarche is more frequent in winter than in summer, which points to an inhibitory effect of photo stimulation. Age at menarche in Asian is similar to Mediterranean girls; mean menarcheal age in Hong Kong (Huen *et al.,* 1997) and Japan (Nanao and Hasegawa, 2000) is 12.38 and 12.2 years, respectively, and in Greece (Papadimitriou,*et al.,* 2008) or Spain (Salces *et al.,* 2001) 12.27 and 12.34, respectively.

In the United States and Denmark onset of sexual maturation in girls decreased the past decades (Anderson, 2003; Anderson2005; Herman-Giddens, 2006; Aksglaede *et al.,* 2009). This trend has been observed in African-American/Caribbean, Hispanics, Indo-Pakistani and Caucasian (Ulijaszek *et al.,* 1991; Anderson,2005). In contrast, the secular trend in age at menarche stabilized in German girls (Gohlke and Woelfle, 2009).

In industrialized countries girls of African descent have the lowest median age at menarche, followed by Hispanic-Latino and Hindo-Pakistani girls, while Caucasian girls have the highest median age at menarche (Ulijaszek *et al.,* 1991; Freedman *et al.,* 2002; Anderson *et al.,* 2003; Anderson and Must, 2005; Herman-Giddens 2006; Salsberry *et al.,* 2009; Biro *et al.,* 2010). Socioeconomic circumstances, improved health, hygiene, nutrition, housing and employment are assumed to be responsible for

most if not all the decline in age at menarche (Kaplowitz, 2008). In classical times until the mid-1950s age at menarche in industrialized countries was lower in girls with high socioeconomic status (Datta and Gupta, 1981). Since then the situation reversed and age at menarche in Caucasian girls with low socioeconomic status (SES) compared to girls with high SES became lowest (Brundtland *et al.,* 1980). Studies indicate that girls of African descent in industrialized countries and girls in Turkey with high SES (still) have an earlier age at menarche than girls with low SES (Ulijaszek *et al.,* 1991; Atay *et al.*, 2011; Braithwaite *et al.*, 2011). Deprivation or malnutrition may be (part of) the explanation. In contrast to girls in Turkey the mean BMI-SDS of Dutch children whose parents were low educated was Mass Index, Weight, Height and Menarche.

Several studies suggest that obese girls mature earlier. However, this has generated controversy (Pierce and Leon, 2005; Bau *et al.*, 2011; Must*et al.,* 2011). The decline in age at menarche is suggested to be related to the obesity epidemic, but obesity cannot solely be held responsible, because the secular change was also found in normal weight girls (Aksglaede *et al.,* 2009). The link between obesity and age at menarche may be due to a mechanism ensuring that pregnancy will not occur unless there are adequate fat stores to sustain both mother and foetus (Kaplowitz, 2008). Although weight is involved in age at menarche it was noted that after adjustment for BMI-SDS the decline in median age at menarche remained significant. Because of the cross sectional study design we cannot differentiate between co-occurrence and causality. Differences in BMI-SDS in pre-menarcheal and post-menarcheal girls are previously observed by O'Dea et al. 1999;Kaplowitz and others (O'Dea, 1995; Anderson *et al.,* 2003; Anderson and Must, 2005; Kaplowitz, 2008).

Dutch girls in different age categories in the 1980, 1997 and 2009 studies show a positive shift in BMI during the maturation process. The differences in mean BMI-SDS between pre- and post-menarcheal girls in 1980, before the obesity epidemic in the Netherlands, are almost identical in 1997 and 2009. Age at menarche is also thought to be dependent on height (Mul *et al.,* 2001). The secular trend in stature stopped decades ago in the United States and Scandinavia (Brundtland *et al.,* 1980; Freedman *et al.,* 2000; Gohlke and Woelfle, 2009); while in the Netherlands it stopped only recently **(**Schonbeck *et al.,* 2012). The assumption was that the secular trend in age at menarche would stop too, but it did not. Thus, increase of height is no longer (part of) the explanation of the decline in age at menarche in 2009. Consequences of Early Menarche for Public Health Early menarche is associated with psychosocial and health problems (Gluckman and Hanson, 2006; Herman-Giddens, 2007). Already one third (33%) of the girls of Turkish descent in primary schools (up to 12 years of age) is menstruating. The continuing younger age at menarche requires changes in sexual education in primary schools. In addition primary schools have to provide facilities for menstruating girls (Gehan *et al.,* 2007).

Furthermore, adult women with early menarche have been shown to have higher risk of breast cancer, metabolic syndrome, depression, and cardiovascular disease which have profound public health implications (Kelsey and Gammon, 1990; Freedman *et al.,* 2002; Herman-Giddens, 2007; Feng *et al.,* 2008; Lakshman *et al.,* 2008;Lakshman *et al.,* 2009; Joinson *et al.,* 2011).

2.3.3 Socioeconomic Influences on Menarche

Socioeconomic factors often given by level of parental education or occupation, family size, family income, often show statistically significant effects. Girls from families with a high socioeconomic status experience menarche at an earlier age than girls from families with lower socioeconomic status (Bodzsar, 1975; duntan *etal*., 1976; Attallah, 1978; Uche and Okorafor, 1979; Attallah *etal*., 1983; Bielicki *etal*., 1986;Henneberg and Louw, 1995;Laska-Mierezejewska,1995;Wronka and Pawlinska-Chmara, 2005).

Furthermore, higher parental education has been associated with earlier timing of puberty (Wronka and Pawlinska-Chmara, 2005). Absence of a biological father, the presence of half- and step-brothers is associated with early menarche, whereas the presence of sisters, especially older ones, in the household while growing up, was associated with delayed menarche (Ellis and Garber, 2000). The prevalence of early menarche is even higher when stepfather presence is combined with a stressful family environment and with maternal mood disorders (Ellis and Garber, 2000).

2.3.4 Nutrition

Regarding nutritional habits, increased energy-adjusted intake was associated with early menarche (Merzenich *et al.*, 1993; Simodon *etal*., 1997). The quality of food intake also influences puberty. High animal protein versus vegetable ratio at the ages of 3-5 years is associated with early menarche, after controlling for BMI Berkey *et al*. (2000).

Much research has been conducted on the effects of artificial hormones in meat and milk on human puberty. However, no substantial evidence linking hormones in meat to earlier puberty exists. But, artificial hormones in milk are thought to possibly contribute to early meanrcheal age. Cows treated with recombinant bovine growth hormone(rBGH) produce higher levels of insulin-like growth factor-1 (IGF-1) which is identical in structure to human IGF-1, thereby tricking the endocrine system into thinking growth hormones have been released in the body (Steingraber, 2007). However, the link between artificial hormones in milk and early menarcheal age is weak (Steingraber, 2007).

2.3.5 Body Mass Index, Weight, Height and Menarche

Several studies suggest that obese girls mature earlier. Even though not fully accepted, decline in age at menarche is suggested to be related to the obesity epidemic, but obesity cannot solely be held responsible, because the secular change was also found in normal weight girls. The link between obesity and age at menarche may be due to a mechanism ensuring that pregnancy will not occur unless there are adequate fat stores to sustain both mother and foetus (Ong *et al.,* 2009).

Several studies have noted the recent secular changes in BMI in the United States (Troiano *et al.*, 1995; Adair and Gordon-Larsen, 2001; Ogden *et al*., 2002), as well as around the world (Fredriks *et al*., 2000; Bundred *et al*., 2001; Armstrong *et al*., 2003; Lissau *et al.,* 2004). Studies in the United States have noted that there has been an increase in mean levels of BMI, with distributions skewed to the right (Flegal and Troiano, 2000), suggesting the extent of overweight has been increasing faster than the prevalence (Jolliffe, 2004). Although the mean BMI has increased for the population,

the BMI in children who are heavier has increased more than children who are less heavy (Persson *et al.,* 1999).

Several factors predisposing to increases in BMI, including increases in total calories and in consumption of fast foods, decreases in physical activity, and, a factor not totally independent of the first two, an increase in hours spent watching television have been proposed. There have been several studies that noted an increase in total consumption of calories over the past 30 years (Jahns *et al*., 2001), with the greatest increases in consumption of salty snacks and soft drinks and decrease in consumption of milk (Nielsen *et al*., 2002). When fast food is consumed (which occurred on 30% of the days), more total energy was consumed, with a greater caloric density (Bowman *et al*., 2004); this study further noted that fast food consumption contributed 57 kcal daily to all US youth (Bowman *et al.,* 2004). Another report noted that when overweight and normal weight adolescents were observed in a fast food setting, overweight participants consumed more calories than their leaner counterparts, and that they consumed more calories on fast food days compared with non-fast food days (Ebbeling *et al*., 2004). The impact of dietary changes has had an impact on Western as well as non-Western populations. In many societies, intake of diets with high saturated fat, sugar and refined foods, and low in fibre has been on the increase (Popkin, 2002).

Body size parameters, such as weight or BMI and height are strongly correlated with the age at menarche,(Frisch and Revelle,1971) proposed a critical body weight and weight gain for the onset of menarche (Frisch and Revelle, 1970; 1971). Higher subcutaneous fat levels and BMI at prepubertal ages (5-9 years) are associated with increased likelihood of early (<11 years) menarche (Freedman,*et al.,* 2002). Age at

menarche is negatively related to hip and thigh circumference and positively related to waist circumference, status and biiliac breadth (Lassek and Gaulin, 2007). Blood leptin levels were also much more strongly related to gluteofemoral than upper body fat, suggesting that leptin may convey information about fat distribution to the hypothalamus during puberty (Lassek and Gaulin, 2007). The association of birth weight with pubertal development has not been yet well documented (Ibanez *et al.*, 2000; Lazar *et al.*, 2003), although there are data that in small for gestational age girls the age at both pubertal onset and menarche are advanced by about 5-10 months, whereas in boys pubertal onset usually occurs at an appropriate age (Persson *et al.*, 1999). On the other hand, Ellison related menarcheal age to height rather than weight, suggesting that skeletal maturation is more important than body fat accumulation for menarche (Ellison, 1981), a finding that was also supported by a survey conducted among schoolgirls in Taiwan (Chang *et al.*, 2000).

Other studies have shown that rapid early infancy weight gain from birth to age 2 months, and also from 2 to 9 months, predicted subsequent greater adiposity, assessed by DXA at age 10 year, and earlier age at menarche in girls, but association was not existent when weight gain occurred later in infancy, i.e. between 9 and 19 months of age (Ong *et al.*, 2009).

2.3.6 Month of Birth, Birth Order and Family Size

In a study of 50,000 South African Bantu school-girls (ten to eighteen years of age) living in the Transkei Reserve, a relation between month of birth and age at menarche was observed. Girls born earlier in the year menstruated four month earlier, on the

average, than those born at the end of the year. This correlation might actually arise from seasonal variations in the adequacy of nutrition (Burrell *etal*., 1961).

The size of the family and the order of birth has also been reported to have a significant effect on the age at menarche—girls from large families showed a delay of maturation (Roberts *etal*., 1971; Clegg, 1980; Billewicz *etal*., 1981; Dann and Roberts, 1984, 1993;Cameron and Nadgdee, 1994; Sa´ nchez-Andre´s, 1997; Apraiz, 1999).

Multiple studies have found strong correlations between number of siblings and age at menarche (Roberts *et al.*, 1971; Clegg, 1980; Dann and Roberts, 1984). The presence of half and stepbrothers accelerated age at menarche, while presence of sisters is correlated with a later age at menarche (Matchock and Susman, 2006). Okasha (2001) found that girls with four or more siblings reached menarche six months earlier than girls with no siblings. In rodent studies, researchers found that puberty was delayed when a young female was quartered with other females, and was accelerated when quartered with males, especially unrelated adult males (Agosta, 1992). Again, some scholars believe girls may be receiving pheromones from their fathers and brothers in an evolutionary effort to inhibit incest **(**Steingraber, 2007).

2.3.7 Physical Activities

It is well known that intensive exercise during pre-pubertal and peripubertal period results in growth and pubertal delay. A Study by Sidhu and Grewal (1980) has established that the age at menarche is delayed in sports women. Moison *etal.*, (1991) observed that participation in dance, ballet, gymnastics figure skating, synchronized swimming and diving competitions had lower risk of reaching menarche at an early age.

Merzenish *et al.*,(1993) noted that the increased sport activity is associated with delay in age at menarche. It may be the vigorous exercise, intense physical and mental stress which delays the menarche. At the same time it is thought that the stress involved with strenuous exercise could inhibit or alter GnRH pulse generator De Cree, (1998).

Exercise can delay early puberty, but in ways scholars do not fully understand (Steingraber, 2007). Grumbach and Styne, (2003) found that, on average; bedridden girls reached puberty earlier than female athletes, who generally reach puberty and menarche later. It is hard, however, to differentiate between stress of competitive sport exercise and daily physical activity.A cross sectional study performed in a group of Colombian university women demonstrated that age at menarche was positively associated with the practice of at least two hours daily of physical activity (Chavarro *et al.*, 2004). Menarche, on average, occurs later in athletes, including ballet dancers, than in the general population, with the exception of swimmers, suggesting that intense exercise delays puberty (Malina, 1983). The most probable explanation for no delay in menarcheal age of swimmers is that the normal body fat composition of swimmers balances the negative hypothalamic effect on GnRH pulsatile exerted by intensive exercise.

2.3.8 Father Absence

Father absence—but not mother absence—is consistently associated with early menarche (Ellis, 1999; Hoier, 2003; Maestripieri, 2004; Matchock and Susman, 2006), and the longer the absence, the earlier the first menstruation (Moffit, 1992). More time spent by fathers in childcare, more father-daughter affection and more paternal

investment in the family all appear to be protective against early puberty among U.S. girls (Ellis, 1999). High contemporary rates of divorce and single parent households notwithstanding, it is not clear that father absence is more common now than in previous times. The demands of war, hunting, fishing, farming, shipping, slave labour, wage labour, homesteading and mining—along with death from infectious diseases—have absented countless fathers from daughter-filled households at many points in U.S. history. It seems unlikely that father absence alone could be responsible for driving down the average age of pubertal onset in U.S. girls during the past half-century. More plausibly, father absence may be contributing to the ongoing racial disparities in pubertal timing among white and black girls, but this is not a question that has been directly examined as yet (Maestripieri, 2004).

Many studies (Ellis *et al.*, 1999; Hoier,2003;Maestripieri,2004; Matchock and Susman, 2006), have found that father absence in the home is consistent with an earlier age at menarche. Moffitt*et al.* (1992) reported that the longer the absence of the father, the earlier the first menstruation. It is thought that father absence in the home accelerates menarche in two ways: first, without the presence of a genetically-related adult male, the evolutionary mechanism for incest avoidance, which causes a later menarcheal age, does not activate (as seen in rodents) (Macleod,2007): Second, the absence of a father in the home can be perceived by the brain as an unstable environment, which may trigger the organism to commence with puberty in order to ensure reproductive success (Ellis and Garber, 2000). The psychosocial acceleration theory, an addition to the life history approach, was used by Belsky*et al.* (1991) and Ellis and Essex, (2007) to suggest that stress from low parental involvement, family conflict, and father absence is

internalized, causing metabolism levels to decrease (an evolutionary trade-off designed to ration metabolic resources in order to sustain vital functions), which leads to weight gain and accelerates menarche. Stepfather presence in the home, on the other hand, has been both correlated to earlier age at menarche (Ellis and Garber, 2000) and no effect at all on age at menarche (Bogaert,2005). However, the effects and/or non-effects of a male stranger on female puberty has been documented in many species, including field mice, voles, lemmings, rats, pigs, cows, and monkeys **(**Vanderbergh,1983).

2.3.9 Genetic Control of Menarche

The age at menarche is known to be influenced by genetic factors. The genetic basis of this event has been shown in studies of resemblance between sisters (Boas, 1932; Reymert and Reymert, 1947), twins (Popenoe, 1928; Petri, 1934; Tisserand-Perrier, 1953; Gedda and Brenci, 1975; Fishbein, 1977; Golden, 1981; Sharma, 1983; Van den Akker *et al*., 1987; Treoloar and Martin, 1990; Meyer *etal*., 1991; Loesch *et al.*, 1995) and also the resemblance between mothers and their daughters (Bolk, 1926; Popenoe, 1928; Gould and Gould, 1932; Damon *etal*., 1969; Brooks-Gunn and Warren, 1988; Malina *etal*., 1994; Campbell and Udry, 1995). However, the magnitude of the genetic contribution still remains unclear.

Menarcheal age is influenced by heredity but the specific genetic determinants are largely unknown. Evidence for hereditary influences on the age at menarche comes from studies that show a trend for maternal age at menarche to predict daughter's age at menarche (Graber *et al.,* 1995). In fact, approximately half of the phenotypic variation among girls from developed countries in the timing of menarche is due to genetic

factors (Towne *et al.,* 2005). In search for specific genes determining the timing of menarche Stavrou *et al.,*(2002) evaluated whether the XbaI and PvuII polymorphisms of oestrogen receptor a (ERa) gene are associated with the age at menarche. After adjusting for body mass index this cohort demonstrated that the difference between XX homozygote and other subjects was 0.57 years (p=0.021). The difference between PP homozygote and other subjects was not significant (0.26 years, p=0.26), while the difference between PX homozygote and other subjects was 0.67 years (p=0.008), suggesting that XbaI XX homozygote or, in more general terms, subjects homozygote for the PX haplotype seem to have a modest delay in the age of menarche. Regardless of the exact mechanism, if ERa gene polymorphisms can alter the oestrogenic biological activity at the cellular level, this may influence the maturation of the hypothalamic-pituitary-gonadal axis, which determines the onset of menarche (Pantsiotou *et al.*, 2008).

On the other hand, investigation for GnRH receptor mutations revealed that genetic variation in GnRH1 and GnRHR is not likely to be a substantial modulator of pubertal timing in the general population (Sedlmeyer *et al.*, 2005). Recently, a genome-wide association (GWA) study was conducted aiming to identify common variants associated with the timing of puberty (Ong *et al.*, 2009).For age at menarche only one single nucleotide polymorphism reached genome wide statistical significance, rs314276 in intron 2 of LIN28B on chromosome 6. Each major allele was associated with 0.12 years earlier menarche. This allele was also associated in girls with earlier breast development, in boys with earlier voice breaking and a faster tempo of growth and shorter adult height in both sexes. The influence of genetic factors may be considered in

the larger context of racial characteristics or in the more immediate aspect of family heredity (Towne *et al.,* 2005).

2.3.10 Family Heredity

Unless data for both mothers and daughters are obtained prospectively, comparison of their menarcheal ages is complicated by the fact that the data on the two generations are really comparable. Either the data for the daughters are prospective, whereas those for the mothers are retrospective, or, if both sets are retrospective, the daughters' accounts of the recent events of menarche are likely to be more accurate than the mothers' recollections of the much more distant event (Popenoe, 1928).

A few reports indicate that there is a fairly good correlation between the menarche ages of mothers and their daughters. Bolk (1923) studied 45 mothers and their 71 daughters and reported that among mothers with menarcheal ages of 11 to 13 years, the daughters' average age at menarche was 12 years and 10 months; among mothers whose menses started at 14 to 16 years, the daughters' average age at onset was 13 years and seven months; and among women whose menstruation started at 17 to 19 years, their daughters experienced menarche at 14 years and 11 months. In a study of 200 mothers and their 351 daughters, a correlation coefficient of 0.40±0.03 between mothers' and daughters' menarcheal ages were found (Popenoe, 1928).

Sisters: Although it would be easier to demonstrate the genetic influence on sexual development by study of twins and sisters, only a few such studies have been reported. Petri (1934) noted a difference in menarcheal age of two and eight-tenths months in a group of 51 pairs of identical twins, 12.0 months in a group of 47 pairs of non-identical

twins, 12.9 months in a group of 145 pairs of sisters and 18.6 months in 120 pairs of unrelated women. Reymert and jost (1947), found a significantly smaller difference in menarcheal age between 72 pairs of sisters than between 200 pairs of unrelated girls. The mean difference for the group of sisters was 13.9 months. A difference in a group of 39 fraternal twins and two and two-tenths months in a group of 46 identical twinsin a study conducted in France (Tiesserand-Perrier, 1953).

Heredity-related or genetic factors may dominate among well-nourished populations (Stark, Peckham, and Moynihan, 1989) and appear to be more important among later cohorts (Treloar and Martin, 1990). This is supported both by important population differences and by studies comparing twins to other siblings. These studies show much larger differences in age at menarche between non-twins (Eveleth, 1978; Marshall, 1978).

2.3.11 Family Dysfunction and Child Sexual Abuse

Multiple studies have reported a connection between family relationships and the timing of menarche. As a group, girls in stressful home environments and those who have suffered child sexual abuse reach menarche sooner (Moffit,1992; Ellis, 1999; Ellis and Garber, 2000; Kaplowitz, 2004). Most of the relevant studies in this area are published in the psychological and anthropology literature, and they rely on questionnaires or interviews to ascertain the timing of puberty. Menarche, rather than thelarche or pubarche, is used a marker for pubertal maturation because the date of its arrival is more accurately recalled by interview subjects. Thus, in spite of the consistency of data on stress/abuse and menarcheal timing, there exist very little data about their impact on the actual onset of puberty(Chang *et al.,* 2000).

These studies are nevertheless impressive in their consistency across geographic and cultural boundaries, with European data largely corroborating U.S. data. In Poland, for example, girls exposed to prolonged familial dysfunction reached menarche four months earlier than girls living in families free of traumatic events (Hulanicka, 2001). Similar results were reported in French-speaking Canada, where adverse family conditions and high anxiety were correlated with precocious puberty (Tremblay and Frigon, 2005). Childhood sexual abuse lowers age of menarche in New Zealand girls (Romans 2003). However, war conditions in Bosnia caused delays in menarcheal ages among girls so exposed (Tahirovic, 1998). In this case, extreme psychological stress was also accompanied by physical injury and poverty.

2.3.12 Exposure to Tobacco Smoke

Exposure to tobacco smoke in utero often contributes to a lower birth weight, which in turn leads to a younger age at menarche. Mothers who smoked a pack of cigarettes a day during pregnancy gave birth to girls who experienced significantly earlier menarche than those whose mothers did not smoke (Steingraber, 2007). A girl's exposure to second hand smoke during early childhood decreases menarcheal age by about four months (Windham, 2004).

2.3.13 Birth Weight

Low birth weight (defined as birth before 37 weeks and/or birth weight of less than 2.5Kg at 40 weeks, according to Steingraber, 2007) has been consistently correlated to earlier age at menarche and is a known predetermining factor for adult onset diseases (Behrman and Butler, 2006). The possible causes of low birth weight are numerous and include such things as foetal exposure to cigarette smoke and maternal exposure to

chemicals such as wood preservatives, alcohol, air pollution, and drinking water contaminants (Ritzand Yu, 1999). Low birth weight usually leads to "compensatory catch-up growth." This phenomenon can be explained by the Barker Hypothesis, which states that: "…foetuses respond to prenatal stress by diverting resources to the developing brain at the expense of other tissues. This leads to low birth weight and "foetal programming" for adult-onset diseases such as diabetes and heart disease (Steingraber, 2007)". Basically, compensatory catch-up growth in early childhood leads to obesity, which then signals to the body that the organism can handle pregnancy, and therefore initiates menarche (Persson *et al*., 1999; Ibanez *et al.,* 2000).

2.3.14 Environmental Influences on Menarche

Various studies focus on the role of environmental chemicals, called endocrine-disruptor chemicals (EDC), on puberty timing alteration. EDC are used as industrial solvents/lubricants [polychlorinated biphenyls (PCBs), polybrominated biphenyls (PBBs), dioxins], plastics [bisphenol A (BPA)], plasticizers (phthalates), pesticides [methoxychlor, chlorpyrifos, dichlorodiphenyltrichloroethane (DDT)], fungicides (vinclozolin), and pharmaceutical agents [diethylstilbestrol (DES)] (Diamanti-Kandarakis *et al.,* 2009). Endocrine disruptors may have structural similarity with oestrogen, thus their action is performed through oestrogen receptor, whereas others, e.g. vinclozolin, interact with the androgen receptor, while other EDC, e.g. fadrozole and ketoconazole, inhibit aromatase or steroidogenesis, respectively. Furthermore, EDC may affect puberty via CNS regulation. For example, atrazine delays puberty in both males and females, reducing circulating LH and prolactin (Cooper *et al.,* 2000).

Phthalates and polychlorinated biphenyls have been associated with earlier breast development and menarche, respectively (Jacobson-Dickman and Lee, 2009). EDC may also influence the endocrine system in a harmful manner, inducing human disorders of sex differentiation (Skakkebaek *et al.*, 2001) and hormone-dependent cancers (Snedeker, 2001).

Explanations for linking exposure to environmental chemicals (many of which are endocrine disruptors) to altered pubertal timing are detailed and extensive, and cannot be explored to the fullest extent here. It should be noted that some scholars have found that children exposed to deleterious environmental chemicals have had delayed puberty, but the majority of studies have found that such exposure is correlated with earlier pubertal development. In fact, exposure to environmental chemicals may be the most likely factor contributing to an earlier age at menarche (McLachlan, 1985; Kuhl *et al*,. 2005). Animal studies have shown that foetal exposure to deleterious environmental chemicals is associated with low birth weight, which has been consistently correlated to early puberty development (Sagiv *et al*., 2007). Because many natural and synthetic chemicals resemble steroids in structure, once in the body they can bind to steroid receptors and alter steroid action (McLachlan,1985). Other compounds such as PCB's and DDT have been found to interfere with the immature brain's conversion of testosterone into oestrogen (Kuhl *et al.,* 2005). As with all potential factors affecting the age at menarche, however, Kaplowitz (2006) and Susman and Dorn (2009) point out that linking early puberty to endocrine disruptors is difficult because onset of puberty may occur many years after exposure to the deleterious chemical. Because of this, few

studies have been conducted on healthy children's exposure to endocrine disrupting chemicals and their effects (Susman and Dorn, 2009).

2.3.15 Diseases

Only a few reports have been published concerning the possible effects of pathologic states on menarcheal age. Arduino and Ferreira, (1958) in a study of 422 diabetic girls in Brazil, reported that menarche occurred earlier (by about one year) in the former. Post (1962),observed a similar correlation in a group of 166 diabetic women (with post-adolescent diagnoses) and 91 normal controls: the mean menarcheal age was 12.77 ± 1.49 years for the diabetic and 13.55 ± 1.51 years for the non-diabetic women. White(1960) studied 222 female 30-year survivors of juvenile diabetes, and found that menarche occurred early in prediabetic girls whose disease became evident after the age of 18, and late when the diabetes appeared before 11 years of age (Ho and Kung, 2005).

Obesity has been found to be associated with precocious menarche (Wolff, 1955). The menarcheal acceleration appears to be in proportion to the degree of obesity, although this correlation does not hold for girls more than 30 per cent over maximum expected weight for their height and somatotype.Beyond this level, girls tend to experience delayed menarche (Gerdhem and Obrant, 2004).

2.3.16 Age at Menarche and Body Growth and Configuration

Although there have been numerous studies of the relation between body configuration and the timing of sexual maturation, their findings are not always in agreement. On the other hand Barker and Stone, (1936) in California, noted that "…Women with late

menarcheal ages tend towards the longitudinal (leptosome) type, whereas those with early menarcheal ages tend towards the lateral (pyknic) type". Kralj-Čerček, (1956) in Yugoslavia, reported that menarcheal age for "Baroque" women (broad and feminine) was 12.93 years, for "Renaissance" (medium) it was 14.61 years**.** Livson and McNeill, (1963**)** in California, found that girls who mature early are less slender at menarche than those who mature late, owing, they thought, to differences in body build that are present from childhood, rather than to differential growth during adolescence. Young *et al*. (1963) in Florence, Italy, reported that girls with early menarche are fatter and less linear than others. These findings aresummarized as follows: "…in countries where nutrition may be more than adequate, fatness and early-maturing go together. Linear people, both men and women, develop later" (Tanner, 1962).

On the other hand, there are many reports indicating that early menarcheal age is associated with genetically advanced body growth and development rather than with body type or height-weight ratio. Simmons and Greulich (1943) reported that girls with early menarche are advanced in mean skeletal age over girls with late menarche. Jokl (1946) studies a group of 40 13-year-old white girls in South Africa and found that those who had not. Studies using school health records of 691 Indian schoolgirls 9–17 years old indicated that in each group those who had experienced menarche were taller and heavier than those who had not (Mukherji and Sengupta, 1962).

2.3.17 Temperature and Humidity

Recent research has not supported the belief, once widely held, that sexual development occurs at an earlier age in the tropics than in temperate zones. In fact, there is now unanimous agreement that climate in itself has little or no effect on menarche. Kennedy

(1933) reported that menarche occurs at the same age in Edinburgh, Rome and South Russia, places in which both temperature and humidity differ markedly. The mean menarcheal age of (14.22±1.00) years reported by Ellis (1950) for girls in Lagos Nigeria, differs very little from that specified in Levine's (1953) study of Alaskan Eskimos (14.42±1.20) years. Israel (1959) noted that the mean menarcheal ages in the hot, humid areas of Central India (14.65±1.55) years and the hot, dry regions of Northern Nigeria (14.65±1.24) years. Identical menarcheal ages were reported in Chauk, Burma (very hot and dry), Upper Assam (very hot but moist) and Digboi (Foll, 1961).

Some studies suggest that menarche may actually be delayed in the tropics. Mills (1937)suggested that the climate of the stormy temperate zone accelerates growth and sexual development, whereas that of moist, humid areas retards maturation. Compared the mean age of menarche in urban Ceyclon (12.84±1.24) years, rural Ceyclon (14.39±1.73) and the south of England (13.39±1.19) years and concluded that the age at menarche is not determined by climate (Wilson and Sutherland, 1953).

Because humans mature slowly, live a long time, and invest greatly in parenting only a few progeny, our bodies require internal systems that are highly sensitive to the geographic and cultural environment (Gluckman and Hanson, 2006; Susman and Dorn, 2009). The life history approach is used in an attempt to explain how events occurring during childhood affect health and resiliency later in life. Draper and Harpending (1982) and Ellis and Essex (2007) suggested that humans have evolved to be especially sensitive to the external environment during childhood because development during this time affects reproductive success later. Belsky*et al.* (1991**)** suggested that even societal

factors affect timing of puberty because children are socialized to be sensitive to availability and reliability of resources, both biological and emotional. Thus, the HPG axis is an internal monitor, and is very sensitive to disruptions, which can trigger the premature release of oestrogen in girls. Therefore, the relationship between the brain and the external environment is a crucial element in the onset of puberty(Steingraber, 2007).

2.3.18 Association between Puberty and Age at Menarche

A question that arises is what is the association between timing of onset of puberty and menarche? In other words will girls with early puberty invariably have menarche at an early age and vice versa? Data gathered from women born between 1977 and 1979, showed only a moderate correlation between menarche and onset of puberty (0.37-0.38), whereas in earlier studies conducted on women born between 1920 and the 1960s much higher correlations (0.64-0.86) were reported (Biro *et al.*, 2006). This may be explained by a change in the maturational tempo in girls born after the 1970s. Indeed, studies carried out during the last 10 years in Spain, the USA and Greece (Marti-Henneberg and Vizmanos, 1997; Biro *et al.*, 2001; Pantsiotou *et al.*, 2008) showed that early maturing girls present a compensatory delay in pubertal progression that could explain the moderate correlation between the age at menarche and at pubertal onset.

These studies have shown that early pubertal maturation in girls is associated with a greater pubertal height gain and a longer period of pubertal growth, which is due to a longer pubertal growth up to the stage of peak height velocity, whereas after that stage there is no significant difference to the duration of pubertal growth irrespective of the timing of the onset of puberty (Pantsiotou *et al.*, 2008).

2.3.19 Declines in Menarcheal Age during the Last Century

There is considerable evidence that in Western Europe and the United States, there has been an acceleration of sexual development during the past 100 years. This trend is regarded as one aspect of a general acceleration of human growth. As (Tanner, 1962), has stated: "Age at menarche has been getting earlier by some four months per decade in Western Europe over the period 1830-1960." The acceleration might be the result of unrelated processes that have affected specific communities at specific times (for example, technologic and agricultural advances, improvements in dietary and public-health practices and urbanization). If so, the lowering of menarcheal age would not necessarily be continuous or general, but would parallel the environmental changes. On the other hand, if a universal biologic process were acting on all girls to accelerate sexual maturation, the downward trend would be uninterrupted and world-wide (Parent *et al.*, 2003).

Studies of menarcheal acceleration have been of two sorts: those investigating the phenomenon over a relatively short time by comparing the menarcheal ages of mothers and their daughters; and those recording the general downward trend of maturational age in large populations over a long period. In both types of reports, it has been almost impossible to separate the effect of the passage of time per se from the multiple effects of concomitant socioeconomic changes. There are many reports that girls have an earlier onset of menstruation than their mothers, but very few in which it is clear that no major nutritional or socioeconomic advances occurred during the 20 or 30 years under consideration(Wilson, 1960).

2. 3.20 Health Implications of Early or Late Menarche

Early puberty is associated with increased body mass index, insulin resistance, total number of metabolic syndrome components and hence increased cardiovascular risk (Feng *et al.,* 2008). Moreover girls with early menarche exhibit elevated blood pressure and glucose intolerance compared with later maturing girls, independent of body composition (Remsberg *et al.,* 2005). A recent large population-based Caucasian cohort study also confirmed these observations, but also correlated in a nonlinear significant manner the earlier age at menarche (<12years) with higher incident cardiovascular disease, incident coronary heart disease, all-cause mortality and cancer mortality after adjustment for age, physical activity, smoking, alcohol, educational level, occupational social class, oral contraceptive use, hormone replacement therapy, parity, BMI and waist circumference. Most of the subjects had a positive family history of heart attack, which indicates that this association may be partly mediated by increased adiposity but genetic mechanisms may contribute as well (Lakshman *et al.,* 2009).

It has also been reported that menarcheal age influences bone mineral density and consequently the incidence of lumbar spine and hip fractures. Girls menstruating earlier have slightly higher bone mineral density of the lumbar spine and femoral neck in older age after excluding subjects who took hormone replacement therapy and adjusting for BMI (Gerdhem and Obrant, 2004). This might be apparently explained due to longer lifetime exposure to the protective effects of endogenous oestrogens at the period of acquisition of peak bone mineral density. On the other hand, late menarche is associated with osteoporosis, since studies including postmenopausal women suggest that those having later menstruated have lower mineral density at forearm, spine and proximal

femur and increased risk of fractures as well (Fox *et al.,* 1993; Tuppurainen *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 2-fold increased risk of low areal bone mineral density at the hip in women aged under 40 years (Ho and Kung, 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). Finally, recent data suggest that in girls experiencing menarche later, the deficit of areal bone mineral density is generated before the onset of pubertal maturation with very mild increment during the whole period of pubertal maturation. This observation indicates that oestrogen 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).

Multiple studies confirm that early menarche is a risk marker for breast cancer (De and Trichopoulos, 1988). This predisposition is enhanced by the observation that earlier onset of menarche is accompanied by abdominal-type obesity and thus higher circulating levels of insulin, testosterone and insulin- like growth factor 1, which in turn act as growth factors for mammary tissue proliferation and are likely to promote mammary gland carcinogenesis (Stoll *et al.,* 1994). Early menarche leads to earlier sexual intercourses and is a risk factor for adolescent depression (Kaltiala-Heino *et al.,*

2003). Girls associate a variety of negative physical and psychological changes with menstruation, reflecting both misconception and ignorance (Koff and Rierdan, 1995) and the fear of being different from peers as well (Comerci, 1982). Girls' attitudes and expectations about menstruation are negatively biased and have been found to contribute to self- objectification, body shame, and lack of agency in sexual decision making (Stubbs, 2008).

Early maturing adolescents with problematic peer relations experience elevated social anxiety symptoms (Blumenthal *et al.,* 2009). A recent research combined accelerated sexual maturation with negative experiences with the opposite sex, indicating that the earlier the menarche, the larger the estimated egocentric distance of virtual male voices and the more negative the evaluations of male faces (Belles *et al.,* 2010). Moreover, if early maturation is combined with social factors, such as an underprivileged neighbourhood, susceptibility to a violent behaviour enhances (Obeidallah *et al.,* 2004). On the other hand, girls with constitutional delay in puberty and onset of menstruation feel that this delay has an impact on school, work or social status and would prefer to accelerate their growth spurt by treatment (Crowne *et al.,* 1991).

2.4 DEFINING THE MENSTRUAL CYCLE

The menstrual cycle is the interval of time marked by the first day of one period to the first day of the next period. The number of days included in that interval may be as few as 20 or as many as 45 (Weideger, 1975; Diaz**,** Laufer, and Breech, 2006). Earlier accounts of menstrual cycle length document 26 to 30 days as typical variation (Willson *et al*., 1966), whereas more recent literature cites 21 to 34 or 35 days as a typical range for estimating cycle length (Steele,1997; Diaz *et al*., 2006). Despite the amount of

individual variation in menstrual cycle length, an estimate of 28 days is consistently reported as the statistical average from the onset of one period of bleeding to the onset of the next period of bleeding (Weideger, 1975; Stoppard, 1992; Steele, 1997).

2.5 PHASES OF THE MENSTRUAL CYCLE

Primarily regulated by the hypothalamus and the anterior pituitary gland in the brain and maintained by feedback from the ovaries and uterus, the menstrual cycle may be elaborated upon in terms of distinct events or phases. The phases cited by practitioners and researchers differ in terminology based upon the area of the female body being investigated, however, the various terms all describe the same 28-day menstrual cycle. When researchers focus upon the anterior pituitary gland function, the menstrual cycle is discussed in terms of the hormones released during those 28 days—follicle stimulating hormone (FSH) and luteinizing hormone (LH). The menstrual cycle is also described based upon the cell structures developed in the ovaries (follicle and corpus luteum) as a response to the hormones secreted by the anterior pituitary gland. Both of these perspectives yield the terms follicular phase and luteal phase (Endicott*et al.*, 2006).

If the focus is upon the output function of the ovaries, the release of hormones again allows for a distinction in phase terminology—the oestrogen (or oestrogenic) phase and the progesterone (or progestational) phase. Lastly, if the uterus is the primary focus of researchers, the menstrual cycle comprises phases based upon the changing endometrium—menstrual phase, proliferative phase, ovulatory phase, secretory phase, and premenstrual phase (Steele, 1997; Doria 1999; Anderson *et al.,* 2007).

When represented graphically, each of these models may mark the midpoint of the cycle (day 14) to indicate the point of ovulation (release of an egg from a mature follicle). Figure 1.1 offers a succinct model of the menstrual cycle based upon these alternative points of focus. In the graph charts, FSH and LH are seen as released by the anterior pituitary gland throughout the cycle. Secondly, ovarian hormone levels of oestrogen and progesterone are charted across the 28-day cycle. Thirdly, the graph depicts the activities of the ovary engaging in follicle formation, ovulation, and corpus luteum formation. Lastly, the changing endometrium inside the uterus is drawn to indicate tissue sloughing or the degeneration of the uterine wall during the menstrual phase and then growth or the thickening of the uterine wall across latter phases (Heinemann*et al.*, 2010).

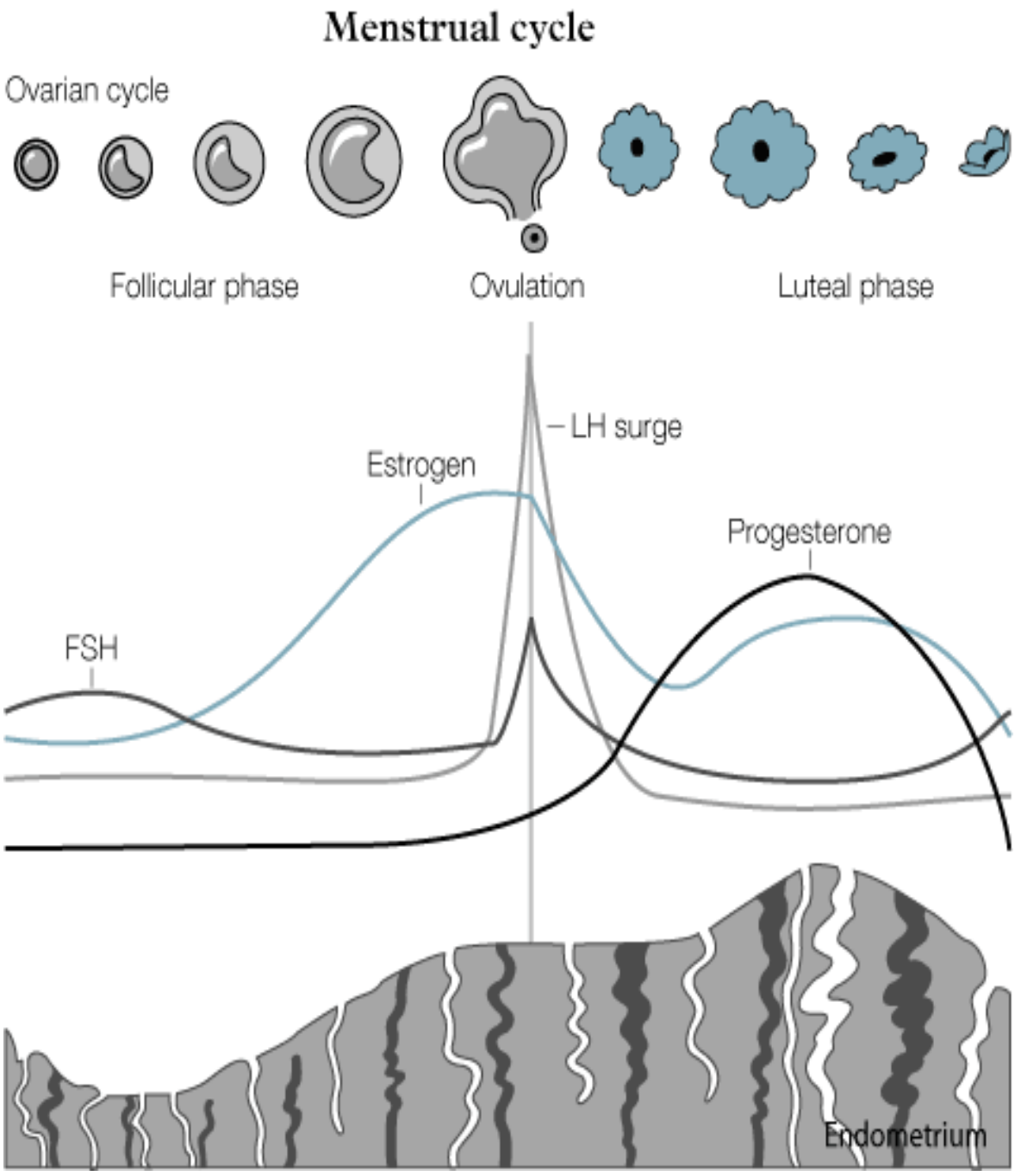

Figure 2.1: Schematic representation of a 28 day menstrual cycle. LH = Luteinizing Hormone, FSH = Follicle Stimulating Hormone. (Megan, 2012)

Days 1 through 5 form the menstrual phase (also known as menstruation, period, flow, and menses) wherein the lining of the uterus disintegrates and is shed as blood, endometrial tissue, tissue fluid, and mucus (Steele, 1997). Ovarian activity is minimal and, consequently, ovarian hormonal levels of oestrogen and progesterone are relatively low (Lein, 1979; Doria, 1999). When oestrogen levels are low, the anterior pituitary gland facilitates the release of follicle-stimulating hormone (FSH) over luteinizing hormone (LH)—this process actually occurs late in the previous cycle and continues through most of the menstrual phase (Lein, 1979).

Days 6 through 12 mark the proliferative, oestrogenic, or follicular phase. During this time, the FSH and LH secreted by the anterior pituitary gland stimulate the formation of fluid- filled sacs or cell clusters called follicles (Lein, 1979; Stoppard, 1994; Doria, 1999). Each follicle houses a developing ovum (egg), but only one follicle will reach full maturity (Lein, 1979; Doria, 1999). The ovaries take turns in performing this function from cycle to cycle so that one ovary is resting during every follicular phase; however, in cases where a female has only one ovary, the ovary will partake in follicle formation every cycle (Lein, 1979). FSH then prompts the follicles inside the ovary to release oestrogen. Estradiol, the most active of three different oestrogenic hormones, actually plays the crucial role in the menstrual cycle; however, the term oestrogen is more commonly used for description (Willson *et al.*, 1966; Doria, 1999). This oestrogen release causes the uterine walls (endometrium) to thicken and blood vessels to approach the lining of the uterus (Doria, 1999; Anderson *et al.*, 2000). The rising level of oestrogen inhibits secretion of FSH while promoting a marked rise in LH. This LH surge allows for the maturity of one follicle (Lein, 1979; Stoppard, 1994).

Days 13 through 15 refer to the ovulatory phase of the menstrual cycle. Approximately 16-24 hours following the peak in LH—others estimate 30 hours (Steele, 1997)—the mature follicle ruptures and releases the ovum it has developed (Asso, 1983; Stoppard, 1994). Fertilization can occur within this window of time (Doria, 1999). The event known as ovulation (the actual release of the ovum) is typically placed at day 14.

Days 16 through 23 compose the secretory, progestational, or luteal phase wherein the empty follicle transforms its endocrine cells into a structure called a corpus luteum. This mass of tissue secretes large amounts of progesterone and some oestrogen (Lein, 1979; Doria, 1999). Progesterone maintains the thickening of the uterine walls (Asso, 1983; Steele, 1997) and causes the cells of the uterus to release other hormones and enzymes to prepare the endometrium for implantation of a fertilized ovum (Stoppard, 1994; Doria, 1999; Anderson *etal*., 2000).

Days 24 through 28 form the premenstrual phase. If a fertilized ovum is not implanted in the uterine lining, the corpus luteum degenerates and oestrogen and progesterone levels decline (Lein, 1979; Doria, 1999). This drop in hormones results in spasms of the arterioles that cause a breakdown of the endometrium (Stoppard 1994; Steele 1997). Finally, high concentrations of prostaglandins cause the uterine muscles to contract, which sheds the lining as tissue, mucus, and blood (Lein, 1979; Asso, 1983; Stocker, 1995; Stoppard, 1994).

Menstruation (bleeding) has again commenced and the female is returned to day 1 of the ongoing menstrual cycle. It is important to understand that the patterns of hormonal changes and the days of the cycle marking various phases are simply generalizations

and estimates across the female population. Oral contraceptives, for example, alter the hormonal profiles of the female menstrual cycle by inhibiting FSH and LH production (Richardson, 1992). This change in the role of pituitary hormones and the fixed levels of synthetic oestrogen and progesterone provided by oral contraceptives prevents ovulation and changes the endometrium inside the uterus (Everett, 1997). For reasons other than oral contraceptive ingestion (inadequate LH surge, for example), some women also experience an ovulatory cycles wherein ovulation does not occur. The corpus luteum responsible for secreting large amounts of progesterone during the luteal phase is not formed when ovulation fails to occur; hence, the biochemical, physiological, and physical effects typically associated with the luteal phase are absent in women with an ovulatory cycles (Lein, 1979).

Difficulty in understanding the menstrual cycle stems not only from the actual variation in female biochemistry and physiology, but also from the numerous ways in which these differences are described in the literature. Sommer (1992) admits that "there is great inconsistency in menstrual-cycle phase definition across different studies".

However, regardless of when ovulation occurs in each woman, the time from that day until the next period of bleeding seems to remain constant at 14 days (Lein, 1979). It is the first half of the cycle that bears the changes in duration of phases. Lein (1979) states that this "rather curious feature of the cycle…means that ovulation always occurs about 14 days before the beginning of the next menstrual period, no matter how long the entire cycle may be". A model to exemplify variation in cycle length with consistency in luteal phase length is shown in Fig. 1.2. In this model, the menstrual period is assumed to last 5 days, the follicular phase includes the day of ovulation, and the luteal

phase spans the day following ovulation to the last day of the premenstrual phase (Lin and Barnhart, 2007).

25-day cycle	Menses	6 days	~~Day~~ 11 14 days	menses

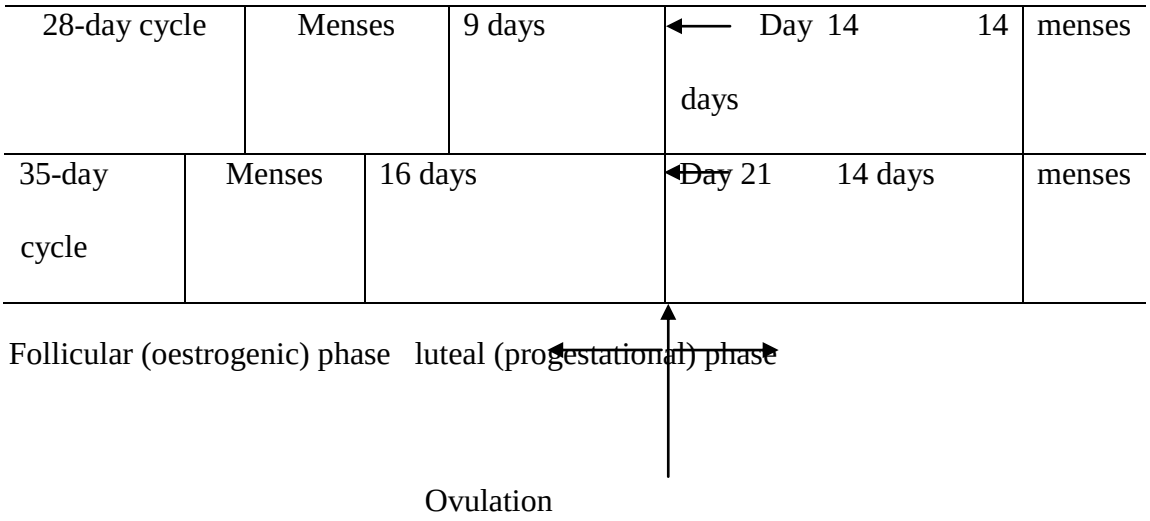

Figure 2.2: Variations in overall cycle length with constant luteal phase

(*Adapted from*: Lein, 1979, p. 53)

CHAPTER THREE

3.0 MATERIAL AND METHODS

3.1 RESEARCH PARTICIPANTS

The subjects that participated in the study were secondary school girls from Kaduna State (n=400, mean age 16.69 ±1.22 years) and secondary school girls from Enugu State (n=400, mean age16.23 ±1.49 years). Figure 3.1 shows the flow chart of the study participants.

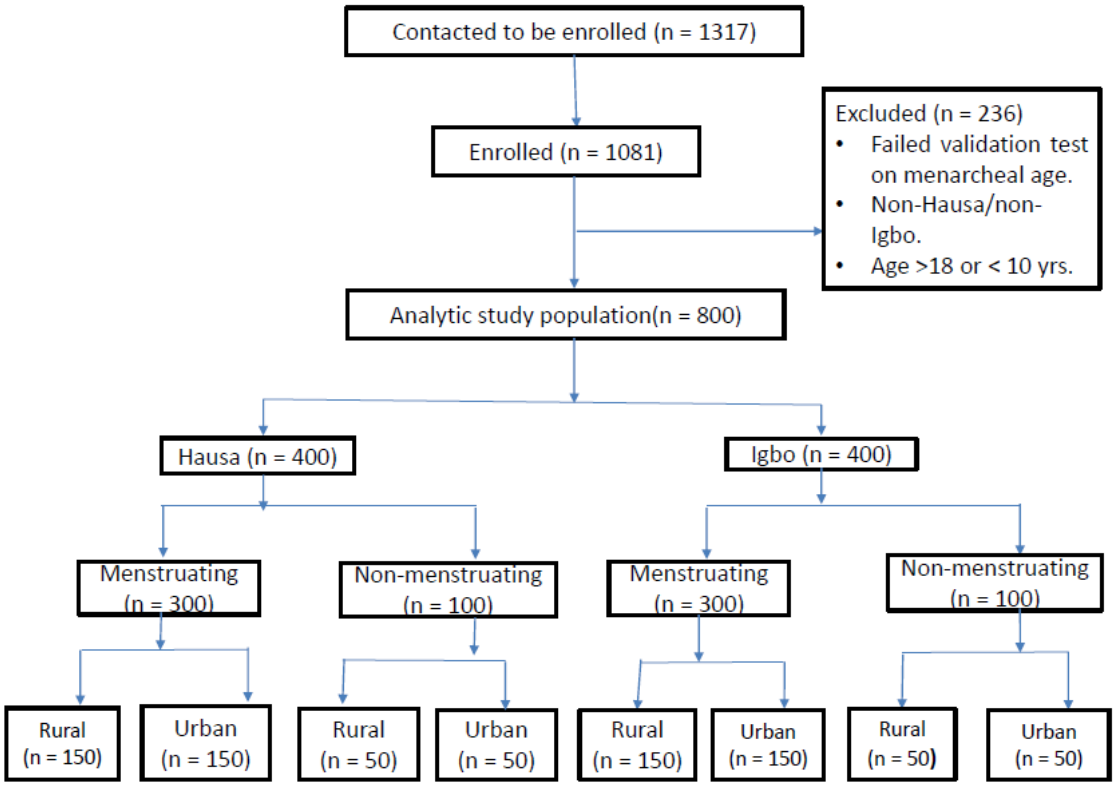

Figure 3.1: Flow chart of study participants

3.2 STUDY AREA

Random selection of secondary schools in urban and rural areas of Enugu and Kaduna States was made. Girls from these schools were enrolled. In both states, participants included junior and senior secondary schools' students in rural and urban centres.

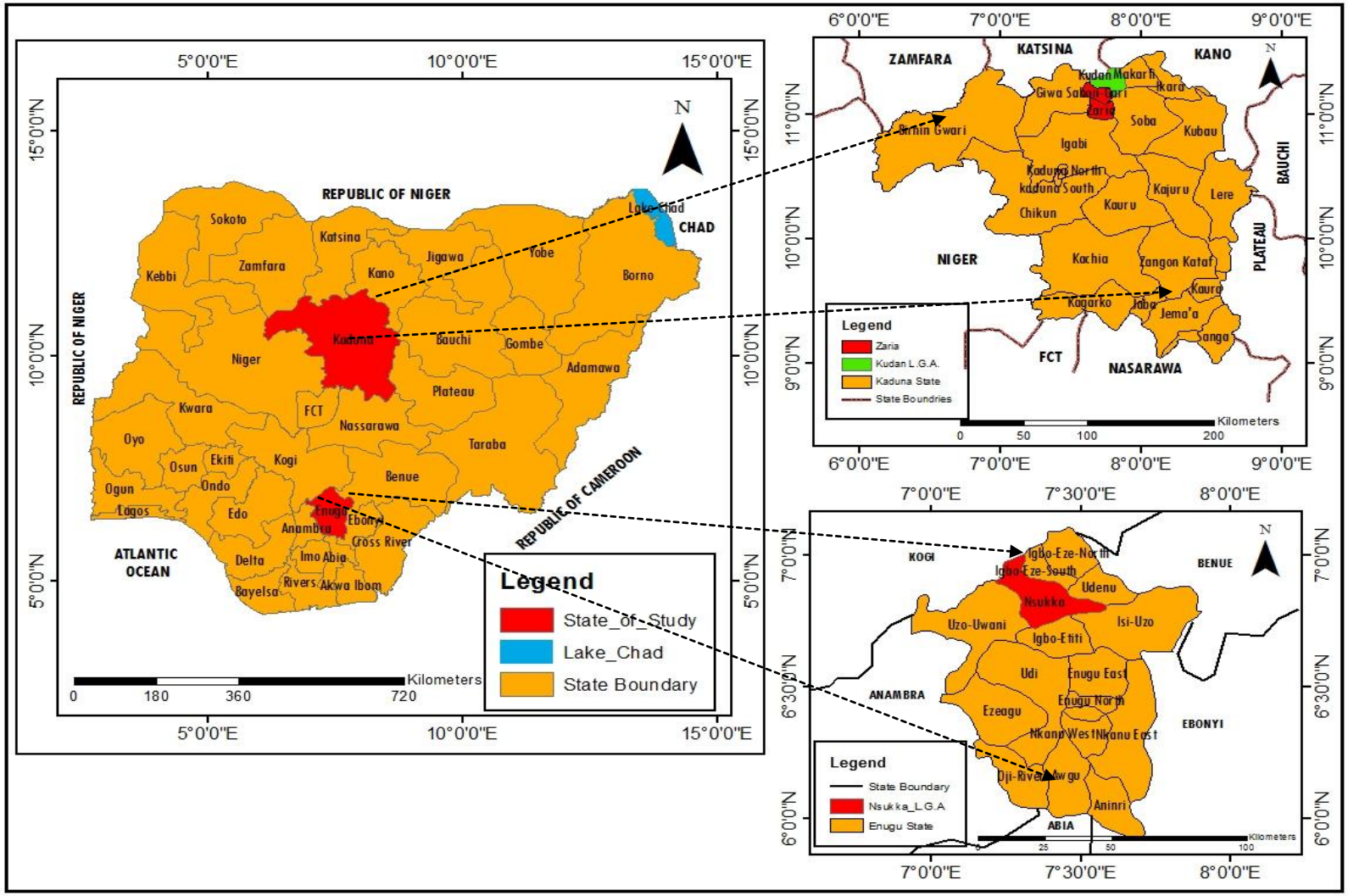

Figure 3.2: Map of Nigeria Showing the two study areas Kaduna State (top right) and Enugu State (bottom right)
Source: Geographic and information systems (GIS)

3.3METHODOLOGY

Data for this study were collected from participants (students). An informed verbal consent was taken from adolescent school girls who were between eleven and eighteen years old and willing to participate in the survey. In order to encourage more candid and reliable responses, participants were made to complete the self-administered questionnaire in confidence with their peers unable to see their answers. Cross-sectional method was used to select 800 school girls from two Nigeria ethnic groups.

Data were collected through self-administered questionnaires. Data pertaining to parents' ethnic group, socio-demographic variables, anthropometric parameters, and incidence of premenstrual syndromes.

Anthropometric measurements on participants were carried out by well-trained female research assistants.The current age and menarcheal age of each girl were asked. Place of residence at childhood and adolescent was classified into two categories: rural centres and urban centres. Subjects were said to be rural dwellers if they reside in an area other than urban area with limited amount of social amenities and the major occupation being farming. Subjects are said to be urban dwellers if they reside in an area with better health-care facilities, better sanitary standards of dwellings, and better schools (Bielicki and Szklarska, 1999).

In order to reduce observation errors, anthropometric measurements were read twice independently and the mean of the two measurements was taken as the actual value.Girls with a BMI of less than 20 were considered underweight; those with BMI in

the range of 20-24.9 were considered normal, 25-29.9 over-weight, while those with BMI greater than 30 were considered obese (WHO, 2003).

Socialstatus was analysed according to parents' level of education, birth order, and the number of children in the family. The mean age at menarche according to social statuswas calculated andanalysed.

For girls who had already attained menarche at the time of the examination some questions relating to their menstruation were asked: how many days was the length of her menstrual cycle, what was the duration of the bleeding, and what type of symptoms occurred prior tothe bleeding days.

The following data were filled by each participant using pre-designed questionnaires:

i. **Demographics:** Data pertaining demographics Include current age (years), ethnic group, place of residence at childhood and at adolescent, number of siblings, birth order, type of school, parents' level of education, parents' occupation, and place of birth.
ii. **Menarcheal status:** Menstruating or not, age at menarche, month of menarche, school grade at menarche.
iii. **Anthropometric assessment:** Weight, height, BMI, mid upper arm circumference, waist circumference, hip circumference, Waist-Hip ratio, thigh circumference, neck circumference, chest circumference, subscapular skin-fold, triceps skin-fold thickness, 2D:4D ratio.

3.4 DATA COLLECTION TECHNIQUE

Samples for the present cross-sectional study were collected from secondary school female students between the ages of 11 to 18years in rural and urban environments of Kaduna and Enugu States.

3.5 SAMPLING SIZE DETERMINATION

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

$[n = z^2pq/d^2]$ (Naing *et al.*, 2006)

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. 0.5)

q= 1.0-p

d= degree of accuracy desired, usually set at 0.04

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

For the purpose of this study a total of 800 subjects for both locations (Enugu and Kaduna states) was used.

3.6 ANTHROPOMETRY

i. **Body Mass Index (BMI):** The BMI was calculated as follows: weight (kg)/ [height x height (m^2)].

ii. **Chest circumference (cm)**: This measurement was taken at the level of the middle of the sternum (breast-bone), with the tape passing under the arms. After the tape is in

position, the arms should be relaxed by the side, and the measurement taken at the end of a normal expiration.

iii. **Height (cm)**: Standing height was measured taking the maximum distance from the floor to the highest point on the head, when the subject was facing forward. Shoes was 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. This measurement will be carried out using a stadiometer**.**

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

v. **Mid Upper Arm Circumference (cm)**: The bicep was flexed, while the tape is wrapped around the flexed bicep, half way between the shoulder and the elbow.

vi. **Thigh Circumference (cm)**: This circumference measure was taken at the level of the mid-point on the lateral (outer side) surface of the thigh, midway between trochanterion (top of the thigh bone, femur) and tibia lateral (top of the tibia bone).

vii. **Triceps**: A pinch of skin fold will be taken on triceps midway between your shoulder and elbow. The measurement will be taken when the person is standing upright, with arms hanging down loosely.

viii. **Waist circumference (cm)**: The tape was used to circle the waist (like a belt would circle the waist) at the natural waistline, which is midpoint between the lowest rib and the iliac crest. The subject was asked to stand erect while measurements were taken.

ix. **Weight (kg)**: An overall measure of body size that does not distinguish between fat and muscle. Weight was measured to the nearest 0.1kg when the subject is standing and putting on light indoor clothes using the inner scan.

3.7 ETHICAL APPROVAL

The study protocol was reviewed and approved byHealth Research Ethics Committee of the Ahmadu Bello University Teaching Hospital, Zaria and permission to conduct the study was obtained from the authorities of participating schools. Only subjects who gave informed consent to participate with the research were included in this study.

3.8.1 Inclusion and Exclusion Criteria

3.8.2 Inclusion Criteria

The following was used as inclusion criteria

i. Girls who are indigenes of Enugu and Kaduna states of Nigeria.
ii. Pre-pubertal female students at junior secondary school and pubertal female students at senior secondary schools will be included.
iii. Subjects must be mentally and physically fit.
iv. Respondent must age between 11-18 years old, because this is the range within the ideal age of menarche.

3.8.3 Exclusion Criteria

The following was used as exclusion criteria:

i. Non-Enugu state and non-Kaduna state indigenes.
ii. Females whose age is not between 11-18years.
iii. Females with Mental disorder.

3.9 STATISTICAL ANALYSIS

Descriptive statistics of continuous variables were expressed as mean $\pm$ standard deviation and percentages. Student's t-test was used to test for difference in mean of all

variables between rural and urban girls and between girls from Hausa and Igbo ethnic groups. One way analysis of variance (ANOVA) was used to evaluate difference in anthropometric variables according to menarcheal age and socio-demographic categories.Pearson's correlation coefficient was used to test the relationship between each of the measured anthropometric parameters. For non-continuous variables, Chi square was used to investigate significant association with prevalence of premenstrual syndrome between the ethnic groups. Linear regression was used to generate equations for predicting menarcheal age of girls and for girls from each ethnic group from certain variables.

$P<0.05$ (two-tailed) was deemed statistically significant and SPSS version 22 (SPSS IBM Inc., Chicago, IL) was used to complete all the statistical analyses.

CHAPTER FOUR

4.0 RESULTS

4.1 ANALYSES OF STUDY POPULATION

Secondary school girls (n = 800) participated in this study, six hundred were post-menarcheal (75%) while the remaining two hundred (25%) were pre-menarcheal girls (fig 3.1). The study was conducted in Enugu state (Nsukka LGA), and Kaduna state (Zaria LGA). The age range of the study subjects is 11-18 years, while their mean age is 15.25 ±2.43 years.

4.2 ANTHROPOMETRIC VARIABLES AND MENACHEAL AGE

Data was collected from pre-menarcheal and post-menarcheal girls using a pre-designed questionnaire. Descriptive statistics of the entire sample population of menstruating girls is shown on Table 4.1. From Table 4.1, the mean age and mean menarcheal age of all the menstruating girls are respectively(16.46 ± 1.38) years and (13.54 ± 0.90)years. Also from the Table, the minimum age at menarche of the subjects in this study is 11 years while the maximum age at menarche is 15 years.The average menarcheal ages of girls from Hausa and Igbo ethnic groups were 13.65 ± 0.92 and 13.44 ± 0.87 years respectively indicating that girls from Igbo ethnic group attained menarche at a significantly younger age when compared to girls from Hausa ethnic group, ($t = -4.16$, $p < 0.05$). The results also revealed that ethnicity is significantly related to anthropometric parameters. The Igbo girls scored higher in all anthropometric parameters than the Hausa girls, with statistically significant difference ($p < 0.001$) except for BMI.

Figure 4.1 is a graph showing the comparison of menarcheal age categories according to ethnicity. Chi-square test to check the association between ethnicity and menarcheal age indicated statistical significance, $\chi^2 = 13.86$, $p = 0.01$.

Table4.2 shows the comparison of mean age, menarcheal age, and anthropometric parametersof Hausaand Igbo school girls residing in urban and rural areas. The mean age at menarche of girls living in rural area is significantly higher than that of girls from urban centres. Results on the table also indicate that Hausa girls from rural area have higher mean menarcheal age than Igbo girls from rural area. Also, Hausa girls from urban centres reach maturity earlier than Igbo girls from urban centres. The mean anthropometric parametersof Igbo girls were significantly higher than among Hausa girls living in urban area $p < 0.05$. However, there is no statistical significance in height, BMI, and MUAC. The mean anthropometric parametersof Igbo girls were significantly higher than among Hausa girls living in rural area $p < 0.05$.

Table 4.1: Mean and standard deviation of menarcheal age and anthropometric parameters of all subjects (n=600) and for subjects according to ethnicity (n = 300)

	(All subjects, n= 600)		(Hausa,n=300)		(Igbo, n = 300)			
Parameters	Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max	t	p
Age (years)	16.46 ± 1.38	13.00-18.00	16.69 ± 1.22	14.00 - 18.00	16.23 ± 1.49	13.00 – 18.00	-4.16	0.001
Menarcheal Age (years)	13.54 ± 0.90	11.00-15.00	13.65 ± 0.92	11.00 – 15.00	13.44 ± 0.87	11.00 – 15.00	-2.96	0.001
Height (cm)	154.92 ± 0.05	143.00-168.00	154.03 ± 5.51	143.00–165.00	155.81 ± 0.05	144.00 – 168.00	4.07	0.001
Weight (kg)	49.02 ± 3.85	40.00-78.00	48.12 ± 2.97	40.00 – 68.00	49.92 ± 4.39	41.00 – 78.00	5.83	0.001
BMI (kg/m²)	20.50 ± 2.13	15.63-31.96	20.36 ± 1.86	15.63 – 28.15	20.64 ± 2.36	15.94 – 31.96	1.72	0.09
Chest Circumference (cm)	72.33 ± 6.54	58.60 - 102.20	68.98 ± 4.03	60.10 – 78.70	75.68 ± 6.86	58.60 – 102.20	14.58	0.001
Hip Circumference (cm)	78.85 ± 7.61	60.40 - 111.80	74.04 ± 4.11	60.40 – 80.90	83.66 ± 7.25	62.10 – 111.80	20.00	0.001
Waist Circumference (cm)	64.30 ± 5.67	50.50 - 87.30	62.99 ± 5.00	50.50 – 71.90	65.61 ± 6.00	50.50 – 87.30	5.82	0.001
Thigh Circumference (cm)	42.77 ± 4.70	23.70 - 63.40	41.44 ± 3.68	35.10 – 50.90	44.10 ± 5.21	23.70 – 63.40	7.22	0.001
MUAC (cm)	24.45 ± 1.50	19.40 – 30.40	24.01 ± 1.33	19.40 – 26.90	24.90 ± 1.54	20.70 – 30.40	7.56	0.001
Neck Circumference (cm)	30.85 ± 2.20	25.50 – 45.20	30.51 ± 2.30	25.50 – 45.20	31.19 ± 2.05	25.50 – 41.20	3.82	0.001
Waist-Hip Ratio	0.82 ± 0.09	0.53 – 1.00	0.85 ± 0.07	0.63 – 1.00	0.79 ± 0.09	0.53 – 0.99	-9.60	0.001
Waist-Chest Ratio	0.82 ± 0.09	0.67 – 1.00	0.91 ± 0.07	0.72 – 1.00	0.87 ± 0.07	0.67 – 1.00	-7.79	0.001
Waist-Height Ratio	0.89 ± 0.07	0.53 – 1.00	0.85 ± 0.07	0.63 – 1.00	0.79 ± 0.09	0.53 – 0.99	-9.78	0.001

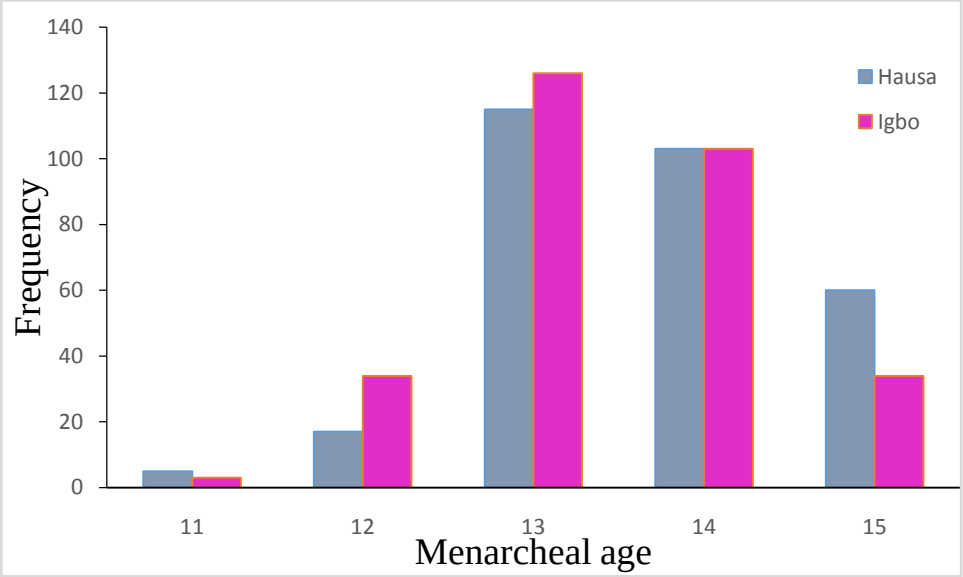

Fig. 4.1: Comparison of menarcheal age categories based on ethnicity. Igbo girls reach menarche earlier than Hausa girls. Chi-square test indicates statistical significant association between menarcheal age and ethnicity. $\chi^2 = 13.86$, $p = 0.01$.

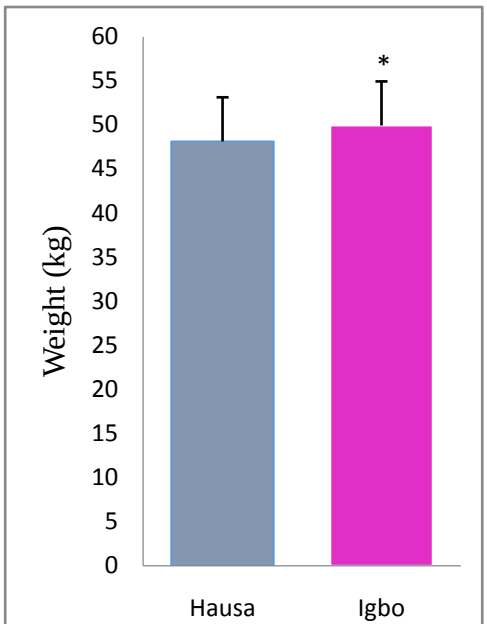

Fig. 4.2: Comparison of weight between Hausa and Igbo school girls. Igbo girls are heavier than Hausa girls. Student t-test indicates significant difference in weight of girls from Hausa and Igbo ethnic groups, $t = 5.83$, $p < 0.05$

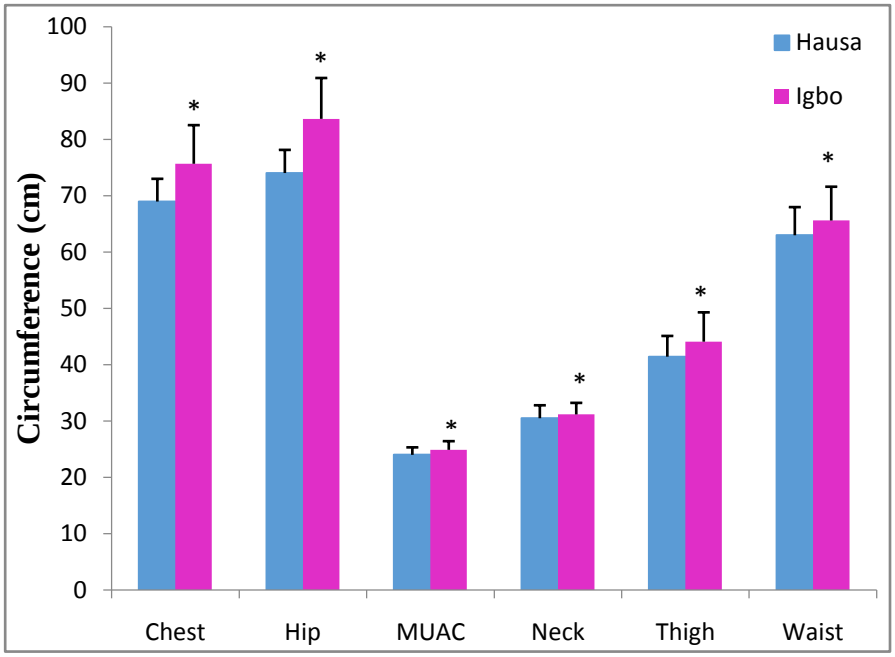

Fig. 4.3: Comparison of circumferences between Hausa and Igbo school girls. Girls from Igbo ethnicity have higher circumferences than girls from Hausa ethnicity. Student t-test indicates significant difference in circumference between Hausa and Igbo ethnic groups, $p < 0.05$.

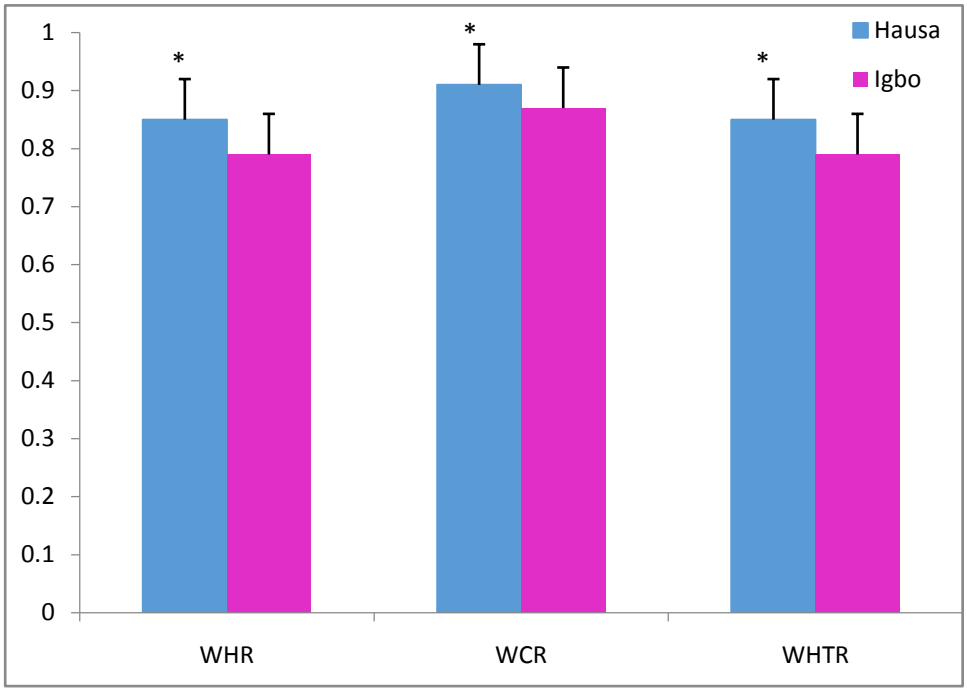

Fig. 4.4: Comparison of indices between Hausa and Igbo school girls. Student t-test indicates significant difference in indices between Hausa and Igbo ethnic groups, $p < 0.05$. WHR = Waist-Hip ratio, WCR = Waist-Chest Ratio, WHTR = Waist-Height Ratio.

Table 4.2: Menarcheal age and anthropometric parameters of girls from Hausa and Igbo ethnic groups from rural and urban areas

	Hausa				Igbo			
	Rural	Urban			Rural	Urban		
Parameters	Mean ± SD	Mean ± SD	t	p	Mean ± SD	Mean ± SD	t	p
Age (years)	16.64 ± 1.32	16.75 ± 1.12†	0.75	0.450	16.41 ± 1.43	16.05 ± 1.54	-2.06	0.040
Age at Menarche (years)	13.83 ± 0.95§	13.48 ± 0.86	-3.33	0.010	13.52 ± 0.87	13.35 ± 0.88	-1.66	0.100
Height (cm)	153.21 ± 5.56§	154.84 ± 5.37	2.58	0.010	155.61 ± 5.12	156.01 ± 5.35	0.66	0.510
Weight (kg)	47.64 ± 2.47§	48.61 ± 3.33†	2.86	0.010	49.75 ± 2.99	50.09 ± 5.45	0.66	0.550
BMI (kg/m²)	20.37 ± 1.80	20.34 ± 1.93	-0.29	0.780	20.61 ± 1.79	20.67 ± 2.83	0.60	0.620
Chest Circumference (cm)	69.73 ± 3.97§	68.24 ± 3.97†	-3.26	0.001	75.19 ± 6.73	76.17 ± 6.96	0.50	0.220
Hip Circumference (cm)	72.77 ± 4.01§	75.31 ± 3.83†	5.62	0.001	81.53 ± 7.11	85.80 ± 6.76	1.24	0.001
Waist Circumference (cm)	62.56 ± 5.38§	63.42 ± 4.56†	1.48	0.140	64.66 ± 5.83	66.57 ± 6.03	5.34	0.010
Thigh Circumference (cm)	40.54 ± 2.55§	42.34 ± 4.36†	4.36	0.001	43.83 ± 5.39	44.37 ± 5.03	2.79	0.370
MUAC (cm)	23.73 ± 1.32§	24.29 ± 1.27	3.74	0.001	25.19 ± 1.23	24.60 ± 1.78	0.90	0.001
Neck Circumference (cm)	31.12 ± 2.12	30.76 ± 2.16†	-1.46	0.140	30.98 ± 1.72	30.05 ± 2.68	-3.39	0.001
Waist-Hip Ratio	0.86 ± 0.08§	0.84 ± 0.07†	-1.96	0.050	0.80 ± 0.09	0.78 ± 0.09	-1.62	0.110
Waist-Chest Ratio	0.90 ± 0.06§	0.93 ± 0.07†	4.22	0.010	0.86 ± 0.07	0.88 ± 0.07	1.75	0.080
Waist-Height Ratio	0.86 ± 0.08§	0.84 ± 0.7†	-2.06	0.040	0.80 ± 0.09	0.78 ± 0.08	-1.79	0.080

§.t-statistics showed statistical significant difference ($p< 0.05$) for comparison between Hausa and Igbo girls residing in rural areas.
†.t-statistics showed statistical significant difference ($p< 0.05$) for comparison between Hausa and Igbo girls from urban areas.

Table 4.3 shows the comparison between mean age and anthropometric measurements of menstruating and non-menstruating girls. The mean anthropometric measures of menstruating girls were significantly higher than those of non-menstruating girls ($p < 0.001$).

The results in Tables (4.4, 4.5 and 4.6) showed the 5, 10, 25, 50, 75, 85, 90, 95, and 97thcentiles of age-to-BMI, age-to-weight and age-to-height. This is to compare the growth pattern of girls from the two ethnic groups. From the table, it is obvious that girls from Igbo ethnicity in most instances have higher score across the various ages and parameters considered. In this study, girls whose BMI for age was less than the 5th percentile were considered as underweight, between 5th and 85th centile as normal, and greater than or equal to 85th centile as overweight (Roland, 1993).

Age of menarche was lowest (13.16 ± 1.01) years among those with BMI equal or greater than 85thcentile as compared to (13.79 ± 0.83) years and for those whose BMI centile is less than 5thcentile (Table 4.7). This difference is statistically significant ($F = 7.51$, $p = 0.001$).

Table 4.3: Anthropometric variables and indexes of menstruating and non-menstruating females

Anthropometric parameters	Post-menarcheal Mean ± SD	Pre-menarcheal Mean ± SD	t	p
Age (years)	16.46 ± 1.38	11.63 ± 0.66	47.63	0.001
Height (cm)	154.92 ± 0.05	147.56 ± 3.54	17.91	0.001
Weight (kg)	49.02 ± 3.85	38.38 ± 2.60	36.41	0.001
BMI (kg/m^2)	20.50 ± 2.13	17.64 ± 1.40	17.52	0.001
Chest Circumference (cm)	72.33 ± 6.54	65.41 ± 6.15	13.16	0.001
Hip circumference (cm)	78.85 ± 7.61	67.20 ± 4.35	20.56	0.001
Waist Circumference (cm)	64.30 ± 5.67	56.38 ± 4.42	18.02	0.001
Thigh Circumference (cm)	42.77 ± 4.70	37.73 ± 2.79	14.35	0.001
MUAC (cm)	24.45 ± 1.50	21.25 ± 1.90	24.40	0.001
Neck Circumference (cm)	30.85 ± 2.20	28.43 ± 1.40	14.61	0.001
Waist-Hip Ratio	0.82 ± 0.09	0.84 ± 0.07	-2.97	0.001
Waist-height ratio	0.82 ± 0.09	0.38 ± 0.03	11.32	0.001
Waist-chest ratio	0.89 ± 0.07	0.87 ± 0.07	4.43	0.001

Table 4.4: Comparison of BMI-for-age centiles of girls from Hausa and Igbo ethnic groups

	BMI centiles																	
	5th		10th		25th		50th		75th		85th		90th		95th		97th	
Age (yrs.)	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**
11	14.90	15.60	15.50	15.60	16.40	16.85	17.40	17.80	18.10	18.90	18.50	19.41	18.92	19.68	20.30	20.35	20.45	20.50
12	15.21	15.22	15.74	15.72	16.40	16.90	17.30	17.47	18.10	19.32	19.54	19.91	19.64	19.92	20.65	20.76	21.29	21.50
13	16.20	15.89	16.22	16.36	17.30	17.95	17.80	18.03	18.35	19.64	18.89	20.72	19.79	20.81	20.73	21.72	22.60	22.88
14	17.47	17.48	17.50	17.64	18.17	18.33	18.52	18.83	20.81	21.13	20.92	21.79	21.39	21.91	21.93	22.86	23.25	24.43
15	17.48	17.58	17.84	17.98	18.61	18.66	18.72	19.88	20.91	21.06	21.32	21.73	21.45	22.11	22.07	23.15	23.39	24.45
16	17.62	17.76	18.08	18.25	18.63	18.73	18.75	20.55	21.27	21.78	20.92	21.89	21.60	22.70	22.85	24.05	24.03	24.63
17	17.75	17.81	18.29	18.43	19.15	19.29	19.38	20.67	22.22	22.36	22.16	22.31	22.28	22.81	23.29	24.20	24.93	25.14
18	17.88	17.98	18.72	18.85	19.75	19.83	19.93	20.92	21.75	21.86	22.37	22.66	22.98	23.37	23.48	24.79	24.26	25.87

H = Hausa, I = Igbo

Table 4.5: Comparison of weight-for-age centiles of girls from Hausa and Igbo ethnic groups

	Weight centiles																	
	5th		10th		25th		50th		75th		85th		90th		95th		97th	
Age (yrs.)	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**	**H**	**I**
11	33.00	36.00	33.40	36.00	35.00	37.00	37.00	40.00	39.00	41.00	40.00	42.00	40.60	42.00	42.00	43.00	42.38	44.00
12	33.00	36.00	33.00	36.00	36.00	37.00	38.00	38.00	41.00	45.00	42.00	46.00	43.00	50.00	44.00	45.00	46.74	48.00
13	35.00	37.00	35.20	37.00	37.00	38.00	46.00	48.00	47.00	50.00	48.00	51.00	49.00	52.00	49.90	50.50	50.00	52.00
14	42.00	43.60	43.00	44.00	45.00	47.00	46.00	48.00	47.20	50.00	49.50	52.20	50.50	53.00	51.00	52.80	51.00	53.00
15	42.45	44.00	44.80	44.00	45.00	47.00	47.00	49.00	48.00	51.00	50.00	53.00	51.00	54.00	53.00	55.80	52.53	56.60
16	43.00	44.00	44.00	45.00	45.00	48.00	48.00	49.00	49.00	51.50	50.20	53.60	52.00	55.00	53.50	56.30	53.00	57.10
17	45.00	45.00	45.10	46.00	46.00	48.00	48.00	50.00	50.00	52.00	51.00	53.90	51.90	55.00	53.00	57.00	54.14	58.60
18	44.00	45.00	45.00	46.00	46.00	49.00	49.00	50.00	50.25	53.00	52.00	54.00	52.00	56.00	54.80	57.00	55.91	59.00

H = Hausa, I = Igbo

Table 4.6: Comparison of height-for-age centiles of girls from Hausa and Igbo ethnic groups

	Height centiles																	
	5th		10th		25th		50th		75th		85th		90th		95th		97th	
Age (yrs.)	H	I	H	I	H	I	H	I	H	I	H	I	H	I	H	I	H	I
11	143.00	144.00	144.00	143.00	145.00	144.50	146.00	149.00	147.00	152.00	149.00	154.00	149.00	155.00	150.90	155.70	153.00	157.86
12	144.00	144.00	144.00	143.00	145.00	146.00	146.00	150.00	147.00	154.00	148.00	154.00	148.80	155.00	149.00	155.00	149.74	155.00
13	144.00	144.10	144.10	143.00	144.75	147.00	146.00	151.00	147.25	155.00	148.70	155.00	149.80	155.80	150.00	160.50	150.00	161.00
14	145.00	146.60	145.40	148.40	150.75	152.00	156.00	155.00	162.00	161.00	162.75	162.20	163.50	163.00	164.00	164.00	164.00	164.00
15	145.45	146.20	146.00	148.80	151.00	153.00	155.00	157.00	159.50	162.00	161.00	163.00	163.10	163.00	165.00	164.00	165.00	165.24
16	145.00	146.00	147.00	148.00	150.00	150.00	153.00	156.00	157.75	160.00	158.45	161.00	160.00	161.00	162.00	163.00	162.29	164.90
17	145.05	148.00	147.00	150.00	148.25	152.00	152.00	156.00	158.00	160.00	159.85	161.00	161.00	162.00	162.95	163.00	164.00	163.20
18	145.15	148.25	147.00	148.50	150.75	152.00	153.50	155.00	159.00	160.00	160.00	162.00	162.00	163.00	164.00	163.00	164.00	163.45

H = Hausa, I = Igbo

Table 4.7: Nutritional status of study subjects

	All subjects		Hausa		Igbo	
BMI centile	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD
< 5 (Thinness)	30	14.00 ± 0.87	18	14.06 ± 0.71	12	13.92 ± 0.90
5 – 84 (Normal)	485	13.59 ± 0.87	256	13.66 ± 0.89	229	13.52 ± 0.84
≥ 85 (Overweight)	85	13.11 ± 0.95	26	13.27 ± 1.08	59	13.03 ± 0.89
		F = 15.32		F = 4.11		F = 9.54
		p = 0.01		p = 0.02		p = 0.01

Table 4.8: 2D:4D ratios in right and left hands of study subjects according to ethnicity

Parameter	Mean ± SD	Min – Max	t	p
All subjects				
R2D:4D	1.01 ±0.08	0.82 – 1.22	10.16	0.001
L2D:4D	1.04 ± 0.07	0.86 – 1.19		
Hausa				
R2D:4D	1.00 ± 0.06	0.82 – 1.15	10.58	0.001
L2D:4D	1.05 ± 0.05	0.91 – 1.18		
Igbo				
R2D:4D	1.02 ±0.06	0.82 – 1.22	3.92	0.001
L2D:4D	1.04 ± 0.05	0.86 – 1.19		

4.3 SOCIO-DEMOGRAPHIC VARIABLES

Table 4.9 shows the results of the influence of birth order and family size on menarcheal age for all the subjects and for subjects from Hausa and Igbo ethnicity. The results revealed that menarcheal age increases with both increase in birth order and family size. One way analysis of variance showed statistical significance ($p < 0.01$) when the difference in means were invested for all the subjects put together, Hausaand Igbo school girls respectively.Fig. 4.5 is a graph that shows the gradation of order of birth with menarcheal age. Early births reach menarche at younger age than later born. Fig. 4.6 shows the trends in menarcheal age with increase in family size. Girls from small family size tend to reach menarche at early age than girls from large families.

Table 4.10 shows age, menarcheal age, and anthropometric characteristics of the school girls according to their mothers' educational level. From the table, it is obvious that girls whose mother had tertiary education had the least menarcheal age and scored higher in the anthropometric measurements than those whose mother do not had any formal education. The influence of maternal level of education did not however show statistical significance ($p > 0.05$) unlike most of the anthropometric measurements that showed statistical significance ($p < 0.05$).

The influence of paternal level of education on menarcheal age and anthropometric measurements were presented on Table 4.11. By the same token, girls whose father had university education scored on the average higher on anthropometric measurements than their counterparts whose father had no formal education. However, school girls whose father had primary education had the least menarcheal age.

Table 4.9: Family characteristics of menstruating subjects

	All subjects		Hausa	Igbo		
Parameters	n	Mean ± SD	Mean ± SD	Mean ± SD	t	p
Order of birth						
1	113	12.82 ± 0.68[a]	13.04 ± 0.79[a]	12.67 ± 0.56[a]	-2.93	0.01
2	132	13.45 ± 0.92	13.51 ± 0.95[b]	13.39 ± 0.89[b]	-0.73	0.47
3	186	13.56 ± 0.92	13.64 ± 1.00[b]	13.57 ± 0.81[b]	-1.20	0.23
≥ 4	168	14.09 ± 0.58[b]	14.10 ± 0.60[c]	13.89 ± 0.73[bc]	-0.28	0.78
		F = 57.81	F = 16.73	F = 26.90		
		p < 0.001	p < 0.01	p < 0.01		
Family size						
1	91	12.78 ± 0.57[*]	12.97 ± 0.57[*]	12.69 ± 0.56[*]	-2.15	0.03
2	146	13.40 ± 0.94	13.44 ± 0.97[*]	13.32 ± 0.88[*]	-0.77	0.44
3	187	13.58 ± 0.90	13.76 ± 0.96[**]	13.47 ± 0.83[**]	-1.76	0.08
≥ 4	176	14.02 ± 0.68[*]	13.95 ± 0.76[**]	14.00 ± 0.68[**]	-0.44	0.66
		F = 49.34	F = 12.13	F = 37.72		
		p < 0.01	p < 0.01	p < 0.01		

Means with different superscripts are significantly different at p < 0.01.

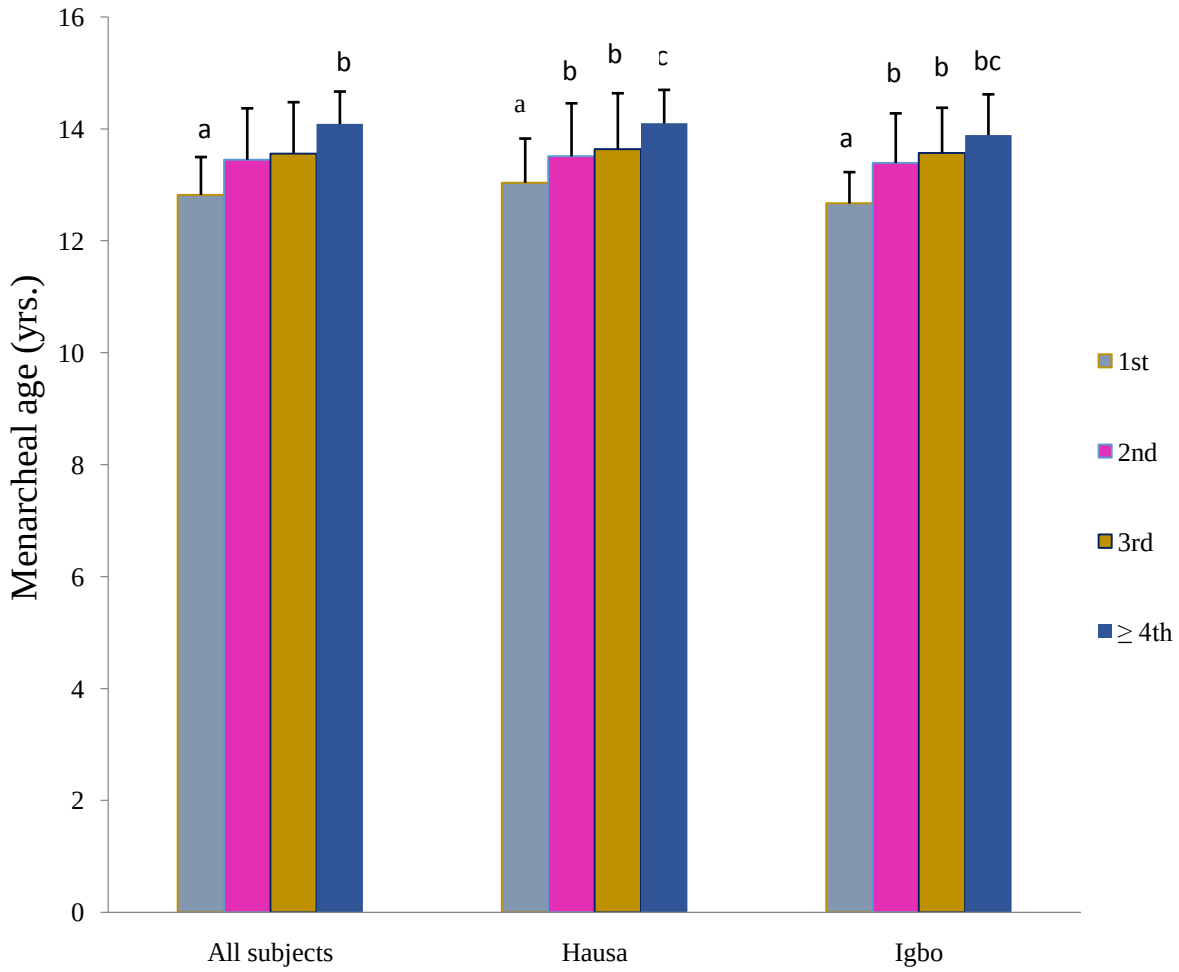

Fig. 4.5: Mean ± SD of menarcheal age according to birth order. One way analysis of variance indicates significant difference in menarcheal age based on order of birth, with F = 57.81, F = 16.73, and F = 26.90 for all subjects, Hausa and Igbo school girls respectively. $P < 0.01$ for the three categories. Birth order with different superscript are significantly different with $p < 0.01$.

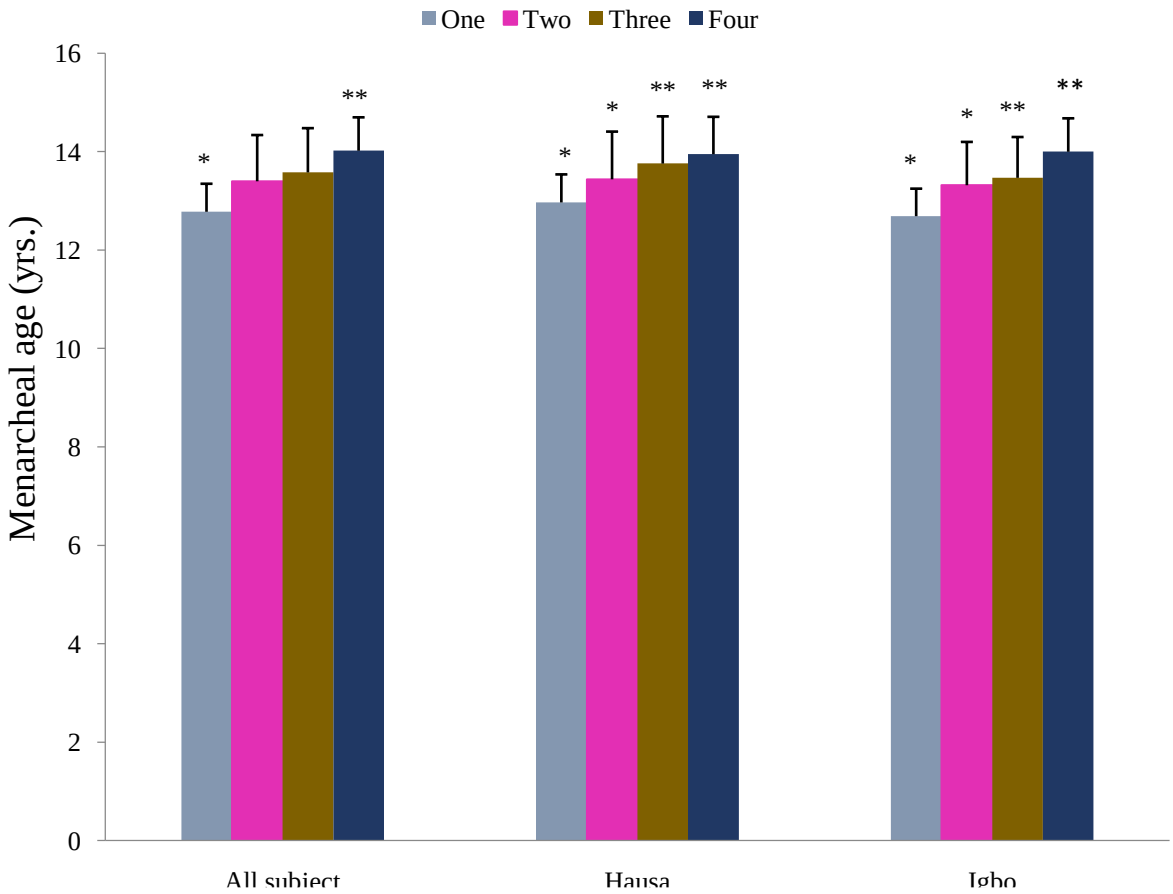

Fig. 4.6: Mean ± SD of menarcheal age according to family size. One way analysis of variance indicates significant difference in menarcheal age based on increase in family size, with F = 49.34, F = 12.13 and 37.72 for all subjects, Hausa and Igbo school girls respectively. *P*< 0.01 for the three categories. Family size with different superscript are significantly different with*p*< 0.01.

Table 4.10: Menarcheal age and anthropometric characteristics of school girls according to their mothers' level of education

Parameters	None (n = 105)	Primary (n = 39)	Secondary (n = 318)	Tertiary (n = 138)	F	p
Height (cm)	154.04 ± 5.34	155.92 ± 5.87	154.61 ± 5.29	156.03 ± 5.58	3.67	0.01
Weight (kg)	47.60 ± 2.48^{a}	49.74 ± 4.13^{b}	48.81 ± 3.48^{ab}	50.36 ± 4.88^{b}	11.74	0.01
Chest circumference (cm)	70.04 ± 4.95^{a}	75.74 ± 5.59^{c}	72.40 ± 6.84^{ab}	72.94 ± 6.62^{b}	8.55	0.01
Hip circumference (cm)	75.24 ± 5.27^{a}	84.47 ± 5.89^{b}	77.95 ± 7.37^{a}	82.08 ± 8.07^{b}	28.10	0.01
Waist circumference (cm)	63.15 ± 5.10^{a}	65.99 ± 6.46^{b}	64.16 ± 5.71^{ab}	65.03 ± 5.60^{ab}	3.45	0.02
Thigh circumference (cm)	40.98 ± 4.13^{a}	44.08 ± 5.16	42.80 ± 4.43	43.69 ± 5.19	8.15	0.01
MUAC (cm)	24.08 ± 1.34	24.40 ± 1.56	24.57 ± 1.53	24.50 ± 1.51	2.92	0.03
Waist-hip ratio	0.84 ± 0.08^{bc}	0.78 ± 0.08^{a}	0.83 ± 0.08^{b}	0.80 ± 0.09^{ab}	9.10	0.01
Waist-height ratio	0.84 ± 0.07^{a}	0.78 ± 0.08^{b}	0.83 ± 0.08^{ab}	0.80 ± 0.09^{b}	8.80	0.01

Means with different superscript are significantly different with $p < 0.05$

Table 4.11: Menarcheal age and anthropometric characteristics of school girls according to their fathers' level of education

Parameters	None (n = 58)	Primary (n = 3)	Secondary (n = 199)	Tertiary (n = 340)	F	p
Menarcheal age (yrs)	13.78 ± 0.84	13.62 ± 0.58	13.46 ± 0.81	13.33 ± 0.96	2.81	0.04

Height (cm)	153.50 ± 5.33	155.67 ± 5.51	154.35 ± 5.37	155.49 ± 5.45	3.36	0.02
Weight (kg)	47.24 ± 1.99	48.67 ± 5.86	48.39 ± 2.73	49.69 ± 4.44	9.76	0.01
Chest circumference (cm)	69.59 ± 4.13	73.67 ± 4.64	72.04 ± 6.62	72.96 ± 6.73	4.69	0.01
Hip circumference (cm)	73.79 ± 4.20	76.63 ± 5.43	77.61 ± 7.28	80.46 ± 7.76	16.73	0.01
Thigh circumference (cm)	40.30 ± 2.93[a]	35.00 ± 4.33[b]	42.83 ± 4.58[a]	43.23 ± 4.84[a]	9.58	0.01
MUAC (cm)	23.82 ± 1.29	24.60 ± 1.56	24.52 ± 1.42	24.52 ± 1.56	3.83	0.01
Waist-hip ratio	0.86 ± 0.08	0.82 ± 0.06	0.83 ± 0.09	0.81 ± 0.08	5.81	0.01
Waist-height ratio	0.86 ± 0.08	0.82 ± 0.06	0.83 ±0.09	0.81 ± 0.08	6.25	0.01

Means with different superscript are significantly different with $p < 0.05$

4.4 CORRELATION BETWEEN ANTHROPOMETRIC VARIABLES

Table 4.20 showed the overall correlation matrix of the school girls' menarcheal age and their anthropometric characteristics. Pearson's correlation coefficient was used to correlate the menarcheal age to the other parameters. Fifty eight percent (58%) of the parameters correlated at $p < 0.01$ and $p < 0.05$. Menarcheal age showed an inverse correlation with BMI, height, and weight. Hip circumference correlated with all the variables except waist-chest ratio. Chest circumference correlated with some of the variables except for BMI and neck circumference. BMI correlated inversely with height, waist circumference, hip circumference, waist-chest circumference and waist-height circumference. Thigh circumference showed statistical significance with nine out of the variables.

Table 4.21 presented the correlation matrix of Hausa (up) and Igbo (down)school girls. Thirty two and forty six percent of the variables from Hausa and Igbo girls have significant correlation in the matrix at $p < 0.01$ and $p < 0.05$ respectively.Considering the matrix for school girls from Hausa ethnicity, menarcheal age shows positive correlation with weight, waist-hip ratio and waist-height ratio. Menarcheal age correlated negatively with BMI and hip circumference. Weight correlated positively with weight while height shows positive correlation with waist, hip and mid-upper arm circumference and inversely correlated with body mass index. Waist circumference correlated positively with hip and chest circumference, body mass index, waist-hip ratio, waist-chest ratio and waist-height ratio. Hip circumference positively correlated with body mass index, waist-hip ratio, waist-chest ratio and inversely correlated with waist-height ratio. BMI inversely correlated with mid-upper arm circumference. Chest

circumference showed positive correlation with waist-hip ratio, waist-chest ratio and waist-height ratio.

Still on Table 4.21, considering variables that showed correlation among the Igbo school girls, menarcheal age showed inverse correlation with weight, BMI and chest circumference. Weight showed positive correlation with BMI while height showed positive correlation with hip, neck and thigh circumference and inverse correlation with BMI, waist-hip ratio and waist-height ratio. Waist circumference shows positive correlation with hip, mid-upper arm and chest circumference. It also correlates positively with waist-hip, waist-chest and waist-height ratios. Hip circumference shows positive correlation with neck circumference, thigh circumference and inverse correlation with waist-hip and waist-height ratios. BMI shows negative correlation with neck circumference. Mid-upper arm shows positive correlation with chest circumference and waist-height ratio. Neck circumference positively correlates with thigh circumference and inversely correlates with waist-hip and waist-height ratios. Chest circumference positively correlates with waist-hip, waist-chest and waist-height ratios. Thigh circumference inversely correlates with waist-hip and waist-height ratios. Waist-hip ratio positively correlates with waist-chest ratio and waist-height ratio while waist-chest ratio positively correlates with waist-height ratio.

Table 4.22 presented the correlation matrix of non-menstruating girls from both ethnic groups. Sixty four percent (64%) of the anthropometric variables showed significant statistical correlation at $p < 0.01$ and $p < 0.05$. Waist circumference and hip circumference showed correlation with all the variables. Height showed correlation with all the variables except with weight, waist-hip ratio, and waist-height ratio. Thigh

circumference and chest circumference also showed correlation with all the variables except with BMI and waist-hip ratio respectively.

Table 4.12: Correlation matrix of menarcheal age and anthropometric characteristics of girls from both ethnic groups

	Age	MA	WT	HT	WC	HC	BMI	MUAC	NC	CC	TC	R2D:4D	L2D:4D	WHR	WCR	WHTR
Age	-															
MA	0.33[a]	-														
WT	-0.05	-0.33[a]	-													
HT	-0.06	-0.05	0.03	-												
WC	-0.10[b]	0.01	0.04	0.09[b]	-											
HC	-0.10[b]	-0.10[b]	0.17[a]	0.25[a]	0.31[a]	-										
BMI	0.00	-0.22[a]	0.73[a]	-0.66[a]	-0.03	-0.04	-									
MUAC	-0.05	-0.05	0.05	0.09[b]	0.19[a]	0.16[a]	-0.04	-								
NC	-0.12[a]	-0.05	0.02	-0.12[a]	-0.07	-0.08	0.04	0.02	-							
CC	-0.13[a]	-0.09[b]	0.15[a]	0.10[b]	0.57[a]	0.35[a]	0.06	0.29[a]	-0.12[a]	-						
TC	-0.15[a]	-0.06	0.11[b]	0.10[b]	0.11[a]	0.42[a]	0.00	0.10[b]	0.24[a]	0.15[a]	-					
R2D:4D	-0.01	-0.04	0.03	0.11[b]	0.05	0.15[a]	-0.05	0.05	0.03	0.11[a]	0.07	-				
L2D:4D	-0.03	-0.02	0.02	0.04	0.01	0.01	-0.01	-0.03	0.01	-0.05	0.03	0.20[a]	-			
WHR	-0.00	0.09[b]	-0.13[a]	-0.14[a]	0.55[a]	-0.61[a]	-0.01	0.01	0.14[a]	0.15[a]	-0.26[a]	0.09[b]	-0.02	-		
WCR	0.03	0.08	-0.12[a]	-0.01	0.46[a]	-0.05	-0.08	-0.09[b]	-0.05	-0.47[a]	-0.05	-0.06	-0.07	0.43[a]	-	
WHTR	0.00	0.09[b]	-0.13[a]	-0.15[b]	0.55[a]	-0.62[b]	-0.01	0.01	-0.15[a]	0.15[a]	0.27[b]	-0.27[a]	-0.10[b]	1.00[a]	0.43[a]	-

MA = Menarcheal age (yrs.), WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index (kg/m^2), MUAC = mid upper arm circumference (cm), NC = Neck circumference (cm), CC = Chest circumference (cm), TC = Thigh circumference (cm), R2D:4D = right second to fourth digit ratio, L2D:4D = left second to fourth digit ratio, WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio. a. correlation is significant at the 0.01 level (2-tailed), correlation is significant at the 0.05 level (2-tailed).

Table 4.13: Correlation matrix of menarcheal age and anthropometric characteristics of girls from Hausa ethnic group (up) and Igbo ethnic group (down)

	Age	MA	WT	HT	WC	HC	BMI	MUAC	NC	CC	TC	R2D:4D	L2D:4D	WHR	WCR	WHTR
Age	-	0.17[a]	0.12[b]	-0.02	-0.04	-0.04	0.10	-0.04	-0.07	0.01	0.01	-0.06	-0.01	-0.02	-0.06	-0.02
MA	0.44[a]	-	-0.37[a]	-0.08	0.07	-0.15[a]	-0.19[a]	0.02	-0.02	0.10	-0.02	-0.04	0.06	0.16[a]	-0.12	0.16[a]
WT	-0.08	-0.28[a]	-	0.06	-0.02	0.07	0.62[a]	-0.04	-0.03	-0.02	0.08	-0.16[a]	0.05	-0.07	-0.01	-0.07
HT	-0.04	0.03	-0.06	-	0.14[b]	0.27[a]	-0.74[a]	0.15[a]	0.01	0.09	-0.03	-0.04	0.01	-0.04	0.07	-0.04
WC	-0.08	0.02	-0.02	-0.03	-	0.23[a]	-0.13[b]	0.08	-0.01	0.41[a]	-0.03	-0.06	-0.07	0.77[a]	0.72[a]	0.77[a]
HC	0.02	-0.05	0.01	0.17[a]	0.22[a]	-	0.16[a]	0.05	0.02	-0.01	0.04	0.04	-0.02	0.44[a]	0.24[a]	-0.44[a]
BMI	-0.04	-0.23[a]	0.81[a]	-0.64[a]	0.00	-0.09	-	-0.15[b]	-0.03	-0.08	0.08	-0.04	0.03	-0.02	-0.07	-0.02
MUAC	0.03	-0.04	-0.02	-0.06	0.17[a]	-0.09	0.02	-	-0.04	-0.01	0.11	-0.08	-0.02	0.04	0.09	0.04
NC	-0.13[b]	-0.05	-0.01	0.19[a]	0.08	0.33[a]	-0.12[b]	-0.02	-	0.06	-0.03	-0.05	0.03	-0.03	-0.05	-0.03
CC	-0.08	-0.11[b]	0.06	-0.03	0.61[a]	0.06	0.07	0.26[a]	0.04	-	-0.04	0.07	-0.08	0.38[a]	-0.34[a]	0.38[a]
TC	-0.17[a]	-0.03	0.03	0.12[b]	0.08	0.44[a]	-0.04	-0.04	0.41[a]	0.03	-	0.03	-0.02	-0.05	0.01	-0.05
R2D:4D	0.04	0.04	0.01	0.01	0.06	0.06	-0.01	-0.01	0.04	0.01	0.09	-	0.03	-0.02	-0.06	-0.02
L2D:4D	-0.02	0.07	0.01	0.07	0.01	0.10	-0.04	0.01	0.03	-0.04	0.12[b]	0.45[a]	-	-0.06	-0.01	-0.06
WHR	-0.11	-0.06	-0.04	-0.14[b]	0.65[a]	-0.58[a]	0.05	0.22[a]	-0.16[a]	0.45[a]	-0.24[a]	-0.01	-0.06	-	0.51[a]	1.00
WCR	-0.01	0.10	-0.09	0.01	0.45[a]	0.18[a]	-0.07	-0.08	0.05	-0.43[a]	0.06	0.07	0.07	0.24[a]	-	0.51
WHTR	-0.10	-0.05	-0.04	-0.14[b]	0.65[a]	-0.59[a]	0.05	0.20[a]	-0.17[a]	0.46[a]	-0.26[a]	-0.01	-0.06	0.99[a]	0.23[a]	-

MA = Menarcheal age (yrs.), WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index (kg/m^2), MUAC = mid upper arm circumference (cm), NC = Neck circumference (cm), CC = Chest circumference (cm), TC = Thigh circumference (cm), WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio.a = p < 0.01 b = p < 0.05

Table 4.14: Correlation matrix of pre-menarcheal school girls and their anthropometric characteristics (n = 200)

	Age	HT	WT	BMI	CC	HC	WC	TC	MUAC	NC	WHR	WCR	WHTR
Age	-												
HT	-0.01	-											
WT	0.05	0.09	-										
BMI	0.06	-0.51[a]	0.81[a]	-									
CC	0.01	0.47[a]	0.25[a]	0.06	-								
HC	0.10	0.25[a]	0.13	-0.03	0.67[a]	-							
WC	-0.06	0.32[a]	0.05	-0.14	0.58[a]	0.36[a]	-						
TC	0.02	0.21[a]	0.21[a]	0.06	0.50[a]	0.35[a]	0.34[a]	-					
MUAC	0.03	0.31[a]	0.20[a]	-001	0.55[a]	0.44[a]	0.33[a]	0.23[a]	-				
NC	-0.11	0.17[b]	-0.05	-0.14[b]	0.25[a]	0.22[a]	0.17[b]	0.08	0.23[a]	-			
WHR	-0.14	0.11	-0.05	-0.10	0.03	-0.45[a]	0.67[a]	0.06	-0.03	-0.01	-		
WCR	-0.08	-0.24[a]	-0.07	-0.62[a]	-0.46[a]	0.27[a]	-0.27[a]	-0.32[a]	-013	0.62	0.36[a]	-	
WHTR	-0.06	0.01	0.03	0.02	0.47[a]	0.30[a]	0.95[a]	0.29[a]	0.25[a]	0.12	0.67[a]	0.36[a]	-

MA = Menarcheal age (yrs.), WT = Weight (kg), HT = Height (cm), WC = Waist circumference (cm), HC = Hip circumference (cm), BMI = Body mass index (kg/m^2), MUAC = mid upper arm circumference (cm), NC = Neck circumference (cm), CC = Chest circumference (cm), TC = Thigh circumference (cm), R2D:4D = right second to fourth digit ratio, L2D:$D = left second to fourth digit ratio, WHR = waist-hip ratio, WCR = waist-chest ratio, WHTR = waist-height ratio. a. correlation is significant at the 0.01 level (2-tailed), correlation is significant at the 0.05 level (2-tailed).

Tables (4.23 and 4.24) showed linear regression equations of menarcheal age from weight, BMI, birth order and family size of girls from Hausa and Igbo ethnic groups. From the table, birth order is a stronger possible predictor of menarcheal age of the school girls from both ethnicity than the other variables. The value of R^2(coefficient of determination) for predicting menarcheal age of school girls using birth order from Hausa and Igbo ethnic groups are respectively 0.138 and 0.295, $p < 0.0001$. For school girls from Hausa ethnic group, weight is another better predictor of menarcheal age than BMI and family size with $R^2 = 0.137$, $p < 0.0001$. On the other hand, for school girls from Igbo ethnic group, family size is a better predictor of menarcheal age than weight and BMI with $R^2 = 0.265$, $p < 0.0001$.

In order to test the strength and reliability of the regression models in Tables (4.23 and 4.24), ten variables were randomly selected from those that were measured from the participants Tables (4.25 and 4.26). These values were then estimated using the regression equations for girls from each ethnic group. Pearson's correlation was then used to ascertain the level of significant correlation between the observed and estimated values.

Table 4.15: Linear regression of menarcheal age from weight, BMI, birth order and family size of girls from Hausa and Igbo ethnic groups

Parameters	Predictive equation	*SEE*	*R*	R^2	*p*
Hausa					
Weight (kg)	MA = 16.253 + (-0.056) × WT	0.854	0.284	0.081	0.0001
Body Mass Index (kg/m^2)	MA = 15.204 + (-0.086) × BMI	0.851	0.232	0.054	0.001
Birth order	MA = 12.757 + 0.326 × BO	0.854	0.372	0.138	0.0001
Family size	MA = 12.728 + 0.330 × FS	0.870	0.323	0.122	0.0001
Igbo					
Weight (kg)	MA = 16.253 + (-0.056) × WT	0.838	0.284	0.081	0.0001
Body Mass Index (kg/m^2)	MA = 15.204 + (-0.086) × BMI	0.851	0.232	0.054	0.0001
Birth order	MA = 12.312 + 0.430 × BO	0.759	0.499	0.295	0.0001
Family size	MA = 12.340 + 0.407 × FS	0.750	0.515	0.265	0.0001

MA = menarcheal age, WT = weight, BMI = body mass index, BO = birth order, FS = family size,SSE = standard error of the estimate

Table 4.16: Linear regression of anthropometric variables of girls from Hausa and Igbo ethnic groups

Parameters	Predictive equation	*SEE*	*R*	R^2	*p*
Hausa					
Hip circumference (cm)	HT = 127.750 + 0.355× HC	5.550	0.265	0.07	0.0001
Waist circumference (cm)	HC = 62.393 + 0.185 × WC	4.016	0.225	0.050	0.0001
Chest circumference (cm)	WC = 28.109 + 0.506 × CC	4.575	0.407	0.166	0.0001
Weight (kg)	BMI = 1.574 + 0.390 ×WT	1.458	0.622	0.387	0.0001
Height(cm)	BMI = 58.966 + (-0.251) × HT	1.247	0.743	0.552	0.0001
Igbo					
Hip circumference (cm)	HT = 145.574 + 0.122× HC	5.163	0.170	0.029	0.0001
Waist circumference (cm)	HC = 66.017 + 0.269 × WC	7.076	0.223	0.050	0.0001
Chest circumference (cm)	WC = 25.242 + 0.534× CC	4.762	0.610	0.372	0.0001
Weight (kg)	BMI = 0.433 × WT + (-0.969)	1.401	0.806	0.649	0.0001
Height (cm)	BMI = 65.293 + (-28.659)× HT	1.826	0.635	0.403	0.0001

HT = height, HC = hip circumference, WC = waist circumference, CC = chest circumference

Table 4.17: Comparison of observed and estimated values of some variables using generated linear regression equations for girls from Hausa ethnicity

	HT		HC		WC		*BMI		**BMI		*MA		**MA	
RS	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**
1	154	153.06	75.70	74.07	64.20	63.48	20.81	20.07	21.58	22.32	14.00	13.55	13.00	13.43
2	152	152.24	80.20	75.16	63.10	63.28	19.22	19.12	20.93	20.56	13.00	13.44	14.00	13.71
3	150	152.74	74.70	74.05	61.40	61.05	22.94	22.24	17.47	17.80	15.00	14.01	14.00	13.85
4	158	155.51	76.40	74.12	67.00	66.21	23.50	23.02	22.35	22.57	12.00	13.09	12.00	13.41
5	156	154.41	73.60	73.38	57.50	58.57	22.07	20.68	23.14	22.07	14.00	13.78	13.00	13.36
6	153	152.28	70.90	72.61	55.20	59.18	23.68	22.63	20.61	21.07	13.00	13.32	12.00	12.93
7	155	154.66	77.40	75.20	60.10	59.84	26.90	28.09	23.28	21.82	15.00	14.24	15.00	13.70
8	153	154.66	77.40	75.18	66.80	65.96	21.64	21.07	22.21	20.56	13.00	13.09	12.00	13.32
9	151	152.56	74.40	74.46	60.00	59.18	20.69	21.46	19.98	20.06	11.00	13.21	15.00	13.83
10	147	149.23	71.80	72.68	54.30	59.23	24.73	21.85	24.32	21.57	12.00	12.29	11.00	13.48
	r = 0.89		**r = 0.92**		**r = 0.92**		**r = 0.89**		**r = 0.82**		**r = 0.80**		**r = 0.72**	
	p = 0.001		**p = 0.001**		**p = 0.001**		**p = 0.001**		**p = 0.004**		**p = 0.005**		**p = 0.02**	

*HT = height estimated from hip circumference (HC), HC estimated using waist circumference (WC), WC estimated from chest circumference, *BMI and **BMI = Basal metabolic rate estimated using weight (WT) and height. MA and **MA= menarcheal age estimated using WT and BMI respectively. RS = random sample, Obs = observed value, Est = estimated value and r = Pearson's correlation coefficient.*

Table 4.18: Comparison of observed and estimated values of some variables using generated linear regression equations for girls from Igbo ethnicity

	HT		HC		WC		*BMI		**BMI		*MA		**MA	
RS	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**	**Obs**	**Est**
1	155.00	154.35	86.30	85.68	62.60	63.81	22.48	22.40	18.67	18.87	13.00	13.49	13.00	13.07
2	160.00	157.91	81.90	82.83	72.20	68.35	23.81	22.84	20.66	21.16	14.00	13.71	14.00	13.77
3	154.00	155.60	82.20	83.66	73.10	69.25	20.66	20.24	24.00	22.30	13.00	13.66	15.00	13.59
4	150.00	154.66	85.10	86.60	58.40	57.57	22.06	21.97	24.86	23.45	12.00	13.15	15.00	13.74
5	157.00	156.01	87.30	85.49	66.70	65.47	19.88	20.24	23.81	22.88	15.00	13.70	12.00	13.42
6	168.00	156.15	84.70	84.33	71.20	70.75	18.29	19.80	19.72	20.59	12.00	13.26	14.00	13.56
7	156.00	156.21	79.80	82.23	62.70	62.69	20.69	21.11	22.07	21.73	15.00	13.71	13.00	13.29
8	158.00	156.31	90.20	85.57	71.30	71.71	23.24	21.97	20.50	21.45	11.00	13.26	14.00	13.84
9	162.00	155.81	89.40	84.28	63.10	61.95	19.15	18.94	22.22	22.30	12.00	13.21	11.00	12.65
10	156.00	155.52	89.60	89.50	68.20	68.35	18.07	19.81	21.21	21.73	11.00	13.21	13.00	13.14
	r = 0.51		**r = 0.71**		**r = 1.00**		**r = 0.92**		**r = 0.93**		**r = 0.89**		**r = 0.82**	
	p = 0.14		**p = 0.02**		**p = 0.01**		**p = 0.01**		**p = 0.01**		**p = 0.01**		**0.004**	

*HT = height estimated from hip circumference (HC), HC estimated using waist circumference (WC), WC estimated from chest circumference, *BMI and **BMI = Basal metabolic rate estimated using weight (WT) and height. MA and **MA= menarcheal age estimated using WT and BMI respectively. RS = random sample, Obs = observed value, Est = estimated value and r = Pearson's correlation coefficient.*

CHAPTER FIVE

5.0 DISCUSSION

Menarcheal age is recognized as an important indicator of pubertal development in females. Besides genetics, menarche is also influenced by socioeconomic and environmental factors. Race, BMI, geography, nutritional habits, exercise all have been shown to influence menarcheal age (Karapanou and Papadimitriou, 2010).The improvement of socioeconomic conditions that took place in Nigeria since the return of democracy in 1999 resulted in an earlier onset of puberty in children, indicated by the fall of the age at menarche. Additionally, mean or median menarcheal age for a particular cohort of girls is an indicator of population health, well-being, and socioeconomic hierarchy and progressively falls when they are subjected to improving environmental conditions (Cameron and Nadgdee, 1996).

In this sample of Hausa and Igbo secondary school girls living in rural and urban area, age at menarche showed statistical significance based on ethnicity and demography. Genetics and nutrition may be responsible to the variation that occurred. Generally, schoolgirls living in the urban area reach menarche earlier than those living in the rural places ($p < 0.001$). Some population, for instance, in France (Ducros and Pasquet, 1980; Crognier and Rocha, 1979) and in Poland (Hulanicka and Waliszko, 1991), showed a significant influence of urbanization in age at menarche. The difference in menarcheal age found in this study based on place of residence is similar to those found by Uche and Okorafor in 1979, and Oduntan *et al.* 1976 in Nigeria, Pasquet *et al.* 1999 in Cameroon and Marrodan *et al.* 2000 in Spain. The urban-rural variations are perhaps due to the fact that various urban centres tend to have much better health-care facilities,

better sanitary standards of dwellings, and better schools, among several other characteristics (Bielicki and Szklarska, 1999).

Age at menarche among the contemporary girls was estimated to be 13.54 ± 0.90 years. The mean menarcheal age of Igbo girls (13.44 ± 0.87) years, is similar to that reported by Chukwujekwu *et al.* (2014), (13.49±0.95) years while, the mean menarcheal age obtained from the present study of school girls (13.65 ± 0.92) years from Hausa ethnic group is similar to that reported by Abubakar *et al.*(2011) in Sokoto state (13.67 ± 1.20) years. However, the mean menarcheal age of girls from Hausa and Igbo ethnicity from rural area is lower than that reported by Ikaraoha *et al.* 2005(14.22 ± 1.47) years in Port Harcourt while the menarcheal age of subjects from urban areas from their study is lower (13.19 ± 1.32) years than that of subjects from both ethnic groups in the present study but lower than that reported by UmeoraandEgwuatu(2008) 15.0 ± 2.0 years in Ebonyi State. The reason for the sharp difference in the mean menarcheal age from the present study and that reported by Chukwujekwu *et al.*(2014)with that reported by UmeoraandEgwuatu is not clear. Similarly, the mean menarcheal age of girls from Hausa ethnic group is slightly higher than that reported by Amaza *et al.*(2012), (13.00 years) in Maiduguri. The mean menarcheal age of school girls from Ibadan (South-western Nigeria) is 14.00 (Marinho and Marinho, 1984; Moronkolu and Uzegbu, 2006; Okusanya, *et al.,* 2009).Thedifference in menarcheal age across the Nigeria ethnic groups may be as a result of tribal differences among the four study populations as reported by Danborno and Oyibo (2008) in Nigeria and Prakash *etal.*(2010) in India.

There is difference in the average anthropometric measurements of the schoolgirls from the two ethnic groups with girls from the Igbo ethnic group having higher

anthropometricvariables. Also, girls from urban places, had higher anthropometric measurements than girls from rural places. The mean weight, height and BMI from this study are similar to that reported by Abubakar *et al*.(2011).The mean of the various anthropometric measurements taken for both post-menarcheal and pre-menarcheal girls were significantly higher among post-menarcheal girls when compared to pre-menarcheal girls. The present study also revealed that the BMI is a good predictor of the possibility of the onset of menstruation (Gehan *et al.,* 2007). BMI percentile can be used to predict both the nutritional status and the occurrence of menstruation. At BMI centile of less than 5^{th}, only 4% of the girls were menstruating. At BMIcentile between 5-85^{th}, 80.33% of the girls are seen menstruating, while at BMI centile above 85^{th}, only 15.67% of the girls are seen menstruating and this is the group at risk of becoming overweight. Obesity and menarcheal age are related perhaps due to a mechanism that is ensuring that pregnancy occurs only when there is enough fat (energy) to keep both the foetus and mother alive (Kaplowitz, 2008).

Data from the present study showed that parents' educational have influence on age at menarche. Girls who haveany of their parents as graduates of tertiary institutions,have the occurrence of menstruation at an early age. Perhaps this may be due to the fact that better educated parents are more likely to have higher income and are more likely to meet the family's nutritional needs of their daughters which will in turn yield a positive effect on the growth and development of the daughters. Currently, some homogenous societies do not show any variation in the occurrence of age at menarche due to parents' level of education (Padez, 2003). In many developing countries for instance Nigeria (Uche and Okorafor, 1979), Sudan (Attallah *et al.,* 1983), Egypt (Attallah, 1978) and

Poland (Bielicki and Welon, 1982; Bielicki *et al.*, 1986) have shown significant influence of parental level of education on age at menarche.

For the influence of parents' educational level on the various anthropometric measurements taken, girls whose parents have obtained educationhad higher anthropometric variables than those whose parents had no education. Meanwhile, such clear difference in terms of scores was not seen for girls whose parents had primary or secondary school education when compared with those whose parents had tertiary education. For instance, in terms of height, chest circumference, and MUAC, girls whose father had primary education had 0.18cm height, 0.71cm chest circumference, and 0.08cm MUAC respectively, higher than girls whose father had tertiary education. For school girls whose mother had primary school education, they scored higher in chest circumference, hip circumference, waist circumference, and neck circumference than girls whose mother had tertiary education. It is assumed that well educated parents are more likely to have higher income and are capable of providing better nutrition to their daughters and this in turn lead to faster growth and development and hence decrease in age at menarche Gehan *et al*. (2007).

The result of this study also showed that both birth order and family size of the subjects have strong influence on mean menarcheal age. Higher age at menarche was associated with larger family size. Result on birth order showed that an older age at menarche was associated with a higher position in the family. These results are in agreement with the findings of many authors, such as, studies in South Africa (Cameron and Nadgdee, 1996), France (Demoulin, 1998), Spain (Sa´nchez-Andre´s, 1997; Apraiz, 1999), and England (Dann and Roberts, 1993; Roberts, 1994). Onyiriuka, *et al.*(2013) also reported

a higher age at menarche among later born with first born attaining menarche earlier than later born in the sibship. The likely reason for the influence of family size and position in the sibship on menarcheal age is not clear. However, Malina *et al.* (1997) suggest that the influence may not be unconnected to the time interval between births.Padez (2003) also reported that family size and birth order were important indicators in determining the menarcheal age of university students in Portugal. In addition, Chavarro *et al*. (2004) reported that age at menarche was positively associated with family size in a study of students at the National University of Colombia, USA. In a recent report, Hossain *etal*. (2010) found that there was no association between age at menarche and family size (number of siblings) and birth order in Bangladeshi university students. These differences may be reflective of the disparityin the socioeconomic backgrounds of these two countries. It could be hypothesized that an increase in the size of a family may result in lowernutritional quality.

There are only few studies that compared menarcheal age and climaticconditions. Results from this study showed that girls who attained menarche during the wet season are relatively lower than that of those who attained menarche during dry season. Bolk in (1923), obtained data on menarche from 2000 Dutch girls and found that the highest monthly incidence of menarche (10.3 %) occurred between May and August, another small peak (8.5%) occurred in December and January, only few girls started menstruation in February or October. Reymert and Jost (1947) study on 261 girls living in Mooseheart, Ilinois also showed that menarche was more likely to occur in summer or winter than in autumn or spring. Matsumoto *et al*. in (1963), reported a rather contrary result in the study of 10,000 Japanese girls. They reported that the incidence of

menarche was greatest in the spring and summer and lower in the autumn and winter. Findings on the influence of season in determining the onset of menarche have not been consistent. However, if menarche does occur more frequently in one season than in the other in the year, it is likely that the influence of season is mediated by the annual cycle of varying length of day Zacharias and Wurtman (1969).

Concerning the correlation matrix of the study population from both ethnic groups, the results showed that there is correlation among the various anthropometric parameters measured. Weight showed a positive correlation with hip circumference, BMI, and chest circumference but showed a negative correlation with waist-hip ratio, waist-chest ratio and waist-height ratio. Height, waist circumference, hip circumference, chest circumference, and thigh circumference all showed a significant correlation in the matrix. Menarcheal age showed a negative correlation with hip circumference, chest circumference, and positive correlation with waist-hip ratio.The correlation matrix of all the school girls in this study showed a positive association between age at menarche and weight and an inverse relationship with height and BMI.

The mean height of the participants in this study is 154.92 ± 5.44 cm and.This is a little below that reported by bothChukwujekwu *et al.* 2014 (160 ± 0.06) cmandAbubakar *et al.* 2011 (159.2 ± 7.4) cm. However, the mean height of participants in the present study is close to that reported by Akbar *et al.*(2011) in Iran.The findings in the present study agreeswith previous studies (Khakbazan, *et al.,* 2005; Kim, *et al.,* 2010; Goon, *et al.,* 2010). Studies by Kaplowitz (2006) and Kaplowitz and colleagues (2001), showed that taller girls (148.60 cm) experience menstruation earlier than shorter ones (135 cm) in

California. Another study has indicated that tall but overweight girls had experienced menstruation much earlier (around age 12.5 years) than short but slender girls (Akhavan-Karbasi and Bafghi, 1997). A study on Korean girls born from 1920 to 1986 indicated that the menarche age had lowered from 16.8 to 12.7 within a 67-year period; simultaneously, their height had increased from 149.23 to 161.75 cm. In other words, a negative correlation between the menarche age and the girls' height is observed. The researchers attributed this trend to the changes in the physical growth of girls in the study (Cho *et al.,* 2010).

Earlier studies show that lower menarcheal age is related with an increase in the adulthood BMI. In thepresent study, it was observed that the school girls' BMI was 20.50 ± 2.13 kg/m^2, which is similar to 20.14 ± 2.72 kg/m^2as reported by Chukwujekwu, *et al.*(2014) and a little higher than 19.4 ± 1.1 kg/m^2 as reported by Abubakar, *et al.* (2011) but lower than that reported by Adesuwa and Oliemen, (2013) in Port Harcourt, in Nigeria. Result from the present study showed that participants who had their menarche have their BMI higher than their pre-menarcheal counterparts. This result is similar to that reported by Goon *et al.* (2010) and Raji *et al.* (2006). In a study conducted by Danborno and Oyibo (2008) in which they studied the anthropometric and menstrual characteristics of girls from Nigeria and Niger Republic, found that Nigerian girls scored on the average significantly higher BMI and lower menarcheal age than girls from neighbouring Niger Republic.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 SUMMARY

In summary, the present cross-sectional study investigated the influence of ethnicity, anthropometric parameters, and socio-demographic factors on age at menarche. Results of the study showed late maturation among girls from Hausa ethnicity than among Igbo girls. Girls from Igbo ethnicity, scored on the average higher in anthropometric parameters than their counterparts from Hausa ethnicity. The mean age at menarche for the overall sample population of the present study is 13.54 ± 0.90 years. The mean age at menarche of girls from Hausa and Igbo ethnic groups are respectively 13.65 ± 0.92 and 13.44 ± 0.87 years ($t = -2.96$, $p < 0.001$). The present study also revealed that girls living in urban centres reach maturation earlier than girls from rural areas. This was the case with girls from both ethnicity. However, girls from Hausa ethnicity living in rural have higher age at maturity than Igbo girls living in rural centres. The mean age at menarche of Hausa and Igbo girls living in rural areas are respectively 13.83 ± 0.95 and 13.52 ± 0.87 years ($t = -2.93$, $p < 0.001$). Girls from Hausa ethnicity living in urban centre reach developmental maturation later than their counterparts from Igbo ethnicity living in urban centres 13.48 ± 0.86 and 13.35 ± 0.88 years ($t = -1.27$, $p < 0.05$) respectively.

The present study also investigate the influence of family background on age at menarche. The effects of birth order, family size and family background on age at menarche were explored. The results of the study revealed that these factors have strong influence on age at menarche. It was found that first-born girls reach maturity earlier

than later born girl and that girls from small family size reach maturity earlier than girls from large family size. Girls whose any of their parents attained tertiary education reach maturation earlier than those whose parents do not have any formal education.

Finally, the study investigated the incidence of premenstrual syndrome among girls from both ethnicity. Results from the study showed that most of the participant in this study reported one form of premenstrual syndrome or the other with varying degrees of severity. There is no predilection in its severity based on ethnicity.

6.2 CONCLUSION

The result of this study shows that the mean age of menarche among Hausa and Igbo ethnic groups is 13.54 ± 0.90 years. It also showed that the mean menarcheal age for girls from Hausa and Igbo ethnic groups are 13.65 ±0.92 and 13.44 ± 0.87 years respectively. The result alsoshowed that girls from rural area have higher menarcheal age than their counterparts from the urban area. This difference in the mean menarcheal age due to geographical location showed statistical significance, $F = 7.69$, $p < 0.001$. Besides ethnicity and demography, genetics, nutritional status, socioeconomic status, and exercise, all have shown to influence menarcheal age. Results from the present study demonstrate that BMI,ethnicity, demography, parents' level of education, order of birth, family size and month of menarche influence menarcheal age.

The present study showed that birth order and family size influence age at menarche. First births reach menarche earlier than later born. Participants from lower family size tend to reach menarche earlier than their counterparts from large family. Parents' educational background also influencedthe determining menarcheal age, that is those

whose any of their parents had tertiary education reach menarche earlier than those whose parents do not had any formal education.

The present study also suggest that generally the lower the anthropometric dimensionsthe lower the possibility of onset of menstruation irrespective of ethnicity or demography. Menstruating girls scored higher mean anthropometric measurements than non-menstruating girls.

6.3 RECOMMENDATIONS

Based on the findings of the present study, the following recommendations are made:

i. Further studies should be conducted to determine age at menarche among other ethnic groups in Nigeria.
ii. Further studies should investigate the associations of childhood/adolescent adiposity and early menarche on disease throughout life.
iii. More studies should are needed to investigate the association between birth weight and age at onset of menarche.
iv. Preventive and treatment strategies for premenstrual disorders are strongly recommended.

6.4 CONTRIBUTIONS TO KNOWLEDGE

i. Girls from Igbo ethnic group reach menarche earlier than girls from Hausa ethnicity (13.44 ± 0.87 years. and 13.65 ± 0.92 years, t = -2.96, p = 0.01) for Igbo and Hausa.
ii. Menarcheal age of girls in rural area is higher than that of those in urban centres irrespective of the ethnicity (13.83 ± 0.95 years, 13.48 ± 0.86 years, t = -3.33, p =

0.01) for Hausa girls in rural and urban and (13.52 ± 0.87 years, and 13.35 ± 0.88 years, t = -1.66, p = 0.01) for Igbo girls in rural and urban places respectively.

iii. Girls born in small families of one child reach maturity earlier 12.78 ± 0.57 years than those born in families of four or more children (14.02 ± 0.68 years, $p < 0.01$).

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APPENDIXI

HEALTH RESEARCH ETHICS COMMITTEE

AHMADU BELLO UNIVERSITY TEACHING HOSPITAL

SHIKA - ZARIA, NIGERIA.

E-mail: abuth@yahoo.com Website: www.abuth.org

Chairman of Board: Chief. Shuaib Oyedokun Afolabi *Fnil*
Chief Medical Director: Prof. Lawal Khalid, *MBBS, FMCS, FWACS, FRCS(ED) mnl*
Chairman, Medical Advisory Committee: Prof. 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

Your Ref:

Date: 26th August 2014

ABUTH HREC FULL ETHICAL CLEARANCE CERTIFICATE

Relationship between age at menarchs Anthrometric Indexes and Socio/economic Status of Girls from Hausa and Igbo Ethnic groups in rural and urban centres of Nigeria.

ABUTH Ethics Committee assigned number:	-	**ABUTH/HREC/K10/2014**
Name of the principal Investigator:	-	**Mr. Monday Nwankwo**
Address of the Principal Investigator:	-	**Dept. of Human Anatomy Faculty of Medicine, ABU, Zaria.**
Date of receipt of valid application:	-	**12th May, 2014**
Date of meeting when final determination on ethical approval was made:	-	**20th & 21st May, 2014**

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 Health Research Ethics Committee.***

Please note: this approval dates from **27th August, 2014– 27th August, 2015**

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

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APPENDIXII

DEPARTMENT OF HUMAN ANATOMY

FACULTY OF MEDICINE

AHMADU BELLO UNIVERSITY, ZARIA

Dear Miss,

I am Monday Nwankwo, an MSc student in the Department of Human Anatomy of the above named institution. I am carrying out a research on the comparative evaluation of menarcheal age, anthropometric indices and sociodemographic status of girls from Zaria and Nsukka local government areas. Participation is voluntary. It involves collection of certain information about your personal and family characteristics and measurements of some anthropometric parameter: weight, height, chest and waist circumference, hip circumference, arm circumference and thigh circumference.

The information collected from you will be used strictly to achieve the objectives of this study and for scientific publication. I assure you that this study has been reviewed and approved by my supervisors and the University Committee on Research Ethics.

Thank you for your understanding.

Yours sincerely,

Monday Nwankwo

APPENDIXIII

CONSENT TO PARTICIPATE IN RESEARCH

Comparison of Menarcheal Age, Socio-demographics and Anthropometrics of Hausa and Igbo Schoolgirls from Enugu and Kaduna States of Nigeria

INTRODUCTION

You are kindly being asked to participate in a research study conducted by Monday Nwankwo for a Master of Science degree under the supervision of Dr. B. Danborno, and Dr. Wilson O. Hamman, 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: Monday Nwankwo, Faculty of Medicine, Tel: 08065712691, Dr. B. Danborno, Faculty of Medicine, Tel: 08139429300; or Dr. Wilson O. Hamman, Faculty of Medicine, Tel: 08062303007.

PURPOSE OF THE STUDY

The purpose of this preliminary study is primarily to establish the average age of menarche among rural and urban girls of Igbo and Hausa ethnic groups. However, it is also expected that the results might implicate certain anthropometric indices, ethnicity, demography, nutrition, physical activities and socio-economic factors that affect the age of menarche within these designated ethnic groups. The study will also include an exploratory aim in which premenstrual symptoms will be described in terms of perception and severity. This study is a partial requirement for the award of MSc degree in Department of Human Anatomy in Ahmadu Bello University, Zaria.

WHY ARE YOU BEING ASKED TO PARTICIPATE?

You are being invited because you are a 10-18 year old female secondary school student.

What will happen during this study?

Information pertaining to menarche, 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 as no sharp or dangerous objects will be used.

POTENTIAL BENEFITS TO PARTICIPANTS

The result of this study, when published will help in establishing the current average age at menarche between the two ethnic groups and how it is influenced by anthropometric indices, ethnicity, demography, nutrition, physical activities and parental level of education. This study may lead to the future development of interventions to decrease premenstrual pains. The conclusions that will be drawn will suggest whether the current age at menarche and the effect of settlement may likely predispose the participants to some ailments later in life or not.

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 "**Comparison of Menarcheal Age, Socio-demographics and Anthropometrics of Hausa and Igbo Schoolgirls from Enugu and Kaduna States of Nigeria**" as described herein. I have been given a copy of this form.

_____
Name of Participant

_____ _____
Signature of Participant Date

_____
Name of Witness

_____ _____
Signature of Witness date

Comparison of Menarcheal Age, Socio-demographics and Anthropometrics of Hausa and Igbo Schoolgirls from Enugu and Kaduna States of Nigeria

Name: Monday Nwankwo

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 study 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

APPENDIXIV

Questionnaire for the Study of the Comparison of Menarcheal Age, Socio-demographics and Anthropometricsof Hausa and Igbo Schoolgirls from Enugu and Kaduna States of Nigeria

Please tick or circle the appropriate letter where necessary below:

DEMOGRAPHY OF PARTICIPANT

1. Research I.D. _____
2. How old are you?_____ (yrs)
3. When are you born? _____/_____/_____(DD/MM/YYYY)
4. Where were you born? _____
5. Have you spent your whole life there? Yes [ ] No [ ]
   If no, where else have you lived? _____
6. Where do you live now? _____
7. "Have you already had your menstrual periods?"

a. "No, I haven't yet" [ ]
b. "Yes, I have at the age of: _____ (yrs)
c. What year? _____
d. What month? _____

8. What class are you at first menstrual cycle? _____
9. What class are you now? _____
10. Number of siblings:

a. Brothers_____ (from your mother only)
b. Sisters_____ (from your mother only)

11. What's your birth order?

a. Firstborn [ ] b. Second born [ ] c. Third born [ ] d. Later born [ ]

12. Type of school attending:

A. Private [ ]
B. Public [ ]

13. Your State of origin _____
14. Ethnic group _____

ETHNIC BACKGROUND

15. Mother's Ethnic Group _____
16. Grand Mother's Ethnic Group _____
17. Father's Ethnic Group_____
18. Grand Father's Ethnic Group _____
19. Place of residence at childhood: A. Rural [ ] B. Urban [ ]
20. Place of residence at adolescent: A. Rural [ ] B. Urban [ ]
21. Who among your parents are you closer to in your childhood?
    A. Mother [ ] B. Father [ ]

22. Who among your parents are you closer to as an adolescent?

A. Mother [ ] B. Father [ ]

23. Does your Father spend much of his time at home at close of work or business each day?

A. Yes [ ] B. No [ ]

24. Do your Father spent much of his time at home with your mum and siblings at weekends or with his friends? A. Yes [ ] B. [ ]

25. If No, are you comfortable with his not spending the weekends at home with you? A. Yes [ ] B. [ ]

PARENTS' EDUCATIONAL BACKGROUND

26. Mother's level of education

A. None [ ]

B. Primary school [ ]

C. Secondary school [ ]

D. Tertiary [ ]

27. Father's level of education

A. None [ ]

B. Primary school [ ]

C. Secondary school [ ]

D. Tertiary [ ]

ANTHROPOMETRIC MEASUREMENTS

28. Weight _____ (kg)

29. Height _____ (m)

30. BMI _____ (kg/m^2)

31. Waist circumference _____ (cm)

32. Hip circumference _____ (cm)

33. Waist-Hip ratio _____

34. Mid upper arm circumference_____ (cm)

35. Triceps skin fold _____ (cm)

36. Subscapular skin fold _____(cm)

37. Neck circumference _____ (cm)

38. Chest circumference _____ (cm)

39. Umbilical skin fold _____(cm)

40. Thigh circumference _____ (cm)

HAND ANTHROPOMETRY

41. Length of digits (mm)

Hand	Fingers				
	I	II	III	IV	V
Right					
Left					

PARENTS' OCCUPATION

42. Mother's occupation _____

43. Father's occupation _____

You have finished the questionnaire — *Thank you*

APPENDIX V

Frequency and percentages of menarcheal ages of subjects according to ethnicity

Menarcheal age	Frequency		Percentage		
(years)	Hausa	Igbo	Hausa	Igbo	Total
11	5	3	62.50	37.50	100
12	17	34	33.30	66.70	100
13	115	126	47.70	52.30	100
14	103	103	50.00	50.00	100
15	60	34	63.80	36.20	100

The 200 girls that have not developed menstruation were excluded.

APPENDIX VI

DEFINITION OF TERMS

Understanding the purpose of this study requires clarification of common terminology associated with this topic. The following list of terms are worth knowing:

i. **Adrenarche:** Maturation of the adrenal gland that results in secretion of androgens from the adrenal cortex. Regulated by the Hypothalamic-pituitary adrenal axis (HPA) but activated by unknown factors, adrenarche occurs independently of gonadal maturation and breast development.

ii. **Gonadarche:** Maturation of the gonads (ovaries in girls) that results in a dramatic increase in sex hormone production (estradiol in girls). Gonadarche is the result of the activation of the Hypothalamus-pituitary-gonadal axis (HPG) and indicates that puberty has commenced. Gonadarche is less visible in girls than boys.

iii. **HPA axis:** Hypothalamus-pituitary-adrenal axis. A second signalling pathway involved in puberty. The HPA axis permits the production of steroidal hormones from the adrenal glands (which sit atop the kidneys). These hormones include androgens.

iv. **HPG axis:** This signalling pathway regulates the production of sex hormones by sending chemical messages from the hypothalamus in the brain to the pituitary gland and then, in girls, to the ovary. Its activation marks the onset of puberty.

v. **Infant puberty** (also known as "mini puberty")**:** The period of early development (from late prenatal life through 3 to 9 months) when the HPG axis is active and prior to its repression during the juvenile period. Sex hormones are produced during infant puberty. Unlike adolescent puberty, infant puberty is not tightly regulated.

vi. **Insulin resistance:** Occurs when increasing amounts of insulin are needed to transport blood glucose into body tissues. The result is hyperinsulinism, often a precursor of type 2 diabetes.

vii. **Isolated premature thelarche:** Breast development without activation of the HPG axis and in the absence of gonadarche in girls younger than 7. Isolated premature thelarche may or may not raise the risk for true precocious puberty. The self-limiting or progressive nature of this condition is a matter of ongoing debate (Salardi, 1998).

viii. **Menarche:** Onset of menstruation and a consequence of estradiol stimulation. It is a late stage event in the pubertal process. Along with thelarche, menarche is a consequence of HPG activation.

ix. **Precocious puberty:** Signs of sexual maturation that appear at an age that is more than two standard deviations below the mean. True precocious puberty refers to premature activation of the (HPG) axis that initiates gonadarche and thelarche. True precocious puberty is five times more common in girls than boys. In the past, true precocious puberty was defined as onset of gonadarche and thelarche before age 8, which was considered the lower limit for normal puberty in girls. In 1999 in the United States, these age limits were revised downward to 7 years old for white girls and 6 years old for black girls (Kaplowitz and Oberfield, 1999).

x. **Premenstrual Syndrome** is defined as the cyclical recurrence of symptoms, physical, psychological, and/or behavioural, that occur after ovulation and disappear within a few days of onset of bleeding. These symptoms affect how women function in daily life, often interfering with work, school or personal relationships.

xi. **Pubarche:** Appearance of pubic and underarm hair, adult body odour, increased oiliness of skin and hair and, sometimes, acne.

xii. **Puberty**: The time at which the onset of sexual maturity occurs and the reproductive organs become functional. This is manifested in both sexes by the appearance of secondary sexual characteristics. These changes are brought about by an increase in sex hormone activity due to the stimulation of the ovaries and testes by pituitary hormones.

xiii. **Thelarche:** Onset of breast development, also called "breast budding." It is a physical consequence of gonadarche and an early visible event in pubertal development.

xiv. **Delayed puberty:** Absence of breast development in girls beyond 13 years old (Traggiai and Stanhope, 2002).