THE STUDY OF ANTHROPOMETRY AND SOMATOTYPE AMONG SCHOOL CHILDREN IN ZARIA, NIGERIA.

By

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DECLARATION

I declare that the work in this thesis entitled 'The Study of Anthropometry and Somatotype among School Children in Zaria, Nigeria' has been performed by me in the Department of Human Anatomy under the supervision of Prof. S.A. Ojo and Dr. S.S. Adebisi. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this Thesis was previously presented for another degree or diploma at any University.

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CERTIFICATION

This thesis entitled 'THE STUDY OF ANTHROPOMETRY AND SOMATOTYPE AMONG SCHOOL CHILDREN IN ZARIA, NIGERIA' by Oyewale, Abdulwaheed Abdulazeez meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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ABSTRACT

Human populations consist of individuals who differ widely in body shape and size. Anthropometry has been employed by anthropologist and public health professionals for defining the normal growth and health status of populations. The development of anthropometry added new dimensions to the study of morphology and full appreciation of the utility of anthropometry requires an understanding of the human body composition. The somatotype and its physiological correlates represent a first descriptive step in recognizing genetic pleiotropism and polygenic interaction. This study attempted to compare the anthropometry and somatotype in Nigerian children of different age, sex and ethnic groups. The study sample comprised of 1,235 apparent healthy children within the ages of 9 – 18 years (male, n = 626 and female, n = 609). Anthropometric measurements considered includes body weight, stretch stature (height), biepicondylar breadth of humerus and femur, upper arm and calf circumferences, triceps; subscapular; supraspinale; and medial calf skinfold thicknesses.

The results obtained show higher mean values in male than female in most of the parameters measured except the skinfold thickness which shows higher mean values for female. It also revealed that females have larger values for weight and height at pubertal stage of development than males.

Thereafter, the males then overtook the females in values for the respective anthropometric variables and maintain this lead up to adolescent. The BMI are higher in female (at pubertal and adolescence stage), this is so because there may be an increase in the weight of females due to hormonal influence during puberty. The results also shows among others the developmental stages that there is increase in the parameters as age increases and all are statistically significant. The differences in variables investigated among various ethnic groups were noted in the Yoruba and Ibo group which had relatively higher values, compared to Hausa. The somatotype of Nigerian children shows more value towards ectomorphy. All the ethnic groups have ectomorphic type of body physique with less mesomorphic. The anthropometric somatotypes of the Nigerian ethnic groups and socioeconomic factors of parental educational level show ectomorphic component being dominant in all age groups and sex, with few changes from ectomorphic to mesomorphic component.

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ABBREVIATIONS, DEFINITIONS, GLOSSARIES AND SYMBOLS

Abbreviations:

1. BMI – Body mass Index
2. HWR – Height – Weight Ratio

Definitions:

1. Somatotype: is a convenient shorthand descriptor of overall physique in terms of body shape and composition independent of body size.
2. Endomorphy: describes the relative fatness of the body.
3. Mesomorphy: it describes the musculo-skeletal component of the body.
4. Ectomorphy: describes the body linearity.
5. Habitus phthisicus – thin bodies
6. Habitus apoplecticus – thick bodies

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Human populations consist of individuals who differ widely in body shape and size. Somatotypes are morphometric ranges along a continuum of functional end products of the whole genetic and developmental complex. The somatotype and its physiological correlates represent a first descriptive step in recognizing genetic pleiotropism and polygenic interaction (Ghosh and Malik, 2004).

Anthropometry has been employed by anthropologist and public health professionals for defining the normal growth and health status of populations. Countries like China have made it a duty to conduct annual anthropometric surveys among school population for the prediction of chronological changes. Anthropometric somatotype studies have gained impetus in the last two decades following the introduction of a simplified method for Somatotyping by Heath and Carter (Rahmawati et al., 2004).

Somatotype reflects an overall outlook of the body and conveys a meaning of the totality of morphological features of the human body (Sheldon et al., 1940). It is a convenient shorthand descriptor of overall physique in terms of

body shape and composition independent of body size (Carter, 1996). It is a basic classification of animal body types according to the prominence of different basic tissues types, roughly: digestive, muscular, and nervous tissues. It describes the physical characteristics of the human body and allows a definition of body type through the analysis of metric characters. It combines an appraisal of relative adiposity, musculo – skeletal robustness and linearity into three number rating (Buffa et al., 2005).

The classical method is the anthropometric somatotype of Heath and Carter (Carter and Heath, 1990; Heath and Carter, 1996). It is based on the definition of three components: endomorphy, mesomorphy and ectomorphy, referable respectively to, relative fatness, to the musculo-skeletal component and to linearity. The somatotype is a rating of the present morphological conformation, which is the observable, external view of body structure. It is a size-dissociated descriptor of shape and relative composition of the body (Carter et al., 1983). Every body shape can be described by three numbers from 1 (low) to 7 (high) with a mean of 4 (average), one for each of the three basic Somatotypes. Therefore, a person who is a pure endomorph would be 7-1-1. A pure (extreme) ectomorph would score a 1-1-7 (Carter et al., 1983).

The somatotype identifies a person as belonging to a biological group or family which appears to be worldwide in distribution and cut across all of the more or less uncertain boundaries by means of which men have attempted to divide themselves according to race, colouring, head dimension, physiology, blood type, geographic birth and so on. The somatotype does not replace these common and conventional identifications but cut across them, binding and relating them. By providing a universal frame of reference it attempts to lay a foundation for adding meaning and usefulness to human description in general, thereby serving the function of a general human taxonomy (Sheldon, 1954).

Somatotyping is a form of body classification, i.e. it is a shorthand method of describing an individual's physique according to certain physical characteristics. It is a well established and excellent tool to explore the spatial temporal variations in human body form and to monitor the effects of physical exercise on human body physique. Somatotyping was originally developed by an American psychologist, William Sheldon in the 1940s, after he studied over four thousand photographs of college age men. He concluded that the physique of men can be divided into the contribution of three fundamental elements. He named his somatotypes after the three germ layers of embryonic development: the endoderm that develops into the

digestive tract, the mesoderm that is to become muscle, heart and blood vessels, and the ectoderm that is to form the nervous system (Sheldon et al., 1940).

Numerous studies indicate that somatotype components have a strong genetic basis. Familial transmission of these components has also supported this viewpoint. Harrison et al. (1976) are of the opinion that certain relationship must exist between body build and endocrine functions and metabolism. To further support this logic they emphasized that it is highly unlikely that persons of different builds have similar basal or habitual functions.

Individuals with dominance of the endomorphic component are heavier and fatter than mesomorphs and ectomorphs (Bolonchuk et al., 2000). Mesomorphs have a greater relative development of the musculo-skeletal component, while ectomorphs present low fat mass and body weight. Various researchers have verified the parameters of the body composition such as fat mass and body cell mass, while the association between mesomorphs and fat free mass is still not conclusive (Bolonchuk et al., 1989, 2000; Slaughter and Lohman, 1976; Wilmore, 1970). The quantity of fat mass increases until age 60 – 75 years, after which the trend is inverted, at

the same time, fat concentrates in the central region of the body. Although, somatotype has often been used to study morphometric variations during growth, the same attention has not been given to variations related to aging. (Bailey et al., 1982; Gaur and Singh, 1997; Herrera et al., 2001, 2004; Pushpa and Sidhu, 1984).

1.2 Statement of the problem

There are very few studies describing somatotype in Nigeria, and none from Zaria and environs. This study attempted to compare the anthropometry and somatotype of different age and sex groups as associated to various degree of development (prepubertal, pubertal and adolescence). The study will consider whether there is correlation between body somatotype and socioeconomic status of an individual. Also, to test the idea that there is a relationship between socioeconomic status and ethnic background and somatotype of children. Differences in physique between populations in different regions also accrue because of cultural differences between populations (Handal et al; 1995). Since the pioneer efforts of Toriola and Igbokwe in 1985 in determining the relationship between perceived physique and somatotype characteristics of 10 – 18 year old boys and girls in

rural Southwest Nigeria, the record of research about body build or physique is scanty.

1.3 Objectives of the Study

The objectives of this study are as follows:

(i) To describe age and sex related variations of somatotype in a cross – sectional sample of healthy children.

(ii) To compare developmental changes in pre-pubertal (9 – 12 years), pubertal (12 – 16 years) and adolescence (16 – 18 years)

(iii) To investigate the influence of ethnic background on the somatotype of children.

(iv) To investigate the influence of socioeconomic status on the somatotype of children.

(v) To promote the use of this technique for the study of body composition in population.

(vi) To compare the findings with reports from other countries.

(vii) To establish a reference somatotype data for our environment.

1.4 Theoretical framework

The study of anthropometry and somatotype is considered in the growth and developmental changes in children. Socio-economic status and ethnicity

as factors that contribute to the growth and development of children, the age and sex variation among others.

1.5 Justification for the study

The results of this study may provide useful data for clinical decision – making as regards the sizes, ratios and proportions specific to the Nigerian Children and adolescent population. The identification of adult disease risk factors in this age group may improve prognosis as a result of the early Institution of intervention measures. This fact may be useful to insurance policy makers. The use of somatotype appears rather promising in the study of pathological conditions of old age, such as Diabetes and Alzheimer disease, which are characterized by strong variations of body composition. The results may also help manufacturers in the garments industry in the accurate determination of the appropriate sizes for adolescents in terms of clothes fitting.

The study may further provide useful baseline data for sports and fitness Coaches interested in the physical characteristics of the adolescent youth for the purposes of talent identification, the monitoring of the effect of training programmes and the scientific prediction of adult performance that are

specific to their sport. Information available through the study of somatotype has also been applied in the field of exercise, sports, growth etc.

The use of somatotype in the study of age-related variations is of both heuristic and applied importance. It also has potential clinical applications, in view of the relationship between physique, nutritional status, and health conditions (Bolonchuk, et al., 2000; Malina, 1997).

Clinical and sport psychologists may find somatotyping useful in body image analysis; especially among adolescents with various kinds of psychological disorders arising from their perception of the changes in their physical appearance associated with the different stages of growth and development.

This study among others will add to the few existing data on the somatotype of Nigerian Children and will be more useful in forensic anthropology. Job requires specific patterns of physique and temperament for success, such patterns varying in strictness and in detail with the nature of Job (Damon and McFarland, 1995). For the individual, it provides a universal frame of reference and lays a foundation for adding meaning and usefulness to human description (helps to maintain a standard body type, that is, when

you know which body type you are or which mixture, you will diet and exercise correctly for that type).

1.6 Statement of research hypotheses

This study will test the following hypotheses:

(i) That there is relationship between age and sex of children anthropometric parameters and somatotype.

(ii) That the somatotype can predict the health status of an individual.

(iii) That the socioeconomic status has an influence on the anthropometric variables and somatotype of an individual.

(iv) That the ethnic background has an influence on the somatotype of an individual and anthropometric variables.

(v) That the level of Education has an influence on the Somatotype.

(vi) That there is relationship between children growth and anthropometric variables.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Early Physique Classifications

Somatotyping is the most recent development in the twenty five century history of morphological taxonomy and constitutional investigation. Tucker and Lessa (1940a, b) in their review of the history of Human classification define constitution as the sum total of the morphological, physiological and psychological characters of an individual, in large part determined by heredity but influenced in varying degrees by environmental factors or, simply, the total biological make up of an individual.

Physicians have been prominent in the history of constitutional investigation, particularly in studies of interrelations of morphology and susceptibility to disease. In the fourth century BC, Aristotle observed that a specific body always involves a specific character. In the fifth century BC, the Greek physicians, Hippocrates, described people with thin bodies as of *habitus phthisicus,* and observed that they were susceptible to Tuberculosis. He called those with short thick bodies' *habitus apoplecticus,* and said they were susceptible to vascular disease and apoplexy. In the first century AD, Celsius, a roman medical encyclopaedist, wrote that above all things one should know the nature of constitution, why some people are fat and some

thin. Avicenna, early eleventh century Arab physician and philosopher, recommended the study of temperament as it related to character (Tucker and Lessa, 1940a, b).

Other early physicians turned their attention to relationships between temperament and susceptibility to disease. In the second century AD, Galen, a Greek physician, applied the idea of four bodily 'humours', which had persisted for the seven centuries. He suggested that the physician needed to ascertain a patient's temperament in terms of humours in order to diagnose and treat disease (Carter and Heath, 1990).

In the late eighteenth and early nineteen century typologies following the pattern of Hippocrates were popular in France. Halle in 1797, followed by Rostan in 1828, described three types of physical constitution as *type digestif, type musculaire and type cerebrale.* Here for the first time the important distinction of predominant muscular development was recognized (Carter and Heath, 1990).

2.1.1. **Early development of anthropometry**

The development of anthropometry added new dimensions to the study of morphology. Anthropometry was first used in studies of morphology in the seventeenth century when Elsholtz, at the University of Padua,

established a method for taking measurements on the body. Two hundred years later Quetelet, a Belgian mathematician and astronomer, was the first to study the measurements of man statistically (Carter and Heath, 1990). In 1878, di Giovanni carried out a long series of anthropometric studies in the school of clinical anthropology that he founded at the University of Padua. His student, Viola (1921), influenced by Beneke at the University of Marburg, differentiated three morphological types. He called subjects with large, heavy bodies and relatively long limbs macrosplanchnic, those with small trunks and relatively long limbs microsplanchnic, and those with intermediate variation normosplanchnic. He himself observed that microsplanchnic was approximately the same as the old term *habitus phthisicus,* and that macrosplanchnic was approximately the same as *habitus apoplecticus*. In order to distinguish between the small trunk; long limb; microsplanchnic and the large trunk; short limb; macrosplanchnic, Viola derived a measure of trunk volume and morphological indices from manipulation of eight trunk measurements and the length of one arm and one leg (Carter and Heath, 1990).

An important trichotomous classification, formulated by Huter about 1880, divided into three types: cerebral (with ectodermic structures

predominating), muscular (with mesodermic structures predominating) and digestive (with endodermic structures predominating).

In Korperbau and Charakter (Krestschmer, 1921; 1968), described four physical and psychic types, deriving from his acute clinical observations and a minimum of measurements. These he called the athletic, pyknic, asthenic and dysplastic physiques. Later he substituted the word leptosomic for asthenic and made a distinction between the linearity and the slenderness, fragility and gracility of the leptosomic type kretschmer's types, which resembled the 'groupings' of di Giovanni, recognized a gradual gradation from psychoses to 'normality'. He had a significant and far reaching influence on constitutional investigation despite criticism for limited sampling, scanty measurements, and lack of indices, subjective estimates, and failure to classify data according to age, sex and social status.

The twentieth century produced considerable interest in constitutional investigation in the United States as well as in Italy and Western Europe. There was an excellent detailed review of these early workers in Tucker and Lessa (1940a, b) and another by Tittel and Wutscherk (1972). Ciocco (1936) and Draper (1944) were primarily interested in relationships between physical type, temperament and susceptibility to various diseases. Those best

known for their classifications of constitutional types were Bean (1912), Bryant (1914), Goldthwaite (1915), Mills (1917), Davenport (1923) and Stockard (1923). There was a similarity of overall picture of variations of physique in such classifications as hypersthenic, sthenic and asthenic; fleshy, medium and slender biotype; lateral, intermediate and linear; and so on (Carter and Heath, 1990).

Early in this century, biologists and anthropologists readily accepted the existence of discrete types and tried to find them in what we recognize today as the complex continuum of human variation. Somatotyping was originally developed by an American psychologist called William Sheldon in the 1940s, after he studied over four thousand photographs of college age men. These photographs have since been termed the 'ivy league posture photographs'. Over the years other scientists and professionals have also been instrumental in further developing body classification systems (kretschemer, 1960; Heath – carter, 1967).

Sheldon's somatotype concept of continuous variation was a striking advance over previous systems of classification. He recognized that every individual instead of being of a particular type was a mixture of all the three basic components of physique, but that these were present in varying degrees in different individuals. These three components, according to

Tucker and Lessa (1940b), he originally called pyknosomic, somatosomic, and leptosomic, but then adopted the names endomorphy, mesomorphy, and ectomorphy, which are strikingly reminiscent of Huter and Von Rohden in 1927.

Sheldon et al. (1940) divided body physiques into three basic categories or somatotype, known as 'extreme somatotype'. An extreme or true endomorphic individual is generally considered to be an individual who is overweight, an extreme mesomorph is generally a smaller, stocky person, and an extreme or true ectomorph is a taller, leaner individual. Obviously your heredity predominantly determines which somatotype you are, however, through a combination of diet and exercise, you can move closer to one particular somatotype (Sheldon, 1954).

From Sheldon's perspective it was not suggested that we were one category or the other, we generally have all three elements in our bodily make up. For example, it would be unusual to meet someone who is a pure ectomorph, with no endomorphic or mesomorphic tendencies. You may meet an Ecto-meso-endomorph (someone who has more ectomorph tendencies than mesomorph and more mesomorph tendencies than endomorph) (Sheldon, 1954).

To assist in the body classification, Sheldon evaluated the degree a somatotype component was present on a scale from one to seven, with one corresponding to the minimum and seven to the maximum tendency to have that component. Using a score of one to seven we can grade our bodies on each of the extreme body types. For example, 2-6-3 indicates low endomorphy-high mesomorphy-low ectomorphy.

2.2 Somatotypes

Somatotype is a classification of physique based on the concept of shape. The somatotype is a rating of the present morphological conformation, which is the observable external view of body structure. It is a size – dissociated descriptor of shape and relative composition of the body (Carter et al., 1983). Somatotyping is a form of body classification, i.e. it is a shorthand method of describing an individual's physique according to certain physical characteristics [a method of description and assessment of the body on three shape composition scales: endomorphy (relative fatness), mesomorphy (relative musculoskeletal robustness) and ectomorphy (relative linearity)] (Carter, 1996).

Full appreciation of the utility of anthropometry requires an understanding of the human body composition. The somatotype provides a general summary of body shape, from which estimates of body composition can be inferred (Bhasin and Jain, 2007). Somatotypes are useful for description and comparison of populations and for monitoring growth and ageing changes and changes due to exercise and physical training. A large variety of somatotype studies have yielded much useful information about human physique and characteristics associated with somatotypes (Bhasin and Jain, 2007). In the past thirty years increasing numbers of these have used the Heath – Carter method (Singh and Sidhu, 1980; Singal and Sidhu, 1984; Malik, 1987; Singh and Bhasin, 1990; Bhasin and Singh, 1991; Singh and Singh, 1991; Bhasin and Singh, 1992b; Singal and Kaur, 1993; Kahlon, 1994; Sidhu and Singh, 1996, Gaur and Singh, 1997).

Heath and Carter have dealt with somatotype distributions of different populations, with heritability of somatotypes, with changes of somatotype in growth and aging, with somatotypes in sports and physical performance and with medical, behavioural, occupational and other variables associated with somatotype. It can be used to record changes in physique and to estimate gross biological differences and similarities among human beings. From the

beginning of somatotype research, investigators in anthropology, biology, medicine, physical education and sports sciences have shown great interest. Primarily their research has concerned methodology, population studies, growth – studies and the effects of exercise and sports on somatotype (Bhasin and Jain, 2007).

Somatotyping is a well established and excellent tool to explore the spatial temporal variations in Human body form and to monitor the effects of physical exercise on Human body physique (Singh and Malhortra, 1989; Carter and Heath, 1990; Carter, 1996 and Kaul et al., 1996). Also, Somatotyping is an effective technique for the study of anthropometric variations and body composition in elderly subjects, even though it has not often been used in this field (Buffa et al., 2005). Moreover, it combines an appraisal of relative adiposity, musculoskeletal robustness and linearity into a three number rating (Carter, 1997).

Somatotypes vary between population groups as well as during growth in the same population (Singh and Sidhu, 1980; Malik et al., 1986a, Kaul et al., 1996). Numerous Somatotypes studies yielding information about Human Physique and characteristics associated with it were conducted in India, mostly in the northern region. Most of these studies have made used of

Heath – Carter method of anthropometric Somatotyping. Somatotype studies were conducted on Bods of the western Himalayas (Malik and Singh, 1978; Malik et al., 1986a; Malik, 1987; Pandey and Malik, 1990), Brahmin Dogras (Singh and Bhasin, 1990), Jat Sikhs and Banias of Punjab (Sidhu and Kansal, 1974; Sidhu et al., 1982; Singal and Sidhu, 1984), Jat Sikhs of Punjab (Singal and Kaur, 1993), Punjabis (Kahlon, 1994), Rajput and Brahmins of chamba, Himachal Pradesh (Singh and Singh, 1991), Santhals of midnapur (Malik et al., 1986b; Prakash and Malik, 1989a, b).

In India, the relationship between physique, sports and body compositions were examined in a variety of sport events (Sidhu et al., 1982; Sidhu and Singh, 1996; Sidhu and Wadhan, 1975; Singh and Sidhu, 1982; Sodhi, 1980a, b; Sodhi and Sidhu, 1984; Verma et al., 1982). Somatotype of sports person and impact of training on somatotype were studied from different parts of the world to provide competitive edge (withers et al., 1986; Casagrande and Viviani, 1993; Carter et al., 1982; Claessens et al., 1986; Carter and Phillips, 1969; Carter and Rahe, 1975)

Apparent somatotypic differences that have been observed at the highest levels of sport studies are due to sex, level of competition, race-ethnicity and age of the competitors (Meszaros and Mohacsi, 1982; Stepnicka, 1986).

Somatotypes refers to the body types and behind this idea lies the belief of earlier Criminologists that there were distinctive body types and these types were associated with personality and temperament (Nicole, 2008).

Somatotype distribution in various ethnic groups are markedly more restricted and dominated by extreme somatotype than the Nationality samples. Studies reveal that Eskimos (Alaska) are primarily endo-mesomorphic, Manus (Papua New-Guinea) and Caingang (Brazil) presents conspicuously mesomorphic Somatotypes with extremes towards mesomorphy (Heath et al., 1968, Heath, 1973, 1977., Carter and Heath, 1990). Strikingly, ectomorphic somatotype is shown by Nilotes of the Nile valley in Africa (Roberts and Bainbridge, 1963) and many population groups living in hot environments of the tropics.

2.2.1 Sheldon theory of Somatotypes

In 1940, Sheldon proposed a theory about certain body types ("somatotype") that are associated with certain personality characteristics. He claimed that there are three such somatotypes: endomorphy, mesomorphy, and ectomorphy. He recognized that every individual instead of being particular type was a mixture of three basic components of physique. The three Somatotypes - endomorphic, mesomorphic and ectomorphic – are basic

classifications of animal body types according to the prominence of different basic tissues types, roughly: digestive, muscular, and nervous tissues (Bhasin and Jain, 2007).

He stated that somatotype is a trajectory along which an individual under average nutritional conditions and absence of major illness is destined to travel. He stressed on the permanence of the physique throughout life.

Using anthropometric methods, Sheldon studied the photographed bodies of some four thousand men from front view, side view, and back view. He concluded that the physique of men can be divided into the contribution of three fundamental elements, the somatotypes. He named his Somatotypes after the three germ layers of embryonic development: the endoderm that develops into the digestive tract, the mesoderm that is to become muscle, heart and blood vessels, and the ectoderm that is to form the nervous system. Sheldon's "Somatotypes" and their (presumed and supposed) associated psychological traits can be summarized as follows (Sheldon, 1954):

i. Endomorphic body type: typically centered on the digestive and can easily become overweight. The endomorphic person has pear-shaped body, rounded head, soft body, underdeveloped muscles, wide hips and shoulders, wider front to back rather than side to side, a lot of fat on the body; upper arms and thighs, and over-developed digestive system.

The endomorphic person also has a 'visceral temperament', which means that they possessed the following associated personality traits which include: love of food, tolerant, evenness of emotions, love of comfort, sociable, good humored, relaxed, need for affection and luxury. Stereotype; "the jolly fat person". Though, in July 2006, a study conducted contradicted the stereotype (jolly fat person), indicating that obese individuals in the United States were more likely to have been diagnosed with depression, bipolar, and panic disorder/agoraphobia. Of note, they had a 25% lower lifetime risk of substance abuse. However, the United States is known to have the biggest proportion of obese people in the world, which does not indicate a higher amount of endomorphs but rather a higher amount of people with eating disorders. Anyone can become fat, even an ectomorph, and being fat is not the same as being endomorphic, therefore the disorders above merely illuminate disorders that cause, are caused by or can go hand-in-hand with eating disorders (somatotype – wikipedia, 2006).

ii. Mesomorphic body type: typically centered on the muscle and circulatory system. They can develop and build muscle mass without much difficulty and can usually eat without too much fear of gaining weight.

The mesomorphic person has a wedge-shaped body, cubical head, wide broad shoulders, muscled arms and legs, narrow hips, narrow from front to back rather than side-to-side, a minimum amount of fat, hard, muscular body, overly mature appearance, rectangular shaped, thick skin and upright posture. The mesomorphic person also has a 'somatotonic temperament' and is courageous, adventurous, desire for power and dominance, indifference to what others think or want, assertive, bold, zest for physical activity, competitive, love of risk and chance (risk taker). Stereotype: the "Jock" or "GI Joe"

iii. Ectomorphic body type: the physique of an ectomorph is centered on the brain and nerves. These people are slim and possibly under weight, and will often have a hard time gaining weight and building muscle mass. The ectomorphic person has a high forehead, receding chin, narrow shoulders and hips, narrow flat chest and abdomen, thin arms and legs, little muscle and fat, delicate build, young appearance, tall and large brain.

The ectomorphic person is likely to have a 'cerebrotonic temperament' and could be described as artistic, sensitive (self-conscious), preference for privacy, introverted, inhibited, socially anxious, mentally intense, emotionally restrained and apprehensive. Stereotype: the "Klein" (Sheldon et al., 1940).

2.2.2 Modern Assessments of Somatotype

Advanced triploblastic animals, such as mammals, or modern humans in particular, do have these three basic tissue layers. Dissecting a cadaver and weighing the tissue broken down into the three layers of origin renders results that support Sheldon's thesis, but only to a degree. Sheldon himself was more a behavioural psychologist than either an anatomist or a psychologist. His behavioural conclusions were based largely on interviews which he or his students carried out over a long span of time, and the actual psychometric data was often more suggestive than conclusive. The physical traits are still useful in of defining body types, and may provide a baseline for future research.

Sheldon's ideas about links between body type, temperament and cognition have received resurgence in modern times because of the new awareness in neurosciences and development of new scientific methods. Sheldon's ideas were not original but a variation on an old ideal, beginning with Aristotle's concept of the "vegetative soul". Harvard psychologist Jerome kagan has convincingly shown the existence of inborn temperament across diverse culture linking cardinal traits to neurochemical activation patterns involving the autonomic nervous system. Antonio Damasio's theory of frontal lobe

function, the somatic maker theory, posits goal directed behavioural as primarily directed by heavy somatosensory input from the internal milieu. It is not a large leap to consider a role for different patterns of somatosensory input in persons with different body types (somatotype – wikipedia, 2006).

2.3 Anthropometry

2.3.1 *Height*

The beginning of the increase in growth velocity is about age 11 in boys and 9 in girls but varies widely from individual to individual. The peak height velocity (PHV) occurs at a mean of 13.5 years in boys and 11.5 years in girls. Pubertal growth accounts for about 20% of final adult height, a total averaging 23-28 cm in females and 26-28 cm in males. The average growth spurt lasts 24-36 months. Growth during the year of PHV in the normal female averages 9 cm/yr and varies normally from 5.4 cm to 11.2 cm. In the normal male, the PHV averages 10.3 cm/yr and varies normally from 5.8 cm to 13.1 cm. Males on average are 12-13 cm taller than females primarily because of the 2-year delay in bone closure as compared to females. This accounts for about a 10 cm difference between the two sexes, in addition, males also have 2 – 3 cm more of growth during their growth spurt.

2.3.2 Weight

Weight velocity increases and peaks during the adolescent growth spurt. Pubertal weight gain accounts for about 50% of an individual's ideal adult body weight. The onset of accelerated weight gain and the peak weight velocity (PWV) attained are highly variable.

2.3.3 Differences in Growth Spurts between Males and Females

PHV occur about 18 – 24 months earlier in the female than in the male. PHV in female's averages 2 cm/yr less than in males. PWV coincides with PHV in males, but PWV occurs 6 – 9 months after PHV in females.

Growth not only involves length and weight of a body but also includes growth and development. Throughout childhood, a child's body becomes more proportional to other parts of his/her body. Growth is complete between the ages of 16 and 18, at which time the growing ends of bones fuse. Normal growth is categorized in a range used by Paediatricians to gauge how a child is growing. The following are some average ranges of weight and height, based on growth charts developed by the Centers for Disease Control and Prevention (CDC, 2000) United States:

Age (year)	Height-Female (cm)	Weight-Female (kg)	Height-Male (cm)	Weight-Male (kg)
1	68.58 – 78.74	6.81 – 9.07	71.12 – 81.28	7.71 – 9.53
2	80.01 – 91.44	9.98 – 14.52	81.28 – 93.98	10.89 – 15.42
3	87.63 – 101.60	11.79 – 17.24	90.17 – 102.87	11.79 -17.24
4	93.98 – 107.95	12.70 – 19.96	95.25 – 109.22	13.61 – 19.96
6	106.68 – 124.46	16.33 – 27.22	106.68– 124.46	16.33 – 27.22
8	119.38 – 137.16	19.96 – 36.29	119.38– 137.16	20.87 – 35.38
10	127.00 – 149.86	24.49 – 48.08	128.27– 149.86	24.49 – 46.27
12	139.70 – 162.56	30.84 – 61.69	137.16-161.29	29.94 – 58.97
14	149.86 – 171.45	38.10 – 72.58	149.86– 176.53	38.10 – 72.58
16	152.40 – 172.72	42.64 – 78.02	160.02– 185.42	47.17 – 84.37
18	152.40 – 173.99	45.36 – 80.74	165.10– 187.96	52.62 – 91.63

2.4 Socioeconomic Status

Analysis of the relationship among biological and social variables is complicated, however, by the difficulty in operationalizing socioeconomic status, a complex concept consisting of two aspects, both of which may exert influences on health directly or through associated behaviors. One aspect includes resources, such as education, income, and wealth and the other

includes status or rank, a function of relative positions in a hierarchy, such as social class (Krieger et al., 1997). A recent National Institutes of Health conference examined measures of socioeconomic status and proposed ways to incorporate a variety of these measures into health surveillance and research (Lee et al., 1995).

Demonstrated racial/ethnic and gender "effects" may be intricately related to socioeconomic factors, because race/ethnicity interacts with and is confounded by social class or socioeconomic status. For example, environmental pollution may be more intense in impoverished areas and may even be sited in those areas because of discrimination based on race/ethnicity or class (Sexton et al., 1993). Little is known about the way that the relationships among these social factors influence the health of children or their effects on the trajectory of the development of adult disease.

Two domains of the relationship between socioeconomic status and health are particularly active areas of research, possibly shedding light on the complexity of the mechanisms whereby this multidimensional variable influences health. The first domain deals with the relationship between the extent of discrepancies in socioeconomic status and health. Numerous studies have documented the relationship between socioeconomic status and health (Feinstein, 1993). Furthermore, standard measures of health correlate

with the extent of income discrepancy between rich and poor, and the extent of income inequality appears to explain more of the variation in health than is explained by other socioeconomic factors, even the absolute level of income (Wilkinson, 1996; Kennedy et al., 1996; Kaplan et al., 1996).

The second domain of the relationship between socioeconomic status and health explores the relationship between childhood socioeconomic conditions and adult health. In Finland, for example, the childhood socioeconomic status of adult men correlated more closely with ischemic heart disease during middle age than did their adult socioeconomic status (Kaplan and Salonen, 1990). The American Academy of Pediatrics acknowledges that race/ethnicity, gender, and socioeconomic status can influence child health through social mechanisms. The Academy recommends that child health studies include these critical variables to improve their definitions and enhance our understanding of the effects that relationships (confounding and interactive) among these variables may have on research findings. The American Academy of Pediatrics believes that race/ethnicity, gender/sex, and socioeconomic status are likely to emerge as important mediators of childhood health, as well as predictors of adult health status (CDC/ ATSDR, 1993; American Academy, 2000).

2.5 Studies on anthropometry and somatotypes of Africa (Nigeria)

Mathur et al. (1985) studied the somatotype ratings and percentage body fat of 131 elite Nigerian male athletes, average 24.2 years of age. They reported that the basketball, handball and soccer players were taller and heavier, and had low percent fat values as compared with the other athletic groups. Judokas and hockey players were endo mesomorphs. Other sports groups were predominantly ecto mesomorphs.

Ogunranti (1990) in his work on surface area (SA) in healthy Nigerian children and adults, the grand mean of the surface area in Nigerian adults (above the age of 21 years) was found to be $1.60m^2$.

Igbokwe (1991) in his study on the somatotypes of Nigerian power athletes, the non athlete (4.02) was most significantly endomorphic ($p< 0.05$), the weightlifters (5.12) and wrestler (5.04) were more significantly mesomorphic ($p<0.05$) than the boxers (3.18) and non athletes (3.06).

Amusa et al. (2002) carried out a study on anthropometric profile of top national track athletes. The athletes' mean somatotypes (Endomorphy: 1.36; Mesomorphy: 3.81; Ectomorphy: 3.21) describe them as ecto mesomorphs. Based on these results, the athletes' physique values were judged to reflect those reported for sprint athletes.

Ibeabuchi et al. (2007) conducted a research on the somatotypes of adolescent male and female Nigerian schoolchildren in urban Lagos. Their results showed that there were significant differences in the mean somatotypes of the groups compared.

2.6 Studies on other factors related to somatotype and anthropometry

Van der Lucht et al. (1992) conducted a study on Socioeconomic health differences among Children aged 10–11 in the Netherlands. They studied the relationships among socioeconomic indicators (fathers' and mothers' educational and occupational level) and children of lower socioeconomic status were less healthy than children from parents with a higher socioeconomic status.

Rebato et al. (1996) carried out a study on Somatotypes of 14 to 19 years old urban boys and girls from Bilbao (Basque Country). In both sexes, somatotype varies with age; the main factor for these variations of the somatotype is in the boys, the endomorphy; and in the girls the mesomorphy.

In another study conducted by Fuster et al. (1996) on somatotype and physical performance in a sample of university students from Madrid.

Results prove the high correlation of test scores implying muscularity (hand grips, pulling strength) with the mesomorphic component of the somatotype, mainly in males.

Gakhar and Malik (1999) conducted a study to delineate age changes and sex differences in anthropometric somatotype and its three components, viz; endomorphy, mesomorphy and ectomorphy among Jats of Delhi in the age range of 10 to 18 years. The results indicated that Jat boys and girls have primarily meso – ectomorphic, balanced ectomorphic and central type of physique.

Toselli and Gruppioni (1999) in their researched work on the study of variations of somatotype, calculated by the Heath – Carter. A tendency toward an increase of endomorphy (adipose component) with age was noticed in both sexes. In females, ectomorphy (component of physical linearity) tended to increase and mesomorphy (muscular-skeletal component) showed a slight decrease during growth, while males exhibited a discontinuous trend.

In the study carried out by Dixson et al. (2003) on Masculine somatotype and hirsuteness as determinants of sexual attractiveness to women, five questionnaire studies asked 685 women to rate the attractiveness of outline

drawings of male figures that varied in somatotype, body proportions, symmetry, and in distribution of trunk hair. These results are consistent with effects of sexual selection upon visual, the back-posed figures of mesomorphic (muscular) somatotypes were rated as most attractive, followed by average, ectomorphic (slim), and endomorphic (heavily built) figures.

In Eiben et al. (2004), the study was conducted on Children's growth and socio-economic status in Hungary. Children from larger families tended to be shorter on average, and have lower weight and skinfold thickness whereas children from Budapest were, on average, taller and heavier than children from elsewhere with bigger chest and calf circumferences and lower skinfold thickness.

Ghosh and Malik (2004) conducted a cross sectional survey in November 2000, with a view to study the age changes and population differences in anthropometric somatotype and its three components, viz., endomorphy, mesomorphy and ectomorphy among the Brahmins and the Rajput boys of Sundarnagar, Himachal Pradesh in the age range of 10-20 years. With the advancement in age, Brahmin boys tend to become ecto-mesomorph from meso ectomorph, while the Rajput boys have a tendency to become ecto-mesomorph from balanced ectomorph.

Also, in another study on variations of somatotype in elderly Sardinians (Buffa et al., 2005). The results show a dominance of the endo- and mesomorphic components in the elderly subjects, with less development of ectomorphy than in younger individuals.

In the study conducted by Ashizawa et al. (2006) titled somatotype in relation to profession in Elderly Japanese. A clear difference correlating to region and/or profession was detected in the somatotype. Endomorphy was most frequently encountered in Tokyo in either sex, whereas in the farming and fishing villages the mesomorphic element was prevalent. Moreover, because in the females in the fishing village the mesomorphic element was the most prevalent, the sex difference with regard to somatotype was very small in this village.

Neni et al. (2007) published a work on somatotypes of young male athletes and non – athletes students in Yogyakarta, Indonesia. The results of the ANOVA of the body measurements showed that the three groups of athletes and the non-athlete students were heterogeneous: the badminton players were shorter and lighter with greater skinfold values among the athlete groups; the soccer players were relatively shorter and with smaller skinfold values and greater arm and leg girths; and the volleyball players were taller

and heavier with smaller elbow and knee breadths and very small skinfold values.

Bhasin and Jain (2007) conducted an extensive work on the Biology of the tribal groups of Rajasthan, India. The Study of body physique reveals that in all the tribal groups' ectomorphic component is dominant, which indicates their linear physique.

Vikram et al. (2007) in a study on Somatotyping of patients with type 2 diabetes mellitus in Amritsar made an attempt to evaluate the somatotype status of patients with diabetes mellitus aged 27-70 years. The results indicate that diabetic females have higher mean values for endomorphy and mesomorphy and lesser mean value for ectomorphy than their male's counterpart.

Buffa et al. (2007) in their study on somatotype in elderly type 2 diabetes patients obtained a higher value of endomorphy. The somatotype method revealed physical peculiarities in type 2 diabetes patients.

Buffa et al. (2007) in another study on somatotype in Alzheimer's disease reported that clinical picture of Alzheimer's disease includes anthropometric and body composition variations. The results shows that the Alzheimer

patients are less mesomorphic and more ectomorphic than the controls, the differences being significant in women

Marini et al. (2007) conducted a research on sex differences in skinfold variability across human populations and during the life cycle. The results obtained shows that skinfold coefficients of variation were greater in males than in females in 79.8% of comparisons with 27.2% significant differences.

CHAPTER THREE

3.0. SUBJECTS AND METHODS

3.1. Location of Study

The present study was conducted in Zaria, a major city in Kaduna state in northern Nigeria. Originally known as Zazzau and one of the seven Hausa – city states (The Britannica Encyclopedia, 2007). The 2007 estimated population was 1,018,827 (The World Gazetteer, 2007). Politically, the ancient city is divided into four (4) zones as follows Zaria/ Tudun wada, Wusasa/ Danmagaji, Sabon gari and Samaru zone. These zones constitute the two local Governments in the area (Zaria and Sabon gari local government).

Since time immemorial, Zaria has been tolerant of varieties of cultures. It is diverse in caste, class, religion and consequently in life styles, eating habits, dress patterns, marriage rituals and other customs. Despite a preponderance of the Hausa speaking people, Zaria can boast of having an admixture of several cultures or ethnic groups. The presence of Higher Institutions of learning has had a great impact on the demographic composition of the city.

However, Zaria has fairly large chunks of communities from other states that have made this place their home for generations. It truly portrays

the Country's axiom of 'Unity in Diversity' and good representation of the Nigeria's ethnic groups.

3.2 Sample

The data utilized in this research were collected from randomly selected twenty six educational institutions (primary and secondary) which comprised of fourteen public and twelve private schools in different zones of Zaria. The study sample consisted of randomly selected 1,235 subjects (626 males and 609 females) between the ages of 9 – 18 years who were later classified as Prepubertal, pubertal and adolescence. Date of birth of subjects was taken from the school register and confirmed from the subjects.

Specially designed questionnaires (appendix 1) were used to elicit information from the participating subject about their date of birth, age, birth order, sex, ethnicity, marital status, parents' ethnicity, occupation and educational status. Only apparently healthy children were considered for this study.

3.3. Anthropometric Tools

Anthropometric tools used for this study includes: weighing machine, portable anthropometer, Digital sliding calipers, non-elastic measuring tape, and slim guide skinfold caliper.

3.4 Anthropometric Somatotype

In accordance with internationally accepted standards and according to standard procedures reported by Lohman (Lohman, et al., 1988) the following anthropometric somatotype measurement was taken (Tanner, et al., 1969; Heath and Carter, 1967, 1996)

i. Body weight: was measured to the nearest 10kg with a portable weighing scale and subjects wearing minimal clothing (plate VI).

ii. Height: Height was measured with a portable anthropometer with an accuracy of 1mm or 0.1cm. Subjects were asked to inhale deeply and maintained fully erect position during the measurement (plate VII).

iii. Biepicondylar breadth of the humerus: the width between the media and lateral epicondyles of the humerus, with the shoulder and elbow flexed to 90^0 was measured with a digital sliding caliper to the nearest 0.05cm (plate VIII).

iv. Biepicondylar breadth of the femur: subjects sat with knee bent at right angle and the greatest distance between the lateral and media epicondyles of the femur was also measured with a digital sliding caliper to the nearest 0.05cm (plate IX).

v. Upper arm circumference: subjects flexed shoulder to 90^0 and the elbow to 45 degrees, clenched the hand, and maximally contracts the elbow flexors and extensors. The measurement was taken at the greatest girth of the arm and measured to nearest 0.1cm with a non-elastic measuring tape (plate X).

vi. Calf circumference: subjects stood with feet slightly apart and the measurement was taken at maximum circumference. This was measured to nearest 0.1cm with a non-elastic measuring tape (plate XI).

vii. Skin folds: four skin folds was measured with a slim guide skinfold caliper to the nearest 0.05cm. They are as follows:

- Triceps skinfold: subjects' arm hanged loosely in anatomical position, a fold was raised at the back of the arm at a level halfway on a line connecting the acromion and the olecranon processes (plate XII).

-Subscapular skinfold: the skinfold was raised on a line from the inferior angle of the scapula in a direction that is obliquely downwards and laterally at 45 degrees (plate XIII).

-Supraspinale skinfold: the fold was taken above the anterior superior iliac spine on a line to the anterior axillary border and on a

diagonal line going downwards and medially at 45 degrees (plate XIV).

- Medial calf skinfold: a vertical fold was raised on the medial side of the leg, at the level of the maximum girth of the calf (plate XV).

3.5 Calculating the anthropometric somatotype

Anthropometric somatotypes were computed according to Carter and Heath (1990). The predictive equations used to calculate endomorphy, mesomorphy, and ectomorphy is as follows:

Endomorphy =-0.7182 + 0.1451 (X) - 0.00068 (X^2) + 0.0000014 (X^3),

Where X is the sum of triceps, Subscapular, and Supraspinale skinfolds multiplied by 170.18/ height (cm).

Mesomorphy = (0.858 x humerus breadth) + (0.601 x femur breadth) + (0.188 x corrected arm girth) + (0.161 x corrected calf girth) – (height x 0.131) + 4.5.

The arm and calf girths was corrected by subtracting the triceps and calf skinfolds (in cm), respectively.

Ectomorphy: three different methods are used to calculate ectomorphy according to Height-Weight Ratios (HWR=height / 3√weight)

$$HWR = \frac{Height}{\sqrt[3]{Weight}}$$

If HWR is greater than or equal to 40.75, i.e. HWR≥ 40.75, then,

Ectomorphy = 0.732 x HWR – 28.58.

If HWR is less than 40.75 but greater than. 38.25, i.e. HWR < 40.75 > 38.25, then, ectomorphy = 0.463 x HWR – 17.63.

If HWR is equal to or less than 38.25, i.e.

HWR ≤ 38.25, then

Ectomorphy = 0.1

If the equation calculation for any component is zero or negative, a value of 0.1 is assigned as the component rating, because by definition, ratings cannot be zero or negative.

3.6 Statistical Analyses

The descriptive statistics of the anthropometric variables was calculated for each group of different sex and age; data were expressed as mean ± standard deviation. Then, complete model of two factors with fixed

effects ANOVA was used to evaluate the role of age and sex (and their possible interaction) on the anthropometric variations.

Student's t-test, one way ANOVA and Pearson correlation analyses were used to check for sex, biocultural differences and relationships in the parameters studied. Statistical significance was deemed acceptable at $p < 0.05$. Relationships were established using Pearson correlation. Sigma Stat 2.0 (Systat Inc., Point Richmond, CA) was used for the statistical analysis.



Plate I: Weighing Scale for measuring body weight in kg.

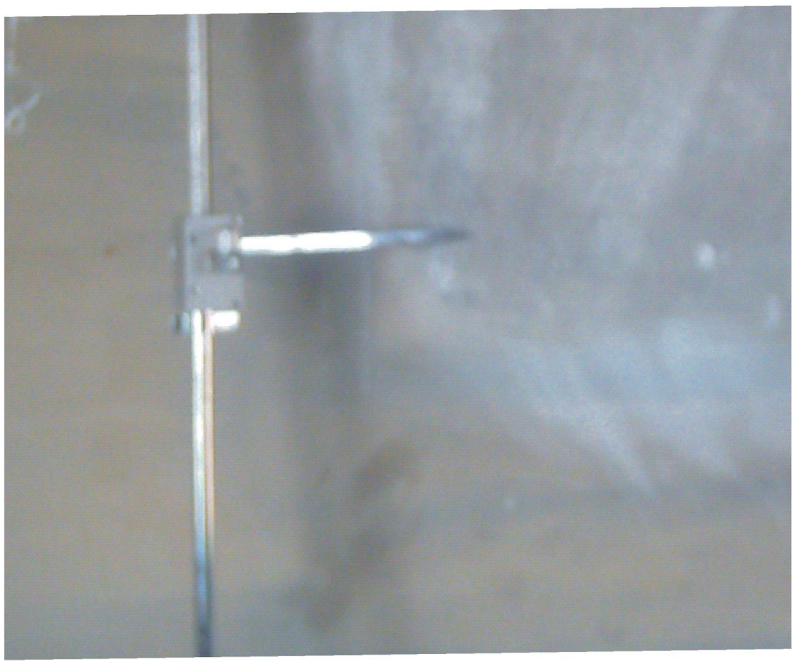
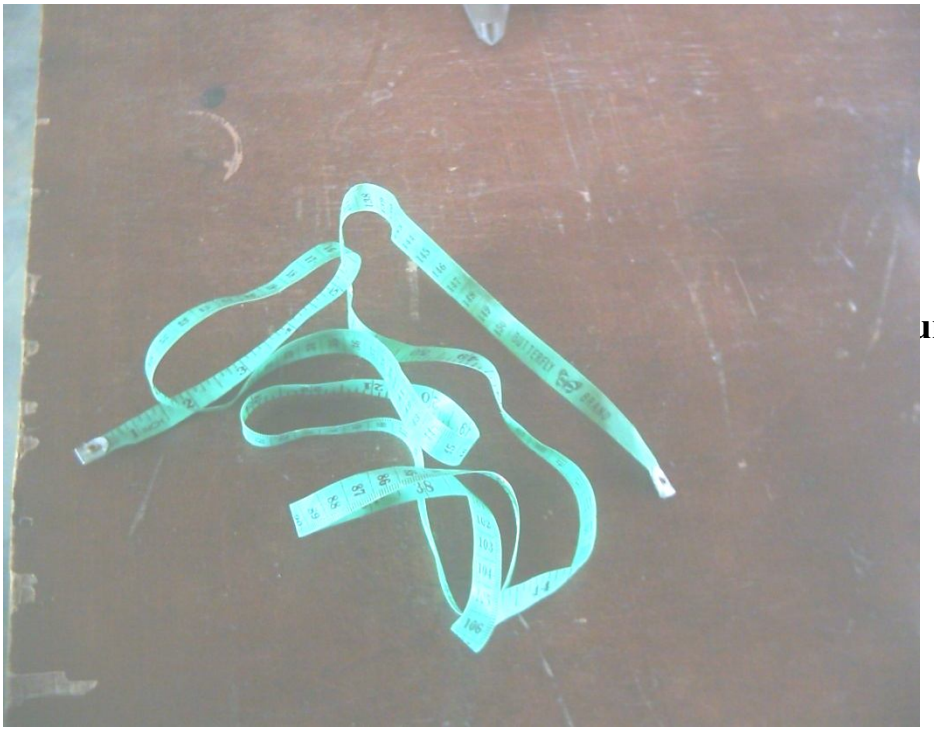


Plate II: Anthropometer for measuring height in mm.



Plate III: A Digital Sliding Caliper for measuring Biepicondylar br



ımferences measureme



Plate V: Slim guide skinfold caliper for skinfolds measurement in mm



Plate VI: Measurement of body weight with a weighing balance in kg.



Plate VII: Measurement of stature (height) with an Anthropometer in r

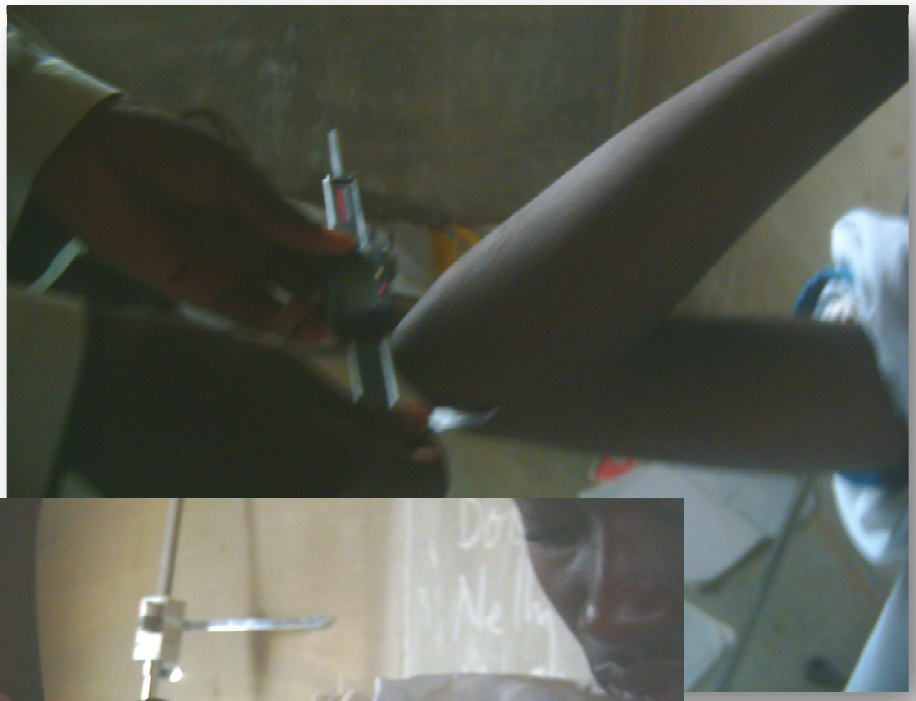


Plate VIII: Measurement of Biepicondylar breadth of humerus with digital



Plate IX: Measurement of Biepicondylar breadth of femur with digital sliding c mm



nce in cm.



nfold in mm.

Plate XIII: Measurement of Subscapular skinfold in mm.







Plate I:



Weighing Scale for measuring body weight in kg.

Pla

Plate I: Bathroom

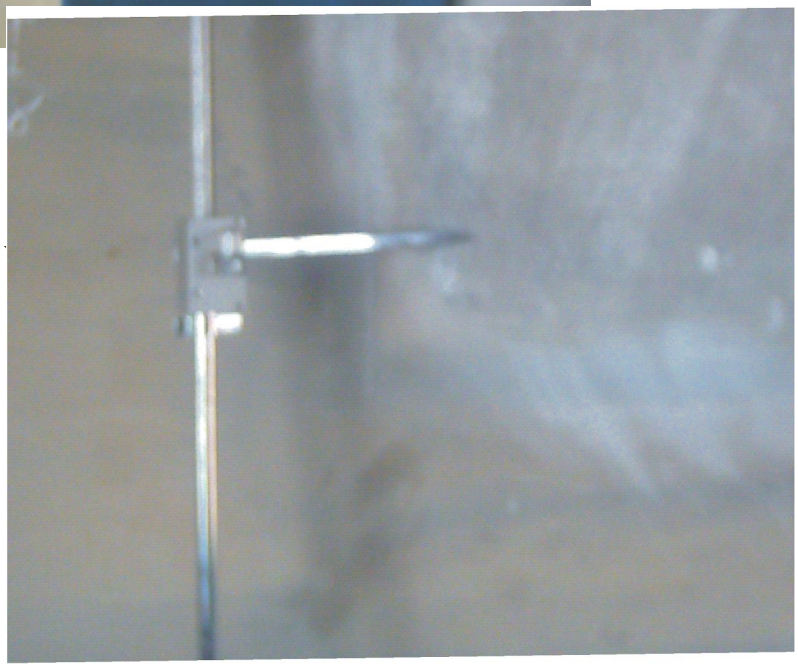
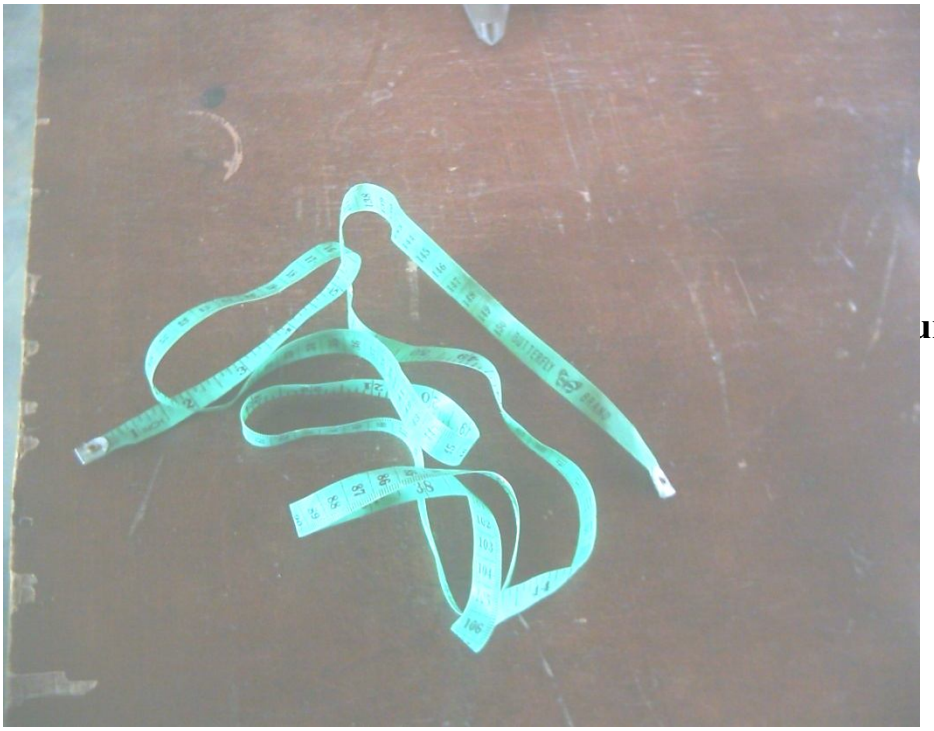




Plate III: A Digital Sliding Caliper for measuring Biepicondylar br



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Plate V: Slim guide skinfold caliper for skinfolds measurement in mm



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Plate VII: Measurement of stature (height) with an Anthropometer in r

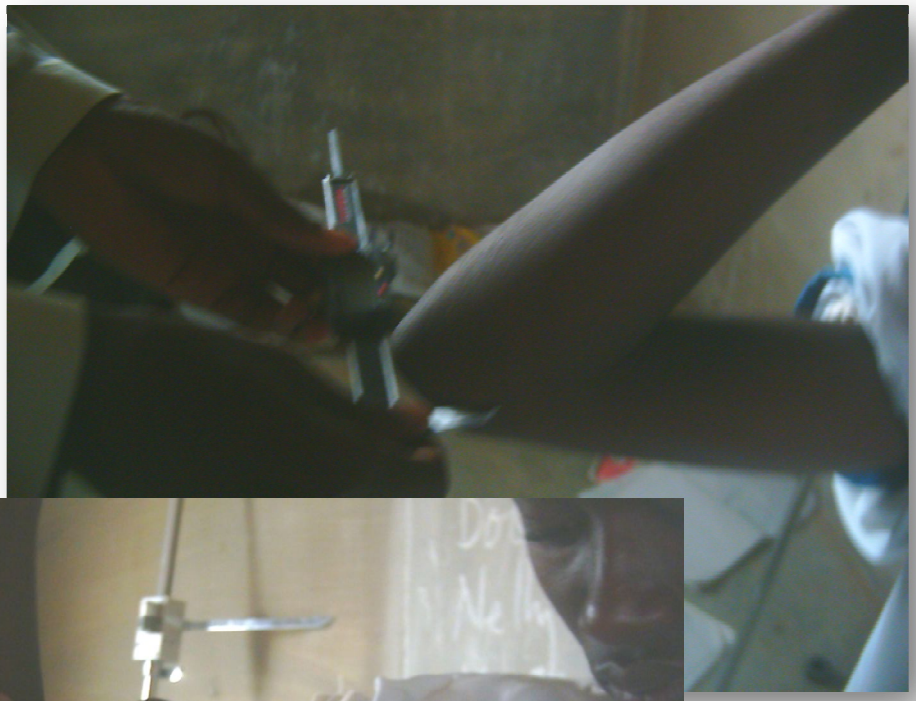


Plate VIII: Measurement of Biepicondylar breadth of humerus with digital



Plate IX: Measurement of Biepicondylar breadth of femur with digital sliding c mm



nce in cm.



nfold in mm.



ıpular skinfold in mm.



pinale skinfold in mm.



CHAPTER FOUR

4.0 RESULTS

4.1 Anthropometry

The mean $\pm$ SD and range of all the anthropometric parameters measured are presented in Table 1. Skinfold thickness showed higher values in female than in male. These were further checked by student t – test for significant difference (Table 2). Biepicondylar breadth of Humerus and Biepicondylar breadth of femur showed significant difference between male and female with $p = 0.027$ and 0.028 respectively.

The effect of ethnic background was shown in table 3 and 4. In male, Yoruba and Ibo children showed higher mean values in most of the anthropometric parameters measured while these were lower in Hausa children. The following measurements showed significant difference in the subjects, these includes weight ($p = 0.006$); Body Mass Index ($p<0.001$); biepicondylar breadth of Humerus ($p = 0.005$); upper arm circumference ($p<0.001$); calf girth ($p = 0.001$) and medial calf skinfold ($p = 0.005$). In table 4, Yoruba and other ethnic groups showed higher mean values in most of the parameters measured in female. Significant differences were recorded in weight ($p = 0.028$), Biepicondylar breadth of Humerus ($p = 0.031$), upper

arm circumference ($p = 0.013$), calf girth ($p = 0.010$), subscapular skinfold ($p = 0.049$) and supraspinale skinfold ($p = 0.010$).

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Table 1: Mean, standard deviation and range of the anthropometric parameters measured in males and females

Parameters	Male (n = 626) Mean ± S.D.	Range	Female (n = 609) Mean ± S.D
Age (year)	13.53 ± 2.89	9.00 – 18.00	13.29 ± 2.79
Weight (kg)	43.18 ± 11.19	22.00 – 69.00	42.54 ± 12.3
Height (cm)	150.14 ± 13.95	120.60 – 174.10	151.61 ± 62
Body mass Index (kg/m^2)	18.78 ± 2.13	14.18 – 28.29	18.70 ± 2.19
Biepicondylar breadth of Humerus (cm)	5.83 ± 0.80	3.80 – 8.70	5.74 ± 0.77
Biepicondylar breadth of Femur (cm)	8.12 ± 3.04	5.70 – 79.00	7.84 ± 0.86
Upper arm circumference (cm)	21.39 ± 3.04	21.39 ± 3.04	21.28 ± 2.65
Calf girth (cm)	27.39 ± 3.79	0.40 – 37.75	27.26 ± 3.53
Triceps skinfold (cm)	0.68 ± 0.25	0.15 – 1.40	0.71 ± 0.26
Subscapular skinfold (cm)	0.57 ± 0.30	0.20 – 1.30	0.58 ± 0.25
Supraspinale skinfold (cm)	0.55 ± 0.28	0.20 – 1.20	0.57 ± 0.26
Medial calf skinfold (cm)	0.75 ± 0.24	0.25 – 2.50	0.77 ± 0.26

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Table 2: Mean and standard deviation of the anthropometric parameters measured in males and females (student t - test)

Parameters	Male (n = 626) Mean ± S.D.	Female (n = 609) Mean ± S.D.	t
Age (year)	13.53 ± 2.89	13.29 ± 2.79	-1.526

Weight (kg)	43.18 ± 11.19	42.54 12.39	-0.956
Height (cm)	150.14 ± 13.95	151.61 ± 62.56	0.573
Biepicondylar breadth of Humerus (cm)	5.83 ± 0.80	5.74 ± 0.77	-2.208
Biepicondylar breadth of Femur (cm)	8.12 ± 3.04	7.84 ± 0.86	-2.198
Upper arm circumference (cm)	21.39 ± 3.04	21.28 ± 2.65	-0.656
Calf girth (cm)	27.39 ± 3.79	27.26 ± 3.53	-0.615
Triceps skinfold (cm)	0.68 ± 0.25	0.71 ± 0.26	1.605
Subscapular skinfold (cm)	0.57 ± 0.30	0.58 ± 0.25	0.997
Supraspinale skinfold (cm)	0.55 ± 0.28	0.57 ± 0.26	1.214
Medial calf skinfold (cm)	0.75 ± 0.24	0.77 ± 0.26	1.281

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Table 3: Mean and standard deviation of anthropometric parameters measured in male children on the basis of ethnic background.

Parameters	Hausa (n = 385) Mean ± S.D.	Ibo (n = 72) Mean ± S.D.	Yoruba (n = 131) Mean ± S.D.	Others (n = 38) Mean ±
Age (year)	13.34 ± 2.82	13.74 ± 2.87	13.89 ± 3.02	13.82 ±
Weight (kg)	41.96 ± 11.21	45.22 ± 9.83	45.44 ± 11.19	43.92 ±
Height (cm)	149.07 ± 14.35	151.98 ± 13.12	152.36 ± 13.31	149.76 ±
Body mass Index (kg/m^2)	18.49 ± 20.08	19.32 ± 1.88	19.23 ± 2.07	19.17 ±
Biepicondylar breadth of Humerus (cm)	5.75 ± 0.82	6.06 ± 0.82	5.95 ± 0.72	5.80 ± 0
Biepicondylar breadth of Femur (cm)	8.18 ± 3.83	8.24 ± 0.89	7.99 ± 0.73	7.76 ± 0
Upper arm circumference (cm)	21.01 ± 2.84	22.65 ± 4.17	21.67 ± 2.67	21.76 ±
Calf girth (cm)	27.02 ± 3.85	28.83 ± 4.34	27.80 ± 3.10	26.91 ±
Triceps skinfold (cm)	0.66 ± 0.25	0.74 ± 0.24	0.70 ± 0.23	0.66 ± 0

Subscapular skinfold (cm)	0.56 ± 0.27	0.58 ± 0.21	0.61 ± 0.27	0.56 ± 0
Supraspinale skinfold (cm)	0.53 ± 0.27	0.56 ± 0.21	0.60 ± 0.32	0.59 ± 0
Medial calf skinfold (cm)	0.73 ± 0.24	0.83 ± 0.22	0.78 ± 0.24	0.78 ± 0

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Table 4: Mean and standard deviation of anthropometric parameters measured in female children on the basis of ethnic background.

Parameters	Hausa (n = 344) Mean ± S.D.	Ibo (n = 80) Mean ± S.D.	Yoruba (n = 139) Mean ± S.D.	Others (n = 45) Mean ±
Age (year)	13.24 ± 2.86	12.90 ± 2.34	13.37 ± 2.83	14.07 ±
Weight (kg)	41.60 ± 10.55	40.93 ± 8.58	44.28 ± 10.49	43.78 ±
Height (cm)	152.52 ± 82.67	148.18 ± 10.65	151.39 ± 12.34	151.09 ±
Body mass Index (kg/m^2)	18.53 ± 2.39	18.44 ± 2.01	19.00 ± 2.09	18.93 ±
Biepicondylar breadth of Humerus (cm)	5.67 ± 0.79	5.72 ± 0.68	5.89 ± 0.78	5.79 ± 0
Biepicondylar breadth of Femur (cm)	7.78 ± 0.89	7.91 ± 0.82	7.96 ± 0.81	7.77 ± 0
Upper arm circumference (cm)	21.04 ± 2.66	21.13 ± 2.66	21.66 ± 2.52	22.14 ±
Calf girth (cm)	26.93 ± 3.52	27.28 ± 3.38	28.11 ± 3.46	26.96 ±
Triceps skinfold (cm)	0.70 ± 0.27	0.69 ± 0.22	0.73 ± 0.24	0.70 ± 0
Subscapular skinfold (cm)	0.58 ± 0.27	0.53 ± 0.17	0.61 ± 0.25	0.65 ± 0
Supraspinale skinfold (cm)	0.56 ± 0.27	0.52 ± 0.18	0.59 ± 0.27	0.67 ± 0
Medial calf skinfold (cm)	0.76 ± 0.26	0.75 ± 0.20	0.79 ± 0.24	0.82 ± 0

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Table 5: Mean and standard deviation of anthropometric parameters measured in male children according to developmental stages.

Parameters	9 – 12 years (n = 248)	13 – 15 years (n = 186)	16 – 18 years (n = 192)

	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	F
Weight (kg)	32.95 ± 5.84	44.12 ± 7.06	55.47 ± 5.34	743.619
Height (cm)	136.08 ± 7.96	153.83 ± 6.03	164.73 ± 5.95	987.390
Body mass Index (kg/m^2)	17.22 $\pm$ 1.33	18.73 $\pm$ 1.73	20.73 $\pm$ 1.98	228.082
Biepicondylar breadth of Humerus (cm)	5.23 ± 0.65	6.00 ± 0.50	6.45 ± 0.04	228.082
Biepicondylar breadth of Femur (cm)	7.32 ± 0.88	8.83 ± 5.32	8.47 ± 0.65	15.709
Upper arm circumference (cm)	18.98 ± 1.57	21.63 ± 2.12	24.26 ± 2.61	343.742
Calf girth (cm)	24.16 ± 2.60	28.88 ± 2.47	30.10 ± 3.06	297.933
Triceps skinfold (cm)	0.51 ± 0.11	0.65 ± 0.18	0.94 ± 0.21	366.420
Subscapular skinfold (cm)	0.38± 0.09	0.51 ± 0.15	0.87 ± 0.22	545.320
Supraspinale skinfold (cm)	0.36 ± 0.09	0.48 ± 0.15	0.87 ± 0.25	507.091
Medial calf skinfold (cm)	0.61 ± 0.14	0.73 ± 0.25	0.97 ± 0.19	187.513

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Table 6: Mean and standard deviation of anthropometric parameters measured in female children according to developmental stages.

Parameters	9 – 12 years (n = 260) Mean ± S.D.	13 – 15 years (n = 193) Mean ± S.D.	16 – 18 years (n = 156 Mean ± S.D.	F
Weight (kg)	32.72 ± 4.63	45.62 ± 5.80	54.27 ± 5.52	870.824
Height (cm)	137.64 ± 7.16	154.95 ± 5.64	161.15 ± 6.29	753.181
Body mass Index (kg/m^2)	17.20 $\pm$ 1.32	18.94 $\pm$ 1.64	20.89 $\pm$ 1.99	256.978
Biepicondylar breadth of Humerus (cm)	5.14 ± 0.59	6.02 ± 0.47	6.38 ± 0.58	282.749
Biepicondylar breadth of Femur (cm)	7.19 ± 0.63	8.22 ± 0.66	8.45 ± 0.64	235.011
Upper arm circumference (cm)	19.18 ± 1.86	22.15 ± 1.83	23.67 ± 1.92	313.882
Calf girth (cm)	24.50 ± 2.30	28.74 ± 2.62	30.03 ± 2.89	273.227
Triceps skinfold (cm)	0.51 ± 0.12	0.76 ± 0.18	0.97 ± 0.24	348.848
Subscapular skinfold (cm)	0.38± 0.09	0.63 ± 0.15	0.87 ± 0.21	545.135
Supraspinale skinfold (cm)	0.36 ± 0.09	0.60± 0.16	0.88 ± 0.24	503.940
Medial calf skinfold (cm)	0.58 ± 0.14	0.85 ± 0.23	0.99 ± 0.21	255.419

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Table 7: Mean and standard deviation of weight measured in male and female according to age group.

Age (year)	N	Male Mean ± S.D.	n	Female Mean ± S.D.	t - value	P
9	64	27.91 ± 4.61	62	29.11 ± 3.21	-1.69	0.09
10	65	31.01 ± 3.65	67	31.03 ± 3.42	-0.03	0.97
11	61	35.90 ± 4.57	70	34.91 ± 3.91	1.34	0.18

12	58	37.60 ± 4.83	61	35.71 ± 4.49	2.21	0.03
13	65	37.95 ± 3.18	62	41.42 ± 4.61	-5.30	<0.001
14	60	43.52 ± 4.53	63	45.60 ± 5.23	-2.35	0.02
15	61	51.30 ± 5.36	68	49.31 ± 4.79	2.23	0.03
16	61	52.03 ± 5.75	57	52.98 ± 6.65	-0.83	0.41
17	68	55.34 ± 3.24	52	54.50 ± 4.38	1.21	0.23
18	63	58.95 ± 4.54	47	55.34 ± 4.93	3.98	<0.001

Table 8: Mean and standard deviation of Height measured in male and female according to age group.

Age (year)	Male N	Mean ± S.D.	Female n	Mean ± S.D.	t - value	P
9	64	128.34 ± 6.93	62	132.05 ± 5.71	-3.27	0.001
10	65	133.97 ± 4.81	67	133.11 ± 4.88	1.02	0.31
11	61	138.44 ± 5.03	70	140.32 ± 3.78	-2.44	0.02
12	58	144.53 ± 4.24	61	145.14 ± 4.86	-0.73	0.47
13	65	148.31 ± 3.82	62	150.59 ± 4.41	-3.12	0.002
14	60	153.58 ± 3.48	63	156.25 ± 5.89	-3.04	0.003
15	61	159.87 ± 3.82	68	157.71 ±	3.22	0.002

				3.79		
16	61	163.04 ± 7.11	57	159.99 ± 6.52	2.42	0.02
17	68	165.46 ± 5.05	52	160.97 ± 5.66	4.58	<0.001
18	63	165.58 ± 5.33	47	162.77 ± 6.45	2.50	0.01

Table 9: Mean and standard deviation of Biepicondylar breadth of Humerus measured in male and female according to age group.

Age (year)	N	Male Mean ± S.D.	n	female Mean ± S.D.	t - value	P
9	64	5.87 ± 0.64	62	4.70 ± 0.39	12.34	<0.001
10	65	6.08 ± 0.80	67	4.81 ± 0.43	11.41	<0.001
11	61	5.36 ± 0.77	70	5.41 ± 0.53	- 0.44	0.66
12	58	5.89 ± 0.81	61	5.63 ± 0.42	2.21	0.03
13	65	6.07 ± 0.68	62	5.90 ± 0.45	1.65	0.10
14	60	5.75 ± 0.83	63	5.99 ± 0.49	- 1.96	0.05
15	61	6.00 ± 0.77	68	6.15 ± 0.45	- 1.37	0.17
16	61	5.94 ± 0.74	57	6.18 ± 0.61	- 1.92	0.06
17	68	6.06 ± 0.66	52	6.38 ± 0.53	- 2.86	0.005
18	63	5.30 ± 0.83	47	6.63 ± 0.52	- 9.66	<0.001

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Table 10: Mean and standard deviation of Biepicondylar breadth of Femur measured in male and female according to age group.

Age (year)	N	Male Mean ± S.D.	n	female Mean ± S.D.	t - value	P
9	64	7.96 ± 0.76	62	6.79 ± 0.40	10.76	<0.001
10	65	8.15 ± 0.80	67	6.92 ± 0.55	10.32	<0.001
11	61	7.69 ± 1.41	70	7.41 ± 0.60	1.52	0.13
12	58	8.12 ± 0.99	61	7.66 ± 0.54	3.17	0.002
13	65	8.19 ± 0.78	62	8.00 ± 0.49	1.64	0.11
14	60	7.76 ± 0.86	63	8.24 ± 0.63	- 3.54	<0.001
15	61	8.13 ± 0.74	68	8.39 ± 0.78	- 1.94	0.06
16	61	8.12 ± 0.82	57	8.36 ± 0.80	- 1.61	0.11
17	68	8.26 ± 0.64	52	8.72 ± 0.51	- 4.28	<0.001
18	63	7.44 ± 0.90	47	8.26 ± 0.42	- 5.79	<0.001

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Table 11: Mean and standard deviation of Upper arm circumference measured in male and female according to age group.

Age (year)	n	Male Mean ± S.D.	n	female Mean ± S.D.	t - value	P
9	64	21.43 ± 2.43	62	18.02 ± 1.48	9.48	<0.001

10	65	22.34 ± 3.42	67	18.80 ± 1.70	7.56	<0.001
11	61	20.15 ± 2.81	70	19.08 ± 1.25	2.88	<0.005
12	58	21.44 ± 3.08	61	20.91 ± 1.76	1.16	0.25
13	65	22.18 ± 2.93	62	20.78 ± 1.41	3.41	<0.001
14	60	20.66 ± 2.95	63	22.58 ± 1.61	- 4.51	<0.001
15	61	21.56 ± 2.56	68	23.01 ± 1.63	- 3.88	<0.001
16	61	21.96 ± 3.39	57	23.22 ± 2.01	- 2.43	0.02
17	68	22.34 ± 3.01	52	23.77 ± 2.10	- 2.92	0.004
18	63	19.63 ± 2.45	47	24.09 ± 1.48	- 11.06	<0.001

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Table 12: Mean and standard deviation of Calf girth measured in male and female according to age group.

Age (year)	Male n	Male Mean ± S.D.	Female n	Female Mean ± S.D.	t - value	P
9	64	27.42 ± 2.75	62	23.17 ± 1.80	10.23	<0.001
10	65	28.28 ± 3.64	67	23.48 ± 1.98	9.55	<0.001
11	61	25.36 ± 3.31	70	24.69 ± 1.56	1.52	0.13
12	58	27.59 ± 3.92	61	26.78 ± 2.01	1.43	0.16
13	65	28.57 ± 3.52	62	26.62 ± 1.70	3.95	<0.001
14	60	26.35 ± 3.21	63	29.11 ± 2.48	- 5.35	<0.001
15	61	27.70 ± 3.25	68	30.32 ± 2.15	- 5.45	<0.001
16	61	28.23 ± 3.91	57	29.93 ± 2.51	- 2.79	0.006

17	68	29.09 ± 3.14	52	30.59 ± 2.78	- 2.72	0.007
18	63	25.44 ± 3.75	47	29.52 ± 3.37	- 5.89	<0.001

Table 13: Mean and standard deviation of Triceps skinfold measured in male and female according to age group.

Age (year)	Male n	Male Mean ± S.D.	Female n	Female Mean ± S.D.	t - value	P
9	64	0.66 ± 0.18	62	0.42 ± 0.08	9.62	<0.001
10	65	0.74 ± 0.22	67	0.45 ± 0.08	10.12	<0.001
11	61	0.55 ± 0.18	70	0.53 ± 0.08	0.84	0.40
12	58	0.74 ± 0.27	61	0.63 ± 0.10	2.98	0.004
13	65	0.75 ± 0.25	62	0.65 ± 0.08	3.01	0.003
14	60	0.66 ± 0.24	63	0.75 ± 0.18	- 2.36	0.02
15	61	0.78 ± 0.30	68	0.87 ± 0.19	- 2.06	0.04
16	61	0.60 ± 0.24	57	0.83 ± 0.27	- 4.90	<0.001
17	68	0.74 ± 0.22	52	1.03 ± 0.18	- 7.73	<0.001
18	63	0.60 ± 0.25	47	1.07 ± 0.14	- 11.60	<0.001

Table 14: Mean and standard deviation of Subscapular skinfold measured in male and female according to age group.

Age (year)	Male n	Male Mean ± S.D.	Female n	Female Mean ± S.D.	t – value	P
9	64	0.55 ± 0.21	62	0.33 ± 0.05	8.03	<0.001
10	65	0.61 ± 0.25	67	0.33 ± 0.06	8.91	<0.001
11	61	0.44 ± 0.21	70	0.40 ± 0.07	1.50	0.14
12	58	0.60 ± 0.28	61	0.47 ± 0.11	3.36	0.001
13	65	0.64 ± 0.26	62	0.53 ± 0.09	3.16	0.002
14	60	0.54 ± 0.28	63	0.62 ± 0.12	- 2.08	0.04
15	61	0.68 ± 0.32	68	0.72 ± 0.15	- 0.92	0.36
16	61	0.54 ± 0.23	57	0.75 ± 0.25	- 4.75	<0.001
17	68	0.61 ± 0.24	52	0.88 ± 0.16	- 7.01	<0.001
18	63	0.48 ± 0.25	47	1.01 ± 0.13	- 13.25	<0.001

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Table 15: Mean and standard deviation of Supraspinale skinfold measured in male and female according to age group.

Age (year)	Male n	Male Mean ± S.D.	Female n	Female Mean ± S.D.	t - value	P
9	64	0.52 ± 0.23	62	0.31 ± 0.05	7.03	<0.001
10	65	0.61 ± 0.30	67	0.31 ± 0.06	8.02	<0.001
11	61	0.44 ± 0.24	70	0.37 ± 0.07	2.33	0.02

12	58	0.59 ± 0.28	61	0.45 ± 0.11	3.62	<0.001
13	65	0.65 ± 0.31	62	0.49 ± 0.10	3.88	<0.001
14	60	0.55 ± 0.31	63	0.62 ± 0.15	- 1.61	0.11
15	61	0.64 ± 0.31	68	0.70 ± 0.16	- 1.40	0.16
16	61	0.47 ± 0.22	57	0.75 ± 0.27	- 6.19	<0.001
17	68	0.58 ± 0.29	52	0.91 ± 0.19	- 7.12	<0.001
18	63	0.44 ± 0.24	47	0.99 ± 0.16	- 13.61	<0.001

Table 16: Mean and standard deviation of Medial skinfold measured in male and female according to age group.

Age (year)	Male N	Male Mean ± S.D.	Female n	Female Mean ± S.D.	t – value	P
9	64	0.75 ± 0.19	62	0.48 ± 0.08	10.34	<0.001
10	65	0.82 ± 0.21	67	0.55 ± 0.12	9.10	<0.001
11	61	0.65 ± 0.20	70	0.60 ± 0.12	1.76	0.08
12	58	0.78 ± 0.24	61	0.70 ± 0.14	2.23	0.03
13	65	0.87 ± 0.34	62	0.72 ± 0.09	3.36	0.001
14	60	0.75 ± 0.24	63	0.85 ± 0.20	- 2.52	0.01
15	61	0.79 ± 0.23	68	0.98 ± 0.27	- 4.28	<0.001
16	61	0.69 ± 0.21	57	0.91 ± 0.27	- 4.96	<0.001
17	68	0.78 ± 0.22	52	1.06 ± 0.13	- 8.15	<0.001
18	63	0.65 ± 0.24	47	1.01 ± 0.17	- 8.77	<0.001

Table 17: Mean and standard deviation of Body mass Index among various age groups in male and female

Age (year)	Male n	Male Mean ± S.D.	Female n	Female Mean ± S.D.	t - value	P
9	64	18.70 ± 1.48	62	16.66 ± 0.99	9.07	<.001
10	65	18.99 ± 1.93	67	17.46 ± 1.01	5.73	<0.001
11	61	17.42 ± 1.94	70	17.67 ± 1.53	- 0.82	0.14
12	58	19.17 ± 2.20	61	16.92 ± 1.42	6.66	<0.001
13	65	19.42 ± 2.11	62	18.31 ± 1.55	3.37	0.001
14	60	18.44 ± 1.96	63	18.66 ± 1.64	- 0.68	0.50
15	61	18.90 ± 2.30	68	19.79 ± 1.35	- 2.71	0.008
16	61	19.47 ± 2.27	57	20.69 ± 2.10	- 3.03	0.003
17	68	19.01 ± 2.31	52	21.07 ± 1.93	- 5.17	<0.001
18	63	18.27 ± 2.00	47	20.92 ± 1.94	- 6.96	<0.001

Table 18: Mean and standard deviation of anthropometric parameters of male children as compared to father's level of education.

meter	None Education (n = 106)	Primary Education (n = 165)	Secondary Education (n = 155)	Tertiary Education (n = 200)	F	P
(year)	13.75 ± 2.95	13.57 ± 2.88	13.17 ± 2.76	13.67 ± 2.97	1.149	0.32
ght (kg)	42.67 ± 11.99	41.88 ± 11.11	42.76 ± 10.93	44.86 ± 10.88	2.407	0.06
ht (cm)	150.85 ± 16.16	148.45 ± 14.21	149.33 ± 13.42	151.77 ± 12.73	1.984	0.11
y Mass Index (kg/m^2)	18.32 ± 2.21	18.62 ± 21.54	18.80 ± 2.08	19.14 ± 2.06	3.903	0.00
icondylar breadth of Humerus(cm)	5.79 ± 0.84	5.79 ± 0.84	5.79 ± 0.82	5.93 ± 0.72	1.511	0.21
icondylar breadth of Femur (cm)	7.94 ± 0.92	7.92 ± 0.91	8.14 ± 1.61	8.02 ± 0.79	1.182	0.31
er arm circumference (cm)	20.98 ± 2.73	21.57 ± 3.80	21.21 ± 2.87	21.59 ± 2.57	1.308	0.27
girth (cm)	26.74 ± 3.53	27.63 ± 4.24	27.08 ± 4.28	27.77 ± 3.03	2.312	0.07
ps skinfold (cm)	0.71 ± 0.29	0.67 ± 0.24	0.65 ± 0.22	0.71 ± 0.25	2.357	0.07
scapular skinfold (cm)	0.61 ± 0.32	0.53 ± 0.20	0.53 ± 0.21	0.61 ± 0.29	5.024	0.00
aspinale skinfold (cm)	0.62 ± 0.36	0.53 ± 0.26	0.51 ± 0.23	0.56 ± 0.28	4.295	0.00
ial calf skinfold (cm)	0.79 ± 0.28	0.74 ± 0.23	0.73 ± 0.22	0.76 ± 0.25	1.501	0.21

Table 19: Mean and standard deviation of anthropometric parameters of Female children as compared to father's level of education.

meter	None Education (n = 77)	Primary Education (n = 156)	Secondary Education (n = 191)	Tertiary Education (n = 185)	F	P
(year)	13.21 ± 2.83	13.18 ± 2.92	13.38 ± 2.64	13.31 ± 2.82	0.168	0.91
ght (kg)	41.16 ± 12.16	40.27 ± 10.28	42.12 ± 9.58	44.70 ± 9.87	5.810	<0.0
ht (cm)	147.48 ± 13.55	146.20 ± 12.32	149.65 ± 11.25	151.81 ± 11.53	6.864	<0.0
y Mass Index (kg/m^2)	18.49 ± 2.71	18.49 ± 2.18	18.53 ± 2.02	19.14 ± 2.09	3.639	0.01
icondylar breadth of Humerus(cm)	5.69 ± 0.82	5.60 ± 0.75	5.73 ± 0.75	5.88 ± 0.76	4.092	0.00
icondylar breadth of Femur (cm)	7.81 ± 1.07	7.66 ± 0.86	7.88 ± 0.79	7.96 ± 0.80	3.842	0.01
er arm circumference (cm)	20.85 ± 2.89	20.70 ± 2.98	21.24 ± 2.39	21.99 ± 2.36	7.814	<0.0
girth (cm)	26.75 ± 3.99	26.40 ± 3.66	27.07 ± 3.18	28.39 ± 3.28	10.600	<0.0
ps skinfold (cm)	0.72 ± 0.32	0.67 ± 0.25	0.70 ± 0.22	0.74 ± 0.27	2.814	0.03
scapular skinfold (cm)	0.60 ± 0.32	0.53 ± 0.21	0.57 ± 0.22	0.64 ± 0.27	5.249	0.00
aspinale skinfold (cm)	0.58 ± 0.32	0.54 ± 0.27	0.56 ± 0.23	0.60 ± 0.26	1.601	0.18
ial calf skinfold (cm)	0.77 ± 0.30	0.73 ± 0.22	0.76 ± 0.22	0.82 ± 0.29	4.459	0.00

Table 20: Mean and standard deviation of anthropometric parameters of male children as compared to mother's level of education.

meter	None Education (n = 161)	Primary Education (n = 162)	Secondary Education (n = 119)	Tertiary Education (n = 184)	F	P
(year)	13.73 ± 2.91	13.97 ± 2.92	13.24 ± 2.49	13.17 ± 3.04	2.841	0.03
ght (kg)	42.46 ± 12.08	44.09 ± 12.14	42.84 ± 9.30	43.23 ± 10.64	0.615	0.60
ht (cm)	150.05 ± 15.22	150.52 ± 14.87	150.62 ± 12.48	149.57 ± 12.92	0.191	0.90
y Mass Index (kg/m^2)	18.40 ± 2.24	19.03 ± 2.36	18.63 ± 1.70	18.99 ± 2.03	3.320	0.02
icondylar breadth of Humerus(cm)	5.73 ± 0.76	5.90 ± 0.90	5.87 ± 0.79	5.84 ± 0.73	1.359	0.25
icondylar breadth of Femur (cm)	8.03 ± 1.13	7.99 ± 0.88	8.18 ± 1.59	7.89 ± 0.80	1.711	0.16
er arm circumference (cm)	21.11 ± 2.87	21.99 ± 3.81	21.33 ± 2.86	21.13 ± 2.42	3.07	0.02
girth (cm)	26.95 ± 4.46	28.02 ± 4.29	27.50 ± 3.15	27.14 ± 2.93	2.526	0.05
ps skinfold (cm)	0.71 ± 0.29	0.69 ± 0.23	0.63 ± 0.20	0.68 ± 0.24	2.409	0.06
scapular skinfold (cm)	0.60 ± 0.29	0.56 ± 0.23	0.53 ± 0.18	0.58 ± 0.29	2.143	0.09
aspinale skinfold (cm)	0.60 ± 0.32	0.56 ± 0.29	0.51 ± 0.24	0.53 ± 0.26	3.130	0.02
ial calf skinfold (cm)	0.78 ± 0.27	0.75 ± 0.25	0.74 ± 0.22	0.73 ± 0.23	1.376	0.24

Table 21: Mean and standard deviation of anthropometric parameters of Female children as compared to mother's level of education.

meter	None Education (n = 159)	Primary Education (n = 153)	Secondary Education (n = 120)	Tertiary Education (n = 177)	F	P
(year)	13.70 ± 2.95	13.32 ± 2.94	13.10 ± 2.46	13.01 ± 2.68	1.970	0.11
ght (kg)	42.39 ± 11.43	41.19 ± 10.99	42.41 ± 9.33	43.14 ± 9.28	0.991	0.39
ht (cm)	149.06 ± 13.03	147.46 ± 12.90	149.22 ± 10.81	150.64 ± 11.21	1.910	0.12
y Mass Index (kg/m^2)	18.66 ± 2.36	18.57 ± 2.36	18.79 ± 2.00	18.78 ± 2.02	0.352	0.78
icondylar breadth of Humerus(cm)	5.71 ± 0.73	5.63 ± 0.83	5.73 ± 0.70	5.85 ± 0.78	2.219	0.08
icondylar breadth of Femur (cm)	7.85 ± 0.98	7.74 ± 0.84	7.81 ± 0.77	7.94 ± 0.80	1.630	0.18
er arm circumference (cm)	21.15 ± 2.84	21.01 ± 2.95	21.27 ± 2.51	21.63 ± 2.26	1.667	0.17
girth (cm)	26.95 ± 4.00	26.84 ± 3.72	27.51 ± 3.31	27.74 ± 2.97	2.448	0.06
ps skinfold (cm)	0.74 ± 0.92	0.67 ± 0.23	0.68 ± 0.23	0.72 ± 0.26	2.435	0.06
scapular skinfold (cm)	0.61 ± 0.28	0.55 ± 0.22	0.57 ± 0.23	0.60 ± 0.26	2.012	0.11
aspinale skinfold (cm)	0.60 ± 0.30	0.55 ± 0.28	0.55 ± 0.23	0.57 ± 0.24	1.106	0.34
ial calf skinfold (cm)	0.79 ± 0.26	0.74 ± 0.23	0.76 ± 0.26	0.79 ± 0.26	1.631	0.18

Table 22: Mean and standard deviation of anthropometric parameters of birth order in male children.

	1st order (n = 193)	2nd order (n = 188)	3rd order (n = 151)	4th order (n = 57)	5th order and above (n = 37)	F
	14.27 ± 2.98	12.93 ± 2.73	13.69 ± 2.84	13.13 ± 2.85	12.75 ± 2.70	6.491
	45.78 ± 10.43	41.86 ± 11.21	43.85 ± 11.53	39.81 ± 10.93	38.78 ± 10.75	6.318
	153.65 ± 13.10	147.75 ± 13.23	151.47 ± 14.31	146.26 ± 15.17	144.56 ± 13.57	7.655
ndex (kg/m^2)	19.10 ± 1.98	18.78 ± 2.19	18.73 ± 2.18	18.22 ± 2.15	18.17 ± 2.10	2.906
r breadth of Humerus(cm)	6.02 ± 0.81	5.74 ± 0.73	5.84 ± 0.75	5.57 ± 0.89	5.71 ± 0.91	5.293
r breadth of Femur (cm)	8.08 ± 0.76	8.00 ± 1.06	8.12 ± 1.52	7.62 ± 0.87	7.82 ± 0.86	2.662
rcumference (cm)	22.30 ± 3.43	20.92 ± 2.50	21.35 ± 2.95	20.61 ± 2.74	20.35 ± 3.08	7.815
n)	28.07 ± 3.59	26.76 ± 3.80	27.63 ± 3.83	26.93 ± 3.94	26.76 ± 3.91	3.516
old (cm)	0.74 ± 0.25	0.64 ± 0.21	0.70 ± 0.27	0.63 ± 0.24	0.58 ± 0.22	6.697
skinfold (cm)	0.64 ± 0.27	0.53 ± 0.25	0.58 ± 0.26	0.50 ± 0.24	0.46 ± 0.19	7.488
skinfold (cm)	0.63 ± 0.31	0.49 ± 0.22	0.59 ± 0.31	0.46 ± 0.22	0.42 ± 0.18	10.57
kinfold (cm)	0.81 ± 0.23	0.72 ± 0.24	0.79 ± 0.27	0.66 ± 0.20	0.63 ± 0.21	9.227

Table 23: Mean and standard deviation of anthropometric parameters of birth order in female children.

	1st order (n = 174)	2nd order (n = 204)	3rd order (n = 131)	4th order (n = 64)	5th order and above(n =36)	F
	14.10 ± 2.96	12.77 ± 2.54	13.43 ± 2.77	13.15 ± 2.82	12.01 ± 2.16	7.802
	44.99 ± 10.14	41.02 ± 9.70	42.71 ± 11.13	41.00 ± 9.78	37.51 ± 9.61	6.178
	152.17 ± 10.61	147.49 ± 11.86	149.89 ± 12.98	147.88 ± 13.04	143.54 ± 11.75	6.106
ndex (kg/m^2)	19.15 ± 2.32	18.57 ± 2.06	18.65 ± 2.39	18.43 ± 1.65	17.90 ± 2.11	3.526
r breadth of Humerus(cm)	5.90 ± 0.74	5.70 ± 0.79	5.72 ± 0.75	5.63 ± 0.69	5.38 ± 0.82	4.469
r breadth of Femur (cm)	7.92 ± 0.73	7.80 ± 0.86	7.99 ± 1.00	7.68 ± 0.81	7.44 ± 0.77	4.056
rcumference (cm)	21.82 ± 2.62	20.95 ± 2.52	21.46 ± 2.80	20.95 ± 2.50	20.46 ± 2.81	3.93
n)	27.86 ± 3.09	26.89 ± 3.42	27.65 ± 4.02	26.34 ± 3.42	26.66 ± 3.88	3.652
old (cm)	0.76 ± 0.25	0.66 ± 0.24	0.74 ± 0.30	0.68 ± 0.24	0.60 ± 0.19	5.522
skinfold (cm)	0.64 ± 0.25	0.54 ± 0.24	0.61 ± 0.27	0.55 ± 0.24	0.49 ± 0.19	5.597
skinfold (cm)	0.64 ± 0.28	0.52 ± 0.23	0.60 ± 0.29	0.54 ± 0.25	0.47 ± 0.21	7.280
kinfold (cm)	0.82 ± 0.25	0.74 ± 0.26	0.80 ± 0.28	0.72 ± 0.22	0.68 ± 0.23	4.732

Table 24: Correlation matrix of anthropometric parameters in male (n = 626)

	Age	Weight	Height	Biepicon.breadth of humerus	Biepicon.breadth of femur	Upper arm circumference	Calf girth	Triceps skinfold	Su sk
Age	-	0.90[a]	0.92[a]	0.74[a]	0.52[a]	0.77[a]	0.73[a]	0.77[a]	0.8
Weight	-	-	0.93[a]	0.79[a]	0.56[a]	0.81[a]	0.79[a]	0.81[a]	0.8
Height	-	-	-	0.80[a]	0.57[a]	0.78[a]	0.76[a]	0.76[a]	0.1
Biepicon.breadth of Humerus	-	-	-	-	0.58[a]	0.78[a]	0.77[a]	0.70[a]	0.6
Biepicondylar breadth of femur	-	-	-	-	-	0.62[a]	0.52[a]	0.48[a]	0.4
Upper arm circumference	-	-	-	-	-	-	0.80[a]	0.67[a]	0.6
Calf girth	-	-	-	-	-	-	-	0.65[a]	0.5
Triceps skinfold	-	-	-	-	-	-	-	-	0.9
Subscapular skinfold	-	-	-	-	-	-	-	-	-
Supraspinale skinfold	-	-	-	-	-	-	-	-	-
Medial calf skinfold	-	-	-	-	-	-	-	-	-

a= p< 0.001

Table 25: Correlation matrix of anthropometric parameters in female (n = 609)

	Age	Weight	Height	Biepicon.breadth of humerus	Biepicon.breadth of femur	Upper arm circumference	Calf girth	Triceps skinfold	Su sk
Age	-	0.89[a]	0.88[a]	0.76[a]	0.68[a]	0.77[a]	0.73[a]	0.80[a]	0.8
Weight	-	-	0.91[a]	0.79[a]	0.78[a]	0.82[a]	0.83[a]	0.80[a]	0.8
Height	-	-	-	0.82[a]	0.79[a]	0.82[a]	0.81[a]	0.78[a]	0.8
Biepicon.breadth of Humerus	-	-	-	-	0.83[a]	0.77[a]	0.76[a]	0.73[a]	0.1
Biepicondylar breadth of femur	-	-	-	-	-	0.74[a]	0.79[a]	0.77[a]	0.1
Upper arm circumference	-	-	-	-	-	-	0.85[a]	0.72[a]	0.1
Calf girth	-	-	-	-	-	-	-	0.75[a]	0.1
Triceps skinfold	-	-	-	-	-	-	-	-	0.9
Subscapular skinfold	-	-	-	-	-	-	-	-	-
Supraspinale skinfold	-	-	-	-	-	-	-	-	-
Medial calf skinfold	-	-	-	-	-	-	-	-	-

a= p< 0.001

Table 26: Mean and standard deviation of Somatotype of children on the basis of ethnic background.

Parameters	Hausa (n = 729) Mean ± S.D.	Ibo (n = 154) Mean ± S.D.	Yoruba (n = 270) Mean ± S.D.	Others (n = 82) Mean ±
Endomorphy	-0.43 ± 0.10	-0.43± 0.08	-0.42 ± 0.10	-0.41± 0
Mesomorphy	2.73 ± 7.42	3.34 ± 1.38	3.03 ± 0.94	2.87 ± 1
Ectomorphy	7.59 ± 12.02	7.35 ± 2.73	7.15 ± 1.12	7.06 ± 1

Table 27: Mean and standard deviation of Somatotype of children as compared to father's level of education.

Parameters	Primary (n = 321) Mean ± S.D.	Secondary (n = 346) Mean ± S.D.	Tertiary (n = 385) Mean ± S.D.	None (n = 183 Mean ±
Endomorphy	-0.44 ± 0.09	-0.44 ± 0.09	-0.42 ± 0.10	-0.41± 0
Mesomorphy	3.07 ± 1.20	2.54 ± 10.72	3.08 ± 1.01	2.81 ± 1
Ectomorphy	6.99 ± 1.41	8.21 ± 17.45	7.13 ± 1.12	7.34 ± 1

To show the developmental changes over the years, table 5 and 6 presented the mean and standard deviation of anthropometric parameters measured in male and female respectively according to various developmental stages (prepubertal 9 – 12 years, pubertal 13 – 15 years and adolescence 16 – 18 years). The results showed that there is increase in the parameters as age increases and all are statistically significant.

To appreciate the changes in these parameters over the years the analytical results for the distribution of the mean and standard deviation of all anthropometric values of male and female were shown in Table 7 to 17 according to various age groups using student t-test. Highest values were recorded at 18 years of age. Table 7 and figure 1 presented weight measurement, male showed the highest mean value at 18 years (58.95 ± 4.54) significant difference were shown at 12years ($p = 0.03$), 13 years ($p<0.001$), 14 years ($p= 0.02$), 15 years ($p = 0.03$) and 18 years ($p<0.001$). Table 8 and figure 2 presented height measurement in both sexes. The mean value varies according to developmental changes in each age group. Significant differences were obtained in most of the parameters measured at various degree of p – level ($p<0.001$, $p< 0.05$) except at 10 and 12 years of age. Biepicondylar breadth of Humerus showed highest mean value in female at various age groups except at 9, 10, 12 and 13years. Significant

differences are shown at various degree of p – value ($p<0.001$, 0.01, 0.05) except at 11 and 15 years (table 9).

Table 10 showed mean and standard deviation of Biepicondylar breadth of femur measured in all age group and sex. Age 9 – 13years showed higher mean value for female. Significant differences are shown in most of the age groups except 11, 13, 15 and 16 years (P <0.001, 0.05). In upper arm circumference (figure 3) and calf girth (table 11 & 12 respectively) age 9 – 13years showed higher mean value in male while 14 – 18years in female. Significant difference were recorded in all anthropometric parameters measured in upper arm circumference except at 12 years of age at various degree of p – value (p <0.001, 0.05) and calf girth except at 12 and 13 years of age.

In all the skinfold thickness measured, age 9 – 13years showed higher mean value in male while age 14 – 18years showed higher mean value in female. Table 13 and figure 4 represented triceps skinfold with significant difference in all ages except 11years. Subscapular skinfold and supraspinale skinfold were presented in table 14 and 15; and figure 5 and 6 respectively with significant differences in all except at 11 and 15years in subscapular and 14 and 15years in supraspinale. Table 16 and figure 7 showed the trend in medial calf with significant difference in most ages except 11 and 14. In most parameters, age 11 showed no significant difference except in height, upper arm circumference and supraspinale where differences were recorded.

Table 17 and figure 8 showed the differences in mean and standard deviation of body mass body index among various age groups. Highest mean value was recorded in female at 17years (21.07 $\pm$ 1.93) and in male at 16years (19.47 $\pm$ 2.27). The sex when compared showed significant difference except at age 11 and 14 years.

The effect of socioeconomic status of each children was also investigated by considering the parents educational level which is a factor of socioeconomic status. The magnitude of socioeconomic differences is not the same in each age group and sex. Table 18 and 19 showed the relationships among socioeconomic indicators (father's level of education) in male and female and table 20 and 21 showed the relationship among socioeconomic indicators (mother's level of education) in male and female. In table 18, male children of father that attained tertiary education showed higher mean value in most of the parameters measured. In most, body mass index, subscapular and supraspinale skinfold showed significant difference ($p = 0.009$, $p = 0.002$ and $p = 0.005$ respectively). In female, only age and supraspinale skinfold do not showed significant level (Table 19). In mother's level of education, male children with parents without formal education (none) and primary education showed higher mean values, significant differences were recorded in age, body mass index, upper arm circumference

and supraspinale skinfold (Table 20). No significant differences are recorded in female children but the female children with mothers that attained tertiary education showed higher mean value in most anthropometric parameters measured. Mean of the skinfold thicknesses are higher in children with none – educational mother (Table 21).

To further appreciate the changes in these parameters according to the birth order, the mean and standard deviation of the children birth order were tabulated in table 22 (male) and 23 (female). In both sexes, children of 1st birth order showed higher mean values in most of the anthropometric parameters measured. The significant level was high in both sexes ($p < 0.001, 0.05$). From table 24 and 25, it was observed that 100% of the correlation matrix of anthropometric parameters in both sexes are significant ($p<0.001$). All the anthropometric parameters are correlated 100%.

4.2 Somatotype

The anthropometric somatotypes of the ethnic background of children are shown in Table 26 with an ectomorphic component being dominant in all groups. Table 27 described socioeconomic status (father's level of education) and maximum values of ectomorphy were also recorded.

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To further appreciate the changes in these parameters according to the birth order, the mean and standard deviation of the children birth order were tabulated in table 22 (male) and 23 (female). In both sexes, children of 1st birth order showed higher mean values in most of the anthropometric parameters measured. The significant level was high in both sexes ($p < 0.001, 0.05$). From table 24 and 25, it was observed that 100% of the correlation matrix of anthropometric parameters in both sexes are significant ($p<0.001$). All the anthropometric parameters are correlated 100%.

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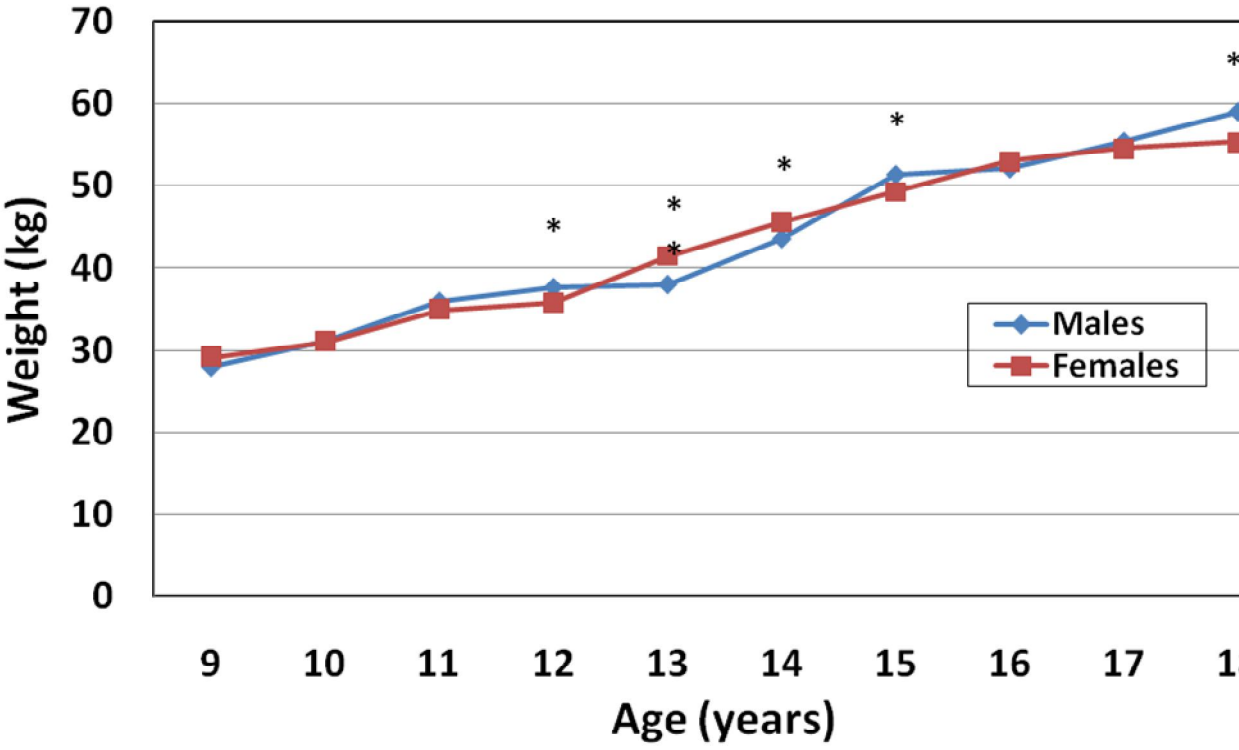


Fig. 1: Mean and standard deviation of weight measured in male a female according to age group. * P<0.05, ** P<0.001

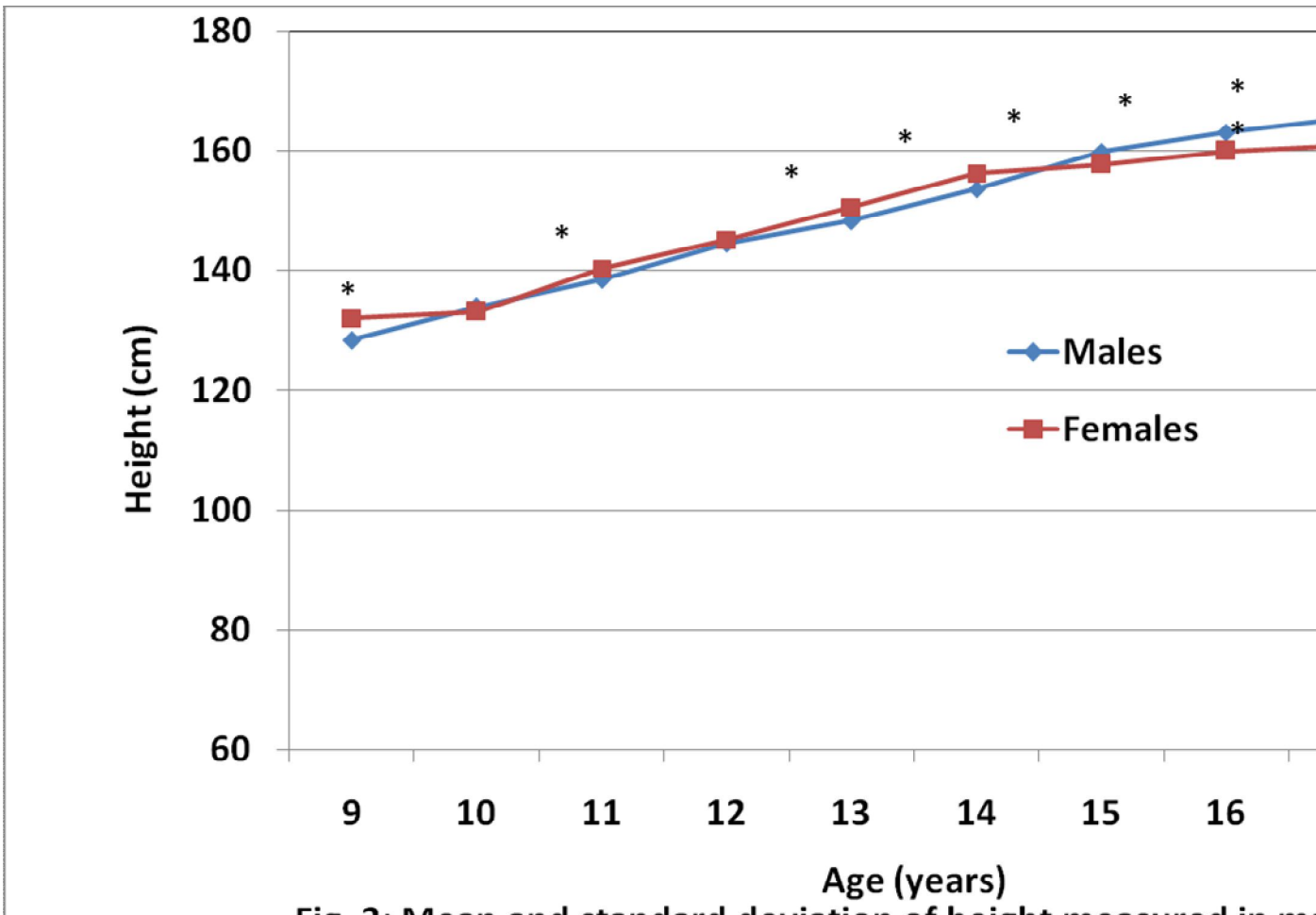


Fig. 2: Mean and standard deviation of height measured in ma
female according to age group. * P<0.05, ** P<0.001

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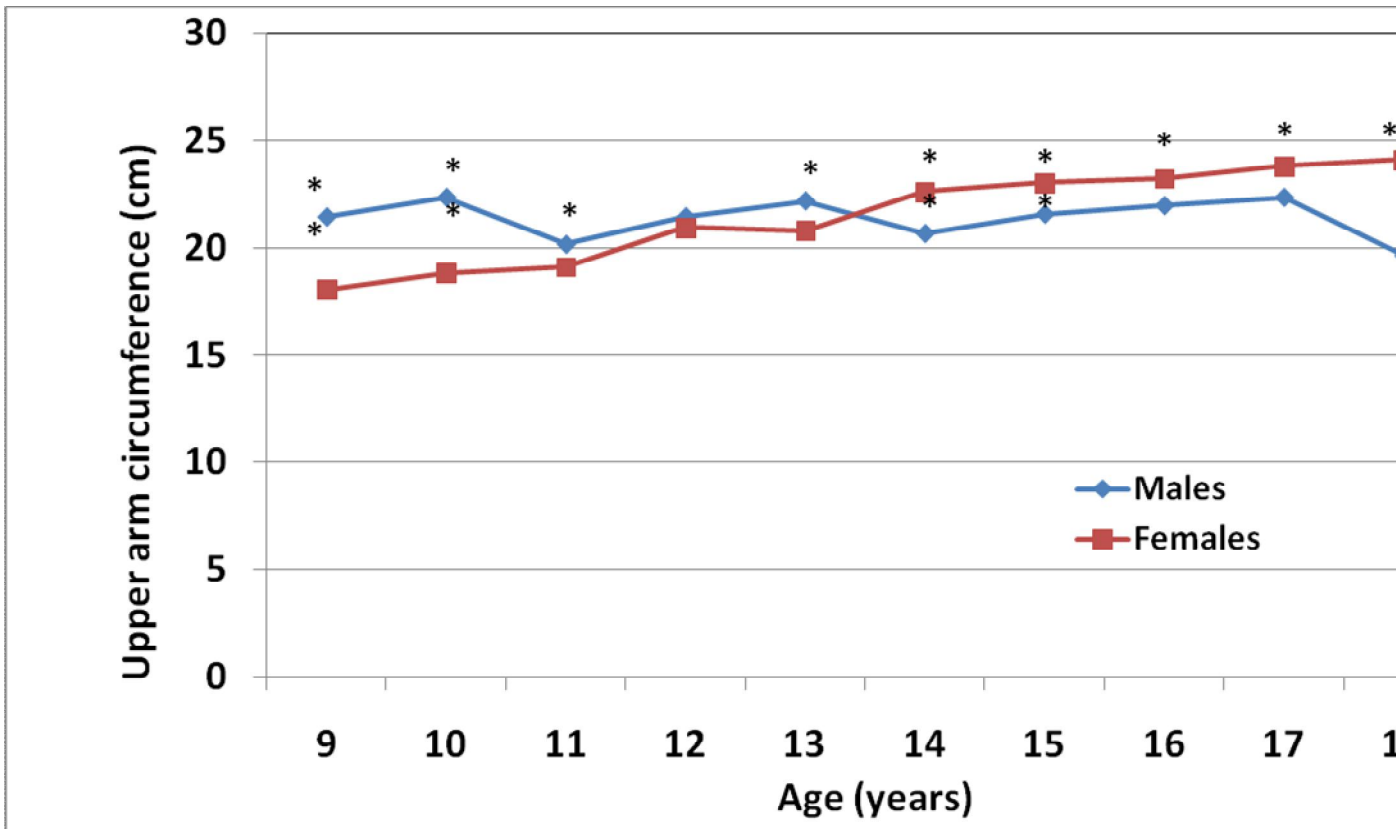


Fig. 3: Mean and standard deviation of upper arm circumfere
measured in male and female according to age group. *P<0.
** P<0.001

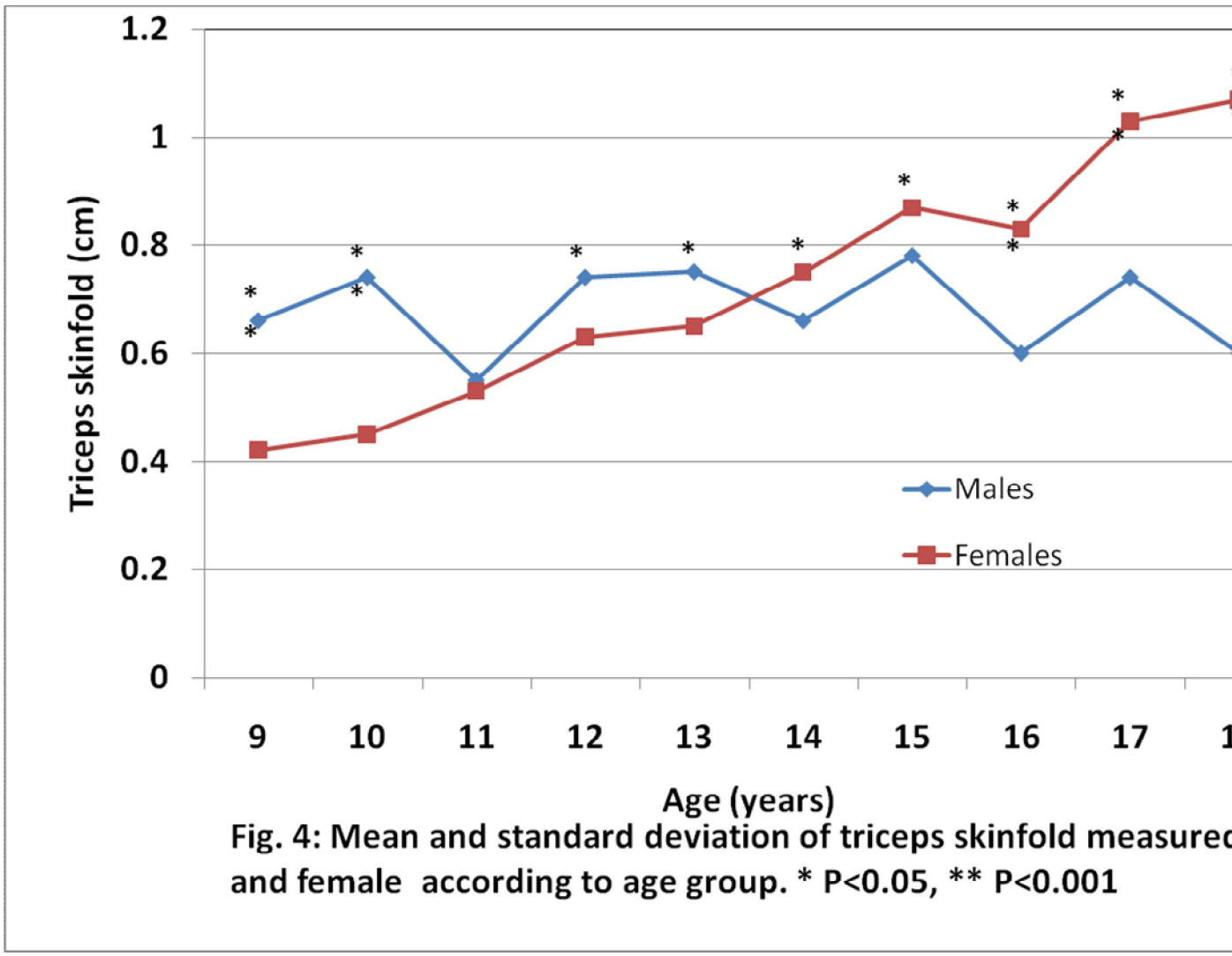


Fig. 4: Mean and standard deviation of triceps skinfold measured
and female according to age group. * P<0.05, ** P<0.001

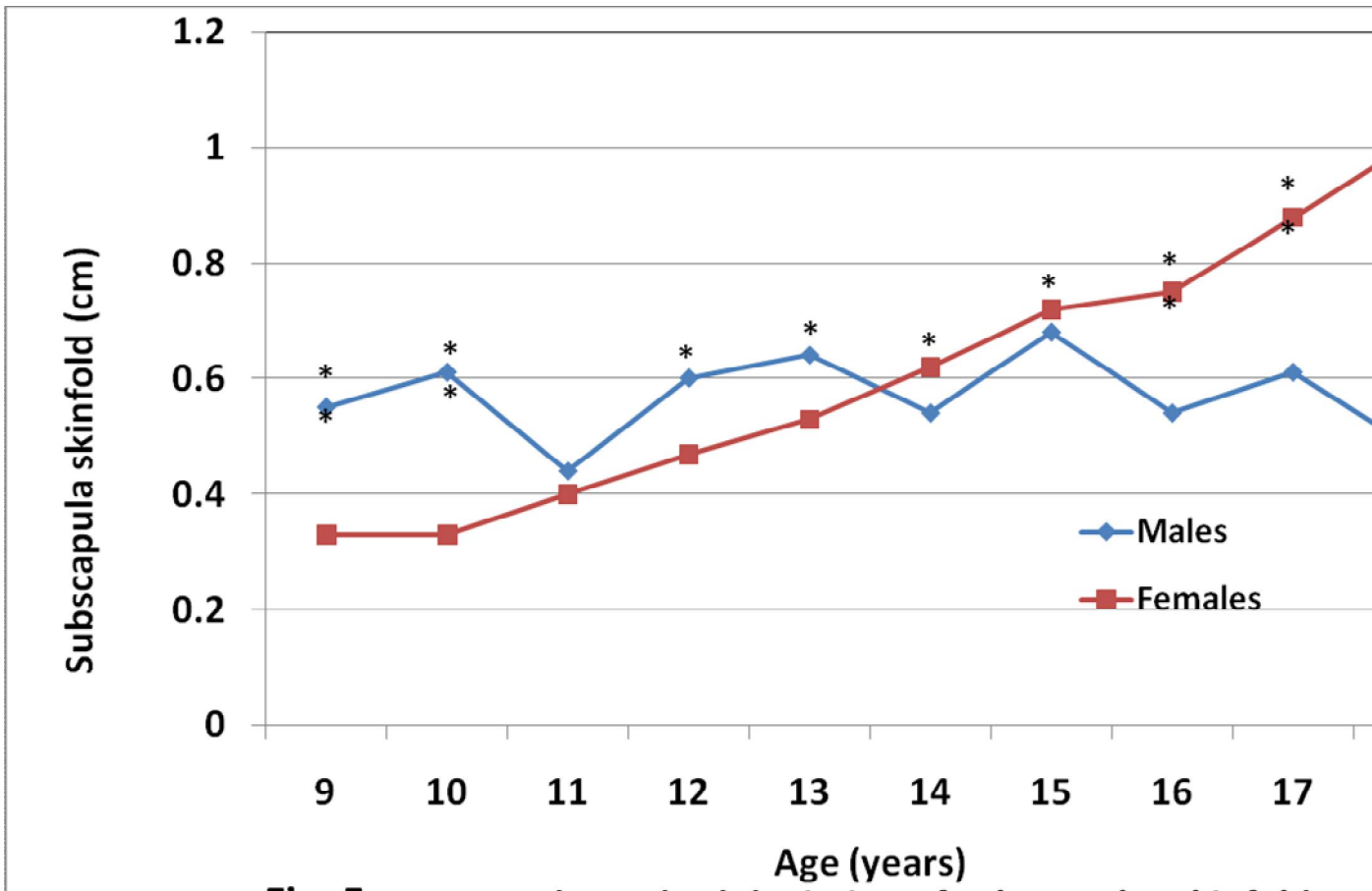


Fig. 5: Mean and standard deviation of subscapular skinfold me
male and female according to age group. * P<0.05, ** P<0.001

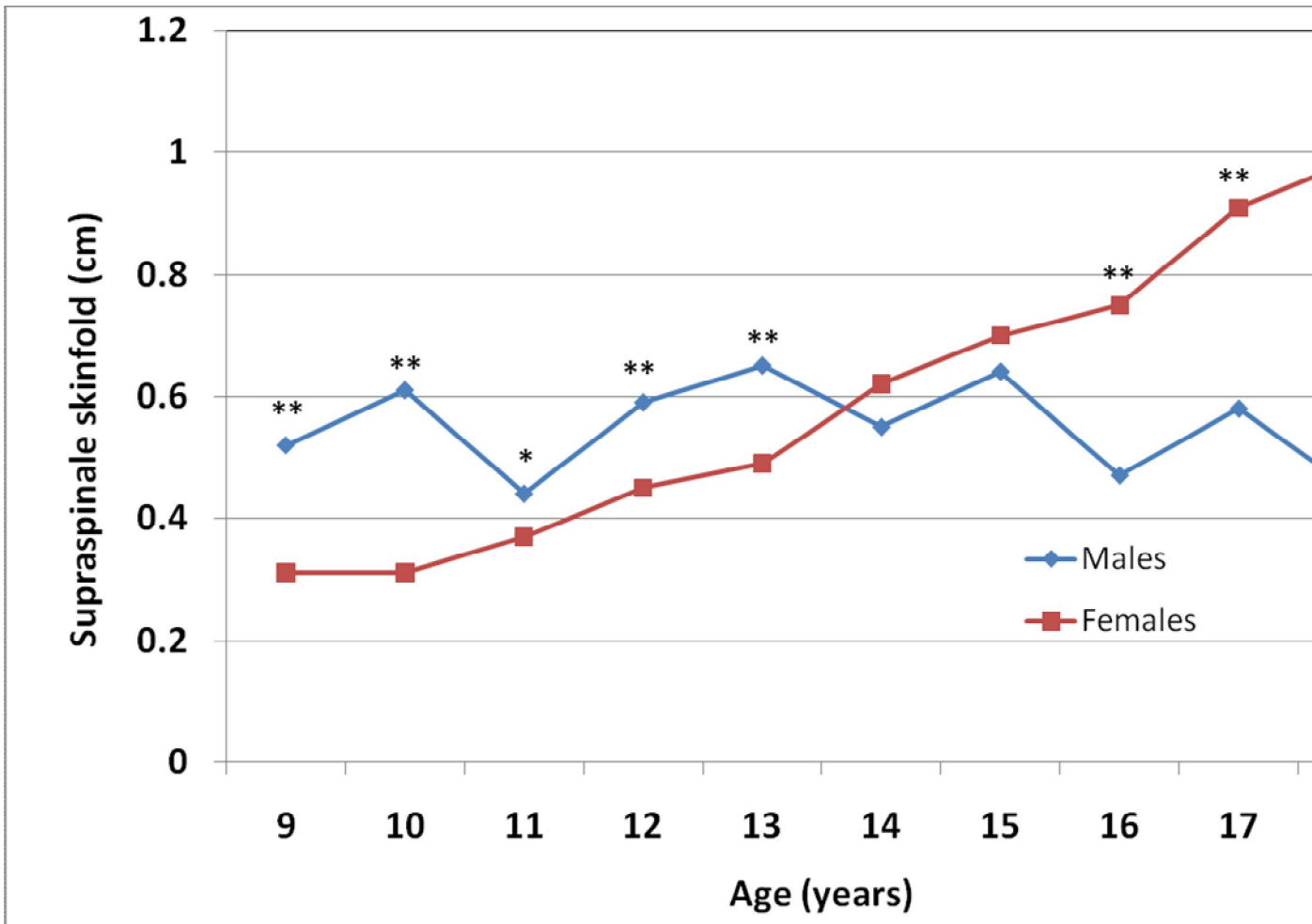


Fig. 6: Mean and standard deviation of supraspinale skinfold me
male and female according to age group. * P<0.05, ** P<0.001

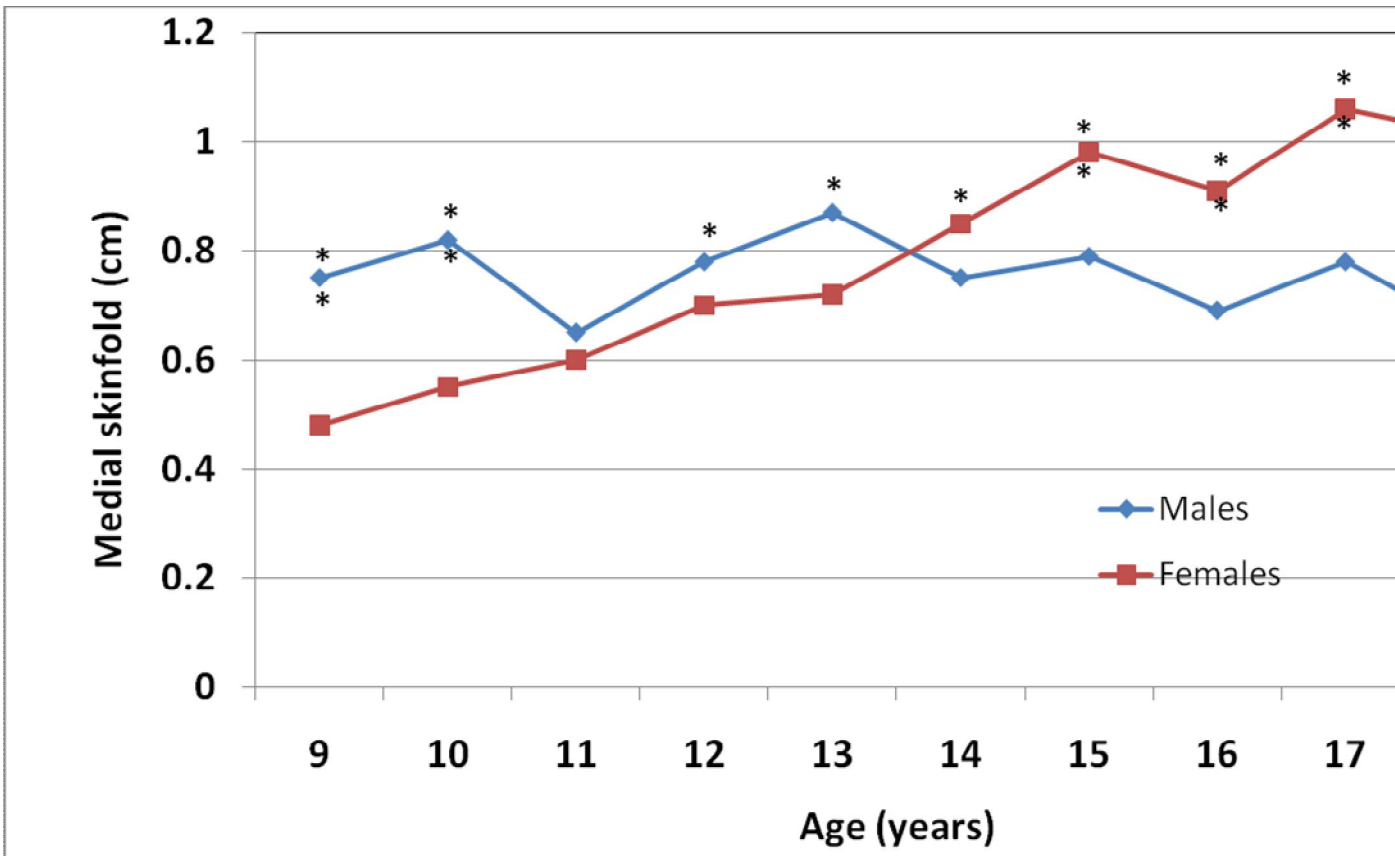


Fig. 7: Mean and standard deviation of medial skinfold measured and female according to age group. * P<0.05, ** P<0.001

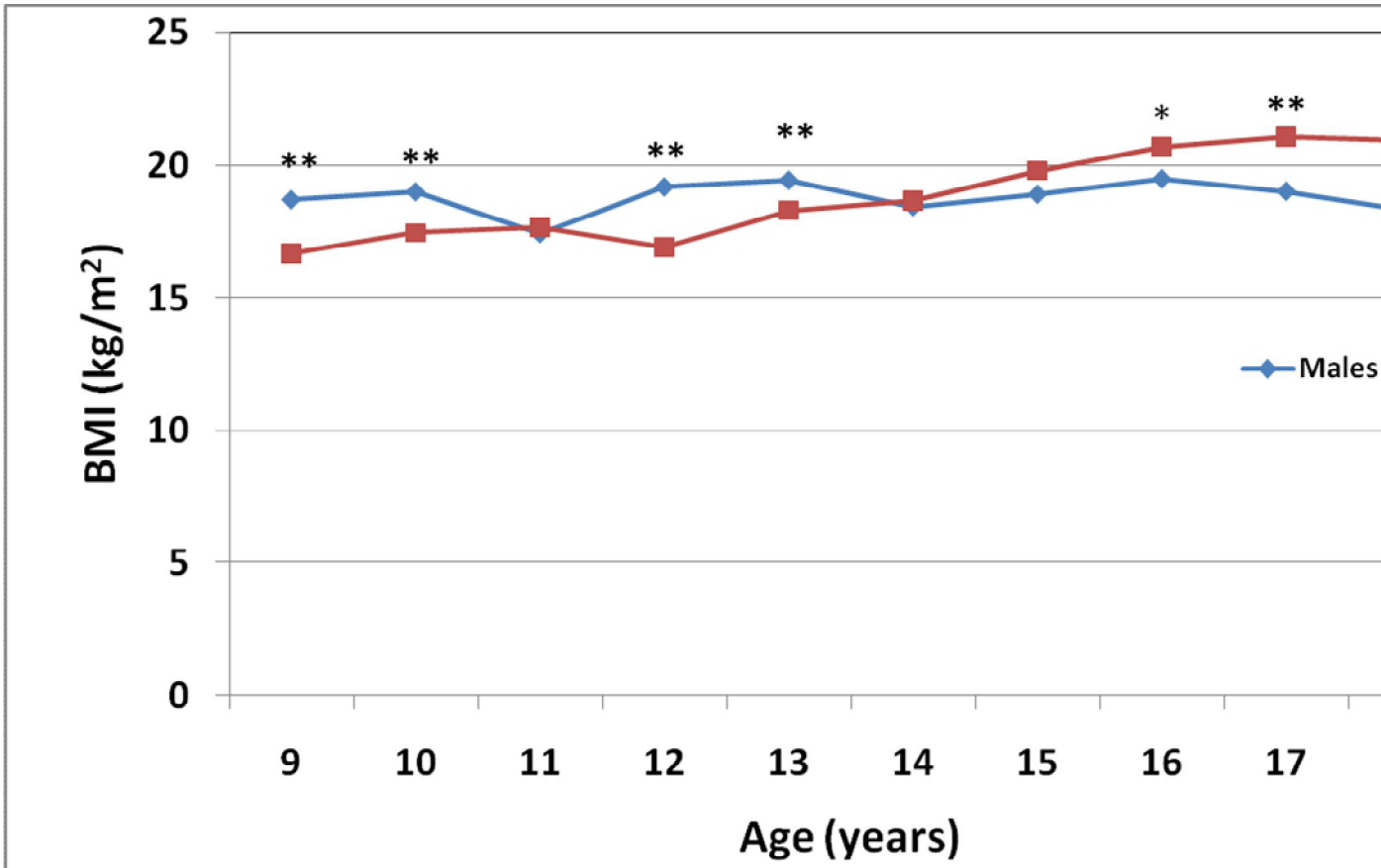


Fig. 8: Mean and standard deviation of Body mass Index among v
age groups in male and female. *P<0.05, ** P<0.001

CHAPTER FIVE

5.0 DISCUSSION

The anthropometric measurements recorded in this study show higher mean values in male than female in most of the parameters considered except the skinfold thicknesses which shows higher mean values for female, the four skinfold thicknesses measured higher in female as at 14 years of age in a linear form which suggest the acquisition of more fat from puberty. In contrast, the skin folds more closely reflect the amount of adipose tissue, but are subject to large measurement errors (Flegal et al., 1990).

The report here is not different from other studies which reported higher values for males (Bailey et al., 1982; Vizmanos et al., 2001). This agrees with the earlier work of Shukla et al., 1977 and Singh et al., 1972. Reports from other studies indicated the same trend of results for males being higher in variables studied even before adult age (Ali and Ohtsuki, 2001; Falk et al., 2001).

The results also revealed that females were both heavier and taller at pubertal stage of development than males. Thereafter, the males then overtook the females in values for the respective anthropometric variables and maintain this lead up to the adolescent. The probable reason for this

female ascendency could be attributed to the fact that on the average, girls began their adolescent growth spurt (which shoots up their growth rate) at an earlier age than do the boys (Shamssain, 1991; Didia and Ogunranti, 1986; Eveleth and Tanner, 1976; Tanner, 1962).

Another interesting thing to note is that the BMI are higher in female (at pubertal and adolescence stage), this is so because there may be an increase in the weight of females due to hormonal influence during puberty. Other investigations showed no significant difference in the height and weight in prepubertal ages but differences begin to set in after puberty (Weitz, 2000; Vizmanos et al., 2001; Sanna and Soro, 2000). These reports were different from that related by Prader (1984), Bailey and Garn (1986) and Tanner (1989) that females are physiologically more matured and skeletally advanced in age than boys.

Only height and weight shows increase with age while other parameters are inconsistent. The females demonstrated higher mean values in weight and BMI at age 14 years, this may be due to the effect of puberty as reported by Frisch (1980, 1987) that females must attain a certain weight to begin reproductive cycles, and BMI is a factor of body weight. Although, normal Body Mass Index was obtained in female at age 16 – 18 years. The relative

weight although easily obtained, reflects bone and muscle mass as well as adipose tissue. Additionally, the body mass index is moderately correlated with height during growth (Garn et al., 1986).

Ethnic differences exist in certain anthropological variables; the study of these phenomena has contributed to our understanding of human biologic variation. In this study, the three Nigerian major ethnic groups (Hausa, Ibo and Yoruba) were investigated and the remaining classified as others. The differences in parameters investigated were noted in the Yoruba and Ibo group which had higher values, whereas the Hausa had the lowest. This may be explained in regard to two factors which are nutritional and genetic (Kouchi, 1983; 2000). There were significant differences in some of the anthropometric variables measured, this suggest significant relationship that exists among various ethnic groups.

Considering the effect of birth order on the physical appreciation of the children, it shows that children born as 1st child have higher mean than others. This could be associated with nutritional status as most of the 1st order children were always given special consideration in terms of feeding and other facilities. The hypotheses tested in this study were all accepted since there are relationships existing in all parameters studied. These

relationships were expected as it was earlier reported by earlier investigations (Kouchi, 1983, 2000) on other populations. Even though there are many factors that might serve as a source of these relationships for instance dietary nutritional factors have been correlated with most of anthropometric variables measured. It could thus, be deduced from this study that a high degree of relationship exists among all the anthropometric variables; hence they are mutually associated to a very high degree.

Generally, lower muscularity was more marked in males than in females, since males at this considered age should normally be involved in more physical activities that build muscles. The males require more muscular effort to build up their muscle content; they were more affected not only by fat deposition but also by loss of muscle content than females. In Nigerians, older age perform most jobs requiring heavy muscular work.

It was clear from this study that growth and maturation of Nigerian children were much more influenced by socio-demographic status has suggested by Ogunranti (1995) on a research conducted on cultural and Biological diversity in medical practice, the mode of life, or in other words, by the "cultural background" of the family (e.g. educational level of the parents) than by the other factors, e.g. genetic endowment. Parents with higher

educational levels tend to live well; their conditions are positive, well – perceptible factors influencing growth and maturation of children. It is obvious that childhood, including prepuberty and puberty, is the most sensitive life – period that could be prone to environmental effects such as socioeconomic factors determined by the educational status of the parents. Several studies have been published in different parts of the world, and in Africa that suggests remarkable differences in the body dimensions and maturity status (Toriola, 1990; Cameron, 1991; Pawloski, 2004).

The Somatotype of Hausa (-0.43 – 2.73 – 7.59), Ibo (-0.43 – 3.34 – 7.35), Yoruba (-0.42 – 3.03 – 7.15) and others (-0.41 – 2.87 – 7.06), show diverse type of body physique towards linearity side. The negative endomorphy component values will become 0.1, Carter (2002) stated that if the calculation for any component is Zero or negative, a value of 0.1 is assigned as the component rating, because by definition ratings cannot be zero or negative. All the ethnic groups have ectomorphic type of body physique with less mesomorphic. The value of the ectomorphy component is higher thus suggesting the greater development of non-essential fat in their body build.

The anthropometric somatotypes of the Nigerian ethnic groups and socioeconomic factors of parental educational level shows ectomorphic component being dominant in all age groups and sex, with few changes from ectomorphic to mesomorphic component. High prevalence of ectomorphic component in the present study indicates their linear physiques. The ethnic groups show lower height – weight ratios than the reference values, therefore, exhibit a more linear or ectomorphic physique than others. This can be attributed to their lower socioeconomic status as Clements and Pickett (1957), reported linear physique of populations belonging to lower socioeconomic on the basis of lower height – weight ratio. Reports from other studies indicated the same trend of results, Singh and Sidhu (1980), Singh and Bhasin (1990), Bhasin and Singh (1991), Singh and Singh (1991) and Bhasin and Singh (1992b) has reported that Indian population groups are ectomorph, endo – ectomorph, meso – ectomorph and balanced ectomorph and their ratings are considerably lower than their western counterparts (Heath and Carter, 1971; Parizkova and Carter, 1976; Singh and Sidhu, 1980; Singh, 1987). The data of the present population also show a similar trend.

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

In conducting this study a number of facts have been established. The dimorphism in the anthropological variables in the population were investigated, with males having higher values than the females. The developmental stages shown attainment of puberty within the range of 13 – 15 years in females and males at a later stage.

Ethnic differences were also seen in the study, with the Yoruba and Ibo ethnic group showing a higher marked difference. The Hausa group had the lowest values on the average. The present study population of Nigerian children shows distinct mean lower mesomorphy values and high ectomorphy ratings in all age groups and sex studied. Overall the children show a lesser musculo – skeletal development and higher linearity. Greater linearity may be attributed to the difference in their gene pools or the environment. This could also be due to the under nutrition and other environmental pressures prevalent in the community as they vastly influence the physique and body composition (Kansal, 1981; Rangan, 1982; Tanner and Whitehouse, 1982; Eiben, 1985).

Socioeconomic status shows differences in the various classes of socioeconomic status, even though the upper socioeconomic class is higher more especially in the children.

6.2 Conclusions

This study has proved the existence of relationship between anthropometric variables and somatotype of all tested hypotheses. It is obvious that childhood, including prepuberty and puberty is the most sensitive life-period for environmental effects like socio-economic factors presented by the parental level of education. Physical activity seems to play a vital role in influencing the development of total body form. Our results once again demonstrated the significance of well-planned and systematic physical education and sports in schools.

The somatotype of Nigerian children from this study shows that the children are ectomorphic dominant than any of the other component.

6.3 Recommendations

Pediatric investigators, in collaboration with social scientists, should develop and apply research methodologies in pediatric research that will result in careful definitions of analysis of interactions among, and, ultimately, documentation of the effects of these variables on child health. Public health

intervention aimed at children and adolescents should help improve dietary habits, encourage physical activities and correct the views on optimal body stature and the somatotype technique could represent a suitable tool for the study and monitoring of these physical variations.

More researches are required in this regard to draw the generalized statements, as distribution of these three somatotype components is area specific, ethnic group specific and nutritional status specific. Negative values obtained for endomorphy component in Nigerian children require an elaborate research studies to find out error that were associated with the result has suggested by Carter (2002).

Also, to create equal chances for growth and physical fitness for children, it is rather an economic and socio-political than a human biological problem. The Biological anthropologist should have an ambition to call the politicians' attention to this problem, to elaborate a better and more equitable distribution, a better and well-considered health and welfare politics as well as a fair youth – politics for a long time.

Furthermore, future studies among various ethnic groups are necessary for understanding the relationship between these ethnic groups. An understanding of ethnic difference in growth is essential to identifying the

extent to which a single reference can be applied worldwide in the field of nutrition, epidemiological and clinical studies.

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APPENDIX

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

RESEARCH PROJECT DATA FORM

RESEARCH TITLE: ***THE STUDY OF SOMATOTYPES AMONG SCHOOL CHILDREN IN ZARIA, NIGERIA.***

BIODATA

- ***Names: ……....***
- ***Name of school: …….***
- ***Date of Birth: ……... Age: ……...***
- ***Birth order: ……... Sex: ……***
- ***Ethnicity: ……... Marital status: ……***
- ***Religious background: ……..***
- ***Father's tribe: …… Father's Occupation: ……...***
- ***Father's level of Education: …… Mother's tribe: ……***
- ***Mother's Occupation: ……. Mother's level of Education: ……***

ANTHROPOMETRY

- ***Weight (kg): …… Calf girth (cm): ……...***
- ***Height (cm): …… Triceps skinfold (cm): ……...***
- ***Biepi. breadth of Humerus (cm): ……. Subscapular S. (cm): …….***
- ***Biepi. breadth of Femur (cm): ……..... Supraspinale S. (cm): ……***
- ***Upper arm girth (cm): …… Medial skinfold (cm): ……....***

SUMMARY

- **X = (Triceps + Subscapular + Supraspinale)Skinfolds x 170.18/ height(cm)**
- **Corrected arm girth = Upper arm girth – Triceps Skinfold.**
- **Corrected calf girth = Calf girth – Medial calf skinfold.**
- **Height-Weight Ratio(HWR) = Height/ (3√ Weight)**
- ***ENDOMORPHY = - 0.7182 + 0.1451(X) – 0.00068(X^2) + 0.0000014(X^3)***
- ***MESOMORPHY = (0.858 x humerus breadth) + (0.601 x femur breadth) + (0.188 x corrected arm girth) + (0.161 x corrected calf girth) – (height x 0.131) + 4.5.***
- ***ECTOMORPHY = 0.732 x HWR – 28.58 (if HWR ≥ 40.75).***
- ***ECTOMORPHY = 0.463 x HWR – 17.63 (if HWR < 40.75 > 38.25).***
- ***ECTOMORPHY = 0.1 (if HWR ≤ 38.25).***

APPENDIX 1: Questionnaire form used for the collection of data