STATURE, WEIGHT OF CHILDREN, ADOLESCENTS AGE (6-19 YEARS) AND MENARCHEAL AGE OF HAUSA GIRLS RESIDENT IN KANO STATE

BY

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DECLARATION

I, GarzaliMarwanaBala, hereby declare that the work in the thesis titled " Stature, weight of children, Adolescents age (6-19 years) and menarcheal age of Hausa girls resident in Kano state" has been performed by me in the Department of Human Anatomy under the supervision of Prof. S.S. Adebisi and Dr. B. Danborno.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis has been previously presented for another degree or diploma at any university.

_________________________ ______________________________GARZALI MARWANA BALA Signature Date

CERTIFICATION PAGE

This thesis entitled “Stature, weight of Children, Adolescents age(6-19 years) and menarcheal age of Hausa girls resident in Kano state” by GarzaliMarwanaBala meets the regulations governing the award of degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my Father, AlhajiMarwanaManladan and Mother, HajiyaAishatuMarwana.

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ABSTRACT

Stature is increasingly used as measure of the health and wellness(standard of living and quality) of population This work was done by taking measurements of height and weight of school children 6-11 years (n=1050) and adolescents 12-19 years (n=1440) of Hausa ethnic extraction of both sexesfrom Kano State using Stadiometer and estimation of leg length by calculating difference between stature and sitting height and comparing these data with parental level of education and birth order. A total of 2400 Students (1134 males and 1346 females) participated in the research. All the eight metropolitan local governments of the state and twelve outside local governments, three in each of the northern, southern, eastern and western parts of the State were randomly selected for the research. Information on Menarcheal age, Menstrual cycle and Menstrual blood flow of menstruating girls were collected by means of questionnaires. Data were analysed using SPSS 16.0 and statistical values acceptable at $p<0.05$. Children were observed to be under weight, (Male BMI; 17.61kg/m2 and Female BMI; 17.54 kg/m^2), adolescents were observed to have normal weight (Male BMI; 21.67kg/m^2 and Female BMI; 22.59kg/m^2). Stature was observed to correlate positively with parental level of education and birth order. Height growth spurt was observed to be between the ages of 12 years and 13 years for both males and females. Correlations between stature, weight, birth order, birth weight, BMI, sitting height and leg length were established. Mean menarcheal age of menstruating Hausa girls was observed to be at the age of 14 years and linear equations for prediction of stature using age, weight, BMI, sitting height andleg length were established. It was also observed that the study population were observed to have normal progressive pattern of growth with female adolescents having higher values of the measured anthropometric parameters while male children were observed to have higher values of the measured anthropometric parameters.

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LIST OFABBREVIATIONS AND SYMBOLS

Abbreviation	Translation
BMI	Body mass index
FIG	Figure
LL	Leg length
MA	Menarcheal age
MC	Menstrual cycle
SH	Sitting height

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

Stature which means standing height (NHANES, 2007) is increasingly used as measure of the health and wellness(standard of living and quality) of population. Height, including leg length is a sensitive indicator of the socioeconomic or nutritional environment as was observed in the secular trend in Japanese children after World War II (Tanner *et al*., 1982;Ashizawa, 2002). Changes in body dimensions have attracted the attention of anthropologists(Ali *et al*., 2000) and in children of developed countries are well documented phenomenon (Jaeger 1998;Loesch*et al*.,2000, Adebisi, 2008).

From an evolutionary perspective there are a number of different reasons why the leg to Body ratio (LBR) may be important in aesthetic judgment of men and women. One possibility is that the LBR is a signal or cue of both stable childhood development as well as current well-being. In terms of the former, the interruption of growth at any stage of the cycle results in a relatively long torso and short legs (Leitch,1951). If the rate of growth is sufficiently slowed down(e.g. due to nutritional deficiencies or psychological stress) the adult will have shorter legs relative to the trunk, indeed, studies suggest that leg length measured in childhood may be the component of stature most sensitive to environmental influences(Gunnell*et al*.,1998).

Growth changes, which are one of the great 19th century discoveries in human growth research, were prominent in the 20th century, especially after World War II. It has been documented by scholars in many developed and developing countries (Eleveth and

Tanner,1990). In the long run, growth trend is a product of continuous and often non additive interaction between genetic and environmental forces, However, this short time ranges involved (a few generations or a single generation) indicate that growth trends are likely to result not from alterations, but in the environment in which growth takes place (Castilho and Lahr 2001). From the 1980s, some studies reported that the acceleration of physical development had already ceased or reached a plateau in some developed countries, which suggest that they were possibly about to achieve their full genetic potential or that their socioeconomic conditions had ceased to improve (Lingren 1998;Krawczynski*et al*.2003, Linsti and Kaarma, 2003). The most important environmental factors to influence growth changes are nutrition and health. Socioeconomic living conditions, control of infectious diseases through mass immunization, social and health care (preventive and curative), sanitary conditions, minimum income, level of education, industrialization and urbanization, as well as the psychological state appear also to be meaningful factors contributing to the secular trends through removing ingredients that had blocked full expression of the biological potential (Malina*et al*., 1987; Tanner, 1992;Haupie *et al*., 1996; Bodzsar and Susanne 1998; Castilho and Lahr, 2001; Whitehead, 2003).

Adult height is influenced by nutrition and health throughout his or her growing years. Although final height is limited by a child genotype, environmental influences also affect his/her adult size (Silventoinen, 2003). Data from the Boyd Orr Cohort showed a significant positive association between childhood leg length and mortality from cancers unrelated to smoking .There were no significant associations in relation to trunk length, with weaker associations from overall height than for leg length (Gunnell*et al*., 1998). These data also showed that coronary heart diseases mortality increased with decreasing childhood leg length. Coronary heart disease was inversely associated with Leg length in another study (Smith *et al*., 2001).

Some studies suggest that increase in height is due to increases in leg length rather than increased trunk length (Tanner *et al.,* 1982; Gerver and De Bruin, 1995) and the Carnegie survey data support the view that leg length is the component of childhood height most sensitive to childhood circumstances (Gunnell*et al*., 1998).In addition, the effects of famine exposure were most marked on the leg length of women exposed to the Dutch Hunger winter during childhood (Van Noord, 2004). Data from 1946 British Birth Cohort showed that leg length was more sensitive to childhood environmental factors and diet while trunk length was more sensitive to serious illness and possibly to emotional disturbances (Wardsworth*et al*., 2002).

In a subset of the Carnegies children (Gunnell*et al.,*1998), for whom information at birth was available, similar correlation between birth weight and leg or trunk length were found, suggesting that differences in the component of stature were not related to growth during the gestational period. Results from the Avon longitudinal study showed that maternal diet in pregnancy was not associated with height or its components (Leary *et al*.,2005). Height is considered an important indicator of Nutrition and health of a population (Akachi and Canning 2007; Deaton, 2007). In the last Century, a consistent increase in height of adults has been found both in developed and developing Countries mirroring the improvements in nutritional (Hoppaand Garlie, 1998) and socioeconomic status (Li *et al.,* 2004). In Europe, height has been increasing in most populations (Gracia and Quintanadomeque, 2007).

However, recent studies have reported that the increase in height has reached a plateau in Germany (Zellner*et al*., 2004) and Poland (Krawczynski*et al*., 2003).

An increase in height has been reported from developing countries such as India (Virani, 2005) and Mexico (Malina*et al.,* 2004). BMI criteria are used to screen for weight categories: underweight (BMI values < 18.5), normal or desirable weight (BMI values 18.5-24.9), overweight (BMI values 25.0-29.9), obese-Class I (BMI values 30.0-34.9), obese-Class II (BMI values 35.0-39.9) and extremely obese (BMI values $\geq$40.0), (WHO, 1995).

With obesity on the rise worldwide and at epidemic levels in the United States, it is critical to better understand its etiology. Obesity is commonly defined by BMI, which is calculated as weight (kg) divided by squared height (m^2). The two components of BMI have different developmental trajectories. Whereas height is determined during childhood and adolescence, weight regulation can occur in all life stages (Li *et al*., 2008). Estrogens and Androgens are known to influence growth and weight. (Yang *et al*., 2006). Disruptions in any component of this biosynthetic pathway can have a number of health consequences, including obesity, (Long *et al.,* 2007).On the molecular level, changes in the expression of the genes that code for the enzymes involved in the synthesis of estrogens and androgens may influence the onset of obesity, (Maffei*et al*., 2007; Musatoy*et al*., 2007).

Obesity is an important risk factor for premature death (Allison *et al*., 1999; Flegal*et al*., 2005) and health problems like diabetes, gallbladder disease, coronary heart disease, high cholesterol, hypertension and asthma (Must *et al*., 1999). Excess weight reduces the quality of life, raises medical expenditures, places stress on the health care system and results in productivity losses due to disability, illnessand premature mortality (Andreyeva*et al.,* 2004).Underweight status represents depleted body fat and/or lean tissue stores. Although there are expert guidelines for classifying underweight based on body mass index (BMI), the WorldHealth Organization defines underweight as a BMI below the 5th percentile for age and gender,(WHO,1995).

Canadian and US studies have demonstrated higher rates of hospitalizations and mortality in underweight adults, compared to those with weights within normal ranges, (Katzmarzyk*et al*.,2001). Higher rates of asthma, scoliosis, intestinal problems and emotional disorders were found in underweight 17 year olds (Luskky*et al.,* 1996), Abnormal menses and subfertility have been demonstrated in underweight females (Lake *et al.,* 1997), amenorrhea may also occur, as a result of low leptin levels, decreased body fat, emotionalstress or anxiety (Kopp *et al*., 1997). The onset of puberty may be delayed in male and female adolescents with a low BMI, (He and Karlberg,2001).

Anthropometry is a key component of nutrition status assessment in children and adults. The NHANES anthropometry data have been used to track growth and weight trends in the U.S. population for more than thirty years (Hedley, 2004). The anthropometric data for infants and children reflect general health status and dietary adequacy and are used to track trends in growth and development over time. The CDC has used NHANES data to produce national reference standards or "growth charts." The CDC growth charts are used extensively by pediatricians and researchers in the U.S. and abroad (Kuczmarski *et al*., 2002).

1.2 STATEMENT OF PROBLEM

Anthropometric data is scarce not only in Kano State but in Nigeria as a whole. Obesity is an important risk factor for premature death (Allison *et a*l., 1999; Fontaine *et al*., 2003; Flegal*et al*., 2005). Height was found to be associated with lower morbidity and mortality from ischaemic heart diseases. Coronary heart disease was found to be inversely associated with leg length (Smith *et al.,* 2001). There is scarcity of the measured anthropometric data in Kano State and these data is significant health wise, therefore, the need to conduct a research of this kind so as to provide certain anthropometric information of Hausa Children and Adolescents residents in Kano state.

1.3SIGNIFICANCE OF STUDY

Kano state is rapidly growing in population and densely populated but the growth pattern of the populace receives less or no attention. The findings of this research work will determine whether or not the children are experiencing normal or stunted growth, so as to sensitize the government of Kano State in particular to come up with programmes that would enhance the socioeconomic well-being of its people. Furthermore, the research outcome would provide a means of obtaining the BMI of Hausas with lower limb deformity by way of predicting their height using their sitting height and consequently, the outcome of this research work would serve as reference point to Scientists and clinicians for subsequent research programmes.

1.4AIM AND OBJECTIVES OF STUDY

1.4.1Aim

The Aim of this study was to describe the pattern of growth in Stature, weight and leg length of Hausa children and adolescents aged 6-19years and to describe menarcheal age pattern of menstruating girls from Kano State.

1.4.2Objectives of Study

The objectives of the present study are as follows:

i. establish the age of Height growth spurt of Hausas 6-19 years from Kano State
ii. establish the age of leg (Subischial) length growth spurt of Hausas 6-19 years from Kano State
iii. investigate the relationship between growth in stature with sex and age
iv. establish the average BMI of Hausas 6-19 years from Kano States
v. establish commencement of menarche in Hausas
vi. investigate the relationship betweenmenarcheal age with height
vii. investigate the relationship between growth in stature with parental level of Education
viii. investigate the relationship between growth in stature with birth order
ix. establish an equation for prediction of height using sitting height measurement

1.5LIMITATIONS

i. Non return of questionnaires

ii. Very few records on birth weight of subjects

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 ASSESSMENT OF GROWTH

Optimal growth depends on genetic constitution, normal endocrine function, adequate nutrition, a nurturing environment, and an absence of chronic disease. Fetal, infant, maternal, and environmental factors can interact to impair intrauterine and postnatal growth (Pinyerd, 1992). Genetic differences in birth-weight among various populations are small and, although there are some racial/ethnic differences in growth, these differences are now known to be relatively minor, compared to worldwide variations in growth which are due to health and environmental influences (e.g. poor nutrition, infectious disease, socio-economic status) (Habicht*et al.*, 1974; Mei and Yip, 1989; Martorell, Medoza and Castillo, 1989).

Child growth is internationally recognized as an important indicator of nutritional status and health in populations (WHO, 1995; Gelander, 2006). Growth monitoring is an integral component of preventive and primary care pediatrics to evaluate individual children, and is a useful public health tool to assess child health status and economic development in the society (Cole, 2006; Victora*et al.*, 2008).

2.2 GROWTH MONITORING

The main objectives of growth monitoring and promotion ofoptimal growth are to: (i) provide a tool for nutrition and health evaluation ofindividual children. (ii)Initiate effective action in response to abnormal patterns of growth. (iii)Teach parents how nutrition, physical activity, genetics and illness can affect growth and, in doing so, motivate and facilitate individual initiative and improved childcare practices. (iv) Provide regular contact with primary health care services and facilitate their utilization (Garner, Panpanich and Logan, 2000; Ashworth, Shrimpton and Jamil, 2008).

There are five main activities linked to growth monitoringand promotion at the individual level (Ashworth, Shrimpton and Jamil, 2008):(i) accurately measuring weight, length or height, and headcircumference, (ii) precisely plotting measurements on the appropriate,validated growth chart (iii)correctly interpreting the child's pattern of growth (iv) discussing the child's growth pattern with the parent(s)/caregiver and agreeing on subsequent action whenrequired (v) on-going monitoring and follow-up, when required,to evaluate the response to the recommended action toimprove the child's growth.

2.3 IMPORTANCE OF ACCURATE MEASUREMENTS ANDPLOTTING

Accurate, reliable measurements are fundamental to growthmonitoring and to making sound clinical judgements on theappropriateness of a child's pattern of growth. A number ofstudies have illustrated a disturbing frequency of inaccurategrowth measurements in a variety of health care settings (Cooney, Pathak and Watson, 1994; Bunting and Weaver 1997; Chen and Shiffman, 2000; Spencer *et al.*, 1996). Accurate measurements have three components: a standardized measurement technique; quality equipment which is regularly calibrated andaccurate andtrained measurers who are reliable and precise in theirtechnique (Henry, 1992; WHO, 1995). Reliable growth data does not require expensive equipment,just careful technique and accurate charting. Informationon the appropriate equipment and techniques for accurateweighing and measuring is readily available(CDC, 2009; CDC, 2001). A child'smeasurements should be consistently and accurately recordedin an age and gender-appropriate growth record, carefullyplotted and then analyzed to identify any disturbances inthe pattern of growth. Failure to plot measurements and/ordocument growth abnormalities also contribute to missedopportunities to identify and address nutrition or illnessrelated growth problems (Chen and Shiffman, 2000; Voelker, 2007).

2.4 GROWTH CHARTS

Growth charts are graphic presentations of bodymeasurements of a population that aid in the assessment ofbody size and shape, as well as the observation of patternsin growth performance. They are used in the assessment andmonitoring of individual children and in screening wholepopulations (Wright *et al.,* 2002). They serve as one component in a holisticapproach to growth assessment and management. They arenot a diagnostic tool and they should always be used inconjunction with other information when evaluating a child'sgeneral health. The ideal growth chart would be based ondata collected longitudinally and should be representativeof children whose feeding and care comply reasonably withrecommended health practices so that the growth illustratedrepresents the best standard possible for all children.Because no geographically diverse growth chart existed, in1978 the World Health Organization (WHO) adopted forinternational use (WHO, 1978) the growth charts from the AmericanNational Centre for Health Statistics (NCHS) (Hamill, 2009). These chartshad been developed from data of American children (ages 2to 18 years) collected in five nationally representative surveysbetween 1963-1974. Charts for infants and toddlers (birth to36 months) were based on data collected in a single regionalstudy of predominantly white infants from middle to uppersocioeconomic class, who were primarily formula-fed.

2.5 THE WHO REFERENCE 2007: 5 TO 19 YEARS

Motivated by the global surge in childhood obesity, and development of the WHO Child Growth Standards for younger children, a work group convened in 2006 by the WHO, United Nations University, and Food and Agriculture Organization recommended development of a single international standard for the screening, surveillance, and monitoring of school-aged children and adolescents (Butte *et al*., 2006; Butte and Garza, 2006). Experts agreed that the 1977 NCHS/WHO charts, the CDC 2000 charts, and the International Obesity Task Force centile curves and cut-offs all had shortcomings that necessitated a new, more appropriate standard for clinical and public health applications for older children. A study similar to the WHO Growth Study was deemed impossible because of challenges in controlling the environmental dynamics of older children in a large multicentre international study (de Onis*et al.,* 2009).As an alternative, the WHO chose to construct a growth reference for pre-adolescents and adolescents using the best available historical data. After examining existing data sets from various countries, the WHO elected to reconstruct the 1977 NCHS/WHO growth reference by addressing its limitations and linking construction to the WHO Child Growth Standards curves for children under five years old. Data points for children and adolescents with measurements suggestive of high adiposity were excluded. The total sample size used to generate the curves was 22,917 children. State of the art statistical techniques were used to construct and smooth the new growth curves (de Onis*et al.,* 2007) and the same statistical methodology was used as in the construction of the WHO Child Growth Standards (WHO, 2006).

2.6 UNDERNUTRITION

The third percentile is recommended by the WHO as the lowercut-off for identifying children in developed countries whoare underweight, stunted, or wasted (Table 2.1) and referringthem for further assessment and intervention. These cut-offsare consistent with those from the CDC, with the exceptionof BMI-for-age, for which the CDC recommends a cut-off ofthe 5th percentile. This cut-off for underweight was based ona recommendation from the (WHO, 1995) prior to the release ofthe new WHO Child Growth Standards.Preliminary scientific research and clinical experienceregarding the use of BMI in underweight, and the choiceof percentile as the cut-off suggest that BMI-for-age maybe the preferred method for identifying wasting. However,until further evidence on BMI and undernutrition indicatesotherwise, the alternative practice may continue of usingeither weight-for-length/stature < 3rd centile, or weight <89% of ideal body weight (IBW) (Klein S, Kinney J, Jeejeebhoy; 1997) as a surrogate measureof wasting. These parameters would particularly applyunder the age of two years, with an awareness of theirlimitations (Klein S, Kinney J, Jeejeebhoy; 1997 Flegal, Wei, and Ogden, 2002; Philips *et al.,* 2007; Poustie*et al.,* 2007)

Table 2.1: Recommended cut-offs by the WHO for screening for undernutrition and over nutrition

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PARAMETERS	WHO CHILD GROWTH STANDARDS	WHO REFERENCE 2007
Age	Birth to 5 years	5-19 years
Underweight weight-for-age	< 3rd centile	< 3rd centile
Stunted length-for-age/ height-for-age	< 3rd centile	< 3rd centile
Wasted weight-for-length/ BMI-for-age*	< 3rd centile	< 3rd centile
Risk of overweight weight-for-length/ BMI-for-age*	> 85th centile	not applicable
Overweight weight-for-length/ BMI-for-age*	> 97th centile	> 85th centile
Obese weight-for-length/ BMI-for-age*	> 99.9th centile	> 97th centile
Severe Obesity BMI-for-age	not applicable	> 99.9th centile

* weight-for-length from birth-2 years; BMI-for-age ≥ 2 years

Source: WHO, 2007

Table 2.2: Cut-off points 2 to 19 years

GROWTH STATUS	INDICATOR	PERCENTILE	
		2-5 YEARS	5-19 YEARS
Underweight	Weight-for-age	< 3rd	< 3rd*
Severe underweight		<0.1st	<0.1st*
Stunting	Height-for-age	< 3rd	< 3rd
Severe stunting		<0.1st	<0.1st
Wasting	BMI-for-age	< 3rd	< 3rd
Severe wasting		<0.1st	<0.1st
Risk of overweight		>85th	not applicable
Overweight		>97th	>85th
Obesity		> 99.9th	>97th
Severe obesity		not applicable	> 99.9th

* weight-for-age not recommended after age 10 years; use BMI-for-age instead

Source: WHO, 2007

2.7 PREVALENCE OF UNDERNUTRITION AND OVERNUTRITION

Important differences between the WHO and CDC chartsexist, and vary by age, growth indicator, and specific centileor z-score curve (de Onis*et al.,* 2007).The biggest differences occur during thefirst 24 months, likely due to differences in study design andsample characteristics, such as type of feeding. Overall, theWHO charts reflect a lighter, and somewhat taller samplethan the CDC charts (de Onis*et al.,* 2007; Mei *et al.,* 2008). When both are applied to the samepopulation, the WHO Child Growth Standards will resultin lower rates of underweight, wasting or thinness (exceptduring the first six months of life), and higher rates ofstunting, overweight and obesity. Prevalence rates appearmore comparable when the 5th and 95th percentiles on theCDC charts are compared with the 2.3^{rd} centile (-2 z-score)and 97.7^{th} centile (+2 z-score) on the WHO charts rather thanthe 5th and 95th percentiles (Mei *et al.,* 2008).

2.8 UNDERWEIGHT

Generally, weight for-age percentiles are lower on the WHOcurves compared to the CDC curves, except between theages of one and six months where they are lower on the CDCcurves. In the first 6 months, a slightly higher proportion ofinfants are below the 3rd centile using the WHO curves versusthe CDC curves while the opposite is true after six months.The fact that more infants between birth and six months willbe screened as being underweight using the WHO standards islikely reflective of the faster rate of weight gain by breastfedbabies compared with formula-fed babies in the first fewmonths of life and the resulting shift upwards in the WHOweight-for-age centiles during this time period.45 Thereafter,the slower pattern of weight-gain on the WHO charts reflectsa healthier rate of growth for breastfed infants. As they movetowards using the WHO Child Growth

Standards, healthprofessionals will need training to understand that moreinfants are likely to be screened as underweight using theWHO Child Growth Standards, and that it is important toconsider the pattern of weight and linear growth and weightrelative to height before suggesting there is a problem withlactation.

2.9 STUNTING

Length/height-for-age is very similar on both sets of charts.Because the growth of children in the WHO Growth Studywas optimal, on average, children in the WHO Child GrowthStandards are somewhat taller than those in the CDCreference. As a result, the WHO curves are shifted upwardsrelative to the CDC charts and for all age groups, stuntingrates (i.e., height-for-age <- 3rd percentile) will be higherwhen based on the WHO Child Growth Standards.

2.10 WASTING

Using weight-for-length, weight-for-height, or BMI-for-age,the proportion of children classified as overweight or obesewill be greater using the WHO Child Growth Standards andthe prevalence of wasting will be lower.

2.11 GROWTH SPURT

The adolescent growth spurt is a rapid increase in individual’s height and weight during puberty resulting from the simultaneous release of growth hormones, Thyroid hormones and androgens. (Steinberg *et al*., 2008). Males experience their growth spurt about 2 years later on average than females, During their peak height velocity (the time of most rapid growth) adolescents grow at a growth rate nearly identical to that of a toddler about 4 inches (10.3 cm) a year for males and 3.5 inches (9cm) for females(Steinberg *et al.*, 2008).

In addition to changes in height, adolescents also experience a significant increase in weight (Steinberg *et al.*, 2008).The weight gained during adolescence constitutes a nearly half of one's adult body weight. (Tanner, 1975). Teenage and early adult males may continue to gain natural muscle growth even after puberty.The accelerated growth in different body parts happens at different times, but for all adolescents it has a fairly regular sequence. The first places to grow are the extremities –the head, hand and feet followed by the arms and legs, then torso and shoulders. (Tanner, 1975).

2.12 PREPUBERTAL GROWTH

Growth during childhood is a relatively stable process. The infancy shifts in the growth pattern are complete and the child follows the trajectory attained previously. Until about the age of 4 y, girls grow slightly faster than boys and both sexes then average a rate of 5–6 cm/y and 2.5 kg/y until the onset of puberty (Tanner, 1989).

2.13 PUBERTAL GROWTH

Puberty is a dynamic period of development marked by rapid changes in body size, shape, and composition, all of which are sexually dimorphic. The onset of puberty corresponds to a skeletal (biological) age of ≈11 y in girls and 13 y in boys (Tanner *et al*., 1975). One of the hallmarks of puberty is the adolescent growth spurt. As puberty approaches, growth velocity slows to a nadir ("preadolescent dip") before its sudden acceleration during midpuberty. The timing of the pubertal growth spurt in girls is typically at Tanner breast stage 3 and does not reach the magnitude of that in boys. Girls average a peak height velocity of 9 cm/y at age 12 and a total gain in height of 25 cm during the pubertal growth period (Kelch*et al*., 1994).

2.14 CORRELATIONS OF SOME ANTHROPOMETRIC PARAMETERS AMONG NIGERIANS

The diversity of Nigerian population provides a unique opportunity to study the morphogenic variations amongst the endogenous sub-populations consisting of different tribes, languages, and religious beliefs living in different geographical and ecological conditions. These sub-populations offer opportunities to study the anthropometric digit variations amongst these groups and tribes (Oladipo *et al*.,2009).

There is a positive correlation between digit lengths and height, weight, and BMI in both males and females but the 2D:4D digit ratio has no relationship with height, weight or BMI of an individual from people of Ebira tribe of Nigeria. (Augustine *et al*., 2012)

2.15 SEASON OF BIRTH AND ANTHROPOMETRIC OUTCOME

Compared to summer and autumn babies, those born in winter and spring tend to be heavierand longer (Tustin *et al.,* 2004) These small anthropometric differences persist into adulthood.(Davies *et al*., 2003).

2.16 SEASON OF BIRTH AND NEUROCOGNITIVE OUTCOME

There is a sizeable body of literature linking seasonof birth to psychiatric and neurological disorders (Torrey, 2000). In particular there is a large body of evidence showing that individuals born in winter and early spring have an approximately 10 percent increased risk of later developing schizophrenia (Davies *et al*., 2003). The literature on the antecedents of schizophrenia shows that children who go on to develop schizophrenia tend to lag behind their peers on a range of physical, neurological, social and educational outcomes (Terrant and Jones 1999).

2.17 BIRTH ORDER AND GROWTH

Like the offspring of other primates, children are heavily dependent on parental investment. For this reason, parental decisions about how to allocate resources among children play an important role in human development. Before the 19th century, childhood illnesses killed half of all children. Parental discrimination by sex and by birth order often determined who lived and who died. (Voland, 1990). Differences in nourishment and healthcare appear to be directly related to mortality. In a study of 14,192 Swedish children third and fourth borns were 2.1 times more likely than firstborns to die before the age of 10 (Modin, 2002).

2.18 WEIGHT-HEIGHT/HEIGHT-AGE

Moderate malnutrition includes all children with moderatewasting, defined as a weight-for-height between –3 and –2 z-scores of the World Health Organization (WHO, 1995) child growth standards, and all those withmoderate stunting, defined as a height-for-age between–3 and –2 z-scores of the WHO child growth standards (WHO, 2006). Most of these children will be moderatelyunderweight (weight-for-age between –3 and –2 z-scores).Moderate malnutrition affects large numbers of children in poor countries, placing them at increased risk of mortality. A recent analysis of data from 388 nationalsurveys from 139 countries from 2005 has providedanestimate that about 36 million children aged 6 to 59 months are suffering from moderate wasting. Approximately178 million are estimated to be stunted (Black*et al*.,2007).Moderate malnutrition increases the risk of death fromcommon diseases and, if not adequately treated, mayworsen, resulting in severe acute malnutrition (severewasting and/or edema) and/or severe stunting (heightfor-age < –3 z-scores), which are both life-threateningconditions. Therefore, the management of moderatemalnutrition is a public health priority.In contrast to severe malnutrition, programs forthe management of moderate malnutrition in childrenhave remained virtually unchanged for the past30 years, although it seems likely that this form ofmalnutrition is associated with a larger proportion ofnutrition-related deaths than severe malnutrition.WHO convened a meeting in Geneva from 30 Septemberto 3 October 2008 to address this problem.

2.19 SOCIOECONOMIC STATUS AND GROWTH

Economic changes in the United States and other countries during the past two decades (e.g increasing income inequality) have enhanced this ongoing interest in how social position and economic resources affect families and the development of children (Conger and Conger 2002). This research by developmental scholars joins with research in social epidemiology on health disparities, or the general trend that more socially and economically disadvantaged adults and children are at increased risk for physical, emotional, and behavioral problems (Oakes and Rossi 2003).With respect to the influence of Socioeconomic Status on children and adolescents there is evidence for an association between poverty and mental health (Ackerman*et al.*, 2004) and social class position and physical wellbeing (Evans and English 2002).

2.20 SKELATAL MUSCLE MASS AND ETHNICITY

Much of what is documented about skeletal muscle mass was derived from persons of Caucasian ethnicity, and there is relatively little information available on other ethnic groups. African-Americans may have different total amounts of skeletal muscle at any given age compared with Caucasian subjects (Gerace*et aI.*, 1994 and Malina*et al.*, 1996), and there may be ethnic differences in the relative loss of skeletal muscle with aging as there are with bone mineral. Earlier studies indicate that African-American subjects have significantly greater skeletal muscle mass and longer appendicular bone lengths (Aloia *et al*., 1991) compared with Caucasian subjects. The possibility therefore exists that longer extremities in African-American subjects might explain their greater appendicular skeletal muscle mass after adjustment for covariates such as height, weight, age, and gender

2.21 BODY MASS INDEX (BMI)

BMI= Weight (kg)/Height^2 (m^2)

Body mass index is defined as the individual's body mass divided by the square of his or her height. The formulae universally used in medicine produce a unit of measure of kg/m^2. BMI can also be determined using a BMI chart.

BMI is used to assess how much an individual's body weight departs from what is normal or desirable for a person of his or her height. The weight excess or deficiency may, in part, be accounted for by body fat (adipose tissue) although other factors such as muscularity also affect BMI significantly (see discussion below and overweight). The WHO regards a BMI of less than 18.5 as underweight and may indicate malnutrition,an eating disorder, or other health problems, while a BMI greater than 25 is considered overweight and above 30 is considered obese (WHO, 1995).These ranges of BMI values are valid only as statistical categories

<18.5, under weight, 18.5-24.9, normal,

25.0-29.9, over weight, 30.0 34.9, class I obesity,

35.0-39.class II obesity and ≥40, class III obesity.

BMI is used differently for children. It is calculated the same way as for adults, but then compared to typical values for other children of the same age. Instead of set thresholds for underweight and overweight, then, the BMI percentile allows comparison with children of the same sex and age (CDC, 2002). A BMI that is less than the 5th percentile is considered underweight and above the 95th percentile is considered obese for people 20 and under. People under 20 with a BMI between the 85th and 95th percentile are considered to be overweight.

Recent studies in Britain have indicated that females between the ages 12 and 16 have a higher BMI than males of the same age by 1.0 kg/m^2 on average.

2.22 MENARCHE

The first episode of menstruation is called menarche and is an indicator of the start of puberty in women. (Macquarie, 1994) Although the role of gonadotropins in menarche is not fully established, the influence of heredity, social class, nutrition and physical or emotional stress on physical maturation and age at menarche has been established in different populations(Hopwood *et al*.,2001).Early menarche (before 12 years) isa risk factor for breast cancer (Hirshaut and Pressma2000).andisassociated with a risk of obesity in postmenopausalwomen with breast cancer(Wasserman.,2004).Relationship has also been shown betweenearly menarche and increasing severity ofpainful menstruation, and pregnancies at ayounger age (Balbi, 2000).

2.23AGE AT MENARCHE AND HEIGHT

Since the early 19th century, secular changes have been described for age at menarche as well as for adult height. In Europe, age at menarche has decreased, although the results from the past 50 years are less consistent (Hauspie *et al*., 1997). In several countries, age at menarche remained stable or has even started to increase since the mid-20th century (Hauspie *et al.,* 1997).Whereas in other countries the downward trend still continues (Okasha*et al.,*2001). In the same period, height has increased by about 0.3–3.0 cm per decade over the last century(Hauspie *et al.,* 1997). Claim that the secular trend in height has slowed down since World War II, but others could not confirm this finding. Secular trends in these established risk factors for breast cancer may also predict changes in breast cancer incidence and are therefore important to monitor. Although on an ecologic (population) level women seem to have their menarche earlier and to grow taller, several studies show that women with earlier menarche reach a shorter adult height compared with women who have menarche at a later age (Okasha*et al.,* 2001)

2.24 AGE AT MENARCHE AND ADULT BODY MASS INDEX (BMI)

Early age at menarche, together with other indicators of early biological maturity, has been shown to be associated with increased adult body mass index (BMI) (Parsons *et al.*, 1999).Between 1972 and 2003, ten longitudinal studies found a negative relation between age at menarche and adult weight-for-height ((Laitinen*et al.*, 2001), assessed by BMI in all but one study (Miller *et al*., 1972), but at least one longitudinal study showed no relation between age at menarche and adult BMI (Wellens *et al.*, 1992).

If there is a true causal link between age at menarche and adult BMI, it could be argued that this association may play a role in explaining the temporal trends in obesity. Age at menarche has been declining (Parent et al., 2003) at the same time as adult BMI has been increasing, although the rate of decline has slowed or stopped in some countries in recent times (Styne, 2004). Whether early age at menarche is causally associated with increased adult obesity is unclear because many factors are related to both age at menarche and adult obesity. In particular, girls who have an early ageof menarche have the highest childhood BMIs (Freedman *et al.*, 2001) In turn, BMI tracks between childhood and adult life.(Biro *et al*., 2001).

Other factors across the life course (Power and Persons 2002) may also explain or mediate the relation between age of menarche and adult BMI. Socioeconomic position at birth (Laitinen*et al*., 2001) and in adult life , parity , current smoking status and alcohol intake (Molarius, 2003) are all associated with BMI in adult life. Social class is also negatively associated with age at menarche (Okasha *et al*., 2001).

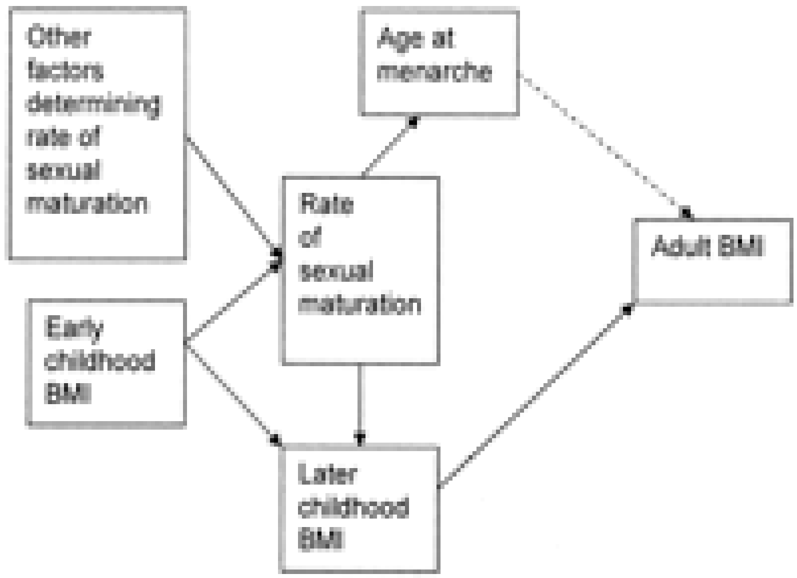

Figure 2.0: Path way relating menarcheal age and adult BMI. (Mary and David2005).

2.25 PARENTAL EDUCATION AND CHILD GROWTH

A study published in Ethiopia found that parental education is one of the key determinants of chronic child malnutrition in Ethiopia. This study also found that the effect of maternal education is almost double that of paternal education and that mothers' secondary school education has a significant effect on anthropometric scores of their children when compared to uneducated mothers (Alderman *et al.,* 2004). However, Uthman (2009) reported the effects ofsocioeconomic status on child health in Nigeria and found that monetary wealth alone was the mostprevalent contributing factor, accounting for one third of theinequality in malnutrition, with mothers' education playing alesser role.

2.26 PARENTAL EDUCATION AND CHILD HEALTH

It has often been argued that, Ceteris paribus, Children of educated mothers experience lower mortality than do children of uneducated mothers. Relying on the many demographic studies that demonstrate a strong correlation between maternal education and child health, public policy discourse has increasingly assumed that investment in women's education are important in lowering infant and child mortality and improving child health.(Schultz, 1993).Nonetheless, a few scholars are uncomfortable about concluding from this correlation that there is a strong causal relationship between maternal education and child health. Unfortunately, their discomfort has been largely ignored in most of the policy discussions because the link between maternal education and child health has rarely been analyzed using appropriate statistical models. Even scholars who point out the lack of conclusive evidence supporting a strong correlation between maternal education and child health (Hobcraft,1993) do so rather hesitantly (Hobcraft, 1994)

2.27 PARENTAL EDUCATION AND CHILD NUTRITION

Mostly using data from the World Fertility Surveys (WFS) or the Demographic and Health Surveys (DHS), the bulk of studies have shown that children of educated mothers experience lower mortality as well as lower malnutrition than children of uneducated mothers (Gwatkin*et al.,* 2000). On the other hand, (Reed *et al*1996) reported unexpected negative association between maternal education and child nutritional status. The fact that most educated women work outside the home without simultaneously ensuring adequate childcare could explain this finding. More recentlyit was found that non-significant effect of maternal education on child nutritional status in Cameroon, (Pongou*et al.*,2006)

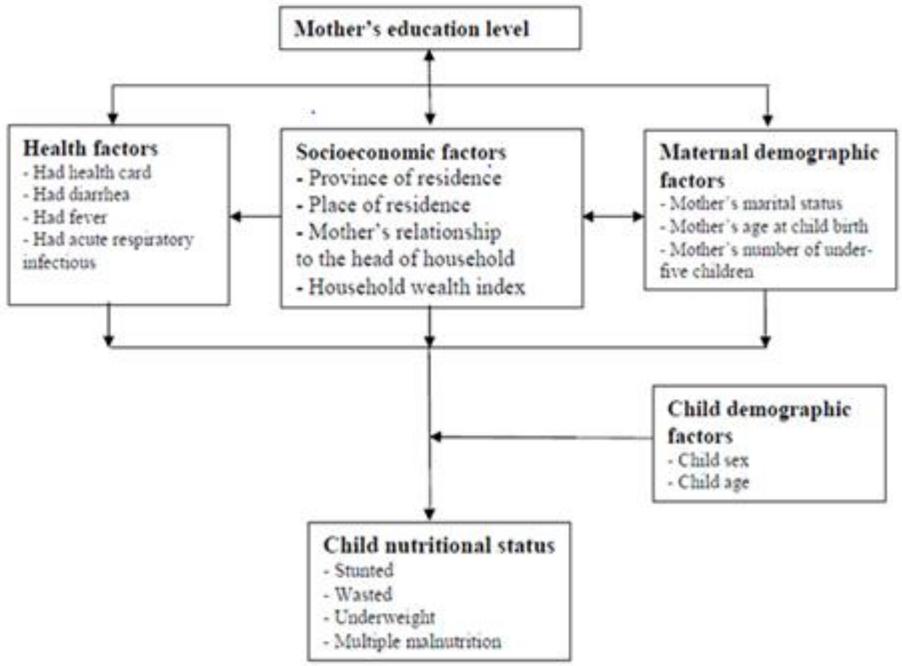

Figure 2.1: path way linking mother's educational level with child nutritional status (UNICEF, 2008)

2.28 HEIGHT ESTIMATION

Estimation of height and weight from different body parts have received great attention in anthropology and forensic sciences. Body parts such as finger lengths can be utilized for the estimation of height and weight.(Danborno *et al*., 2009). Relationship that exist between different part of the body and height had been of great interest to anthropologists, forensic and medical scientists for many years (Ozaslan *et al*., 2003, Sanli*et al*., 2005, Krishan and Sharma 2007) This is because of the increase in the number of catastrophic events causing mass deaths from natural or man-made errors. Such disasters like flooding, tsunamis, earthquakes, plane crashes, train crashes , terrorist attacks usually requires the identification of victims from fragmentary and dismembered human remains (Ozaslan *et al*., 2003, Sanli*et al*., 2005,Krishanand Sharma, 2007) . Earlier reports have shown that relationship exists between stature and z and shoe dimension. (Jasuga *et al*., 1991 and Ozden*et al.*, 2005).

2.29 ANTHROPOMETRY

Anthropometry is the study of the measurement of the human body in terms of the dimensions of bone, muscle, and adipose (fat) tissue. The word “anthropometry” is derived from the Greek word “anthropo” meaning “human” and the Greek word “metron” meaning “measure” (Ulajaszek, 1994). The field of anthropometry encompasses a variety of human body measurements. Weight, stature (standing height), recumbent length, skinfold thicknesses, circumferences (head, waist, limb, etc.), limb lengths, and breadths (shoulder, wrist, etc.) are examples of anthropometric measures.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY LOCATION/DURATION

The study was conducted in 20 Local Governmentareas (LGAs) of Kano state. Three local governments were randomly selected from each of the northern, southern, eastern and western parts of the state and all the eight metropolitant LGAs were considered for the research. The research was conducted in both primary and secondary schools of the concerned LGAs.

Kano state is located in North-Western Nigeria. The capital of Kano State is Kano with 44 LGAs. Coordinates11°30′N 8°30′E,created on May 27, 1967 from part of the Northern Region, Kano state bordersKatsinaState to the north-west, Jigawa State to the north-east, Bauchi State to the south-east and Kaduna State to the south-west.

Historically, Kano State has been a commercial and agricultural state, which is known for the production of groundnuts as well as for its solid mineral deposits. The state has more than 18,684 square kilometersof cultivable land and is the most extensively irrigated state in the country. The official language of Kano state is English but Hausa is the major and widely spoken language. According to the NPC 2006 census figures Kano state had a population totaling 9,383,682.

The LGAs included in the study are:

i. Kano metropolitant LGAs : Nassarawa, Dala, Gwale, Fagge, Tarauni, Ungoggo, Kumbotso and Kano municipal

ii. Northern part: Bichi, Tsanyawa and Makoda

iii. Southern part: Kura, Tudunwada and Madobi

iv. Eastern part: Wudil, Gaya and Ajingi

v. Western part: Tofa, Gwarzo and Kabo

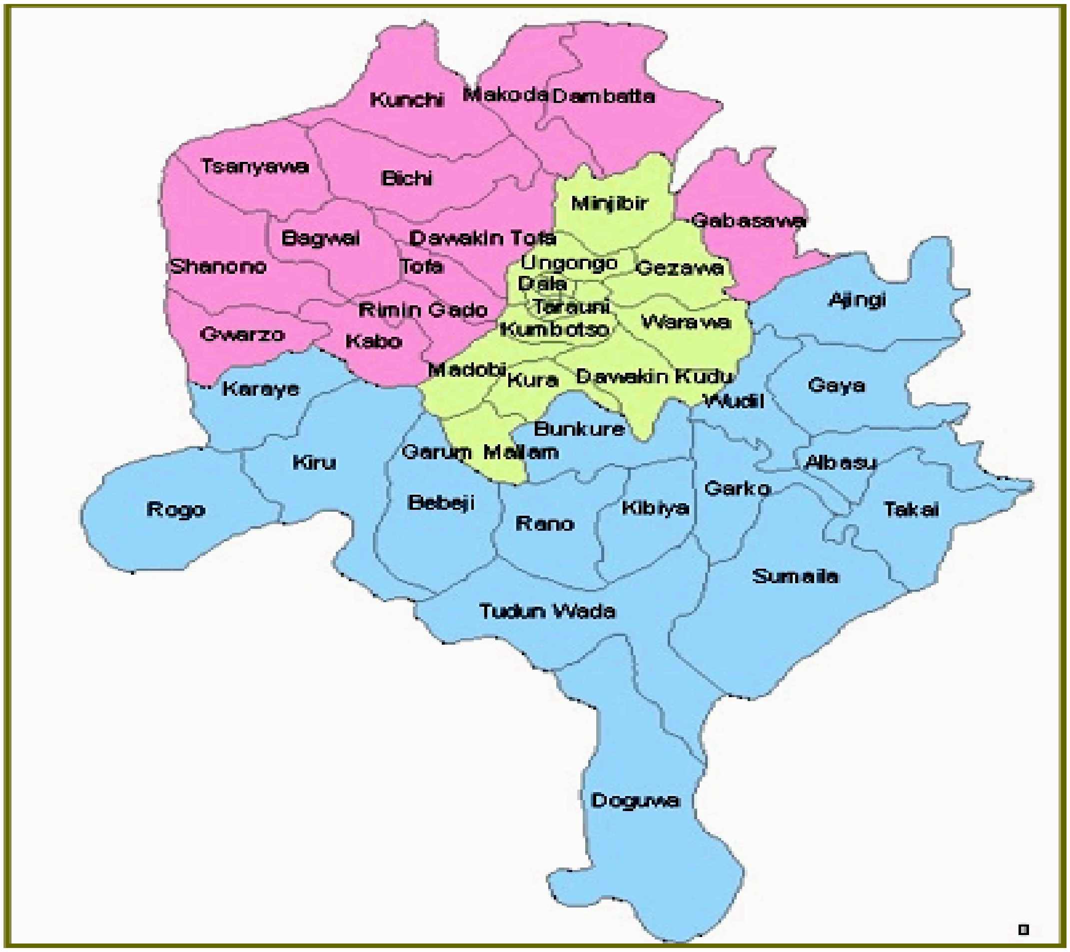

Figure 3.0: Map of Kano state showing location of study area
Source: Satellite city map

3.4 SUBJECTS

Data for the study was collected from 2,490 subjects (1134 Males and 1356 Females) age 6-19 years attending primary andsecondary schools in the affected local governments of Kano State. One hundred and fifty (150) subjects in each of the metropolitan local government except Dala (240) and one hundred (100) each in the remaining out side LGAs

3.5 INCLUSION AND EXCLUSION CRITERIA

3.5.1 Inclusion Criteria

i. Children and adolescents aged 6 to 19 years of either sex

ii. Subjects were mentally and physically fit

iii. Subjects were Hausas (grand parentage) from Kano State

iv. Subjects participated willingly without any form of compulsion

3.5.2 Exclusion Criteria

i. Subjects outside the age range of 6 to 19 were excluded

ii. Subjects who declined to participate were excluded

iii. Non Hausas were excluded

iv. Subjects with physical deformity such as limb deformity were not included

3.6 METHODOLOGY

Data were collected via questionnaires distributed tosubjects,however, pupils were assisted in filling certain information contained in the questionnaire. Subjects provided certain information right away while some were given the questionnaires to take home and consult their parents for some information. Questionnaires were filled and were verified and mistakes corrected before collection. Weight and height were measured using stadiometer with subjects wearing no shoes and with minimum clothing and were positioned as described below.

3.7ANTHROPOMETRIC MEASUREMENTS

3.7.1Height

Height was measured with a stadiometer, with the subject standing erect and without shoes on the floor surface of the stadiometer.Stature which means height was measured and recorded to the nearest 0.1 cm.

The correct position for the head is in the Frankfort horizontal plane. The arms hang freely by the sides. The head, back, buttocks and heels are positioned vertically so that the buttocks and the heels are in contact with the vertical board of the stadiometer. The subjects were then asked to take in a deep breath and hold it, the head piece of the stadiometer was then lowered to firmly rest on the and to compress hair so that measurement was done from the highest point of the head to the standing surface of the subject, (NHANES,2007)

3.7.2 Weight

The position for stature/height measurement above was maintained for weight measurement as the stadiometer has a weighing scale attached to it. The weight was then measured with minimum clothing and recorded to the nearest 0.1 kg

3.7.3 Leg (Sub-ischial) Length:

Estimated as difference between standing height and sitting height to the nearest 0.1cm.

3.7.4 Sitting Height

Sitting height gives a measure of the length of the trunk. It is a measurement of the distance from the highest point on the head to the base sitting surface. The subject sat on a chair with both feet on the floor, looking straight ahead.(Head in its anatomical position) Measurement was done with a ruler placed against the chair.

3.7.5 Body Mass Index

BMI is calculated by dividing the individual's weight in kilograms by square of their height in meters. This allows for the factoring in of an individual's height. It is recorded in kg/m^2

3.8ETHICAL CONSIDERATION

An introductory letter from the Department of Anatomy Ahmadu Bello University, Zaria addressed to Principals and Headmasters of Secondary Schools and Primary Schools respectively, where research was conducted was given. An approval was obtained from the Parents/Teachers Association (PTA) of each School were research was conducted. Informed consent was also sorted from participants before collection of data.


Plate I: Measurement of height

Plate II:Measurement of weight

Plate III:Measurement of sitting height

Plate IV: Stadiometer used for the measurement of height and weight

3.9 STATISTICAL ANALYSES

Data was expressed as mean ± standard deviation. Student's t-test was used for differences between males and females in all variables studied.One way ANOVA was applied to assess differences between data across age groups and socioeconomic status.Pearson correlation was applied to test relationship between each of the measured anthropometric parameters, linear regression was applied to predict height in males and females from the various anthropometric variables. Statistical significance was deemed acceptable at $p < 0.05$.SPSS version 16 for Windows was used for statistical analyses.

CHAPTER FOUR

4.0 RESULTS

4.1 ANALYSES OF STUDY POPULATION

The scope of this study was restricted to children and adolescents from Kano State. 2,490 children and adolescents (1356 females and 1134 males) aged 6-19 years, randomly selected constituted the analytic subjects. Data were recorded after obtaining necessary permission from relevant authorityof the state (after reviewing the study protocols (guidelines))and from authorities of participating schools.Data pertaining to age, sex, date of birth, state of origin, local government, and birth order were collected using a predesigned questionnaires. For adolescent female subjects, data pertaining menstrual cycle, length of menstrual blood flow and menarcheal age were collected. The anthropometrics including height, weight, sitting height, leg length of each subject were measured using stadiometer, mechanical weighing machine and measuring tape following standard technique by trained investigators.

4.2 DESCRIPTIVE STATISTICS OF STUDY POPULATION

The mean and standard deviation (SD) of mean values of age and anthropometrics of the participants are shown in Table 4.1. The mean age of the overall study population is 12.60 ± 3.80 years. Their mean weight and height are respectively 54.84 ± 10.75 kg and 138.80 ± 15.70 cm.

Table 4.2 shows the mean age and anthropometric variables of subjects based on sex. Results from the table indicate that female subjects are older and are heavier, taller and have longer leg length. However, they have lower sitting heights compared to the males.

Table 4.3 shows the descriptive statistics of children according to sex. The result did not reveal any statistical difference ($p > 0.05$) in the measured anthropometric variables except for their sitting height and leg length with female children having longer leg length while the males have higher sitting height ($t = -2.65$, $p < 0.01$; $t = 3.86$, $p < 0.01$) respectively.

Descriptive statistics of adolescent females and males is presented on Table 4.4. Results on the table revealed that female subjects are significantly heavier, taller, higher BMI, and longer legs than their male counterparts ($t = 6.14$, $t = 5.59$, $t = 4.53$, $t = 10.67$) at $p < 0.001$ for all variables respectively. The table also revealed that the males have statistical significant higher sitting height than the females ($t = -2.08$, $p < 0.05$). Still on the same table, the mean menarcheal age of the adolescent females in the present study is 14.00 ± 1.00 years. The mean menstrual cycle of the adolescent females is 28.30 ± 2.80 days with mean length of menstrual blood flow of 4.20 ± 1.50 days.

Table 4.1 Overall Descriptive statistics of children and adolescents (n= 2490)

Parameters	Mean ± SD	Min	Max
Age (years)	12.60 ± 3.80	6.00	19.00
Weight(kg)	54.84 ± 10.75	23.00	82.00
Height (cm)	138.80 ± 15.70	99.00	180.00
BMI (kg/m²)	20.25 ± 4.08	5.34	37.16
Sitting height (cm)	64.30 ± 7.80	42.00	86.20
Leg length (cm)	73.30 ± 13.30	23.00	105.00

Table 4.2: Descriptive statistics of subjects according to sex

	Females (n = 1134)			Males (n = 1356)		
Parameters	Mean ± SD	Min	Max	Mean ± SD	Min	Max
Age (yrs.)	13.02 ± 3.84	6.00	19.00	12.03 ± 3.66	16.00	19.00
Weight (kg)	42.25 ± 15.72	24.00	82.00	38.23 ± 14.00	23.00	79.00
Height (cm)	140.00 ± 16.02	100.00	180.00	136.68 ± 15.06	99.00	176.00
BMI (kg/m^2)	20.65 ± 4.30	11.02	33.12	19.78 ± 37.16	5.34	37.16
Sitting height (cm)	64.20 ± 7.86	42.00	86.00	64.33 ± 42.00	42.00	85.00
Leg length (cm)	76.23 ± 10.10	23.00	82.00	72.34 ± 8.68	50.00	97.00

Table 4.3: Anthropometric parameters according to sex in children (n=1050).

	Females (n = 524)			Males (n = 526)				
Parameters	Mean ± SD	Min	Max	Mean ± SD	Min	Max	T	p
Weight (kg)	27.75 ± 9.01	20.00	65.60	27.79 ± 5.67	20.00	59.00	-0.10	0.92
Height (cm)	124.90 ± 7.80	100.00	152.00	125.20 ± 8.60	99.00	170.00	-0.67	0.50
BMI (kg/m^2)	17.54 ± 2.68	9.98	27.66	17.61 ± 2.49	9.92	26.48	-0.39	0.70
Sitting height (cm)	57.80 ± 5.20	42.00	73.40	59.00 ± 5.20	42.00	74.00	3.86	<0.01
Leg length (cm)	67.00 ± 5.80	23.00	105.00	66.10 ± 5.70	24.00	97.00	-2.65	<0.01

Table 4.4: Anthropometric parameters according to sex in adolescents (n=1440)

	Females (n = 836)			Males (n = 604)				
Parameters	Mean ± SD	Min	Max	Mean ± SD	Min	Max	t	p
Weight (kg)	51.51 ± 12.64	24.00	82.00	47.37 ± 12.62	23.00	79.00	6.14	<0.0001
Height (cm)	159.20 ± 12.10	110.00	180.00	146.80 ± 11.40	118.00	176.00	5.59	<0.0001
BMI (kg/m^2)	22.59 ± 3.97	12.91	33.12	21.67 ± 3.64	11.02	37.16	4.53	<0.0001
Sitting height (cm)	68.20 ± 6.50	48.00	86.20	68.90 ± 6.50	51.00	85.00	-2.08	0.04
Leg length (cm)	82.00 ± 7.70	60.00	104.00	77.80 ± 7.00	60.00	95.00	10.67	<0.0001
Menarcheal age (yrs.)	14.00 ± 1.00	12.00	17.00	_	_	_	_	_
MC (days)	28.3 ± 2.80	15.00	38.00	_	_	_	_	_
LMF (days)	4.20 ± 1.50	2.00	9.00	_	_	_	_	_

4.3 GROWTH PATTERN

Percentiles of height, weight and BMI for female and male subject according to age are shown in Tables 4.5-4.10. The 5th, 10th, 25th, 50th, 75th, 90th and 95th centiles of these parameters for each sex and age are shown in the table. The results indicated that there is no much difference in the centile values of females and male subjects. However, the girls have slightly centile values than their male counterparts.

Undernutrition among Hausa children and adolescents from Kano state in terms of their height deficit (stunting) and weight deficit (underweight) are presented in Table 4.11. Subjects are categorized into moderate (below -2 *Z*-score) or severe (-3 *Z*-score). The prevalence of stunting and underweight among the subjects are similar. From the table, prevalence of stunting and underweight are higher among female children than male children (6-11) years. However, the prevalence is less in female adolescents than in male adolescents.

Table 4.5: Height percentiles according to age for female subjects

Height (cm)	N	Percentiles 5	10	25	50	75	90	95
6	63	107.60	113.20	116.70	121.00	125.00	130.60	133.80
7	71	110.00	113.20	117.00	122.00	124.20	127.00	130.60
8	88	112.45	114.00	119.15	124.00	127.00	132.10	137.10
9	96	110.85	114.70	121.00	127.00	130.00	135.30	139.15
10	68	112.35	116.90	121.00	125.50	129.75	135.00	140.55
11	140	113.15	118.10	125.10	129.00	132.00	139.90	142.62
12	96	122.00	123.94	127.00	131.00	139.00	146.00	149.32
13	77	127.36	129.00	135.00	142.00	148.00	150.84	156.26
14	82	135.15	137.00	140.75	148.00	152.00	158.00	160.00
15	117	134.96	139.16	147.00	151.00	156.50	161.10	166.00
16	111	136.20	143.20	148.00	154.00	159.00	162.24	167.00
17	168	137.90	146.00	150.00	157.00	161.00	165.02	167.00
18	113	145.40	148.00	153.00	158.00	161.20	167.00	170.00
19	66	142.83	147.79	151.00	156.85	164.00	168.51	172.95

Table 4.6: Height percentiles according to age for male subjects

Height (cm)	N	Percentiles						
		5	10	25	50	75	90	95
6	64	107.25	111.00	116.00	120.00	124.00	130.00	133.00
7	97	110.30	114.00	118.00	122.00	126.00	130.00	130.10
8	80	114.01	115.20	119.00	122.00	127.95	135.80	141.00
9	82	116.05	118.00	121.00	126.00	130.00	134.70	139.55
10	73	112.70	117.40	123.40	127.40	133.50	137.60	141.30
11	130	117.55	120.00	124.00	128.00	133.00	138.00	142.45
12	104	120.75	124.65	128.00	131.05	136.75	143.00	145.75
13	111	127.68	129.00	134.00	139.00	144.00	150.00	155.20
14	74	136.60	137.70	140.75	149.00	153.00	157.50	160.00
15	70	135.55	138.10	144.75	150.00	157.00	161.00	168.35
16	80	140.05	143.28	149.00	154.00	159.00	162.80	166.90
17	75	139.84	141.00	148.00	155.00	162.00	167.34	169.20
18	64	138.65	143.00	150.00	157.50	165.80	168.60	171.75
19	30	135.85	140.00	144.00	151.00	160.10	169.40	170.00

Table 4.7: Weight percentiles according to age for female subjects

		Percentiles						
Weight (kg)	N	5	10	25	50	75	90	95
6	63	16.20	18.00	20.00	25.00	28.00	30.00	33.60
7	71	18.30	20.00	21.60	25.00	28.00	30.40	31.00
8	88	18.67	19.90	22.63	26.10	28.53	33.00	34.44
9	96	18.96	20.28	24.00	28.00	31.00	34.30	37.45
10	68	19.56	20.92	25.15	28.40	31.00	33.65	40.30
11	140	21.00	23.63	27.00	30.00	33.23	38.00	42.00
12	96	24.00	27.00	29.00	32.00	37.00	40.51	44.00
13	77	27.80	30.00	34.35	40.00	47.00	54.20	59.10
14	82	33.15	36.00	39.90	45.00	53.25	58.00	60.85
15	117	31.90	39.00	47.00	51.00	58.00	65.68	68.30
16	111	40.00	44.00	49.20	56.00	61.00	67.00	70.00
17	168	42.00	45.00	49.00	57.00	64.90	69.00	71.00
18	113	43.76	48.00	55.00	62.00	67.50	71.00	72.60
19	66	43.11	47.40	52.00	60.10	69.25	71.00	77.00

Table 4.8: Weight percentiles according to age for male subjects

Weight (kg)	N	Percentiles 5	10	25	50	75	90	95
6	64	15.40	18.50	21.25	24.50	27.00	30.00	30.75
7	97	19.00	19.96	23.00	26.00	28.00	31.00	33.10
8	80	20.00	21.00	23.15	27.00	28.45	31.90	36.85
9	82	18.32	20.59	24.80	28.00	30.00	33.70	34.09
10	73	19.00	21.00	25.00	29.00	32.00	36.84	40.30
11	130	23.00	25.00	27.00	30.00	34.00	37.00	40.00
12	104	24.25	26.50	30.00	32.00	36.00	40.25	44.75
13	111	28.76	31.42	35.00	40.00	45.00	49.00	55.00
14	74	32.75	36.20	39.30	45.00	50.00	56.00	58.10
15	70	30.64	37.10	47.00	51.00	59.25	64.90	69.00
16	80	37.00	44.00	48.13	56.00	59.75	65.18	67.95
17	75	35.60	40.00	49.00	58.00	66.00	68.00	70.00
18	64	34.75	43.50	50.00	60.50	69.00	70.50	76.50
19	30	40.65	42.00	44.50	55.00	59.50	63.90	72.82

Table 4.9: BMI percentiles according to age for female subjects

BMI (kgm^{-2})	N	Percentiles						
		5	10	25	50	75	90	95
6	63	12.20	12.97	14.81	16.53	17.76	19.67	20.76
7	71	13.49	13.66	14.88	17.64	18.90	20.16	21.65
8	88	12.71	13.52	15.88	17.38	18.59	20.45	21.37
9	96	13.65	14.31	15.65	17.57	19.36	21.14	21.96
10	68	13.54	14.65	16.00	17.69	19.36	21.40	24.70
11	140	13.97	14.65	16.42	18.2	19.82	21.26	23.30
12	96	14.45	15.45	17.13	18.3	20.07	23.32	24.86
13	77	14.27	16.01	17.34	20.12	23.98	26.13	27.31
14	82	15.83	16.55	18.24	21.22	24.21	27.03	27.47
15	117	15.87	17.66	20.40	22.61	25.61	27.98	28.80
16	111	18.08	20.01	21.88	23.81	25.64	28.18	29.22
17	168	17.60	18.97	21.35	23.50	25.97	27.64	29.61
18	113	17.71	18.62	21.66	25.33	27.21	29.09	30.01
19	66	17.76	18.80	21.47	25.13	27.44	28.67	29.01

Table 4.10: BMI percentiles according to age for male subjects

BMI (kgm^{-2})	N	Percentiles						
		5	10	25	50	75	90	95
6	64	12.34	13.27	15.14	16.48	17.91	19.49	20.01
7	97	14.35	14.78	15.78	17.09	18.88	20.13	20.50
8	80	13.62	14.16	15.86	17.53	18.92	20.12	22.68
9	82	14.03	14.39	15.57	17.36	18.60	20.12	20.90
10	73	14.84	14.86	15.64	17.36	19.21	21.92	22.92
11	130	14.41	15.72	17.08	18.63	20.20	22.06	23.12
12	104	14.57	15.46	17.01	18.9	20.38	22.51	23.49
13	111	16.29	16.88	18.37	20.93	22.58	24.64	25.55
14	74	15.49	16.18	18.71	21.75	22.77	24.80	26.53
15	70	16.20	17.25	20.40	23.03	25.00	27.27	27.89
16	80	16.58	18.14	20.97	24.5	25.21	27.02	28.27
17	75	17.13	18.48	21.46	23.80	25.81	27.12	28.76
18	64	18.95	19.52	21.86	24.03	25.55	27.98	28.97
19	30	16.90	17.76	21.18	23.26	25.10	26.46	28.06

Table 4.11: Prevalence of stunting and underweight (moderate and severe based on < -2 Z and < -3 Z scores, respectively)

	Females				Males			
	Stunting		Underweight		Stunting		Underweight	
Age (yrs.)	Moderate (%)	Severe (%)	Moderate (%)	Severe (%)	Moderate (%)	Severe (%)	Moderate (%)	Severe (%)
6	13 (20.63)	3 (4.76)	3 (4.76)	-	14 (21.88)	2 (3.13)	9 (14.06)	3 (4.69)
7	13 (18.31)	6 (8.45)	19 (26.76)	4 (5.63)	22 (22.68)	7 (7.22)	8 (8.25)	7 (7.22)
8	24 (27.27)	4 (4.55)	20 (22.73)	2 (2.27)	26 (32.50)	6 (7.50)	22 (27.50)	2 (2.50)
9	24 (25.00)	8 (8.33)	25 (26.04)	4 (4.17)	20 (24.39)	3 (3.66)	22 (26.83)	4 (4.88)
10	14 (20.59)	4 (5.88)	12 (17.65)	6 (8.82)	21 (28.77)	5 (6.85)	11 (15.07)	4 (5.48)
11	19 (13.57)	10 (7.14)	28 (20.00)	8 (5.71)	32 (24.62)	6 (4.62)	19 (14.62)	6 (4.60)
12	33 (34.38)	2 (2.08)	25 (26.04)	4 (4.17)	35 (33.65)	5 (4.81)	24 (23.08)	5 (4.81)
13	22 (28.57)	4 (5.19)	20 (25.97)	2 (2.60)	30 (27.03)	4 (3.60)	28 (25.23)	5 (4.50)
14	19 (23.17)	4 (4.87)	23 (28.05)	4 (4.88)	22 (29.73)	3 (4.05)	25 (33.78)	4 (5.41)
15	20 (17.09)	6 (5.13)	19 (16.24)	5 (4.27)	14 (20.00)	4 (5.71)	10 (14.29)	6 (8.57)
16	21 (18.92)	8 (7.21)	18 (16.22)	8 (7.21)	18 (22.50)	6 (7.50)	20 (25.00)	4 (5.00)
17	37 (22.02)	13 (7.74)	45 (26.79)	8 (4.76)	14 (18.67)	9 (12.00)	16 (21.33)	7 (9.33)
18	21 (18.58)	5 (4.42)	20 (17.70)	7 (6.19)	14 (21.88)	5 (7.81)	19 (29.69)	4 (6.25)
19	19 (28.79)	3 (4.55)	20 (30.30)	2 (3.03)	9 (30.00)	1 (3.33)	9 (30.00)	1 (3.33)

4.4 INFLUENCE OF SOCIAL STATUS ON GROWTH OF HAUSA CHILDREN AND ADOLESCENTS

Comparison of anthropometric variables of children and adolescents according to parents' educational attainment are presented on Tables 4.12-4.15. Results from these tables showed that on the average children and adolescents whose parents have tertiary education have significantly ($p < 0.05$) higher mean anthropometric values than those whose parents have no education, primary or secondary education.

Table 4.12: Anthropometric parameters according to father's level of education in children

Parameters	None (n = 334) Mean ± SD	Primary (n = 178) Mean ± SD	Secondary (n = 274) Mean ± SD	Tertiary (n = 269) Mean ± SD	*p*-value
Age (yrs.)	9.88 ± 2.70	8.48 ± 3.70	8.64 ± 4.00	8.21 ± 3.22	0.07
Weight (Kg)	27.66±5.75	26.61±13.31	27.79±5.29	28.58±6.09	0.63
Height (cm)	124.90±4.70^{b}	123.00±7.80^{b}	125.70±8.80^{a}	125.90±8.30^{a}	<0.01
BMI (Kg/m²)	17.64±2.64^{a}	16.93±2.45^{b}	17.55±2.59^{a}	17.91±2.51^{a}	<0.01
Sitting height (cm)	58.70±5.00^{b}	56.80±5.10^{a}	59.00±5.40^{a}	58.50±5.20^{a}	<0.01
Leg length (cm)	66.20±5.40^{b}	66.40±6.80^{a}	66.50±5.60^{a}	67.40±5.50^{a}	0.04

Means that do not share a subscript are statistically different

Table 4.13: Anthropometric parameters according to mother's level of education in children(n=1050)

Parameters	None (n = 334) Mean ± SD	Primary (n = 178) Mean ± SD	Secondary (n = 274) Mean ± SD	Tertiary (n = 269) Mean ± SD	*p*-value
Age (yrs.)	8.93 ± 4.01	9.00 ± 3.65	8.54 ± 4.00	8.81 ± 6.00	0.05
Weight (Kg)	27.17±5.17[b]	26.14±13.08[a]	27.69±5.42[a]	29.55±6.18[a]	<0.01
Height (cm)	124.90±7.60[b]	122.30±7.80[a]	125.30±8.40[a]	126.80±8.50[a]	<0.01
BMI (Kg/m²)	17.39±2.55[b]	16.80±2.56[a]	17.59±2.55[a]	18.27±2.50[a]	<0.01
Sitting height (cm)	58.90±5.10[a]	56.6±5.10[b]	58.80±5.30[a]	58.70±5.20[a]	<0.01
Leg length (cm)	66.00±5.30[b]	65.60±6.10[a]	66.30±5.30[a]	68.10±6.10[a]	<0.01

NB: means that do not share subscript are statistically differen

Table 4.14:Anthropometric parameters according to Father's level of education in adolescents (n= 1440)

Parameters	None (n = 334) Mean ± SD	Primary (n = 178) Mean ± SD	Secondary (n = 274) Mean ± SD	Tertiary (n = 269) Mean ± SD	*p*-value
Age (yrs.)	15.99 ± 3.66	15.32 ± 6.00	15.89 ± 5.88	14.87 ± 4.54	0.07
Weight (Kg)	49.29±12.85[b]	47.12±12.22[a]	50.02±12.64[a]	51.54±12.94[a]	<0.01
Height (cm)	148.00±11.50[b]	147.60±12.10[a]	148.00±11.60[a]	150.30±12.20[a]	0.02
BMI (Kg/m²)	21.99±3.95[a]	21.29±3.58[b]	22.53±3.70[a]	22.61±3.98[a]	<0.01
Sitting height (cm)	68.70±6.30[b]	67.20±7.00[a]	68.40±6.20[a]	69.00±6.80a	0.02
Leg length (cm)	79.90±7.50[b]	80.50±7.50[a]	79.60±7.70[a]	81.13±7.80[a]	0.01

NB; means that do not share subscript are statistically different

Table 4.15: Anthropometric parameters according to mother's level of education in adolescents (n= 1440)

Parameters	None (n = 334) Mean ± SD	Primary (n = 178) Mean ± SD	Secondary (n = 274) Mean ± SD	Tertiary (n = 269) Mean ± SD	*p*-value
Age (yrs.)	16.00 ± 6.88	16.34 ± 6.90	17.32 ± 5.50	17.00 ± 3.90	0.08
Weight (Kg)	$49.50{\pm}12.75^a$	$47.28{\pm}12.23^b$	$49.54{\pm}12.53^a$	$52.29{\pm}13.27^a$	<0.01
Height (cm)	149.00±11.40	148.00±11.90	148.40±11.80	149.27±12.30	0.34
BMI (Kg/m^2)	$22.00{\pm}3.93^b$	$21.29{\pm}3.64^a$	$22.26{\pm}3.79^a$	$23.03{\pm}3.89^a$	<0.01
Sitting height (cm)	$69.30{\pm}6.30^a$	$67.30{\pm}6.70^b$	$68.20{\pm}6.30^a$	$68.90{\pm}6.8^a$	0.01
Leg length (cm)	79.70±7.60	80.60±7.70	80.30±7.80	80.70±7.50	0.28

NB: means that do not share subscript are statistically different

4.5 INFLUENCE OF PARENTS' LEVEL OF EDUCATION ON MENARCHEAL AGE AND MENSTRUAL CHARACTERISTICS

Tables 4.16 and 4.17 show the influence of paternal and maternal educational attainment on menarcheal age and menstrual characteristics. From the tables, parents' educational attainment have no significant influence in determining age at menarche, menstrual cycle and length of menstrual blood flow ($p > 0.05$).

Table 4.16: Menarcheal variables according to Father's level of education in menstruating adolescent girls

Parameters	None (n = 210) Mean ± SD	Primary (n = 78) Mean ± SD	Secondary (n = 194) Mean ± SD	Tertiary (n =188) Mean ± SD	*p*-value
Menarcheal age (yrs.)	14.00±0.90	14.00±1.10	13.80±0.90	14.00±0.90	0.18
Menstrual cycle (days)	28.40±2.80	28.20±2.90	28.30±2.90	28.10±2.90	0.78
Length of menstrual blood flow (days)	4.10±1.60	4.40±1.50	4.10±1.40	4.30±1.50	0.30

Table 4.17:Menarcheal variables according to mother's level of education in menstruating adolescentgirls (n= 670)

Parameters	None Mean±SD (n=187)	Primary Mean±SD (n=85)	Secondary Mean±SD (n=251)	Tertiary Mean±SD (n= 147)	P value
Menarcheal age (years)	14.00±1.00	14.20±1.10	13.90±0.90	14.00±0.90	0.1023
Menstrual cycle (days)	28.10±2.90	28.50±2.80	28.20±2.90	28.40±2.80	0.6962
Length of menstrual blood flow (days)	4.20±1.60	4.50±1.50	4.10±1.40	4.0±1.60	0.1414

4.6 INFLUENCE OF BIRTH ORDER ON THE MEASURED ANTHROPOMETRIC DIMENSIONS

The influence of birth order on the measured anthropometric variables among children arepresented on Table 4.18. Results from the table revealed that birth order has no significant influence on the measured anthropometric variables except for BMI and leg length among female children only. The *p*-value for the t-test is <0.05 for the difference in BMI and leg length among female children. Table 4.19 on the other hand presents results on the influence of birth order on anthropometric variables for adolescents from both sexes and on menstrual characteristics of the females. From the table, birth order has no significant influence on the anthropometric dimensions and menstrual characteristics except for weight and BMI in females only ($p < 0.05$).

Table 4.18: Anthropometric parameters according to birth order in children (n=1050)

Parameters	Females First borns Mean±SD (n=52)	Females Later borns Mean±SD (n= 472)	*p*-value	Males First borns Mean±SD (n=56)	Males Later borns Mean±SD (n=470)	*p*-value
Weight (kg)	29.49 ± 9.32	27.60±9.32	0.15	29.04±5.32	27.59 ±5.70	0.07
Height (cm)	126.40±6.70	124.70±7.90	0.13	126.40±2.15	125.10±8.50	0.29
BMI (kg/m²)	18.42 ± 2.77	17.45±2.65	0.01	18.08±2.15	17.55±2.52	0.13
Sitting Height (cm)	57.10 ±5.00	57.90±5.20	0.30	59.20±5.20	59.00±5.20	0.34
Leg length (cm)	69.10 ± 5.20	66.80±5.80	0.01	66.60±6.00	66.00±5.60	0.47

Table 4.19: Anthropometric parameters according to birth order inadolescents (n= 1440)

Parameters	Females First borns Mean±SD (n= 84)	Females Later borns Mean±SD (n= 752)	P value	Males First borns Mean±SD (n=51)	Males Later borns Mean±SD (n=553)	*P*-value
Weight (kg)	54.71±13.04	51.15±12.53	0.0140	47.44±15.49	47.36±12.36	0.9667
Height (cm)	151.80±11.40	150.10±11.40	0.1947	145.30±14.10	146.90±11.90	0.3751
BMI (kg/m²)	23.50±3.93	22.49±3.97	0.0269	21.84±4.02	21.65±3.61	0.7260
Sitting height (cm)	68.60±7.00	68.20±6.40	0.5658	68.80±6.80	68.90±6.50	0.8607
Leg length (cm)	83.10±7.10	81.90±7.70	0.1626	76.30±8.30	77.90±6.90	0.1223
Menarcheal age (years)	14.00±1.00	14.00±0.90	0.9678	-	-	-
Menstrual cycle (days)	28.70±2.80	28.20±2.90	0.1350	-	-	-
Length of menstrual blood flow (days)	4.00±1.30	4.20±1.50	0.2199	-	--	-

4.7 PEARSON CORRELATION MATRIXES

Results in Table 4.20 show the relationship between birth weight, birth order and anthropometric variables for the overall subjects. From the table, birth weight have inverse relationship with the other variables except birth order. However, these relationships are not significant ($p > 0.05$). Birth order on the other hand indicate inverse significant relationship with the other variables ($p < 0.01$). The table also revealed that age, weight, height, BMI, sitting height and leg length showed positive significant correlation at $p <0.01$.

Table 4.21 showsthe relationship between anthropometric variables, menarcheal age and menstrual characteristics. From the table, birth weight showed significant positive relationship with menarcheal age only ($p <0.05$). Menstrual cycle did not show any significant relationship with any of the other variables ($p >0.05$). Length of menstrual blood flow showed significant positive relationship with birth order, weight, height, and BMI ($p <0.01$). It showed an inverse relationship with sitting height ($p <0.01$). No significant correlation was observed between length of menstrual blood flow with age, leg length, menarcheal age and menstrual cycle ($p>0.05$).

The relationship between anthropometric variables with birth weight and birth order are shown on Table 4.22. Birth weight showed inverse relationship with all other variables, except that these correlations are not significant ($p>0.05$). All other variable however showed significant inverse or positive relationship at $p<0.01$.

Table 4.23 presents is the Pearson's correlation matrix of non-menstruating girls. From the table, birth weight did not showed significant correlation with other variables ($p >0.05$). Birth order on the other hand showed significant inverse relationship with age, weight, height, BMI, and sitting height ($p < 0.05$) but no significant relationship with leg length ($p > 0.05$). All the other variables indicated positive significant correlations ($p < 0.01$).

Table 4.20: Correlation of anthropometric parameters for both sexes

	BW	BO	AGE	WT	HT	BMI	SH	LL
BW	-							
BO	0.057	-						
AGE	-0.019	-0.142[a]	-					
WT	-0.117	-0.211[a]	0.835[a]	-				
HT	-0.196	-0.163[a]	0.837[a]	0.881[a]	-			
BMI	-0.150	-0.225[a]	0.644[a]	0.860[a]	0.542[a]	-		
SH	-0.261	-0.155[a]	0.705[a]	0.775[a]	0.878[a]	0.481[a]	-	
LL	-0.097	-0.141[a]	0.789[a]	0.806[a]	0.915[a]	**0.**493[a]	0.620[a]	-

a: $p<0.001$
BW: Birth weight (kg), BO: Birth order, WT: Weight (kg), HT: Height (cm),
BMI: Body mass index (kg/m²), SH: Sitting height (cm), LL: Leg length

Table 4.21: Correlation of anthropometric parameters in menstruating girls

	BW	BO	AGE	WT	HT	BMI	SH	LL	MA	MC	LMF
BW	-										
BO	0.208	-									
AGE	0.204	0.080[b]	-								
WT	0.369	0.241[a]	0.472[a]	-							
HT	0.098	0.097[b]	0.420[a]	0.578[a]	-						
BMI	0.099	0.221[a]	0.289[a]	0.811[a]	0.016	-					
SH	0.265	0.063	0.249[a]	0.415[a]	0.711[a]	0.019	-				
LL	0.085	0.074	0.358[a]	0.430[a]	0.743[a]	0.010	0.067	-			
MA	0.772[b]	0.091[b]	0.488[a]	0.212[a]	0.173[a]	0.133[a]	-0.016	-0.259[a]	-		
MC	0.461	0.031	0.061	0.012	0.063	0.055	0.041	0.043	0.072	-	
LMF	0.722	0137[a]	0.005	0.231[a]	0.131[a]	0.180[a]	-0.135[a]	-0.060	0.037	0.044	-

a:$p < 0.001$, b: $p <0.05$

BW: Birth weight (kg), BO: Birth order, WT: Weight (kg)

HT: Height (cm), BMI: Body mass index (kg/m²), SH: Sitting height (cm)

LL: Leg length (cm MA: Menarcheal age, MC:Menstrual cycle, LMF: Length of menstrual blood flow

Table 4.22:Correlation of Anthropometric parameters in males

	BW	BO	AGE	WT	HT	BMI	SH	LL
BW	-							
BO	-0.047	-						
AGE	-0.119	-0.090 [a]	-					
WT	-0.264	-0.144 [a]	0.813 [a]	-				
HT	-0.278	-0.126 [a]	0.812 [a]	0.887 [a]	-			
BMI	-0.261	-0.150 [a]	0.623 [a]	0.849 [a]	0.538 [a]	-		
SH	-0.311	-0.129 [a]	0.717 [a]	0.815 [a]	0.907 [a]	0.503 [a]	-	
LL	-0.211	-0.103 [a]	0.770 [a]	0.814 [a]	0.927 [a]	0.487 [a]	0.683 [a]	-

a: $p < 0.001$

BW: Birth weight (kg), BO: Birth order, WT: Weight (kg)
HT: Height (cm), BMI: Body mass index (kg/m²), SH: Sitting height (cm)
LL: Leg length (cm)

Table 4.23: Correlation of Anthropometric parameters of non-menstruating girls

	BW	BO	AGE	WT	HT	BMI	SH	LL
BW	-							
BO	0.110	-						
AGE	0.230	-0.096[b]	-					
WT	0.110	-0.212[a]	0.634[a]	-				
HT	0.022	-0.110[a]	0.597[a]	0.744[a]	-			
BMI	0.088	-0.247[a]	0.411[a]	0.798[a]	0.220[a]	-		
SH	-0.096	-0.114[a]	0.431[a]	0.625[a]	0.782[a]	0.245[a]	-	
LL	0.116	-0.072	0.496[a]	0.559[a]	0.800[a]	0.114[a]	0.308[a]	-

a: $p < 0.001$; b: $p < 0.05$

BW: Birth weight (kg), BO: Birth order, WT: Weight (kg)
HT: Height (cm), BMI: Body mass index (kg/m^2), SH: Sitting height (cm)
LL: Leg length (cm)

4.8 LINEAR REGRESSION MODELS

Tables 4.25 and 4.26 are the linear regression models for predicting height using various independent variables for female and male subjects. From the table, leg length is a better predictor of height due to its high coefficient of determination (R^2 = 0.829) for females and (R^2 = 0.858) for males.

Table 4.24 Linear regression of Height from Anthropometric parameters in females

Parameters	Predictive equation	R	R^2	SEE	P value
AGE	94.20 + (3.553 × AGE)	0.851	0.725	0.81	<0.0001
Weight	102.87 + (0.890 × WT)	0.873	0.763	0.61	<0.0001
BMI	99.28 + (1.995 × BMI)	0.536	0.287	1.80	<0.0001
Sitting height	26.71 + (1.772 × SH)	0.869	0.756	1.77	<0.0001
Leg length	30.37 + (1.444 × LL)	0.911	0.829	1.37	<0.0001

HT; height, BMI; body mass index, WT; weight, SH; sitting height, LL; leg length, SEE standard error of the estimate, R; correlation coefficient; R^2; coefficient of determination.

Table 4.25: Linear regression of Height from anthropometric parameters in males

Parameters	Predictive equation	R	R^2	SEE	P value
AGE	HT = 96.41+ (3.346 × AGE)	0.812	0.660	0.90	<0.0001
Weight	HT = 100.19 + (0.95 × WT)	0.887	0.787	0.60	<0.0001
BMI	HT = 93.93 + (2.16 × BMI)	0.538	0.289	2.03	<0.0001
Sitting height	HT = 23.14 + (1.765 × SH)	0.907	0.822	1.58	<0.0001
Leg length	HT = 20.29 + (1.609 × LL)	0.927	0.858	1.42	<0.0001

HT; height, BMI; body mass index, WT; weight, SH; sitting height, LL; leg length, SEE standard error of the estimate, R; correlation coefficient; R^2; coefficient of determination.

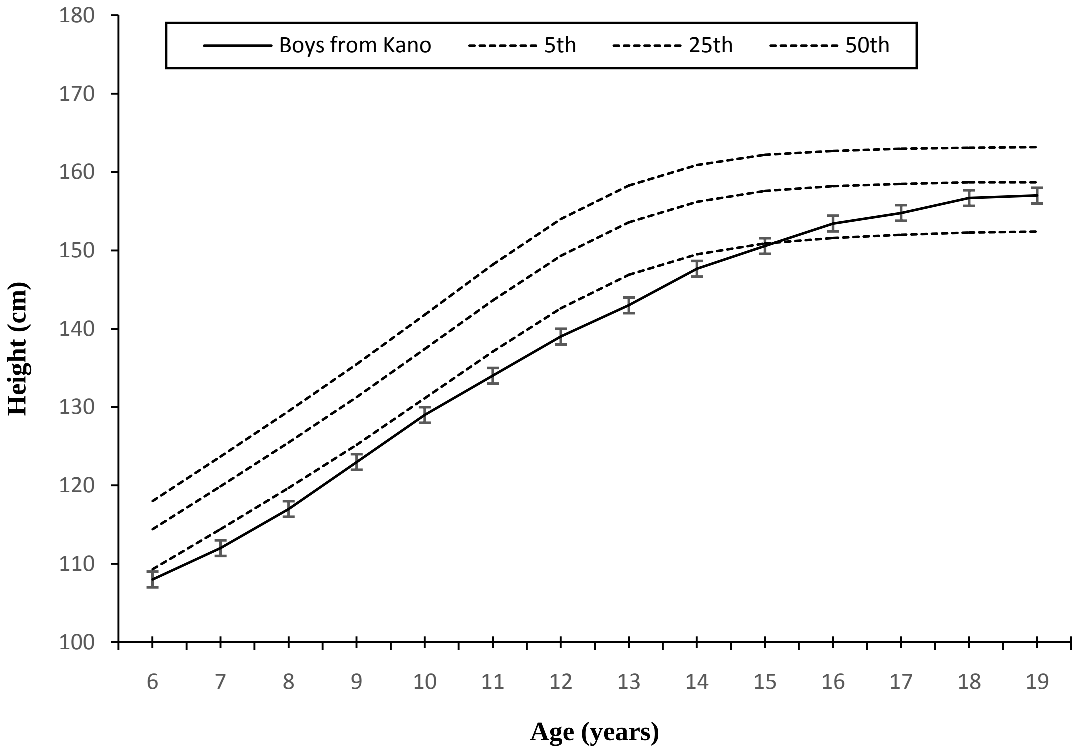

Fig. 4.1: Height percentile in males

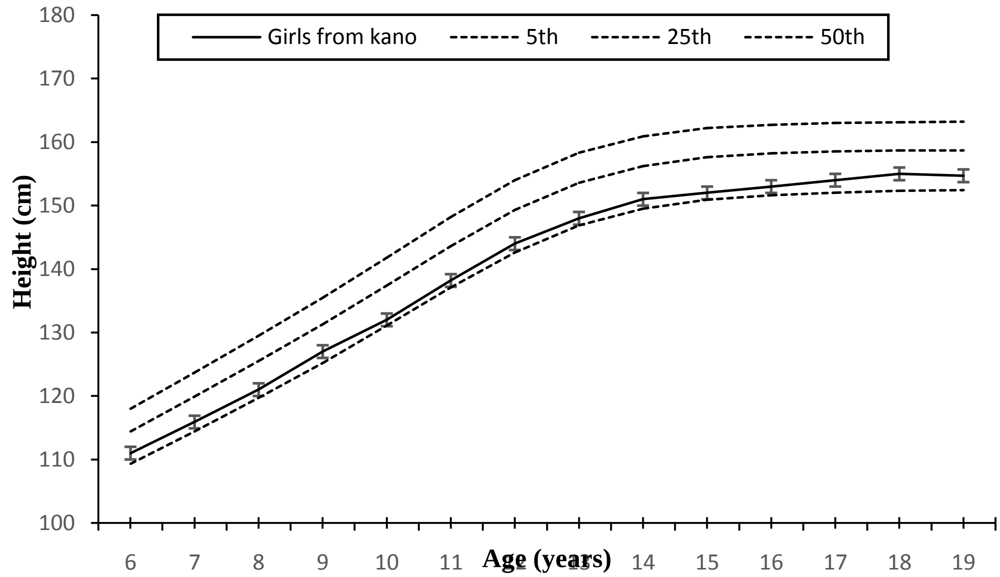

Fig. 4.2: Height percentile in females

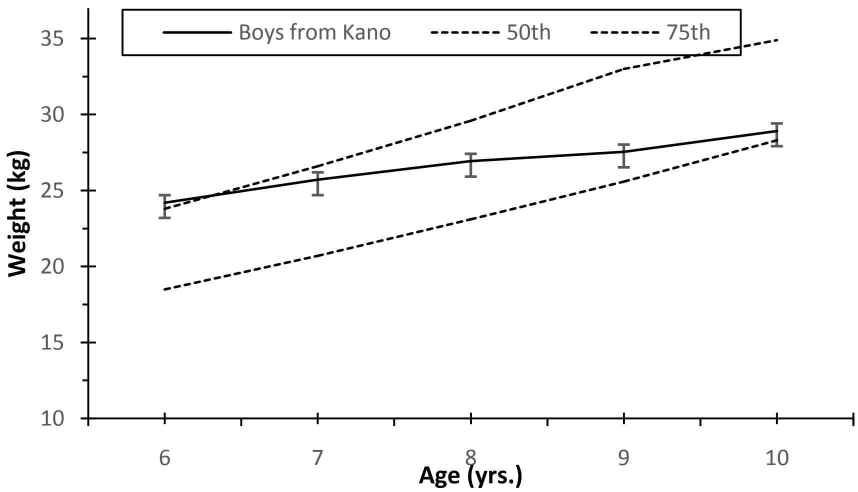

Fig. 4.3: weight percentile in males

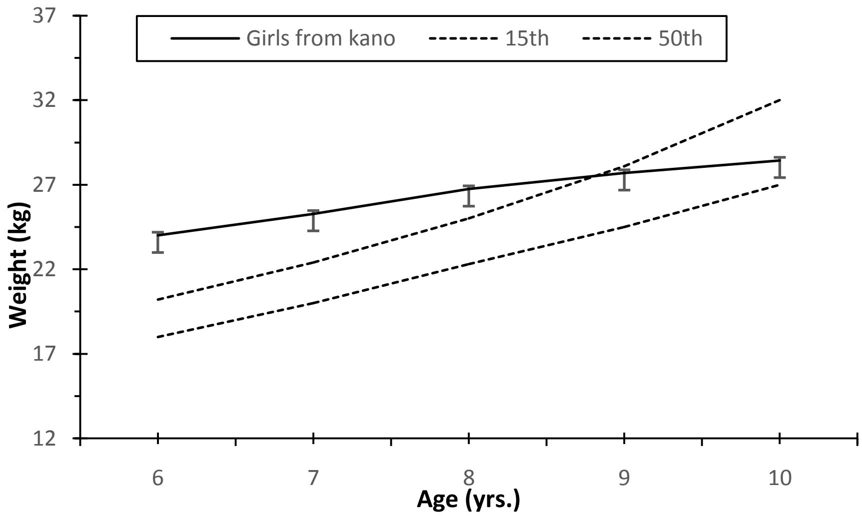

Fig. 4.4: weight percentile females

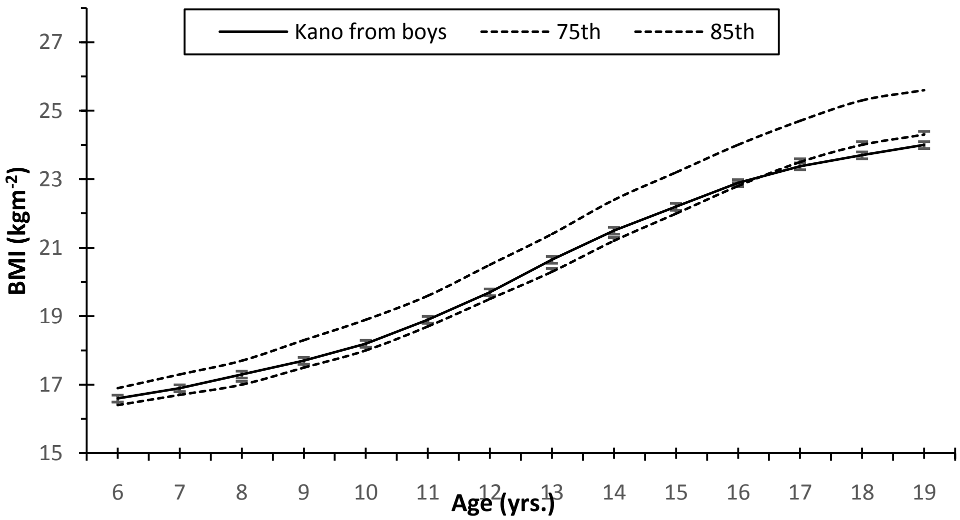

Fig 4.5: BMI percentile in males

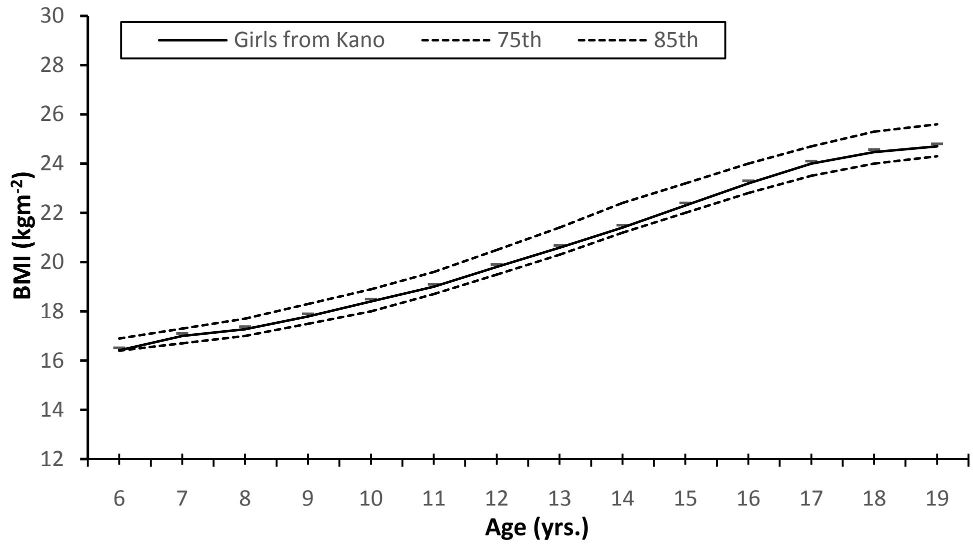

Fig 4.6: BMI percentile in females

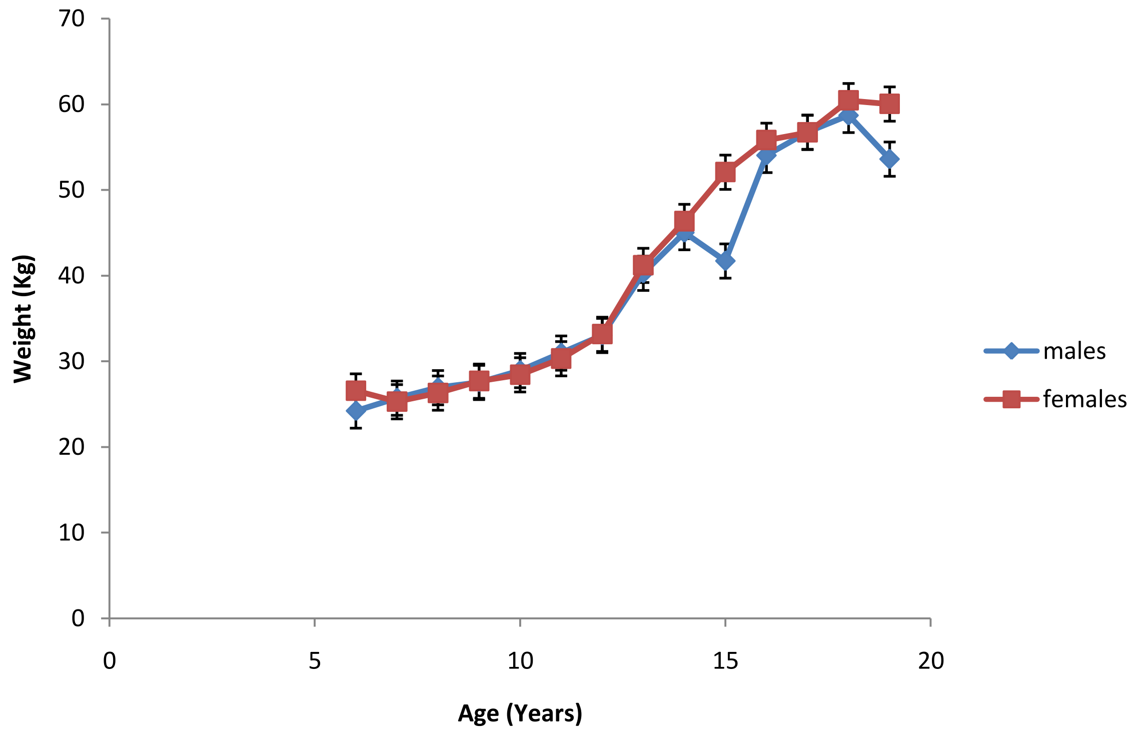

Figure 4.7: graph of weight (kg) against age (years)

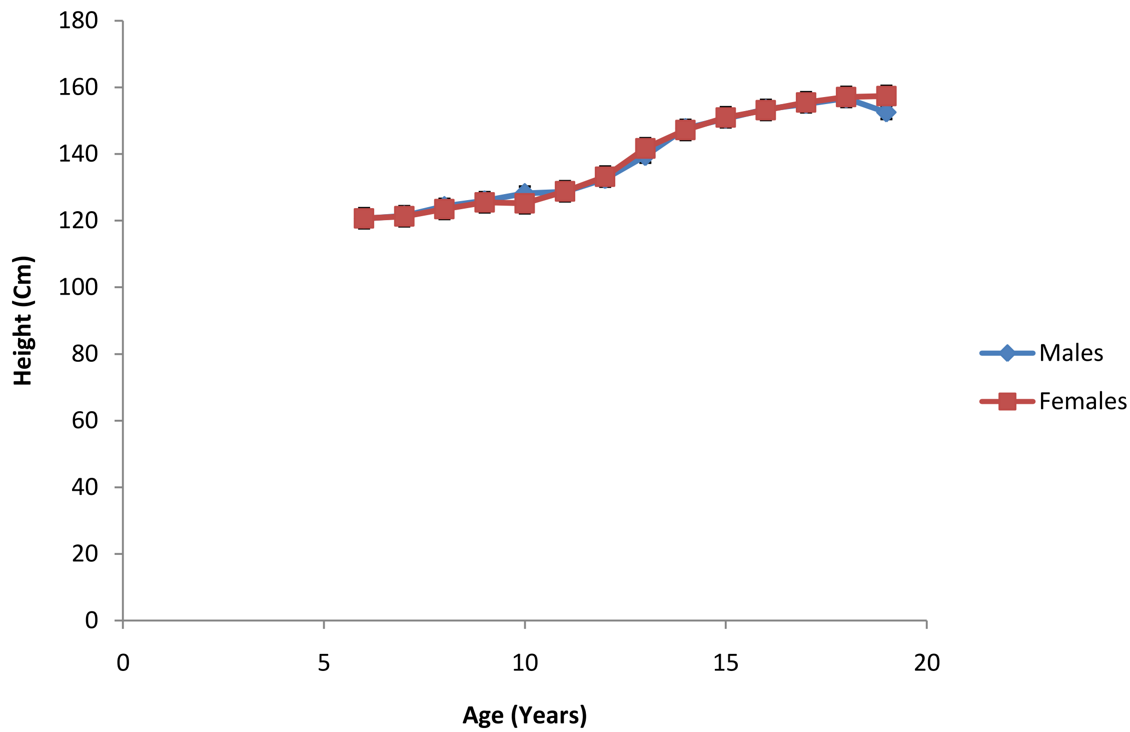

Figure 4.8: graph of height (cm) against age (years)

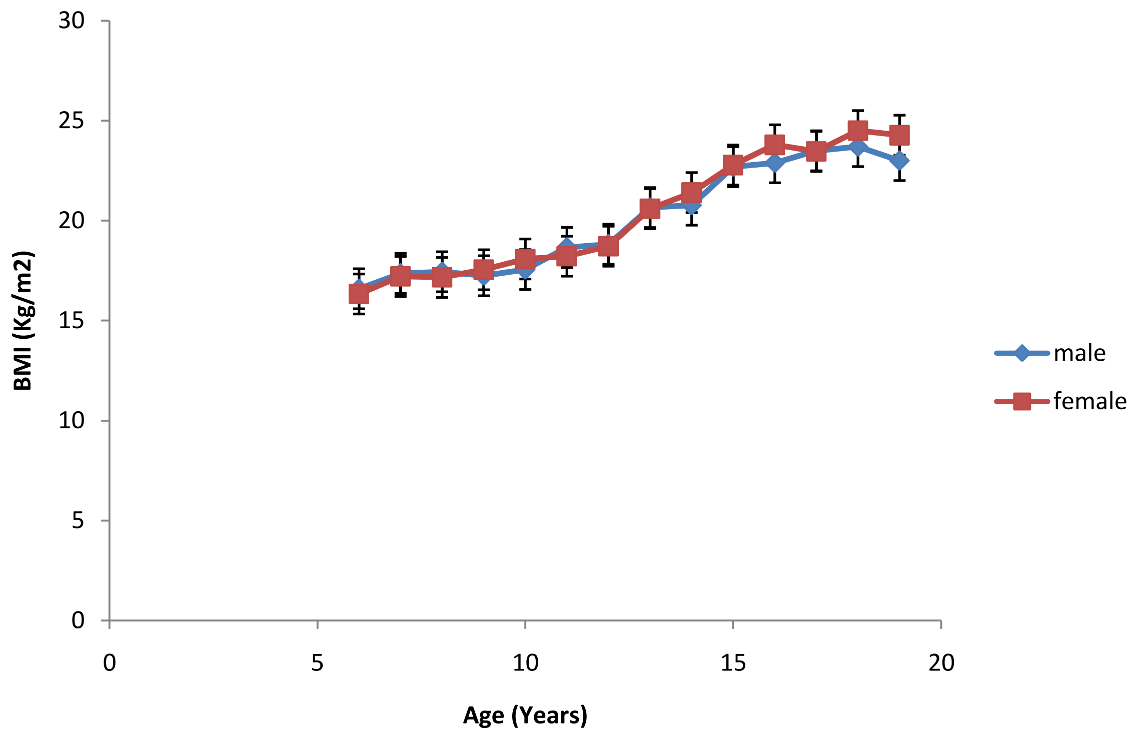

Figure 4.9: graph of BMI (kg/m^2) against age (years)

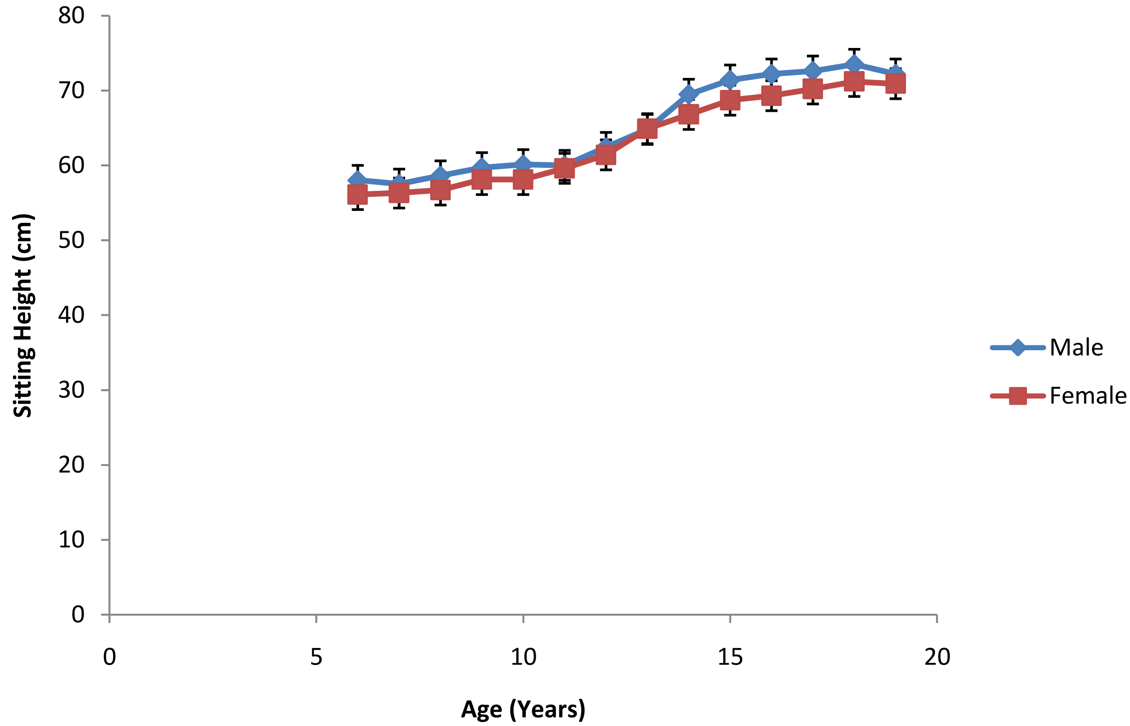

Figure 4.10: graph of sitting height (cm) against age (years)

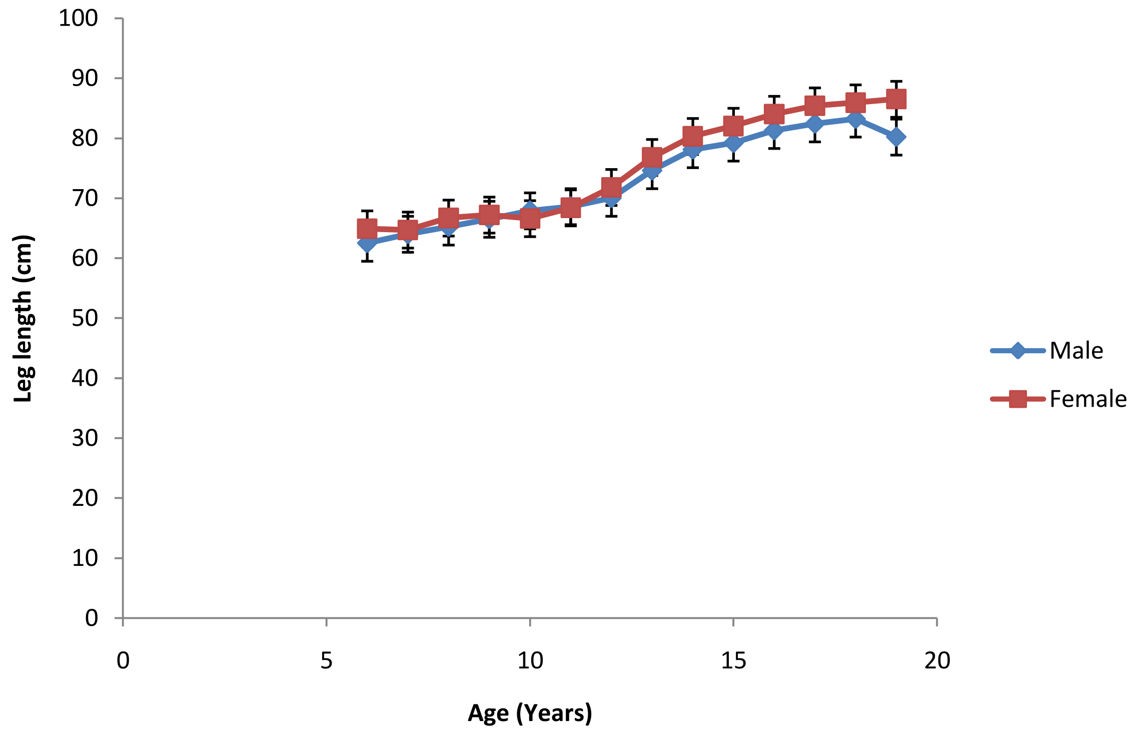

Figure 4.11: graph of leg length (cm) against age (years)

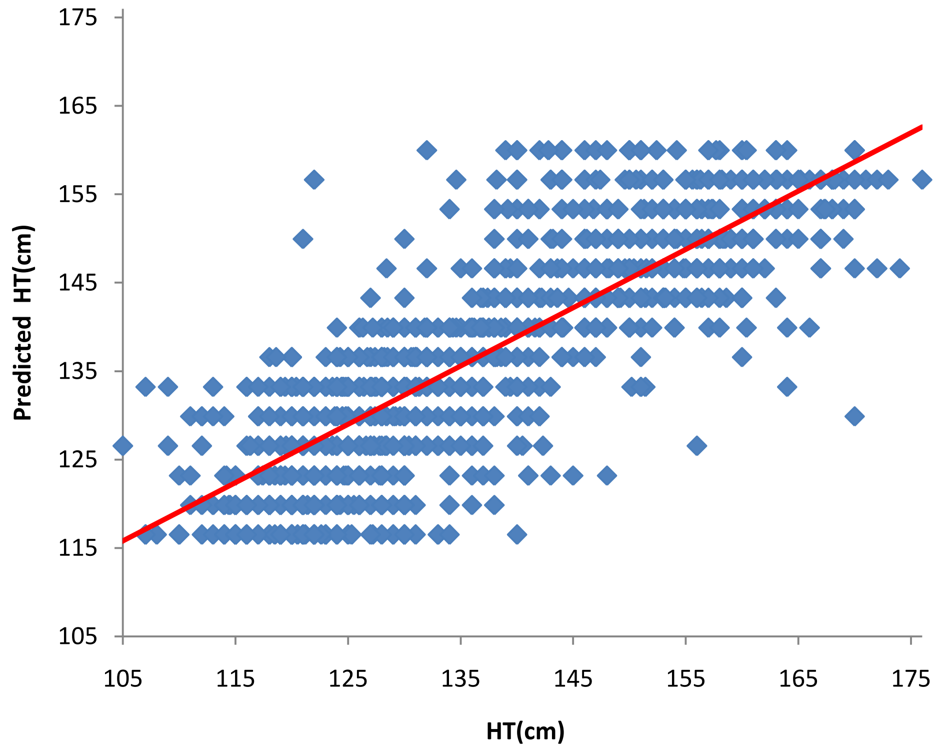

Figure4.12 :Scatter plot of predicted height (cm) against real height (cm) using age (years) in males

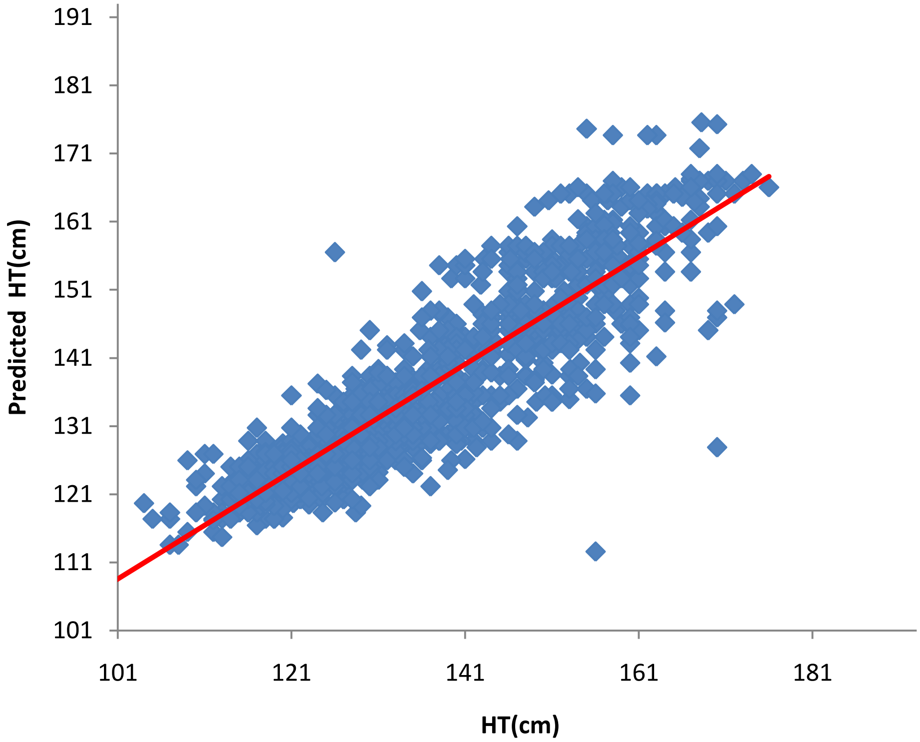

Figure 4.13: Scatter plot of predicted height (cm) against real height (cm) using weight (kg) in males

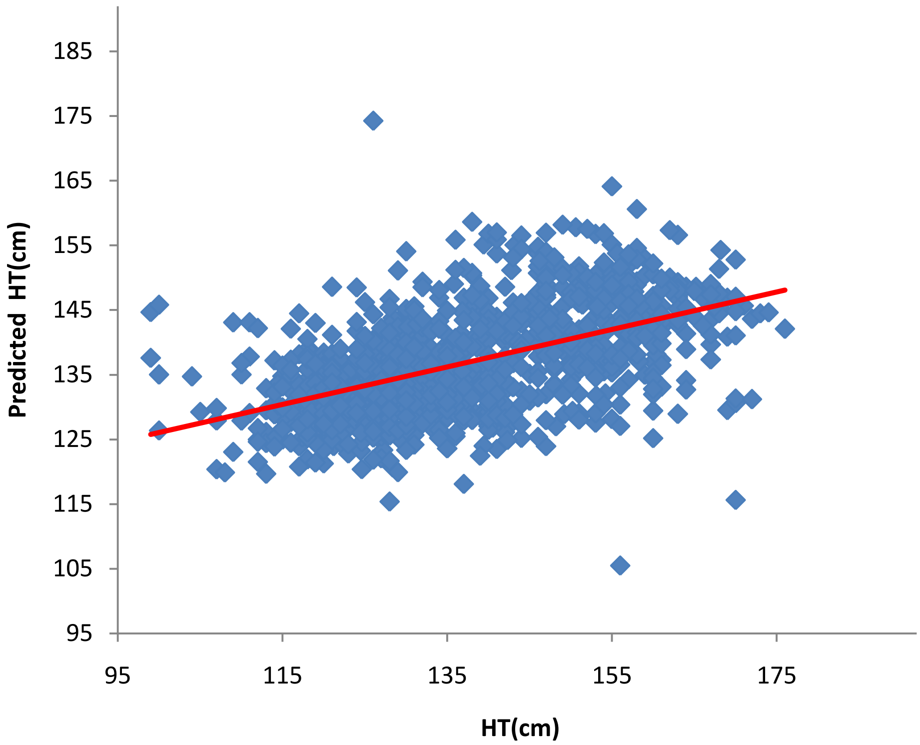

Figure 4.14: Scatter plot of predicted height (cm) against real height (cm) using BMI (kg/m^2) in males

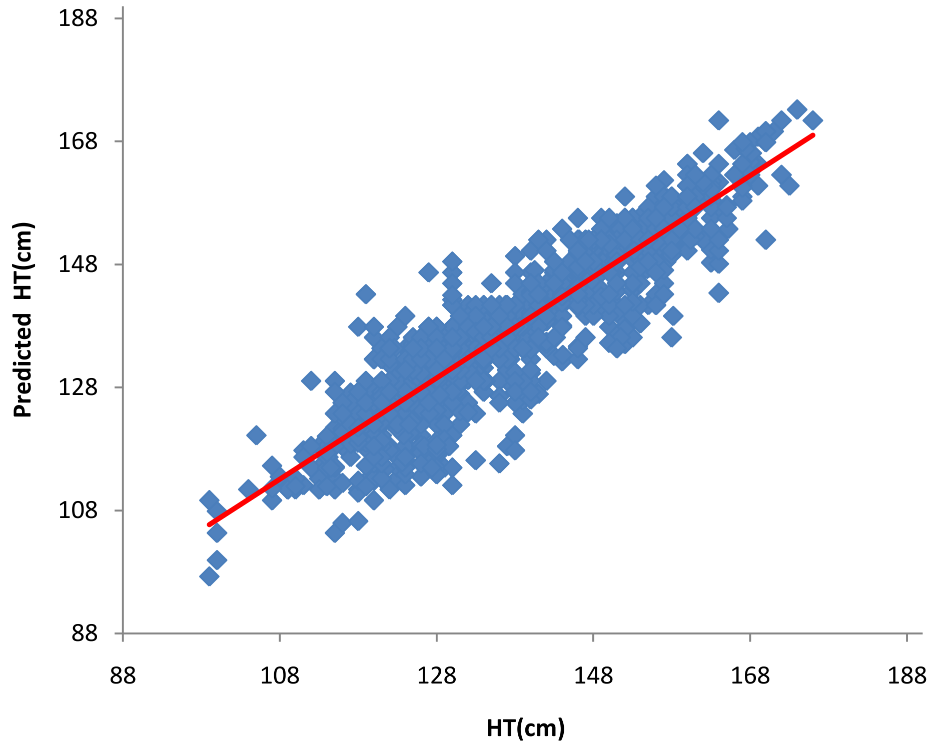

Figure 4.15: Scatter plot of predicted height (cm) against real height (cm) using sitting height (cm) in males

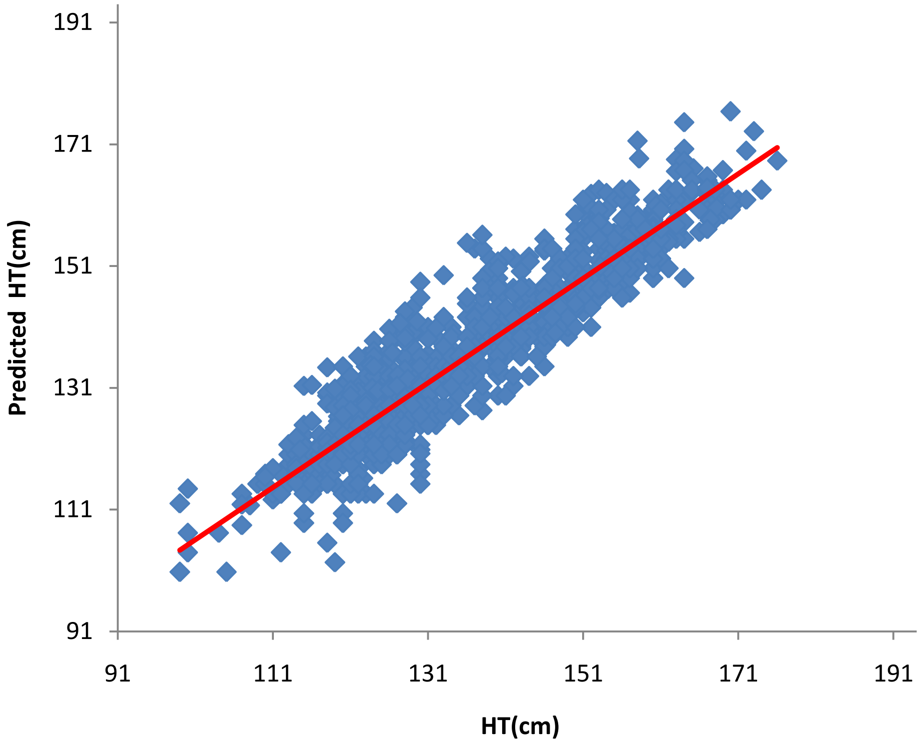

Figure 4.16: Scatter plot of predicted height (cm) against real height (cm) using leg length (cm) in males

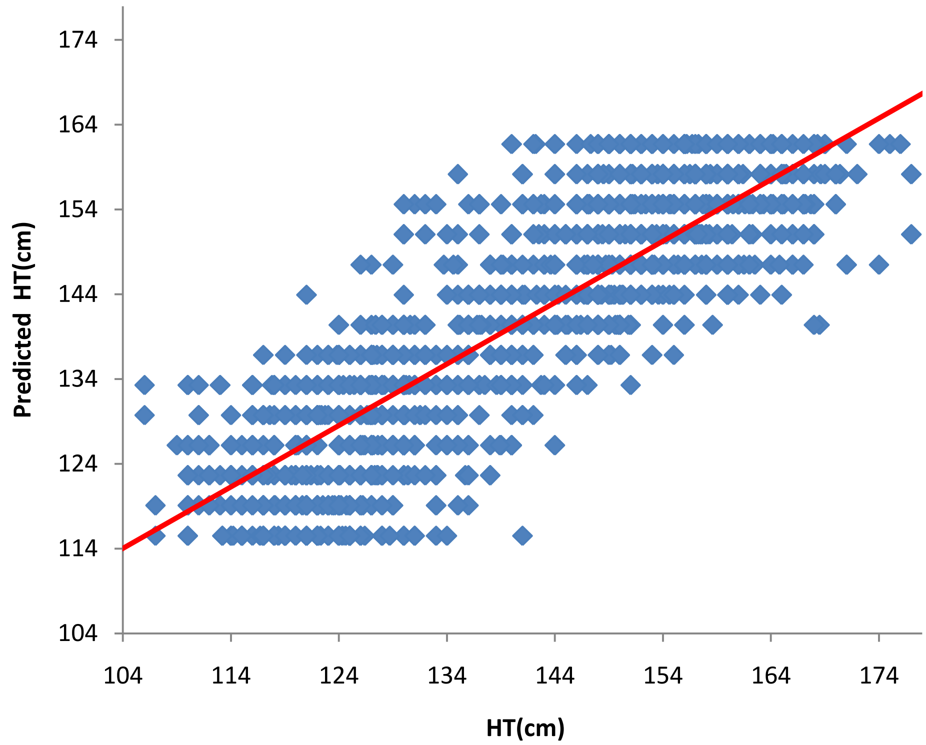

Figure 4.17: Scatter plot of predicted height (cm) against real height (cm) using age (years) in females

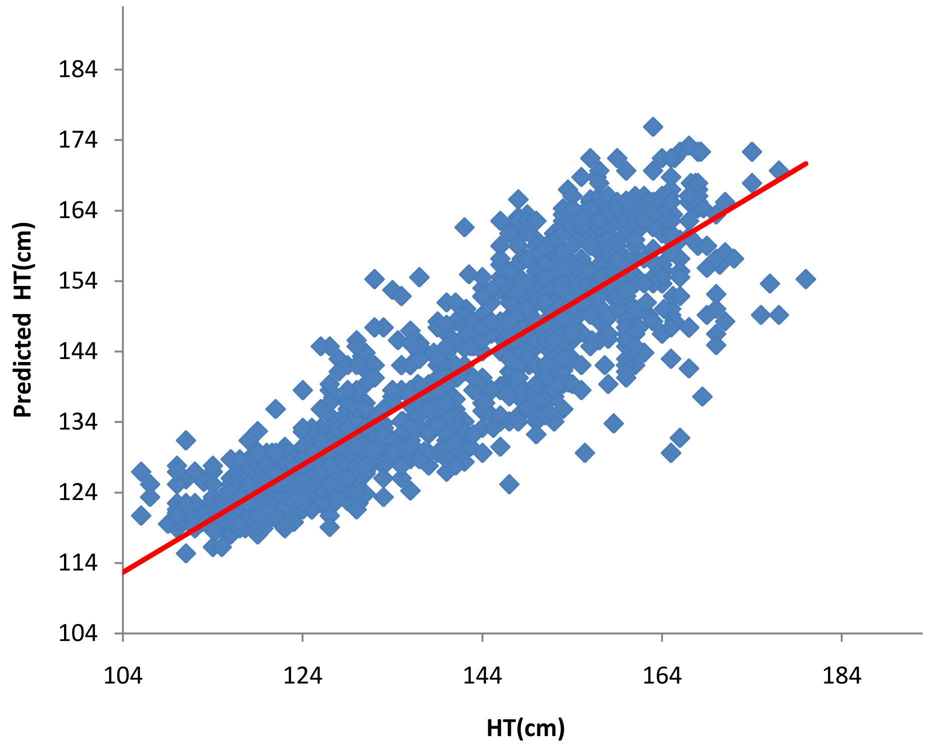

Figure 4.18: Scatter plot of predicted height (cm) against real height (cm) using weight (kg) in females

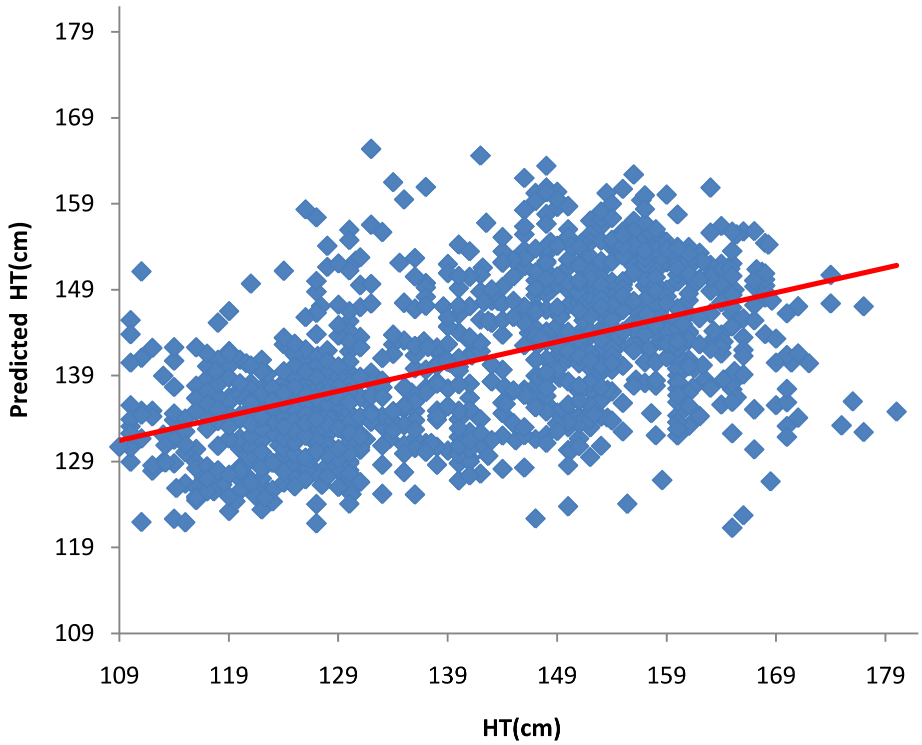

Figure 4.19: Scatter plot of predicted height (cm) against real height (cm) using BMI (kg/m²) in females

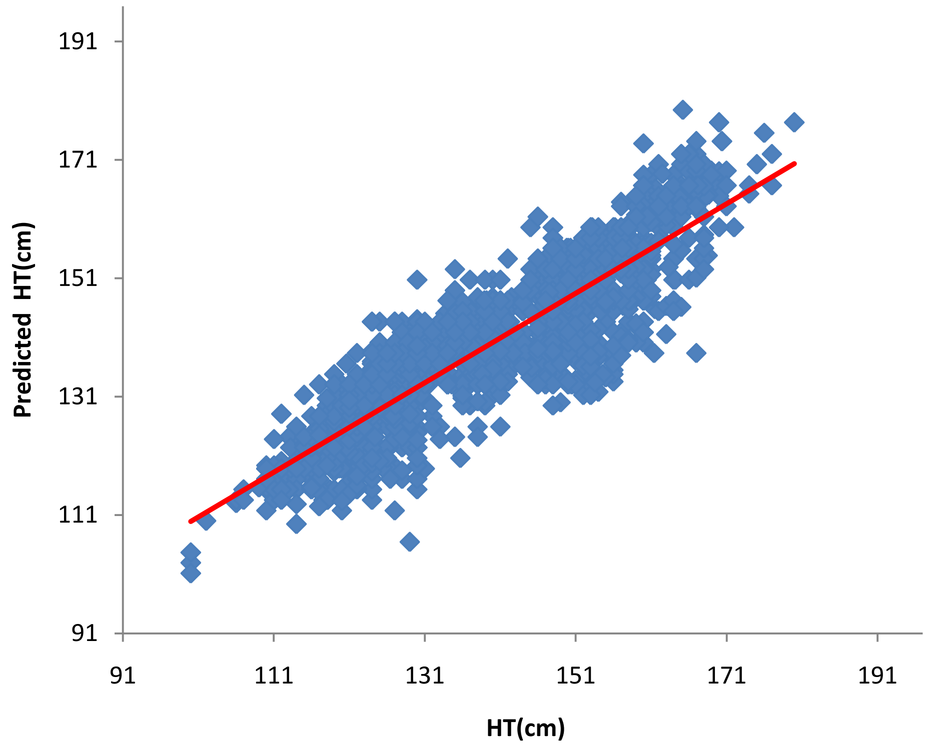

Figure 4.20: Scatter plot of predicted height (cm) against real height (cm) using sitting height (cm) in females

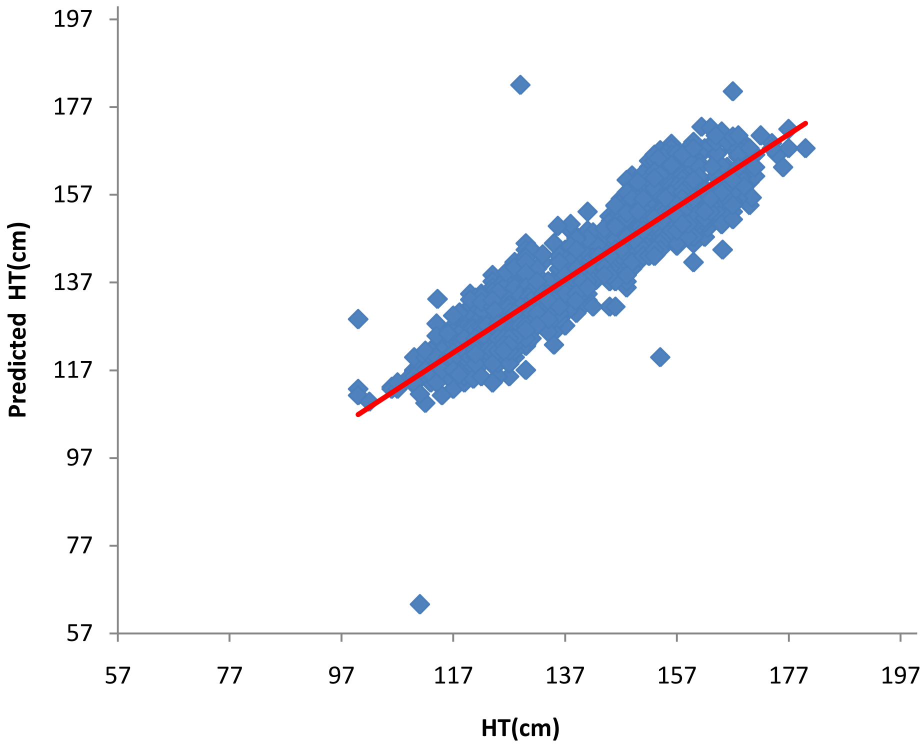

Figure 4.21:Scatter plot of predicted height (cm) against real height (cm) using leg length (cm) in females

CHAPTER FIVE

5.0 DISCUSSION

Height growth spurt for Hausas in this research was found to be between the ages of twelve and thirteen (12 and 13) years for both sexes .This partly agreed with (Bogin, 2010), who reported a growth spurt at an average of twelve (12) years and ten (10) years for boys and girls respectively. However, our findings disagreed with findings of (Steinberg, 2008), who reported that males have their growth spurt two (2) years later than males. Leg length growth spurt for the two sexes was found to be also between the age of twelve and thirteen years which proceed with females having longer legs.

Male children up to age of ten (10) and females up to the age of eleven (11) in this research work were found to be of BMI<18.50 kg/m² (underweight, WHO). While adolescents of both sexes were found to be averagely of BMI between 18.50 and 29.90 kg/m², normal weight, (WHO, 2000). Prevalence of obesity was not found on the average. BMI was found to be progressively increasing with age with female adolescents significantly having higher BMI than their male counterparts. This supported the findings of (Ansa *et al*., 2001) who conducted a research on BMI profile in Calabar, Nigeria, and that of (Perrissinotto, *et al*., 2002). Hausa females, particularly adolescents lived a sedentary life style compared to their male counterparts. This could explain the higher BMI in female adolescents.

Female Children and adolescents were found to be significantly of loner legs than their male counterparts, thiswas not unconnected with the fact that females of the study area and population were not subjected to stress as compared to their male counterparts. These findings could readily be married with that of (Gunnell*et al*., 1998) that leg length is the component of height most sensitive to environmental circumstances. This also supported sexual dimorphism in anthropometry. (Radu and Lulia, 2009).

Parental level of education (particularly maternal) was found to have a significant effect on the growth of children. Children whose parents were ofhigher educational level were found to be significantly better in terms of the anthropometric parameters than those of parents with secondary, primary and none educational level. This agrees with findings of (Michell, 2010) and that of (Alderman *et al.*, 2004) but disagrees with findings of (Uthman, 2009) which revealed that monetary wealth alone was the most prevalent contributing factor for nutrition and growth with maternal education playing a lesser role.

Mean menarcheal age was found to be 14.0 years which is higher than that of (Goon *et al*., 2010) who found the mean menarcheal age in Wannune Benue state of Nigeria to be 13.02 years and also higher than that of urban school girls in port Harcourt which was found to be 13.19 years but lower than that of urban and rural secondary school girls in Rivers state, Nigeria, which was observed to be 14.22 years, (Ikaraoha*et al*., 2005). The meanmenarcheal age obtained in this research would have been lower if it were for the urban school girls alone. However, the research did not demarcate urban girls from rural ones. Mean menstrual blood flow was observed to be 4.20 days which wasslightly higher than that obtained by (Ali *et al*., 2011) in School girls in Kassala eastern Sudan, who found it to be 4.00 days

This study revealed significantly, that women who reached menarche at later age tend to be taller than those with early menarcheal age (positive correlation between menarcheal age and height. This is in conformity with findings of (Georgiadis et al., 1997) and (Helm et al., 1995).

Anthropometric parameters were correlated with one another. Some correlated positively with one another while some correlated negatively with one another. Positive correlation between two anthropometric parameters means as one parameter increase in value the other one also increases simultaneously. On the other hand negative correlation between anthropometric parameters means as one parameter increases in value the other one decreases simultaneously and vice-versa.

The study anthropometric parameters were found significantly and positively correlate with age in both sexes. However, for the menarcheal variables (menarcheal age, menstrual cycle and length of menstrual blood flow) in menstruating female adolescents, only menarcheal age was found to correlate significantly with age.

Linear regression equations were formulated from the anthropometric parameters of this research work for the prediction of human stature among Hausa children and adolescents in Kano state.

Anthropometric parameters in this research work were related to birth order of the study population. All parameters of first borns were higher than those of later born individuals.

This agreed with findings of (Jonathan *et al*., 2011). However, only BMI and leg length in female children and BMI and weight in female adolescents showed statistically significant values.

CHAPTER SIX

6.0 Summary, Conclusion and Recommendation

6.1 Summary

The study population could be described as following a normal pattern of growth with normal progressive increase in the anthropometric parameters with regards to age. Females were on the average having higher values of anthropometric parameters especially at adolescence (except sitting height). Growth spurts particularly of stature among the study population were established.

Level of weight in accordance with the WHO BMI classification (under weight, normal weight, over weight and obese) was established among Hausa children and adolescents in the Kano state with children on the average falling within the under weight category and adolescents within the normal range. Relationships of both BMI and other anthropometric parameters with parental level of education and birth order were established. Likewise correlations of the anthropometric parameters were developed.

The minimummenarcheal age (12) years, maximum menarcheal age (17) years and mean menarcheal age (14) years of the menstruating Hausagirls were found. Means of menstrual cycle (days) and that of the length of menstrual blood flow (days) were found to be within the normal physiological range.

Linear regression equations for prediction of stature using other anthropometric parameters in both children and adolescents were established.

6.2 CONCLUSION

Height growth spurt of Hausa children and adolescents 6-19 years from Kano state is between the ages of 12years and 13 years for both sexes. Children were observed to be underweight while adolescents were observed to have normal weights

Stature of Hausa children and adolescents from Kano state can be predicted if the age, weight, BMI, sitting height or leg length is known using the linear regression equation established in the research work

Mean menarcheal age of Hausa menstruating girls from Kano state is 14.00 years, mean menstrual cycle is 28.30 days and mean length of menstrual blood flow is 4.20 days

Parental level of education and birth order of Hausa children and adolescents 12-19 years from Kano state correlate positively with the measured parameters, also all the measured parameters correlate with each other.

6.3 Recommendation

From the foregoing it is recommended that:

i. The government of Kano state and other well-meaning appropriate bodies should come up with a concrete programme that would be mainly concerned with child nutrition empowerment

ii. Mothers should receive adequate and solid knowledge on child care and proper handling

iii. Similar but broader research that would in addition to our parameters take into consideration, parental level of income, number of people in the house, social amenities available, type of settlement e.t.c be conducted

iv. Child record like birth weight, mortality and other related records be kept and made available to researchers on request with a view to describing growth pattern and provide solutions to growth problems

v. Researchers put hands together in elucidating the mechanism as to how birth order and parental level of education affect growth with a view to enhancing growth and development of children and adolescents

vi The use of equations derived in this project with a view to finding BMI of children and adolescents particularly those with lower limb deformity without demanding any sophistications

vii.This project should serve as a reference point to anthropologist, clinicians and researchers.

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APPENDIX I

Table 4.2: Weight (kg) of both males and females according to age (n=2490)

Age (yrs)	Weight (Kg)				t value	p value
	n	Males Means ± SD	n	Females Means ± SD		
6	64	24.21 ± 4.28	62	26.55 ± 21.29	0.86	0.39
7	97	25.710 ± 4.11	71	25.29 ± 4.38	-0.64	0.52
8	80	26.93 ± 5.74	87	26.30 ± 5.34	-0.73	0.47
9	82	27.54 ± 5.05	96	27.69 ± 5.34	0.19	0.85
10	73	28.93 ± 5.80	68	28.43 ± 5.45	-0.53	0.60
11	130	30.97 ± 5.79	140	30.31 ± 5.79	-0.95	0.35
12	104	33.02 ± 5.88	96	33.16 ± 5.65	0.16	0.87
13	109	40.28 ± 7.60	79	41.20 ± 9.06	0.76	0.45
14	74	45.02 ± 7.41	83	46.33 ± 8.74	1.01	0.31
15	69	41.71 ± 10.43	117	52.07 ± 10.38	0.23	0.82
16	80	54.03 ± 9.05	113	55.80 ± 8.86	1.35	0.18
17	74	56.75 ± 10.35	168	56.71 ± 9.70	-0.02	0.98
18	64	58.70 ± 12.82	114	60.43 ± 9.51	1.02	0.31
19	30	53.60 ± 9.23	66	60.03 ± 10.09	2.97	0.0038

APPENDIX II

Table 4.3: Height (cm) of both males and females according to age. (n=2490)

Age (yrs)	Height (cm)				t value	p value
	n	Mean ± SD	N	Mean ± SD		
6	64	120.60 ± 7.50	62	120.7 ± 7.40	0.05	0.96
7	97	121.50 ± 7.00	71	121.30 ± 6.00	-0.17	0.87
8	80	124.30 ± 6.80	87	123.50 ± 6.80	-0.63	0.53
9	82	126.00 ± 7.50	96	125.50 ± 7.90	-0.45	0.65
10	73	128.20 ± 8.90	68	125.20 ± 7.20	-2.16	0.03
11	130	128.70 ± 8.20	140	128.80 ± 7.70	0.15	0.88
12	104	132.50 ± 7.20	96	133.20 ± 8.40	0.63	0.53
13	109	139.40 ± 8.10	79	141.70 ± 9.30	1.81	0.07
14	74	147.70 ± 7.70	83	147.20 ± 8.00	-0.39	0.70
15	69	150.60 ± 9.40	117	151.00 ± 8.70	0.28	0.78
16	80	153.40 ± 8.20	113	153.20 ± 8.30	-0.21	0.83
17	74	155.00 ± 8.90	168	155.50 ± 8.50	0.47	0.64
18	64	156.70 ± 10.60	114	157.10 ± 8.40	0.32	0.75
19	30	152.50 ± 9.90	66	157.40 ± 8.30	2.53	0.01

APPENDIX III

Table 4.4: BMI (kg/m²) of both males and females according to age (n=2490)

Age (yrs)	n	BMI (Kg/m²) Male Mean ± SD	N	BMI (Kg/m²) Female Mean ± SD	t value	p value
6	64	16.59 ± 2.34	62	16.33 ± 2.33	-0.61	0.54
7	97	17.36 ± 1.97	71	17.21 ± 2.54	-0.41	0.68
8	80	17.44 ± 2.63	87	17.16 ± 2.35	-0.72	0.47
9	82	17.24 ± 2.09	96	17.54 ± 2.65	0.85	0.40
10	73	17.55 ± 2.86	68	18.08 ± 3.00	1.08	0.28
11	130	18.66 ± 2.50	140	18.22± 2.70	-1.37	0.17
12	104	18.82 ± 3.16	96	18.72 ± 2.87	-0.23	0.82
13	109	20.65 ± 3.02	79	20.59 ± 3.87	-0.11	0.91
14	74	20.77 ± 3.12	83	21.40 ± 3.84	1.13	0.26
15	69	22.69 ± 3.38	117	22.78 ± 3.78	0.16	0.88
16	80	22.89 ± 3.33	113	23.79 ± 3.04	1.95	0.05
17	74	23.49 ± 3.15	168	23.46 ± 3.60	-0.05	0.96
18	64	23.70 ± 3.70	114	24.50 ± 3.69	1.39	0.17
19	30	23.00 ± 3.05	66	24.27 ± 3.67	1.61	0.11

APPENDIX IV

Table 4.5: Sitting height (cm) of both males and females according to age (n=2490)

Age (yrs)		Sitting Height (cm)		Sitting Height(cm)	t value	p value
		Male		Female		
	n	Mean ± SD	n	Mean ± SD		
6	64	58.00 ± 5.30	62	56.10 ± 5.30	-2.01	0.05
7	97	57.50 ± 5.10	71	56.30 ± 5.00	-1.45	0.15
8	80	58.60 ± 5.70	87	56.70 ± 4.60	-2.35	0.02
9	82	59.70 ± 4.30	96	58.10 ± 5.40	-2.06	0.04
10	73	60.10 ± 5.50	68	58.10 ± 5.20	-2.21	0.03
11	130	60.00 ± 5.10	140	59.60 ± 4.80	-0.67	0.51
12	104	62.40 ± 4.30	96	61.40 ± 4.90	-1.63	0.11
13	109	64.80 ± 4.90	79	64.90 ± 5.50	0.20	0.84
14	74	69.50 ± 4.80	83	66.80 ± 4.70	-3.54	0.0005
15	69	71.40 ± 5.20	117	68.70 ± 5.30	-3.28	0.01
16	80	72.20 ± 4.48	113	69.3 ± 5.30	-3.84	0.0002
17	74	72.60 ± 5.20	168	70.20 ± 6.40	-2.90	0.0041
18	64	73.50 ± 6.50	114	71.20 ± 6.30	-2.24	0.03
19	30	72.20 ± 6.00	66	70.90 ± 6.80	-0.93	0.34

APPENDIX V

Table 4.6: Leg length (cm) of both males and females according to age (n=2490)

Age (yrs)	n	Leg length (cm) Males Mean ± SD	N	Leg length (cm) Females Mean ± SD	t value	p value
6	64	62.50 ± 4.30	62	64.90 ± 4.60	3.11	0.0023
7	97	64.00 ± 4.50	71	64.70 ± 4.00	1.02	0.31
8	80	65.20 ± 5.00	87	66.70 ± 5.40	1.95	0.05
9	82	66.50 ± 5.10	96	67.20 ± 4.90	0.83	0.41
10	73	67.90 ± 6.50	68	66.60 ± 7.10	-1.18	0.24
11	130	68.60 ± 5.70	140	68.40 ± 6.30	1.05	0.30
12	104	70.00 ± 5.10	96	71.80 ± 6.40	2.20	0.03
13	109	74.60 ± 5.70	79	76.80 ± 6.10	2.56	0.01
14	74	78.10 ± 4.90	83	80.30 ± 6.50	2.27	0.02
15	69	79.20 ± 5.60	117	82.00 ± 6.50	2.97	0.0034
16	80	81.30 ± 5.50	113	84.00 ± 6.30	3.10	0.0022
17	74	82.40 ±5.60	168	85.40 ± 5.90	3.76	0.0002
18	64	83.20 ± 5.30	114	85.9 ± 5.80	3.03	0.0028
19	30	80.20 ± 5.40	66	86.50 ± 5.30	5.33	<0.0001