Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi Ethnic Groups of Yakurr Local Government Area of Cross River State, Nigeria

BY

KOKO OTTOH ARIKPO
P15MDHA8020

DEPARTMENT OF HUMAN ANATOMY
FACULTY OF BASIC MEDICAL SCIENCES
COLLEGE OF HEALTH SCIENCES
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

APRIL, 2018

Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi Ethnic Groups of Yakurr Local Government Area of Cross River State, Nigeria

BY

Koko Ottoh ARIKPO, B.Sc. (UNICAL) 2014
P15MDHA8020

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

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN HUMAN ANATOMY

DEPARTMENT OF HUMAN ANATOMY
FACULTY OF BASIC MEDICAL SCIENCES
COLLEGE OF HEALTH SCIENCES
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

APRIL, 2018

DECLARATION

I, KOKO OTTOH ARIKPO declare that the work in the dissertation titled **‘‘Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi Ethnic Groups of Yakurr Local Government Area of Cross River State, Nigeria’’** was carried out by me in the Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Ahmadu Bello University, Zaria. The information used for my literature review was fully acknowledged in the text and references. This dissertation has not been presented in any scientific gathering, neither has it been presented for another degree or diploma at any University.

KOKO OTTOH ARIKPO

______________ ___________

SIGNATURE **DATE**

CERTIFICATION

This dissertation entitled **''Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi Ethnic Groups of Yakurr Local Government Area of Cross River State, Nigeria''**by Koko Ottoh Arikpo meet the regulation governing the award of Master of Science (M.Sc.) degree in Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Ahmadu Bello University, Zaria, under the supervision of **Dr. B. Danborno**and**Dr. J. A. Timbuak.** It is therefore approved for the contribution to knowledge and literary presentation.

Dr. B. Danborno (B.Sc., M.Sc., PhD) __________________ ____________
Chairman, Supervisory Committee Signature Date
Department of Human Anatomy,
Faculty of Basic Medical Sciences,
Ahmadu Bello University

Dr. J. A. Timbuak (B.Sc., M.Sc., PhD) __________________ ____________
Member, Supervisory Committee Signature Date
Department of Human Anatomy,
Faculty of Basic Medical Sciences,
Ahmadu Bello University

Dr. (Mrs.) Z. M. Bauchi (B.Sc., M.Sc., PhD) __________________ ____________
Ag. Head of Department Signature Date
Department of Human Anatomy,
Faculty of Basic Medical Sciences,
Ahmadu Bello University

Prof. S. Z. Abubakar __________________ ____________
Dean School of Postgraduate Studies Signature Date
Ahmadu Bello University

ACKNOWLEDGEMENTS

I heartily give glory to the Almighty God (the great teacher and giver of wisdom) for the inspiration, excellent health and success so far attained and many more to come. Your praise will never cease from my lips (Amen). This dissertation is the result of the generosity of those who have held my hand both literally and figuratively through this process. I pray that someday I may be able to reciprocate some of what you have generously given so freely.

I would like to express my profound and immeasurable gratitude to my supervisor Dr. B. Danborno for his support, counsel, hours of assistance, moral advice, encouragement and consummate professionalism and for putting me through some of the statistical analyses. I am indeed grateful for allowing me to be a beneficiary of your immense intellect, I cannot thank you enough. Dr. J. A. Timbuak always had an open door and great enthusiasm for the work I was doing, I am indebted for being under you because your contributions for the completions of this work had been tremendous.

My special thanks goes to the Ag. Head of Department, Dr. (Mrs.) Z. M. Bauchifor her contributions to knowledge. I also appreciate the efforts of all the postgraduate lecturers of Human Anatomy Department for their dedication, kind attitudes and immense contribution to this work: Dr. B. Danborno, Dr. J. A. Timbuak, Dr. S. A. Musa, Dr. (Mrs.) Z. M. Bauchi,Professor S. S. Adebisi, Dr. I. Iliya, Dr. U. E. Umana, Dr. W. O. Hamman and Dr. A. U. Dahiru.I also wish to thank members of staff of the Department and Faculty at large; I really learnt a lot from each and every one of you.

My invaluable gratitude goes to all my classmates: Abdulateef Yusuf, Raji Kazeem, Iorwese Mtonga, Barka Ishaku, Abdulateef Babatunde, Yomi Samson, Shadrack Kenis, Francis Mishelia, Mascot Omini, who have always been a source of challenge to my academic ability, bravo to you all, keep the flag flying.

My sincere thanks goes to all students from Cross River State School of Nursing, Itigidi, All Saints' Presbyterian Academy, Ugep and non-students who participated willingly from the various communities I went to conduct this research, as well as all the staff and relevant authorities who showed strong cooperation and eagerness to participate in the research. I am also grateful to all individuals who selflessly participated in this study as subjects. My unreserved thanks also goes to my research assistants especially, Fatima Utum, Otu Eteng, Philip Patrick, Ezai Patrick and Okoi Onun, who were initially trained on how to execute the measurements, proforma administrations and data gathering. My appreciation also goes to all who made suggestions and constructive criticism during the course of this work because this has brought the work to its success.

Finally, I am particularly grateful to my father, mother and sister, Mr. Arikpo Ottoh Arikpo, Mrs. Mercy Arikpo Ottoh and Vera Arikpo Ottoh who have invested so much in me and made my achievements in life a reality. I will never put down my pen without mentioning you, Prof. A. O. Igiri, Dr. E. C. Ikechukwu (Mrs), Dr. Ruku Ubom and Mr. Uruakpa Kelechi, for the lifetime of encouragement you have given me and the fine example you have provided, both of which have supplied me with the strength and fortitude necessary to follow my dreams. And to all my relatives, family and friends for their supports, prayers and encouragement.

It is virtually impossible for me to thank individually all the good people out there who in one way or the other contributed to the success of this work, I say thanks to you all. You have made my journey successful and pleasurable. This is a time I shall never forget and I will always carry a part of you with me as my career advances.

DEDICATION

This dissertation is dedicated to the Almighty God for his special grace and providence. To my parent Mr. Arikpo Ottoh Arikpo and Mrs. Mercy Arikpo Ottoh for their love, encouragement and support towards my academic pursuits.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF PLATES

ABSTRACT

Stature prediction occupies relatively a central position in anthropometric research. Estimation of stature of an individual from the mutilated or amputated limbs has obvioussignificance in the personal identification, in the events of murders, accidents or natural disasters. This study aimed at determining the anthropometric parameters and estimationof stature for both males and females using anthropometric parametersin four different ethnic groups (Lokaa, Ayiga, Agoi and Ekoi) of Yakurr Local Government Area of Cross River State. Investigate sexual dimorphism in anthropometric parameters inthe ethnic groups studied, determine the relationship between stature and demi span, biaxillary, neck, hand, finger, thigh, leg and foot lengths, neck, chest, waist, hip, thigh and calf circumferences and sitting height in the ethnic groups studied and to generate formulae of stature estimation for both males and females using anthropometric measurements of some length parameters for the study population, in order to establish a reference data base for the relationship between anthropometric length variables considered in this study and stature in the four ethnic groups, as height equations are population specific. This study was carried out to determine the reliability of anthropometric parameters in estimating stature in Yakurr L.G.A. of Cross River State population. A cross sectional study was conducted and the subjects comprised 800 adult indigenes (400 males and 400 females) of Cross River State between the ages of 18 and 32 years drawn from the four ethnic groups Lokaa, Ayiga, Agoi and Ekoi of Yakurr L.G.A. Ethical clearance was obtained from the Health Research Ethics Committee on Human Subjects of the Ahmadu Bello University Zaria and self-administered proforma was used which were completed by the enumerators. Body anthropometrics were measured using stadiometer and measuring tape from which BMI was calculated. The study showed that the overall mean age of the subjects was 24.75 ± 4.05 years. The average ages of the subjects from Agoi, Ayiga, Ekoi and Lokaa ethnic groups were 24.26

± 4.35, 25.72 ± 3.58, 24.78 ± 4.21 and 24.23 ± 3.85 years respectively. The mean height of the overall sample population was 165.70 ± 6.26 cm, with a mean height for males and females 169.11 ± 5.50 cm and 162.29 ± 4.99 cm respectively. The mean height for Agoi, Ayiga, Ekoi and Lokaa ethnic groups were 162.61 ± 4.87, 166.00 ± 7.29, 167.15 ± 6.03 and 167.04 ± 5.53 cm respectively, indicating that the subjects from Ekoi ethnic group are significantly taller in height when compared to subjects from Agoi, Ayiga and Lokaa ethnic groups. The was a statistically significant ($P < 0.001$) difference in anthropometric parameters between male and female.Also, males showed higher correlation between measured variables and stature compared to females. Linear regression models for stature estimation from anthropometric variables of each ethnic group were generated. Sitting height, thigh length, leg length, demispan length and hand breadth and combination could be applied for height estimation in Yakurr adult's population, although sitting height had the highest precision as single prediction parameter.

The present study could be of immense benefit to forensic anthropology,establishing ancestral relationship and stature estimation among adultmale and female of the four ethnic groups of Yakurr of Cross River State in south-south of Nigeria.

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Stature (height) has been reported as one of the most important anthropometric parameters which determines the physical identity of an individual (Ozaslan *et al*., 2006). Because of this, the reliability of stature estimation from upper extremity measurements as well as lower extremity and other body segments has been documented. The usefulness of this, is continually been applied in forensic medicine (Kanchan *et al.,* 2008) clinical practice, anthropology, and other medical sciences (Krishan and Vij, 2007).

Estimation of stature has a significant importance in the field of forensic anthropometry. To assess the height of an individual, from measurements of different parts of the body, has always been of immense interest to anatomists, anthropologists and forensic experts (Danborno *et al.,* 2009).Physical anthropologists have been mainly concerned with the study of the human origin and human evolution as well as the varieties of mankind in different parts of the world (Duyar and Pelin, 2003). Estimation of stature of an individual from the skeletal material or from the mutilated or amputated limbs or parts of limbs has obvious significance in the personal identification, in the events of murders, accidents or natural disasters mainly concerns with the forensic identification analysis (Ozaslan *et al*., 2003). Stature along with age, race and gender, the big four parameters, are considered to develop the anthropometrical databases, these data can confirm the process of identification (Ekezie *et al.,* 2015).

The relationship between specific body dimensions /proportions can be used to help solve crimes in the absence of complete evidence. For example, it has been proved that stature can be estimated from imprints of the hand, foot or footprints or from a shoe left at the scene of a crime (Hairunnisa, 2014). Similarly, the stature of a victim can be estimated when a part of body, such as a long bone, or hand, is all that remains. Relationships between body parameters vary from population to population and ethnic origin to ethnic origin due to differences in nutrition and levels of physical activity (Hairunnisa, 2014).

Anthropometric technique commonly used by anthropologists and adopted by medical scientists has been employed to estimate body size for over a hundred years (Ozaslan *et al.*, 2003). Stature provides insight into various features of a population including nutritional health and genetics. Stature is considered as one of the parameters for personal identification (Anite, 2007).

Estimation of stature is considered to be an important assessment in the identification of unknown human remains. The hand bones have been recognized as good anthropometric parameters and have been shown to exhibit sexual dimorphism. A study was carried out by Numan *et al*. (2013) on estimation of stature from anthropometric measurement of hand in three major ethnic groups in Nigeria. Other studies involving Nigerian populations were carried out by Danborno and Elukpo (2008) who estimated stature in Northern Nigerian subjects when they used the dimensions of hand.

In forensic investigations, the dimensions of the hand and foot have been used in the determination of sex, age, and stature of an individual. Stature reconstruction is important as it provides forensic anthropological estimation of the height of a person in the living state which plays a vital role in the identification of individual remains (Bhatnagar *et al*., 1984; Boldsen, 1984). Intact long limb bones have been used in the derivation of regression equations for stature assessment in different population groups. Anthropologists observe and compared the relation between body and segments to highlight variations between and within groups. Determination of stature is a major concern in forensic medicine and forensic anthropology (Fessler *et al*., 2005). The bone area values at different sites strongly correlates to muscle strength and also correlate to body size, height, weight, lean mass, fat mass and body mass index (BMI) (Fessler *et al*., 2005). It is commonly accepted that standards for skeletal identification vary among different populations and the standard for one population may not be used for another (Thakur and Rai, 1987; Iscan, 1988).

In the last half of the 20th century, studies have been more vigorous when skeletal collections have been assembled in many parts of the world (Ozaslan *et al.*, 2003). There has been an increase in the frequency of various mass disasters (air and train crash, bombing, mass suicide, flooding, powerful storm). To the list one should add the more recent tragedies such as the Marmara earthquake, Turkey and the attack on the World Trade Center and Pentagon in the US where thousands of people were killed (Ozaslan *et al*., 2003).

The hand length was found to be the most reliable alternative and the hand can be used as a basis for estimating age-related loss in height. The length of the body while alive is one of the key parameters established in the course of identification of unknown skeletal remains (Auberch and Ruff, 2004; Hauser *et al*., 2005).

Hand length could be used to predict body weight status and body surface area independent of the sex of the individual (Bidmos, 2009). Correlation between hand length and foot length has also been studied and that if the hand length is known, the foot length can be predicted and vice-versa. Hand length has been shown to be a reliable and precise means in predicting the height of an individual (Gauld and Rakhir, 1996: Ebite *et al*., 2000).

Establishing personal identification of victims is often required and the estimation of stature from extremities and their parts plays an important role in identifying the dead in forensic examinations (Nath *et al.*, 1998; Munoz *et al.*, 2001). The reconstruction of stature has been a subject of study since the beginning of the 19th century in the specialized areas of forensic anthropology which deals with the application of methods and techniques of analyzing skeletal remains (Trotter and Glesser, 1951; Iscan, 1988; Iscan, 2001).

It is already well known in scientific literature that the measurement of body height is important in many settings: it is an important measure of body size and gives an assessment of nutritional status (Datta, 2011), as well as an important measure of determination of basic energy requirements, standardization of measures of physical capacity and adjusting drug dosage, and evaluation of children's growth, prediction and standardization of physiological variables such as lung volumes, muscle strength, glomerular filtration and metabolic rate etc. (Mohanty *et al*., 2001; Golshan *et al*., 2003; Golshan *et al*., 2007; Ter Goon *et al*., 2011). However, the exact body height cannot always be determined the usual way because of various deformities of extremities or in patients who have undergone amputations or similar injuries. In such circumstances, an estimate of body height has to be derived from other reliable anthropometric indicators such as hand and foot lengths (Sanli *et al*., 2005; Agnihotri *et al*., 2007; Agnihotri *et al*., 2008; Kanchan *et al*., 2008b; Rastogi *et al*., 2008), knee height (Hickson and Frost, 2003; Fatmah, 2010; Karaday *et al*., 2012), length of the forearm (Ilayperuma *et al*., 2010), sitting height (Fatmah, 2010), arm span (Aggrawal *et al*., 2000; Bjelica *et al*., 2012). Therefore, all these anthropometric indicators which are used as an alternative to estimate body height are very important in predicting age-related loss in body height. Also in identifying individuals with disproportionate growth abnormalities and skeletal dysplasia or body height loss during surgical procedures on the spine (Mohanty *et al*., 2001), as well as predicting body height in many older people as it is very difficult to measure it precisely, and sometimes impossible because of mobility problems and kyphosis (Hickson and Frost, 2003). However, the associations of arm span and body height was found to vary in different ethnic and racial groups (Bjelica *et al*., 2012; Popovic *et al*., 2013).

1.2 STATEMENT OF RESEARCH PROBLEM

There is a need to have representative anthropometric data for all ethnic groups. While this exists for some, there is paucity of data on Lokaa, Ayiga, Agoi and Ekoi ethnic groups of Cross River State. This work is a step to bridge that gap and stimulate further research. The use of hand lengths, foot lengths and other body dimensions to predict stature has not been reported for the Yakurr population of Cross River State. Cross River has different ethnic groups with the major ones Efik, Ejagham, and Bekwarra, all the three ethnic mainly located in the three senatorial districts namely Southern, Central, and Northern, respectively. When available literature was searched, it was discovered that there was no published literature on estimation of stature in Yakurr indigenes ofCross River State using hand dimensions and other body segments. Thus, the main aim of this work was to establish the standards for stature estimation in indigenes of Yakurr, Cross River State by obtaining population- specific regression equations which can be used for estimating stature from anthropometric measurement of the hand, leg, foot and other body segments.

1.3 JUSTIFICATION/ SIGNIFICANCE OF STUDY

This study could provide anthropometric data on the various ethnic groups of Yakurr. Comparisons made with other populations could contribute to the understanding of the relative status of Yakurr population in the context of the anthropometric variations around the world. In forensic anthropology, this study can be used by law enforcement agents and forensic scientists to identify fragmentary and dismembered human remains in Nigerian adults of Yakurr descent of Cross River State. This study can also help in prediction of heights of Yakurr tribe of Cross River State.

1.4 AIM AND OBJECTIVES OF THE STUDY

1.4.1 Aim of the Study

The aim of this study was to determine the anthropometric parameters and estimate stature using anthropometric parametersin four different ethnic groups (Lokaa, Ayiga, Agoi and Ekoi) of Yakurr Local Government Area (LGA) ofCross River State, Nigeria.

1.4.2 Objectives of the Study

The objectives of this study were to:

i. determine some anthropometric parameters in Lokaa, Ayiga, Agoi and Ekoi ethnic groups of Yakurr Local Government Area of Cross River State, Nigeria.
ii. investigate sexual dimorphism in anthropometric parameters of Lokaa, Ayiga, Agoi and Ekoi ethnic groups in Yakurr Local Government Area of Cross River State, Nigeria.
iii. determine the relationship between stature and some anthropometric parameters in Lokaa, Ayiga, Agoi and Ekoi ethnic groups of Yakurr Local Government Area of Cross River State, Nigeria.
iv. generate predictive equations for stature estimation for the study population.

1.5 RESEARCH HYPOTHESES

In order to investigate the above listed objectives, the following working hypotheses were proposed:

i. demi span, hand, finger, leg, foot, neck, thigh, biaxillary lengths and sitting height will strongly predict stature in both males and females in the ethnic groups studied.
ii. predictive equation generated will differ in the ethnic groups studied.

2.0 LITERATURE REVIEW

2.1 Historical Background of Stature Estimation

Variation is one of the most important phenomena occurring in humans, and it has been attributed to a number of factors such as mutation and natural selection. Many studies have emphasized the importance of anthropometric measurements as a means of studying variation in human populations as well as an important tool in forensic science for crime detection. In the 20th century, the application of anthropometry to the study of racial types was replaced by more sophisticated techniques for evaluating racial differences. Recently, anthropometry has found increase use in medical sciences especially in the discipline of forensic medicine (Ozaslan *et al.,* 2003).

Estimation of the body size such as height and weight are required for assessment of growth, nutritional status, calculating body surface area and predicting pulmonary function of children (Amirsheybani *et al*., 2000; Gauld and Rakhir, 2004). Measurement of height is important for determination of basic energy requirement, standardization, and measures of physical capacity and for adjusting drug dosages (Jalzem and Gledhil, 1993). However, in some situations the exact height cannot be determined directly because the patient is unable to stand as a result of neuromuscular weakness, deformities of axial skeleton such as kyphosis, lordosis, scoliosis, loss of lower limbs and in patients who have undergone amputations (Duyar and Pelin, 2003; Duyar *et al*., 2006). In such patients, height does not reflect the body size and the use of height measurements in prediction equation is likely to produce error. For example, in scoliosis patients, the predicted spirometric values were underestimated when the measured body was used and under such circumstances, an estimate of height has to be computed based on another body parameter (Amirsheybani *et al*., 2001, De Mendonca, 2000).

The hand length was found to be the most reliable alternative and the hand can be used as a basis for estimating age-related loss in height. The length of the body while alive is one of the key parameters established in the course of identification of unknown skeletal remains (Auberch and Ruff, 2004; Hauser *et al*., 2005). Stature provides insight into various features of a population including nutritional health and genetics. Stature is considered as one of the parameters for personal identification (Anite, 2007).It is commonly accepted that standards for skeletal identification vary among different populations and the standard for one population may not be used for another (Thakur and Rai, 1987; Iscan, 1988).

Hand length could be used to predict body weight status and body surface area independent of the sex of the individual (Bidmos, 2009). Correlation between hand length and foot length has also been studied and that if the hand length is known, the foot length can be predicted and vice-versa. Hand length has been shown to be a reliable and precise means in predicting the height of an individual (Gauld and Rakhir, 1996: Ebite *et al*., 2000).

Jasuja *et al.* (1991) collected data from 256 adult males from different villages of Patiala district of Punjab. They measured their stature, foot length, foot breadth, shoe length and shoe breadth and derived multiplication factors from these measurements to calculate stature from the foot and shoe measurements. They also revised these multiplication factors to reduce error.

Nath and Chug (2002) made an attempt to formulate regression formulae for estimation of stature from hand and foot lengths among male and female Brahmins of Sundernagar of Himachal Pradesh. They derived regression formulae for reconstructing height from hand length and foot length for males and females separately.

A study was carried out on 203 adult male and 108 adult female Turks by Ozaslan *et al*. (2003) correlating the various lengths of the lower extremity and stature which showed a good correlation between lower limb measurements and stature. The correlation coefficient between stature and various parameters studies were 0.74 in males and 0.79 in females for leg length, 0.82 in males and 0.86 in females for thigh length, 0.86 in males and 0.83 in females for foot length, 0.86 in males and 0.87 in females for foot height.

Fessler *et al.* (2005) examined the data available from two previous anthropometric studies (Davis, 1984; Ozaslan *et al.*, 2003) and foot tracings of Steggerda collection at US National Museum of Health and Medicine and explored sex differences in the ratio between foot length and stature. They concluded that although varying in degree, across populations, proportionate to stature, female foot length was consistently smaller than male foot length.

Patel *et al*. (2007) conducted a study based on measurements of foot length and body height of 502 students between 17-22 years of age (278 males and 224 females) belonging to Gujarat region. A good correlation of height was observed with foot length which was statistically significant (r = 0.65 for males and 0.80 for females). They also derived regression equations to calculate height from foot length. (H= 75.45 + 3.64FL for males and H = 75.41 + 3.43FL for females).

Agnihotri *et al*. (2007) conducted a study to develop relationship between foot length and stature regression models. Measurements of foot length and stature were taken from 250 medical students (125 males and 125 females) aged between 18-30 years of Mauritius.

The correlation coefficient obtained was r ɑ = 0.72 in males and 0.61 in females. The regression equations were H = 68.59 + 4.04 FL in males and H = 77.06 + 3.54 FL in females.

In a study, attempts were made by Krishan, (2008) to reconstruct stature in a sample of footprints and foot outlines obtained from 1040 Gujjars of North India ranging from 18-30 years. The study showed significant and positive correlation to exist between stature and various measurements of footprints and foot outline.

Jaydip and Shila (2008) conducted a study on the Rajbanshi population of North Bengal by measuring the foot length, foot breadth and stature of 350 individuals (175 males and 175 females). They found that there was a correlation between foot measurements and stature. They also found a higher correlation between foot length and stature (correlation coefficient r= 0.62 for males and 0.68 for females) than foot breadth and stature (correlation coefficient r= 0.52 for males and 0.39 for females).

Kanchan *et al.* (2008) studied the relationship between stature and foot dimensions among Gujjars, a North Indian endogamous group. They measured stature, foot length and foot breadth of 200 subjects comprising of 100 males and 100 females. Their study showed that correlation coefficients between stature and foot dimensions were positive and statistically significant. The highest was correlation coefficient between stature and foot length in males and foot breadth and stature in females. They derived multiplication factors and regression equations from foot dimensions to estimate stature.

Krishan (2008) in his study made an attempt to examine the relationship of stature to foot size in 1040 adult male Gujjars of North India aged from 18-30 years. He measured the distance from most prominent point on the heel to anterior most point on each of the toes. He also measured foot breadth at heel and at ball. He derived stature from foot and its segments by using division factor method and regression analysis.

Gulsah *et al.* (2008) conducted a study to estimate stature and gender using foot measurements. The study population included 249 adults (113 females and 136 males) aged between 18-44 years born in Turkey. They found highest correlation to be between foot length and stature than other foot measurements. The correlation coefficient found for various foot measurements with height were 0.87 in males and 0.71 in females for foot length, 0.70 in males and 0.23 in females for foot breadth, 0.64 in males and 0.26 in females for malleolar height and 0.68 in males and 0.35 in females for navicular height.

Danborno and Elukpo (2008) conducted a study using foot and hand lengths to establish sexual dimorphisms and to estimate stature. The study group comprised of 400 Nigerian students selected randomly including 250 males (mean age 24.50 ± 2.82) and 150 females (mean age 22.22 ± 1.99). They concluded that height could be predicted accurately from combination of hand and foot lengths and also showed sexual dimorphism in foot and hand length indices and stature ratios.

Various anthropometric measurements such as body mass index (BMI), waist circumference (WC), waist hip ratio (WHR), waist height ratio (WHTR) and various skin fold thicknesses have been studied in relation to the health and nutritional status of individuals. (Cox and Whichelow, 1996; Lahti-Koski *et al.,* 2000; Teixeira *et al.,* 2001; Despres *et al.,* 2001). A number of associations have also been established between these body ratios and dimensions with health and nutritional status (Anyanwu *et al.,* 2007). Vague (1956) was the first to make association between body dimensions and health risks associated with obesity. Obesities in the various regions of the body can be assessed using some of these ratios and measurements. Some of these ratios have been proved to predict adiposity in certain regions of the body more than the others. Where total adiposity index is accessed better, using body mass index, (Ben-Noun and Laor, 2003), upper body obesity is assessed using neck circumference (NC), waist circumference (WC), waist-to-hip ratio, abdominal sagittal diameter and subscapular, and triceps skin fold thicknesses, (Kissebach *et al.,* 1982; Sjostrom *et al.,* 1995; Sjostrom *et al.,* 1997; Jensen, 1997; Ben-Noun and Laor, 2003) and lower –body obesity is accessed using thigh circumference (Heitmann and Frederiksen, 2009). Heitmann *et al.* (2004) in their ground breaking study; 'Thigh circumference and risk of heart disease and premature death: prospective cohort study', concluded that a low thigh circumference seems to be associated with an increased risk of developing heart disease or premature death.

Bhavana and Nath (2009) recorded stature, femur length, tibial length, fibular length, foot length and foot breadth in Shia Muslims (503 males and 508 females) within the age group of 20-40 years. Analysis of the study revealed that tibial length amongst males exhibited the overall highest value of correlation with stature (r= 0.77), while among females' femur length exhibited the highest value of correlation (r= 0.74) with stature. However, the foot breadth exhibited the lowest correlation with stature in case of both males and females.

Investigators have also used other parameters to estimate stature which include head lengths, hand lengths, and breadths, phalangeal lengths, vertebral column lengths (Nagesh and Pradeep, 2006), skull measurements (Bidmos and Asala, 2005; Bidmos, 2006), measurements of bones of the upper limb like humerus, radius and ulna, lower limb bone lengths like femur, tibia, fibula, calcaneus (Bidmos, 2006), metatarsals, measurements of sacrum, coccyx and sternum. These studies were conducted on skeletons, cadavers, and living subjects by somatometric measurements, and radiographic measurements of different population groups (Bhavana and Nath, 2009).

Hand anthropometry measurements, relevant to the design of hand tools and other manual devices, have been published for various nationalities, such as ethnic Vietnamese living in USA (Imrhan *et al.,* 1993), United Kingdom females (Davies *et al.,* 1980), Hong Kong Chinese females (Courtney, 1984), Indian agricultural workers (Karunanithi *et al.*, 2001), Western Nigerian rural farm workers (Okunribido, 2000), Eastern Indians (Kar *et al.,* 2003), Central Indian farm workers (Gite and Yadav, 1989), Mexicans (Imrhan and Contreras, 2005), Bangladesh females (Imrhan *et al.,* 2005), Bangladesh males (Imrhan *et al*., 2006), and few hand anthropometric dimensions has also measured for Filipino manufacturing workers (Del Prado-Lu, 2007). In an effort to account for the effects of the differences in anthropometric dimensions between people of India and Western Europe noted by Sen *et al*. (1977) and Gupta *et al*. (1983), Kar *et al*. (2003) have compiled data on eight important hand dimensions from eastern India to influence the design of agricultural equipment.Similarly, Okunribido, (2000) have compiled data on 18 hand dimensions from rural farm workers in Ibadan, Nigeria, to enable better fitting manual farming equipment. The data from both studies indicate relatively large differences compared to other nationalities. Few hand anthropometric dimensions have been measured for the north eastern region of India; the analysis shows that significant differences exist between male farmers in north east India and those of the central, eastern, southern, and western regions of India (Dewangan *et al*., 2005). Therefore, significant differences in hand dimensions may also exist between groups within a nation.

The importance of hand anthropometric measurements is further emphasized in its use, sometimes with other variables, in the development of predictive models of other body dimensions and hand strength-predicting hand length and grip strength (Nag *etal.*, 2003), predicting stature (Krishan and Sharma, 2007), predicting peak pinch strength (Eksioglu *et al.*, 1996), and predicting grip strength and endurance (Nicolay and Walker, 2005) using different methodologies, such as neuro-fuzzy and artificial neural networks, simple linear regression, and multiple linear regression. A comparison has even been performed between an artificial intelligence method known as ‘‘adaptive neuro-fuzzy inference system’’ and multiple regression analysis for estimating certain hand dimensions including those of the hand (Kaya *et al*., 2003).It is already well known in scientific literature that the measurement of body height is important in many settings: it is an important measure of body size and gives an assessment of nutritional status (Datta, 2011), as well as an important measure of determination of basic energy requirements, standardization of measures of physical capacity and adjusting drug dosage, and evaluation of children’s growth, prediction and standardization of physiological variables such as lung volumes, muscle strength, glomerular filtration and metabolic rate etc. (Mohanty *et al*., 2001; Golshan *et al*., 2003; Golshan *et al*., 2007; Ter Goon *et al*., 2011). However, the exact body height cannot always be determined the usual way because of various deformities of extremities or in patients who have undergone amputations or similar injuries. In such circumstances, an estimate of body height has to be derived from other reliable anthropometric indicators such as hand and foot lengths (Sanli *et al*., 2005; Agnihotri *et al*., 2007; Agnihotri *et al*., 2008; Kanchan *et al*., 2008; Rastogi *et al*., 2008), knee height (Hickson and Frost, 2003; Fatmah, 2010; Karaday *et al*., 2012), length of the forearm (Ilayperuma *et al*., 2010), sitting height (Fatmah, 2010), arm span (Aggrawal *et al*., 2000; Bjelica *et al*., 2012). Therefore, all these anthropometric indicators which are used as an alternative to estimate body height are very important in predicting age-related loss in body height. Also in identifying individuals with disproportionate growth abnormalities and skeletal dysplasia or body height loss during surgical procedures on the spine (Mohanty *et al*., 2001), as well as predicting body height in many older people as it is very difficult to measure it precisely, and sometimes impossible because of mobility problems and kyphosis (Hickson and Frost, 2003). However, the associations of arm span and body height was found to vary in different ethnic and racial groups (Bjelica *et al*., 2012; Popovic *et al*., 2013).

2.2 THE ESTIMATION OF STATURE FROM LENGTH PARAMETERS OF THE BODY

2.2.1 Demispan Length

Demi-span (defined as the distance between the mid-point of the sternal notch and the tip of the middle finger with the arm outstretched laterally) has been included in most years of the Health survey for England (HSE), because it can be easily measured without causing discomfort or distress, and is more reliable than other surrogate measures in assessment of nutritional status in adults (Chumlea *et al*., 1985; Cockram and Baumgartner, 1990; de Lucia *et al*., 2002), and is considered a better measure for assessing BMI (Hirani and Mindell, 2008). For this, a demi-span equivalent height (DEH) using the equations developed by Bassey (1986) can be used in BMI calculation.

The Bassey equations (Bassey, 1986) are limited in usefulness for estimating maximal adult standing height from the demi-span measurement, because they are derived from a small sample of young adults (125 people). The equations were derived to be sex specific, but not age specific. New equations have been developed (Weinbrenner *et al*., 2006) to predict current height in older people based on an elderly Spanish population.

Mean height has increased by 0.3-3.0 cm/ decade over the last century (Cole, 2000; Cavelaars *et al*., 2000). For example, a 1-cm leg length difference has been reported between members of the 1946 and 1958 birth cohorts (Li *et al*., 2008). This marked cohort effect means that DEH equations need to be updated for subsequent cohorts. New and potentially more robust equations can be derived using height and demi-span data from a large sample of young adults to estimate maximal height from demi-span (Hirani *et al*., 2010).

Ngoh *et al*. (2012) reported in their study of demi-span equations for predicting height among the Malaysian elderly that the regression equations for height estimation was; Men: Height (cm) = 67.51 + (1.29 × demi-span) - (0.12 × age) + 4.13; Women: Height (cm) = 67.51 + (1.29 × demi-span) - (0.12 × age) . The sample consisted of 328 Malaysian elderly, of whom 204 were men (62.2%) and 124 women (37.8 %); 167 were Malays (50.9 %), followed by 108 Chinese (32.9 %) 53 Indians (16.2 %). The mean (SD) age was 71.5 (7.4) years for men and 71.5 (8.1) years for women (age range: 60-97 years). For men, mean (SD) height was 159.9 (6.7) cm and mean demi-span was 75.0 (3.8) cm; and for women the mean (SD) height was 147.4 (6.9) cm and mean (SD) demi-span was 68.5 (4.3) cm. Pearson's correlation analyses revealed that there was a strong, positive association between height and demi-span in both genders ($r = 0.76$ for men and $r = 0.80$ for women). However, age was weakly and negatively associated with height and demi-span in both genders he also added that; an examination of scatter plots and regression lines revealed a linear relationship between height and demi-span, it was evident in this study that; multiple linear regression analysis revealed that demi-span, gender and age contributed significantly to the prediction of height ($p < 0.05$). However, ethnicity did not make a statistically significant contribution to the prediction of height ($p > 0.05$) in his study and was therefore removed from analysis. He further argued that;

The resulting regression equation was found to be valid for both genders: height (cm) = 67.51 + (1.29 × demi-span) + (4.13 × gender) - (0.12 × age), therefore the height predicted from these new equations demonstrated good agreement with measured height and no significant differences were found between the mean values of predicted and measured heights in either gender ($p > 0.05$). However, the heights predicted from previous published adult-derived demi-span equations failed to yield good agreement with the measured height of the elderly; significant over-estimation and under-estimation of heights tended to occur ($P > 0.05$). The new equation provides a bias-free estimation because no violation of the regression assumptions was observed.

Hirani and Mindell (2008), in their study of a comparison of measured height and demi-span equivalent height in the assessment of body mass index among people aged 65 years and over in England reported that; a valid height measurement was obtained from 82.0% of the total private household sample aged ≥ 65 years (3,346). A valid demi-span measurement was obtained from 71.8 % of informants (2,401). Those who had both a valid height and demi-span measurement were representative of those aged ≥ 65 interviewed. The mean ages were not significantly different for either sex aged ≥ 65 years interviewed (men 73.40 ± 6.31; women 74.80 ± 6.98) in comparison with those that had a valid height (men 72.80 ± 5.97; women 73.70 ± 6.42) or demi-span measurement (men 73.00 ± 6.13; women 74.10 ± 6.59). There were no significant age differences between the sexes. Men had significantly higher values of weight, height, demi-span, waist circumference and BMI calculated using demi-span equivalent height (DEH) in the total group as well as in the five-year age groups. There were significant decreasing linear trends for all measurements, by age and sex except for the waist measurement. The results show a strong correlation between DEH and measured height for men ($r = 0.71$) and women ($r = 0.72$) aged ≥ 65 years. The correlation coefficients for each five-year age group and sex were between 0.63 and 0.73. The Blant-Altman analysis of agreement showed that DEH estimates current height with a mean difference of -0.46, in men and -2.64 in women. The limits of agreement are however wide, (8.73 cm and -9.65 cm in men and 6.10 cm and -11.38 cm in women), it was evident in his study that examining the difference between height and DEH by sex and five-year age group showed that in men aged 65-69 years, height was significantly greater than DEH. Thereafter, from age group 70-74 years onwards, the height measurement was lower than the DEH. Among women, the height measurement was lower than the DEH in each age group. The Blant-Altman analysis of agreement showed that BMI calculated using DEH over-estimates BMI by an average of 0.12 in men and 1.52 in women. The limits of agreement were between 3.04 kg/m^2 and -2.74 kg/m^2 cm in men and between 3.88 kg/m^2 cm and -2.08 kg/m^2 in women. As expected, their results show a close correlation between DEH and height in those aged ≥ 65 years, as have other studies (Smith *et al*., 1995; Hickson and Frost, 2003). Their results from agreement analysis (Blant and Altman, 1986) show that BMI calculated using DEH and BMI calculated using measured height shows a closer agreement for both men and women than DEH and height measurement but results are very similar, especially for men to a recent study (Weinbrenner *et al*., 2006).

Hirani *et al*. (2010), in their study on development of new demi-span equations from a nationally representative sample of adults to estimate maximal adult height reported that; valid height and demi-span measurement were obtained at the nurse visit from 591 male and 830 female participants aged 25-45 years (59 % of the 2390 of that age group interviewed). Nearly 86 % of participants were White. Demi-span measures did not differ between the White (79.50 ± 5.40) and non-White population (79.60 ± 5.40). Among those aged ≥ 65 years, valid height and demi-span measurements were obtained by nurse from 452 men and 516 women (60 % of the 1622 of that age group that were interviewed). Similarly, mean demi-span measures did not differ between the White (77.30 ± 5.10) and non-White (79.20 ± 5.50) older population.

The following prediction equations were developed to calculate DEH_{new} based on participants aged 25-45 years. The robust SE are given in parentheses: Men: DEH_{new}(cm) = 65.8 (4.3)-1.33 (0.5) × demi-span and women: DEH_{new} (cm) = 64 (5.1)-1.31 (0.07) × demi-span.

In men aged 25-45 years, measured height, $DEH_{new,}$ and demi-span did not vary by age. However, in women in this age range, measured height, $DEH_{new,}$ and demi-span tended to be less with increasing; younger women were slightly taller and had greater DEH_{new} and demi-span compared with older women ($P < 0.05$ for all the measures). Men aged 25-45 years had significantly greater height, demi-span, and DEH measurements than women overall and in the 5-years age groups. In both men and women aged ≥ 65 years, height, demi-span, $DEH_{new,}$ and DEH_{Bassey} declined by age group ($P < 0.05$ for all the measures). Regarding the differences between measured height and DEH_{new} in young adult, the Hirani *et al*. (2010) reported that; Only men aged 25-29 years had a higher DEH_{new} than height measurement (0.68 cm; $P = 0.04$); there were no significant differences in either sex in any other age groups.

Because both demi -span and measured height have increased by~ 1cm in men aged ≥ 65 years and women aged ≥ 75 years since 1994, this confirms that the regression equations for estimating DEH need to be revised periodically to allow for the population becoming taller. The new regression equations based on demi-span measured in adults aged 25-45 years in 2007 to predict maximal adult height gave significantly higher values (DEH_{new}) than results using DEH_{Bassey} in every age group in both sexes, although the changes by age were very similar. The expected effect of osteoporosis on measured height occurring at younger ages in women than in men was reflected in the pattern of differences between DEH_{Bassey} and measured height in women but not for $DEH_{new.}$

2.2.2BiaxillaryLength

According to Chittanatarat *et al*. (2012), the mean and standard deviations of males biaxillary length across the the younger and older age group was 38.80 ± 3.50 and 36.30 ± 3.60 with a p value of < 0.01 respectively, and 36.20 ± 4.20 and 35.70 ± 3.80 and p value of 0.04 of females, this indicates that males have generally longer biaxillary length than females across all age groups in both males and females of this study although it did not reach any statistical significant in female gender. It was also evident from this research that biaxillary length decreases as age advances which could be as a result of bone shrinkage in old age.

2.2.3Neck Length

Chittanatarat *et al*. (2012) in their study on Thai people of Thailand reported the mean and standard deviations of neck length of males as 10.30 ± 1.20 and 9.80 ± 1.20 across the younger and older age group respectively, and 9.80 ± 1.40 and 9.60 ± 1.10 across the younger and older age group of females respectively, and both reached a statistically significant difference at < 0.01 which shows that neck length decreases as age progresses and is sexually dimorphic with the male neck length longer than that of a female. They also reported a weak positive correlation between stature and neck length across all the age groups of their study even though it did not reach any statistically significant in both the genders and across all age group.

Vasavada*et al*. (2007) in their study reported that: the mean and standard deviation of male's neck length was found to be 10.80 ± 0.50 and 10.70 ± 0.50 that of females. This demonstrated that male and female necks are not geometrically similar; further, geometric differences can explain much of the gender difference in neck strength. The male neck length is generally longer to that of a female counter part.

2.2.4Hand Length

IIayperuma *et al*. (2008) reported in their study of the prediction of personal stature based on the hand length that, gender differences with respect to the hand length and height were found to be highly significant (P < 0.01). Mean hand lengths of the males were significantly larger than that of the females (P< 0.01). (Total mean height for males was 170.14 ± 5.22 and for females 157.55 ± 5.75, the Mean hand length for males was 19.01 ± 0.86 and for females was 17.62 ± 0.93, the correlation coefficient for males and females were 0.58 and 0.59 respectively). The Regression equation for stature estimation was derived as follows; for males: Height = 103.73 + 3.49 (hand length). For females: Height = 93.69 + 3.63 (hand length). For both male and female (combined): Height = 60.81 + 5.64 (hand length).

Hossain *et al.* (2010) in their study reported that the mean normal values of the hand measurement (right and left hand length were 16.39 ± 0.72 cm and 16.33 ± 0.67 cm respectively and breadth of right and left hand were 7.22 ± 0.38 cm and 7.18 ± 0.30 cm respectively)and the stature (152.79 ± 5.62 cm) were found. The multiplication factors were estimated for the same hand measurements with the stature. Significant positive correlation was found in case of hand length with the stature. There was positive correlation (r = 0.17, p = 0.09 and r = 0.15, p = 0.12) between the stature and breadth of the right and left hand but the result did not reach any statistically significant level.

Patel *et al*. (2012) in their study of correlation between hand length and various anthropometric parameters reported that the mean hand length was 17.76 ± 1.25 and the result showed a definite significant correlation between stature of an individual and hand length, hand breadth, foot length, foot breadth, and arm span. The highest correlation was found between stature and arm span (r = 0.91) followed by hand length (0.81), followed by foot length (0.77). Hand breadth showed the lowest degree of correlation (0.47).

Kaur *et al*. (2013), reported in their study of anthropometric measurements of hand length for estimation of stature in north Indians that, the mean height for males was 160.91 ± 5.75 cm and for females was 175.98 ± 6.76 cm, the mean hand length for males was 18.80 ± 1.09 cm and for females was 18.54 ± 10.72 cm. This indicated sexual dimorphism with males having a higher stature and hand length than females, it was evident in their study that there was significant strong positive correlation between stature and hand length in both males and females (r = 0.59 for males and r = 0.55 for females respectively), the regression equation for stature estimation was; for males: S = 130.90 ± 2.40 (hand length) and for females: S = 160.41 ± 0.03 (hand length).

Danborno and Elukpo (2008) reported in their study that the mean height for males was 173.73 ± 7.13 and the mean height for females was 160 ± 6.22 which were all significant in both genders, it was also evident from their study that the mean right hand length in males was significantly higher (19.85 ± 0.86) than that of females (18.51 ± 0.66). Also the mean left hand of males (19.93 ± 0.93) was significantly higher than that of females (18.52 ± 0.77) respectively, which were both significant at $p \leq 0.001$, they argued that there were strong positive correlations between height and hand length in males (r = 0.53 right and r = 0.55 left respectively), and there was weak positive correlation between height and hand length in females (r = 0.43 right and 0.40 left respectively) which were both statistically significant.

Sanli *et al.* (2005) reported in his study of anthropometric data of hand, foot and ear of university students in Nigeria that the mean hand length in males was 20.10 ± 0.59 and for females the hand length was 21.50 ± 1.21. There were no significant differences between the hand dimensions of the females and those of their male counterparts (t =

0.26, p = 0.80 for hand breadth; t = 1.67, p = 0.10 for hand length; t = 1.72, p = 0.09 for hand thickness). The results do not agree with the work of Danborno and Elukpo (2008) that reported that the hand lengths and breadths in males were significantly larger than those of their female counterparts.

Jasuja (2004) reported in their study of estimation of stature from hand and phalange length that mean stature in the males is higher as compared to that of the females (175.20 ± 5.24 for males and 159.70 ± 5.17 for females respectively), the mean right hand length for males was 19.80 ± 0.73 measured, and 20.23 ± 0.72 print, and the left hand length was 19.79 ± 0.76 measured, and 20.30 ± 0.69 print respectively. For female subjects the measured right hand length was 17.51 ± 0.81 and 17.87 ± 0.85 prints respectively. The measured left hand length in females was 17.47 ± 0.80 and the print was 17.83 ± 0.89 respectively. This shows that the male hand length is longer than that of the females; this is in line with the report of Bhatnagar *et al*. (1984) and Thakur and Rai (1987), the findings also indicated a strong positive correlation between the height and the predictive variables. Saxena (1984) also reported statistically significant correlation between stature and hand length.

Chittanatarat *et al*. (2012) reported in their study of Thai populations that the mean male's hand length for younger and older age group were 18.40 ± 1.20 and 18.10 ± 1.40 which were both significant, and the mean hand length for females across younger and older age group were insignificantly 17.10 ± 1.10 and 17.20 ± 1.20 respectively. This shows a higher value of hand length in males than females. Statistically insignificant weak correlations existed between height and hand length in both males and females in their study.

Oommen *et al*. (2006) reported in their study that the mean right hand length for males as 19.06 ± 0.74 and for left hand length as 19.06 ± 0.72. The mean right hand length in females was 17.33 ± 0.90 and for the left hand as 17.25 ± 0.88 which indicates that male's hand length is longer than that of their females' counterpart, their study has shown that there is a significant correlation between hand length and foot length ($p < 0.0001$). The results, therefore, indicate that if the hand length is known, foot length can be predicted and if the foot length is known, hand length can be predicted and vice versa.

Kaur *et al*. (2013) reported in their study of hand: a scientific tool of measurement? That the mean height of males was 170.07 ± 6.52 and that of females was 155.92 ± 6.38 indicating sexual dimorphism with males on the average taller than the females, they further indicated that the mean hand length for males and females were (for males right and left as 18.77 ± 1.01 and 18 .86 ± 1.03 respectively and 17.34 ± 0.78 and 17.41 ± 0.84 for females right and left length respectively). They further argued in their study that r-value for estimating hand breadth from hand length was ranging from 0.51-0.57 and 0.55-0.75 in males and females respectively. The results showed that: 1. Hand length provides a reliable means in predicting the hand breadth than the height, and 2. Hand breadth was having the highest r-value with hand length on the left side (0.57 and 0.75, respectively) as compared to right side, both in males and females. Rastogi *et al*. (2008) in Indian population and Hossain *et al*. (2010) in Bangladeshi females estimated the height from length and breadth of the hands. They also found that there is weak correlation coefficient between height and hand breadth.

2.2.5Thigh Length

It is well documented that the intact femur has the highest correlation with stature and as such has been widely used in the derivation of regression equations for stature estimation. As intact femur is not always present for analysis in Forensic cases, it has become necessary to derive regression equations for the estimation of stature from fragments of this bone (Sandeep *et al*., 2013).

Sandeep *et al*. (2013) in their study on the regression equation for estimation of femur length in central Indians from inter-trochanteric crest reported that: the mean value of femoral length and the inter-trochanteric crest length were 43.75 cm and 6.31 cm respectively. The Pearson's correlation coefficient was found to be 0.58 which was statistically significant ($p < 0.05$). It is therefore suggested that in the absence of intact femur, regression equation derived from its present study can provide a reliable estimation of adult stature.

Reports by Ozaslan*et al*. (2003) showed that, from the measurements it was seen that the maximum length of the femur correlates well with the epicondylar breadth. Pearson's coefficient was 0.85. The correlation was statistically significant at 0.01 levels. (Two tailed), the following regression equation were obtained: $y = 7.02 + 4.83x$. Where – x is the epicondylar breadth (in cm) and – y is the maximum femoral length. The standard error of estimate was 1.68 and the value of R squared was 0.72.

Sheta *et al*. (2009) reported that the stature of Egyptian adults ranged from 164 to 191cm (mean 175.33 ± 7.20) for males, while that of females ranged from 150 to 175cm (mean 160.68 ± 5.81) with statistically significant difference between both means ($p = 0.0001$) indicating sexual dimorphism. CT scanogram examination revealed that the femur maximum length in males ranged from 39.35 to 48.83cm with a mean of 44.78 ± 2.22cm. Where as in females it ranged from 35.93 to 44.95cm with a mean of 41.01 ± 2.13cm, there was a significant difference between the mean length in males and females as $p = 0.0001$. The femur maximum length exhibits higher correlation coefficient ($r = 0.70$ for males and 0.75 for females) than the humerus maximum length ($r = 0.61$ for male and 0.59 for females).

Chittanatarat *et al*. (2012) reported that the mean and standard deviation of thigh length among younger (< 60 years) and older age groups (≥ 60 years) were 39.30 ± 4.00 and

38.70 ± 3.70 which are significant in males and 35.20 ± 3.10 and 35.20 ± 3.40 which are not significant in females respectively. There was strong positive correlation (r = 0.61) between stature and thigh length in males of younger age group even though it's insignificant, and strong positive correlation (r = 0.71) for the older age group in males which is statistically significant. There was significant weak positive correlation (r = 0.44) between height and thigh length in the younger age group and significant strong correlations (r = 0.64) between height and thigh length in older age groups in females respectively.

2.2.6Foot Length

Danborno and Elukpo (2008) reported in their study of Nigeria populations that, the mean and standard deviations of the right foot length in males was 28.39 ± 1.73 and for females it was 24.52 ± 9.08 which were both significant, and for the left foot length in males and females it was found that their means was 26.42 ± 1.60 and 24.70 ± 1.10 respectively, which were both significant at $p \leq 0.01$, which shows higher anthropometric measurements in males than in females, there were significant strong positive correlation between height and right foot length in males and females (r = 0.58 males and r = 0.61 females), there was also strong positive correlations between height and left foot length in males (r = 0.61) and weak positive correlations in females (r = 0.41), which were both significant.

Sanli *et al.* (2009) reported that the mean and standard deviations of foot length in males were 27.50 ± 1.20 and the mean foot length in females was 27.00 ± 1.40, it was evident from his study that there were significant differences between the foot lengths of males and those of the females (t = 5.61, p = 0.000), those of the males were larger. The results of his study are in agreement with the study of Ashizawa *et al.* (1997) that observed that

Japanese women had smaller feet than those of their male counterparts but contradicts Baba (1975) who found that Japanese women had larger feet than their male counterparts. It also supports the work of Danborno and Elukpo (2008) that noted that foot length in males were larger than in females but contradicts the same work in terms of foot breadth.

Oommen *et al*. (2006) reported that the mean and standard deviation of the right foot length in males were 26.22 ± 1.28 and that of left foot length in males were 26.00 ± 1.56, the mean and standard deviations of the right foot length in females were 23.76 ± 1.13 and that of the left foot length were 23.69 ± 1.14, it is clear from these observations that the male's foot length is longer than their female's counterpart. Their study has shown that there is a significant correlation between hand length and foot length ($p < 0.0001$). The results, therefore, indicate that if the hand length is known, foot length can be predicted and if the foot length is known, hand length can be predicted and vice versa.

Ebimobo *et al.* (2014) in their study reported that the general mean and standard deviations of height for males and females was 168.00 ± 0.40, and for males it has been shown to be 175.00 ± 0.50, the female's was 161.40 ± 0.40 which were all statistically significant at $p \leq 0.001$. The general mean and standard deviations of foot length were 25.7 ± 0.1, the foot length for males was 26.80 ± 0.90 and that of females was 24.70 ± 0.10. They further said that the linear regression equations were derived for estimation of stature from foot length and foot breadth and foot index in both genders. From a combined gender value, the regression formula for height estimation from foot length was Height = 4.67 (foot length) + 47.79. There was a statistically significant positive correlation ($P < 0.05$, $r = 0.80$) between foot length and height. In males, the regression formula for height estimation from foot length was Height = 3.86 (foot length) + 71.19. There was a statistically significant positive correlation ($P < 0.05$, 0.7) between foot length and height in males. In females, the regression formula for height estimation from foot length was Height = 3.58 (foot length) + 73.15. There was a statistically significant positive correlation ($P < 0.05$, $r = 0.80$) between foot length and height in females. It could be deducted from this study that all the parameters studied was significantly higher ($P < 0.01$) in males than females. This is in agreement with an earlier study by Obikili and Didia (2009) that showed that males had significantly higher values of foot length and foot breadth than females ($p < 0.001$). Sen and Ghosh (2008) also confirmed this among Rajbanshi, an indigenous population of North Bengal. Their study indicated that female Rajbanshi individuals exhibit shorter stature and smaller feet than their male counterparts. Furthermore, the male's height was significantly higher ($P < 0.01$) than the female height. The male's foot length was significantly higher ($P < 0.01$) than the female foot length. The male foot breadth was significantly higher ($P < 0.01$) than the female foot breadth. The male foot breadth was significantly higher ($P < 0.05$) than the female foot breadth at 95% probability level. Obikili and Didia (2009) had placed the mean foot length of adult Nigerians (18 years and above) at 26.90 cm for males and 25.00 cm for females while Didia *et al.*(1987) placed it at 27.10 cm for males and 25.10 cm for females.

Ashizawa *et al*. (1997) and Wunderlich and Cavanagh (2001) reported in their respective study that males have longer and broader feet than females for a given stature. The larger foot dimensions of males in their study in comparison with females is in agreement with this postulation. Besides, Didia *et al*. (1987) in their study on the Nigeria population also found that males have broader and longer foot dimensions than females. The higher correlation coefficient between stature and foot length was greater than stature and foot breadth and pointing to the fact that foot length, rather than foot breadth, is more accurate in estimating stature. This is in agreement with the work done by Krishan and Sharma

(2007) and the work done by Sen and Ghosh (2008) which indicated that the foot length provides highest reliability and accuracy in estimating stature of an unknown individual.

Macdonnel (1901) studied 3000 English criminals and derived regression formulae for estimation of stature from foot length, 166.46 + 4.03 (foot-25.69) ± 2.90 centimeters. However, sex was not being given due consideration in his study. Qamra *et al*. (1980) computed linear regression equations for estimating stature from either foot length or foot breadth of 1015 subjects between the ages of 17-32 years. After testing validity of equations, foot length was found to be more suitable. The variability derived in this present study could be due to the former study being conducted on a particular region whereas Ebimobo *et al.* (2014) study involved a diverse group. Qamra *et al*. (1986) suggested that a true relationship existed only between foot length and stature, and the relationship in other combination of variables was affected to a great extent by foot length alone. Giles *et al*. (1991) also suggested that foot length displays a biological correlation with height and the latter can be estimated from foot length. Gordon and Buikstra (1992) estimated stature from foot dimensions and models containing both foot length and foot breadth were found to be significantly better than those containing only foot length. In Ebimobo *et al.* (2014) study, strong relationship was established between foot/boot lengths.

Singh and Phookan (1993) examined Thai male population of Assam and suggested foot length to be a better indicator of stature than foot breadth. Jain *et al*. (1996) devised multiplication factors for estimation of stature among Brahmin males of Kumaon from foot length which was 6.56 whereas in Krishan (2008) study these were 7.26 and 7.23 for right and left foot length respectively. This difference could be due to the regional variation in study subjects. Zeybek *et al*. (2008) developed formulae for estimation of the stature and gender through foot measurements. They derived multiple regression formulae for stature estimation and logistic regression analysis for gender estimation using foot measurements.

The foot dimension in males and females in Ebimobo *et al*. (2014) study is comparatively larger than Caucasian values (Wolanski, 1970; Stranisev *et al*., 1970; Dupertius *et al*., 1972). This finding is in accord with theoretical expectation that populations living in warm climates would have longer arms and legs than populations living in cold environments. Schreider (1975) reported that tropical climate dwellers have longer limbs than temperate climate dwellers. Large foot dimensions are adaptation to tropical environment as they increase the surface area available for heat loss.

On the clinical application of foot dimension, Gorman *et al*. (1997) in their study on the relationship between shoe size in women and mode of delivery noted that a woman with a small shoe size did not have a higher chance of being delivered by caesarean section.

Schultz *et al*. (1998) reported that many girls with Rett syndrome had small feet for height. Besides, Rodier *et al*. (1997) also noted that children with autism had smaller feet compared with the control group.

Brenda and Rohren, (2011) reported in their study of estimation of stature from foot and shoe length: applications in forensic science, that the results of their study on the 40 subjects indicated a higher positive correlation between foot length and stature than for shoe length and stature. This is consistent with the findings of other researchers (Byers *et al*., 1989; Jasuja *et al*., 1991; Ozden *et al*., 2005; Sanli *et al*., 2005). Therefore, it is recommended that preference be given to foot length measurements in estimating stature whenever possible (Brenda and Rohren, 2011).

Swati *et al*. (2012) in their study titled estimation of height (stature) from inferior extremity length and foot length in children reported that there were significant differences ($p < 0.05$) in stature, inferior extremity length and foot length between sexes. Stature, inferior extremity length and foot length are positively and significantly correlated with each other ($p < 0.01$).

Krishan (2008) reported in his study of stature estimates from foot dimensions that in males, stature varied from 150.10 cm to 184.50 cm with mean values of 169.50 cm and standard deviation of 6.57 cm. In females, it varied from 148.00 cm to 173.00 cm with mean values of 159.52 cm and standard deviation of 5.86 cm. The mean and standard deviations of right foot length in males were 23.35 ± 1.58 and for left were 23.46 ± 1.60, for the females the right foot length were 20.60 ± 1.42 and the left were 20.69 ± 1.45 which indicates bilateral symmetry between left and right foot as well as sexual dimorphism between males and females with males having statistically significant higher measured values than females. The regression formula from foot length for males; Stature: 98.32 + 3.05 FLRT r = 0.81 for right foot length, and stature: 97.28 + 3.08 FLLT r = 0.73 for left foot length respectively. The regression formula from foot length in females; Stature: 90.21 + 3.37 FLRT r = 0.81 for right foot length, and Stature = 91.11 + 3.31 FLLT r = 0.81 for left foot length in females respectively. This result indicates strong correlations between stature and foot length in this particular populations of India.

Jasuja *et al*. (1991) derived multiplication factors for Punjabi Jat males for estimation of stature; 6.88 and 6.44 for right and left foot length respectively. In Rani *et al*. (2011) study, they were 7.26 for right foot length and 7.23 for males for left foot length. The difference in multiplication factors between these two studies could be due to the former study being undertaken for a particular regional group whereas Krishan (2008) study involves a diverse population group.

Jasuja (1987) reported stature estimation from stride length by measuring it while walking fast on smooth substrate and it was compared with the stride length in the normal pattern of walking. They found that for faster pace, formulae are different but the range of error for estimation of stature remained same. Krishan (2008) study involves stature estimation from foot measurements with foot in completely stretched position.

Nath *et al*. (1999) formulated multiplication factors for reconstruction of stature from foot length of Rajputs and Brahmins of Srinagar, Garhwal (Utta Pradesh) with reasonable accuracy. These were 6.87 for Rajput males, 6.64 for Brahmin males and 6.73 and 6.68 for Rajput and Brahmin females respectively. In comparison in Krishan (2008) study the multiplication factors were 7.76 and 7.71 in females and 7.26 and 7.23 from right and left foot length for males respectively.

Jain *et al*. (1999) formulated multiplication factor as 6.59 for reconstructing stature among Jats females of Delhi between 17-20 years. Ozaslan *et al*. (2003) analyzed relationships between lower limb dimensions and stature on a sample of 203 males and 108 female adults Turks residing in Istanbul. They measured stature, trochanteric height, thigh length, lower leg length, leg length, and foot height, breadth, and length. They concluded that stature can be deduced using dimensions of the lower limb.

Sanli *et al*. (2005) established the relationship between hand length, foot length and stature using multiple linear regression analyses. Their study sample included 155 adults (80 males, 75 females) Turks residing in Adana. They found multiple linear regression model for both genders together to be the best model with the highest values for the coefficients of determination $r^2 = 0.86$ and r^2 adjusted = 0.86, and multiple correlation coefficient $r = 0.93$.

Agnihotri *et al*. (2007) developed a relationship between foot length and stature using linear and curvilinear regression analyses on a study group comprising of 250 medical students (125 males and 125 females) aged 18-30 years. It was concluded that general multiple linear regression model was highly significant ($P < 0.001$) and validated with highest values for the coefficients of determination r = 0.77 and multiple correlation coefficient r = 0.88.

Krishan and Sharma (2007) examined the relationship between stature and dimensions of hands and feet among Rajputs of Himachal Pradesh on a group of 246 subjects (123 males and 123 females) 17 to 20 years old. In their study also the highest correlation coefficient existed between stature and foot length. The lowest standard error of estimate indicated that the foot length provides highest reliability and accuracy in estimating stature.

Kanchan *et al*. (2008) examined the relationship between stature and foot dimensions among 200 (100 males and 100 females) Gujjars (North Indian community). They devised linear and multiple regression equations for estimating stature using foot dimensions. The results are similar to Krishan (2008) study, who examined the relationship of stature to foot size of 1040 adult male Gujjars of North India (age 18 to 30 years). The highest correlation coefficients were shown by the toe length measurements (0.79-0.86). Grivas *et al*. (2008) evaluated the relationship between foot length and stature in a large sample of 5093 juveniles in Greece, average age being 11.47 ± 2.71 years. It was suggested that foot length can estimate the stature and weight of a juvenile, especially after adjusting for age and sex.

Sen and Ghosh (2008) established the relationship between stature and feet dimensions among Rajbanshi male and females of North Bengal on a sample of 350 adult Rajbanshi and 100 adult Meche individuals of 18-50 years residing in different villages located in the Darjeeling District of West Bengal. Stature, foot length and foot breadth are positively and significantly correlated with each other. Their study has provided equations to estimate stature from the feet dimensions among the Rajbanshis.

2.2.7Sitting Height

Fatmah (2009) in a study of predictive equations for stature estimation from knee height, arm span, and sitting height in Indonesian Javanese elderly people reported that the average elderly male height which was reduced from 159.5 cm in 55-59 years old to 158.40 cm in 69 years old and afterwards. The elderly female height was reduced from 149.20 cm in 55-59 years old to 146.30 cm in 69 years old and afterwards indicating skeletal osteoporosis due to old age. The biggest discrepancy for reduced height in these two age ranges was found in elderly female (2.90 cm). In general, male height was greater than female height. There was significant positive correlation between the height and sitting height for both men and women (r = 0.78 for men and r = 0.77 for women respectively). In general, elderly male had higher average sitting height compared to elderly female in all age groups. The sitting height of elderly male was higher (89.90 cm) than the elderly female (83.80 cm). The different average value of the height predictor was due to the taller height and more physical activities of males compared to females (Santos, 2004).

Chittanatarat *et al*. (2012) reported a strong positive correlation between height and sitting height in younger and older age group of elderly males and females (r = 0.59 and r = 0.54 for males younger and older age groups and r = 0.59 and r = 0.52 for females younger and older age groups respectively). The result was statistically significant among all the age groups.

2.3 EFFECT OF AGE ON STATURE

The height of an individual, irrespective of race and sex, was at its maximum at the age of 21 years (Trotter and Glesser, 1951). Thereafter, the height decrease notably after 30 years (Trotter and Glesser, 1951), 35 years (Boas, 1940) or 40 years according to Bochi (Trotter and Glesser, 1951). This reduction in length was said to be as much as 0.06cm (Trotter and Glesser, 1951) or 1cm per year over the age of 50 (Galloway, 1988; Himes and Roche, 1982). Galloway (1988) was confident that age was overriding parameter in estimating stature and that the major decline in stature according to him did not begin until the age of 45 years after which the rate of loss in stature was very rapid. (Giles andHutchinson, 1991) suggest a decrease in stature of Americans in their mid-forties, which in males is 1mm per year compared to 1.25mm per year for females.

Statistical analyses carried out by (Pearson, 1899) proved that shrinkage of bones with ageing does not appear to alter the correlation studies in (Trotter and Glesser, 1951) proved otherwise. Negative correlation between stature and age, and in some cases between bone length and age, were reported to occur. Regression formulae, which were devised by Trotter and Glesser (1951), adjusted for the effects of ageing on stature. The only problem with the proposed formulae was that the sample recorded height of young military group and did not include those of older individuals. Friedlander *et al.* (1977) reported that a reduction in stature, associated with an increase in age is brought primary by changes in the vertebral column in 2005, Raxter *et al*. attempt to address the issue of age correlation of stature in their skeletal sample aged between 31 to 85 years. The observation these authors noted change within the individual vertebrae, which they incorporated into the anatomical technique of fully. These authors also reported an age adjustment of 0.04 cm per year in comparison to the 0.06 cm per year recommended by (Trotter and Glesser 1951). The adjustment of age proposed by (Trotter and Glesser

1951) has been questioned by a number of authors (Galloway, 1988; Cline *et al*., 1989; Chandler and Bock, 1991). The debate reigns on the fact that firstly, the age reduction is nonlinear and secondly, that a decline of stature in males and females follows different patterns. Thus, a gradual loss in height during the fourth decade would be difficult to identify without long term longitudinal data. (Melton and Cooper, 2001) reported greater height loss in females than in males which predisposes them to vertebrae fractures. Due to anatomical variations in individuals, the age at death is always given as a range. In order to overcome these problem in forensics, (Raxter *et al*., 2005) devised regression equation for estimating living stature from skeletal height which excluded the age correlation factor. This adjustment was done so that their equations would be applicable to forensic cases.

2.4 PROCESS OF GROWTH

Growth in stature is determined by its various factors which results from lengthening of bones through cellular divisions chiefly regulated by somatotropin; human growth hormones, (hGH) secreted by the anterior pituitary gland. Somatotropin also stimulates the release of another growth inducing hormone which is the Insulin-like growth Factor 1 mainly by the liver (Gasser *et al*., 1991). So both hormones operate on most of the tissues of the body, they have many other functions, and continue to be secreted through life; with peak levels coinciding with peak growth velocity and gradually subsiding with age after adolescence. (Gasser*et al.*, 1991). The bulk of secretion occurs in burst especially for adolescents with the largest during sleep.

Height is sexually dimorphic and statistically it is more or less normally distributed, but with heavy tails. The majority of linear growth occurs as growth of cartilage at the epiphysis of long bones which gradually ossify to form hard bones. The legs composed approximately half of adult human height, and leg length is somewhat sexually dimorphic trait. Some of these growths occur after the growth spurt of the long bones. (Gasser*et al.*, 1991). Additionally, the variation in height between population and across time is largely due to changes in leg length. The remainder of height consists of the cranium.

2.5 SEXUAL DIMORPHISM IN STATURE AND FACTORS AFFECTING STATURE DETERMINATION

Stature is influenced by gender, genetic endowment, age, nutrition and environmental factors. Height is like other phenotypic traits determine by combination of genetic and environmental factors. Genetically, the height of father and daughter and of mother and son correlate suggesting that a shorter mother will more likely bear a shorter son and a tall father will have tall daughters (Malina, 1994). Males tend to have relatively longer limb than females, there is some evidence from studies of twins that the size of an individual body segment is heritable (Chitterjee *et al*., 1999). Several studies have reported important ethnic differences in stature (Palomino *et al*., 1978; Malina *et al*., 1994; Eveleth and Tanner, 1990). However, it is difficult to disentangle genetic from nutrition and environment, since the precise relationship between the environment and genetic is complex and uncertain (Rogol *et al*., 2002).

Stature change considerably throughout life. Infants and toddler, have relatively short limb compared to adults. Before puberty, the limb grows faster than trunk, whereas the trunk grows faster during puberty (Dangour, 2001). Individual who experience puberty early have relatively shorter limb due to timing of puberty. Among person of the same age and sex, those who are taller have relatively long limb than those who are shorter. Diet in addition to nutrient; such as junk food and health problems such as obesity, exercise, fitness, pollution exposure, sleep patterns, climate according to Allen's rule and Bergmann's rule and even happiness or psychological wellbeing are factors that can affect growth and final height. Human height is 90% heritable (Anite, 2007) and has been considered polygenic since the debate a hundred years ago (Stock, 2006). The only gene so far attributed with normal height variation is HMGA2, this is only of many, as each copy of the allele concerned confers an additional 0.40cm, accounting for just 0.3% of population variance (Anite, 2007).

2.6 IMPORTANCE OF STATURE IN PUBLIC HEALTH

Stature is an issue that cannot be ignored in public health. Congenital or acquired proportionality disorders are not rare and can substantially affect health, development and wellbeing. It has been shown that stature can be greatly influenced by resources, energy intake and environmental condition. Hence, health outcome related to environmental condition during childhood may be strongly associated with limb length and body proportions. Certain studies have shown that height is a factor in overall health while some suggest tallness to be associated with better cardiovascular health and shortness with overall better than average health and longevity (Seilers, 2008). Some research also revealed that childhood limb length shows stronger association than overall height with adult mortality from cancers and coronary heart disease (Gunnel *et al.*, 1998). Leg length was observed to be the component of childhood height most strongly associated with socioeconomic and dietary exposures. There was no significant relation between childhood height and overall mortality. Height mortality relations were observed in relation to both coronary heart disease (CHD) and cancer. Leg length was the component of height most strongly related to cause specific mortality. In men and women CHD mortality increased with decreasing childhood leg length. Men with the lowest leg length quintile had a relative risk (RR) of 2.50 (95% of 1.00 to 6.20) compared to those with the longest leg (linear trend $p < 0.01$) (Gunnel *et al.*, 1998). Taller people have been shown to have an increased risk of breast, prostate colorectal and hematopoietic cancer, while the risk of stomach, cervical and oesophageal cancer is low in taller individuals (Gunnel *et al*., 1998). Also factors related to the insulin resistance syndrome were shown to be less favorable in men with shorter legs, and leg length was found to be inversely associated with diabetes.

Epidemiological studies have demonstrated a positive correlation between height and intelligence. The reason for this associate appear to include that height serves as a biomarker of nutrition status or general mental and physical health during development. The common genetic factor may influence both height and intelligence, and both are affected by adverse early environmental exposures. Height extremes of either excessive tallness or shortness can cause social exclusion and discrimination for both men and women (heightism) (Gunnel *et al.,* 1998).

2.7 SECULAR TREND IN STATURE

Stature is generally influenced by living condition, nutrition and genetic makeup of an individual. But in developed countries it is levelling off (Padez, 2002). Though investigation have reported that as part of secular increase in stature, limb length increases much more than stature (Tanner *et al*., 1982).

Meadows and Jantz (1995), found that lower limbs are relatively allometric, becoming relatively longer with increase stature while upper limb are isometric keeping constant proportion with stature. They showed that this trend follows the secular trend in stature closely. The observed secular trend in height was due to increase in limb length. Secular trend in stature has been characterized by different secular changes for different linear segment of the body. Over the last 200 years, changes in physical growth and development of children and adolescents have been systematically monitored throughout the world. The belief that human growth depends on the interaction of genetic and environmental factors, thus being a measure of social welfare, is the keystone of the discipline of anthropometrical history (Meadows and Jantz, 1995).

Secular changes were prominent in the 20th century (especially after World War II) and were expressed as a steady increase in mean height and weight of European and US populations (Eveleth and Tanner, 1990). Concomitantly assessment of the age at menarche have revealed progressively earlier age of puberty onset in adolescents, largely related to improved health, general nutrition and fat content in the diets (Eveleth and Tanner, 1990; Bogin and Keep, 1999) traced secular changes over eight thousand years back around the world. Secular changes in Europe and America in particular, are expressed as a consequence of industrialization in the 19th and 20th centuries, positive secular trend is detected especially in developed countries, most probably reflecting improved nutritional and health status of these population (Eveleth and Tanner, 1990). Several studies have demonstrated a sensitivity of secular trend to changes in life standards both over time and between different social groups (Bogin and Keep, 1999)). In France military records show a steady increase in height during the 19th century, the Panisian elite became increasingly shorter (Hauspie *et al.*, 1996). The secular trend reflects the remarkable development plasticity that characterized many living things not just human (Hauspie *et al.*, 1996). Awareness of it effect and implication can assist understanding of the changes that have occurred and those still occurring in some groups; there by we may better guide children on their path to adulthood.

2.8COMPARING LIVING STATURE AND CADAVERIC STATURE

The height of a human being is a measure of how tall or short a person is and this can be defined from a forensic (Driver's License) or biological (cadaver or living individuals) perspective (Smith, 2007), living stature is measured in the living person, while cadaveric stature is measured directly from an embalmed body. The outcome of measuring cadaveric stature is to ultimately reach an estimate of living stature. Methods employed to derive at living stature thus differ, which may also bring about certain advantages and disadvantages with each method used.

One example is that of reported height in living individuals. This method is commonly used as it is easy to guess how tall or short a person is. The disadvantage is that forensic anthropologists need accurate information for identification purposes. Report on living stature in black, coloured and white South Africans of both sexes were provided by Smith (2007), in his measurement based on the definition of ISO 7250 (2004). He assessed the vertical distance from the standing Surface to the highest point of the head (vertex) with his subjects in the erect standing position. The author classified his subject as short (for results in the lower 25% of stature distribution). Tall (upper 25% of stature distribution) and average or medium in height (middle 50% of stature distribution).

2.9 ABNORMALITY OF HEIGHT

There are various disease and disorders that cause growth abnormalities (Schultz *et al.,* 1998). Most intra population variance of height is genetic. Short stature and tall stature are usually not a health concern. If the degree of deviation from normal is significant, hereditary short stature is known as familial short stature and tall stature is known as familial tall stature (Iseri and Arslan, 2009). Extreme height may be pathological, such as gigantism, which is very rare resulting from childhood hyperpituitarism, and dwarfism, which has various causes. Rarely no cause can be found for extreme height; very short person may be termed as having idiopathic short stature (Schultz *et al.*, 1998). Confirmation that exceptional height is normal for a male and a female respectively can be ascertained by comparing stature of family member and analyzing growth trends abrupt changes among others (Schultz *et al.*, 1998). Idiopathic tall stature is a rare occurrence and it is a less used term but recognized problem. If enough growth hormone is not produced or secreted by the pituitary gland, then a patient with growth hormone deficiency can undergo treatment (Schultz *et al.,* 1998). This treatment involves the injection of pure growth hormone into thick tissues to promote growth.

3.0 MATERIALS AND METHODS

3.1 RESEARCH PARTICIPANTS

The subjects that participated in the study were indigenes of Lokaa, Ayiga, Agoi and Ekoi ethnic group of Yakurr, Cross River State (n = 800 with the mean age ± S.D of 24.75 ± 4.05 years).

3.2 STUDY AREA

Random selection of subjects in urban and rural communities of Yakurr was made. Participants included students and non-students of the named communities.

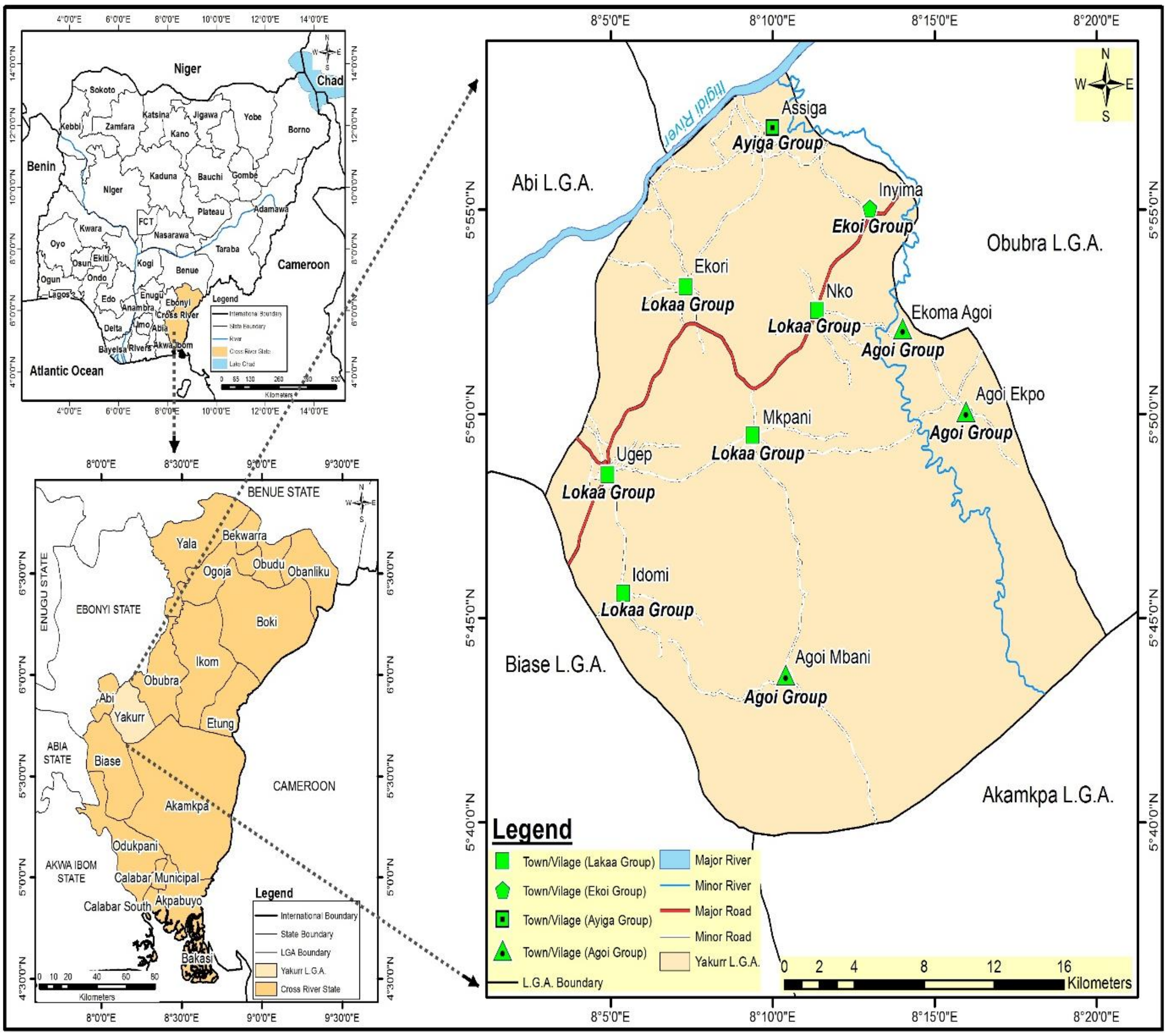

Figure 3.1: Map of Yakurr L.G.A. showing four Ethnic Groups
Source: Modified from the Administrative Map of Yakurr L.G.A.

3.3CROSS RIVER STATE

Cross River State is a coastal state in South Eastern Nigeria, named after the Cross River (Oyono), which passes through the state. Located in the Niger Delta, Cross River state occupies 20,156 square kilometers. It shares boundaries with Benue state to the north, Enugu and Abia states to the west, to the east by Cameroon Republic and to the south by Akwa-Ibom state and the Atlantic Ocean and Calabar is the capital (Ukpenetu, 1987). It consists of eighteen (18) local government areas, and the major towns in the state are Calabar, Ugep, Akamkpa, Odukpani, Ikom, Obubra, Biase, Ogoja, Obudu, Obanliku and Akpabuyo.

The state is composed of three major ethnic groups- these are the Efik, the Ejagham and the Bekwarra. Traditional festivals relating to farming activities such as the Leboku New Yam Festival, Ugep are observed in the state annually to celebrate the rich harvest of the season(Okoi, 2011). As regards tourism, Cross River State offers both its visitors and interested indigenes many centers of attraction. The outstanding ones are Obudu Cattle Ranch, Obudu, Old Residency Museum, Calabar, Agbokin water falls, Ikom, Etanpim cave, Odukpani, Tinapa, Calabar and Mary Slessor's Tomb, Calabar. The state capital, Calabar, can be reached by air, sea and road, while other parts of the state are accessible by road.

3.3.1 Climate of Cross River State

The climate within Cross River State is tropical-humid with wet and dry seasons, with average temperatures ranging between 15^{o}C to 30^{o}C, and the annual rainfall between 1300 to 3000mm (Okoi, 2011). The high plateau of Obudu experience climatic conditions which are markedly different from the generalized dry and wet period in the rest of Cross River State. Temperatures are 4^{o}C to 10^{o}C lower due to high altitude than in the surrounding areas. Similarly, the annual rainfall figures are higher than in areas around them, particularly on the windward side. Cross River State can, thus, be broadly divided into the following Sub-climatic regions:

i. The moderated sub-temperate within the high plateaus of Obudu; and

ii. The hot, wet tropical extending from the southern lowlands to the central and northern hinterland parts.

3.3.2 Yakurr

Yakurr area lies between latitudes 50 401 and 60 101 north of the equator and longitudes 80 21 and 60 101 east of the Greenwich Meridian and 120 km (75 km) northwest of Calabar, the capital of Cross River State. They share their northern and eastern boundaries with the Obubra local government area, the southern boundary with the Biase local government area and their western boundary with the Abi local government area. Yakurr is found in the present-day Yakurr Local Government Area and comprises of four ethnic groups, the Lokaa, Ayiga, Agoi and Ekoi ethnic groups (Enang, 2009).It is the largest LGA in the state in terms of population, with 14 primary health care centers (PHC) and 1 general hospital located at the local government area headquarters (Ugep). The population of Yakurr is approximately 226,900 (projections from 2011 national census). The Yakurr (also Yako and Yakaa) comprises five urban settlements in Cross River State, Nigeria. They were formally known as Umor, Ekoli, Ilomi, Nkoibolokom and Yakurr be Ibe. Due to linguistic problem encountered by the early European visitors, the settlements have come to be known by their mispronounced versions – Ugep, Ekori, Idomi, Nko and Mkpani (Okoi-Uyouyo, 2002). Mkpani is a short word for Yakpanikpani (which in Lokaa means “tricks”), a name which according to Enang (1980) was given to them by the Ugep people after being tricked in a conflict. The language spoken by the Yakurr is Lokaa, an Upper Cross River language. According to Ethnologue, it was spoken by 120,000 people in 1989. The Yakurr exhibits a very high degree of social heterogeneity, but linguistic, political, religious and cultural homogeneity (Okoi-Uyouyo, 2002).

All Yakurr share a common tradition of overland migration and ancestry. The ancestral homeland of the Yakurr people is “Akpa”. The migration of Yakurr from their ancestral homeland started at about AD 1617, when a misunderstanding between the Yakurr and their neighbours, arising from the violation of a burial custom forced their neighbours to wage a war against them leading to them being driven from their homeland (Okoi-Uyouyo, 2002). The migratory history of the Yakurr people, as given by Ubi (1978 and 1986) is that, between 1617 and 1677, the Yakurr migrated from that ancestral homeland to look for a new homeland following a military defeat from Akpa. About AD 1660, some Yakurr migrants founded new homelands in their present locations. These locations are Ugep and Idomi. Between 1677 and 1707, some other Yakurr migrants founded the towns of Ekori and Nko. Between 1707 and 1737 yet another wave of Yakurr migrants founded Mkpani settlement. The reasons for the relations of populations in new settlements by the Yakurr is mainly due to competing demands for land resources as a result of growing populations in one hand and unresolved conflicts in the other (Okoi-Uyouyo, 2002). This development is aided by the patrilocality of marriages and strong patriarchy in the family system. It was thus easy for patricians to relocate to new settlements. This has produced a slight parallelism in names of patricians and strong parallelism in names of matricians in all the Yakurr settlements (Okoi-Uyouyo, 2002).

3.3.3Occupation

Yakurr is an agrarian community with most towns such as Ugep, Ekori, Nko engaging in commercial activities because of their proximity to express road that links the local government area to other state, this means that the inhabitants depend solely on agriculture as their major occupation (Enang, 2009). Their main crop, except where the soil is exhausted is the yam, and traditionally all other cultivation was subordinated to its requirements, however, subsidiary crops such as cocoyams, maize, okra, rice, cassava, palm produce, rubber, plantain and pumpkins are also grown. Major livestock in the area are goats and sheep (Enang, 2009).

3.3.4 The climate of Yakurr

Yakurr records a high rainfall of about 2000mm annually. The rainfall last for about seven months from March to September, June-August records the highest rainfall. Dry season is between November to March in most cases early April. The climate is affected by two air masses, the tropical maritime and the continental air masses. The monthly temperature hovers between 21^0C and 32^0Cwith annual temperature range of about 11^0C. The study area is drained by Cross River with tributaries such as Lokpoi Stream (Enang, 2009).

3.3.5 Natural vegetation

The natural vegetation of the Yakurr is that of dense tropical forest, transitional between the evergreen equatorial forest and the mixed deciduous forest of the area farther north. The valleys are prone to flooding in the wet season (Enang, 2009).

3.4METHODOLOGY

Data for this study were collected from participants after informed verbal consent was obtained from participants who were between eighteen and thirty-two years old and willing to participate in the survey. In order to encourage more candid and reliable responses, participants were made to complete a self-administered proforma in confidence with their peers unable to see their answers. Random sampling method was used to select 800 subjects from four ethnic groups ofYakurr.

Data were collected through self-administered proforma. Data pertaining to parents' ethnic group, socio-demographic variables and anthropometric parameters were taken.

Anthropometric measurements on participants were carried out by well-trained male and female research assistants. In order to reduce observation errors, anthropometric measurements were read twice independently and the mean of the two measurements was taken as the actual value.

Social status was analyzed according to parents' level of education, birth order, and the number of children in the family.

The following data were filled by each participant using pre-designd proforma:

i **Demographics:** Data pertaining demographics include current age (years), place of birth, ethnic group, number of siblings, birth order, parents' occupation and parents' level of education.

ii **Anthropometric assessment:** Height, weight, BMI, neck length, demi span length, biaxillary length, hand length, hand breadth, finger length, thigh length, leg length, foot length, foot breadth, sitting height, neck circumference, chest circumference, waist circumference, hip circumference, thigh circumference, calf circumference.

3.5 DATA COLLECTION TECHNIQUE

Samples for this study were collected from randomly selected subjects (students and non-students) between the ages of 18 to 32 years in rural and urban communities, churches and market places of Yakurr Local Government Areas of Cross River State.

3.6 SAMPLE SIZE DETERMINATION

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

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

Where:

n = the desired sample size per ethnic group

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

p= the proportion in the target population having the particular trait (when no estimate 50% is used; i.e. 0.5)

q = 1.0 - p

d=degree of accuracy desired, usually set at 0.04

Therefore, $n = (1.96)^2(0.5)\ (0.5)/\ (0.05)^2 = 800$

For the purpose of this study a total of 800 subjects for both gender (Lokaa n = 200, Ayiga n = 200, Agoi n = 200 and Ekoi n = 200) for the location (Yakurr Local Government Area of Cross River State) was used.

3.7 ANTHROPOMETRY

i. **Height (cm):** Standing height was measured to the nearest 0.1cm taking the maximum distance from the floor to the highest point on the head, using an anthropometer with subject standing erect on a horizontal resting plane, bare footed, having the palms of the hands turned inwards and the finger pointing downwards, heels held together, toes apart, and the head held in the Frankfurt plane as recommended by International Biological Program (Mauthausem and Gusen, 1959; WHO, 1995), (Plate III).

ii. **Weight (kg):** An overall measure of body size that does not distinguish between fat and muscle. Weight was measured to the nearest 0.1kg when the subject was standing, bare footed and lightly dressed (Menezes and Khany, 1998; Yyagi *et al*., 1999), (Plate IV).

iii. **Body Mass Index (BMI):** BMI is a number calculated from a child's weight and height, and is a reliable indicator of body fatness for most children and teens. BMI was calculated as follows: weight (kg)/ height^2 (m^2) (WHO, 1995; Reeves *et al*., 1996). Individuals with a BMI of less than 20 were considered underweight; those with BMI in the range of 20-24.9 were considered normal, 25-29.9 overweight, while those with BMI greater than 30 were considered obese (WHO, 1995).

iv. **Demispan length (cm):**This measurementwas taken as the distance from the middle of the sternal notch to the tip of the middle finger in the coronal plane (Plate V).

v. **Biaxillary length (cm):** This measurementwas taken on the ventral surface, side to side at the junction of deltopectoral groove and anterior axillary fold, in a supine or sitting position with an adduction close to the body (Plate VI)

vi. **Neck length (cm):**This measurementwas taken as the linear distance between two easily recognizable and fixed bony points- the external occipital protuberance and the spinous process of C7 vertebra (vertebra prominence), with the individual standing upright and the neck held in neutral position (Rolland *et al.*, 2003).

vii.**Hand length (cm):** This measurementwas taken as a straight distance between the distal crease of the wrist joint and the most anterior projecting point (tip of the middle finger) in extension as described by Amirsheybani *et al*. (2001), (Plate II).

viii. **Hand breadth (cm):**This measurementwas takenasthe linear distance between the most prominent point on the lateral aspect of the head of second metacarpal and the most prominent point on the medial aspect of the head of fifth metacarpal in adducted position as described by Ibeachu *et al*. (2011), (Plate I).

ix. **Thigh length (cm):**This measurement was taken from the midpoint of the inguinal ligament to the proximal edge of the patella on a ventral surface, in a sitting or supine positionwith 90-degree flexion of knee and 30-45 degree of hip.

x. **Leg length (cm):**This measurement was taken from the tibiale to the medial malleolus of the tibia (Plate X).

xi. **Foot length (cm):**This measurement was taken as the maximum distance between the most prominent part of the heel (tip of heel) to the most distal part of the longest toe (great or second toe) with a sliding calliper.

xii. **Foot breadth (cm):** This measurement was taken as the distance between the most prominent point on the medial aspect of head of first metatarsal and the most prominent point on the lateral aspect of head of fifth metatarsal.

xiii. **Digit length (mm):**This measurement was taken on the ventral surface of the hand from the basal crease of the digit to the tip of the first, second, third, fourth and fifth digits in both right and left hands using an Avenger digital calliper (MicroMak, USA) measuring to 0.01mm.

xiv.**Sitting height (cm):**This measurement was taken as the distance from the vertex of the head to the base of the sitting surface on fully erect posture. It gives a measure of the length of thetrunk (Plate VII).

Plate I: Measurement of hand breadth (cm) using a digital calliper (Cescorf, Brazil).

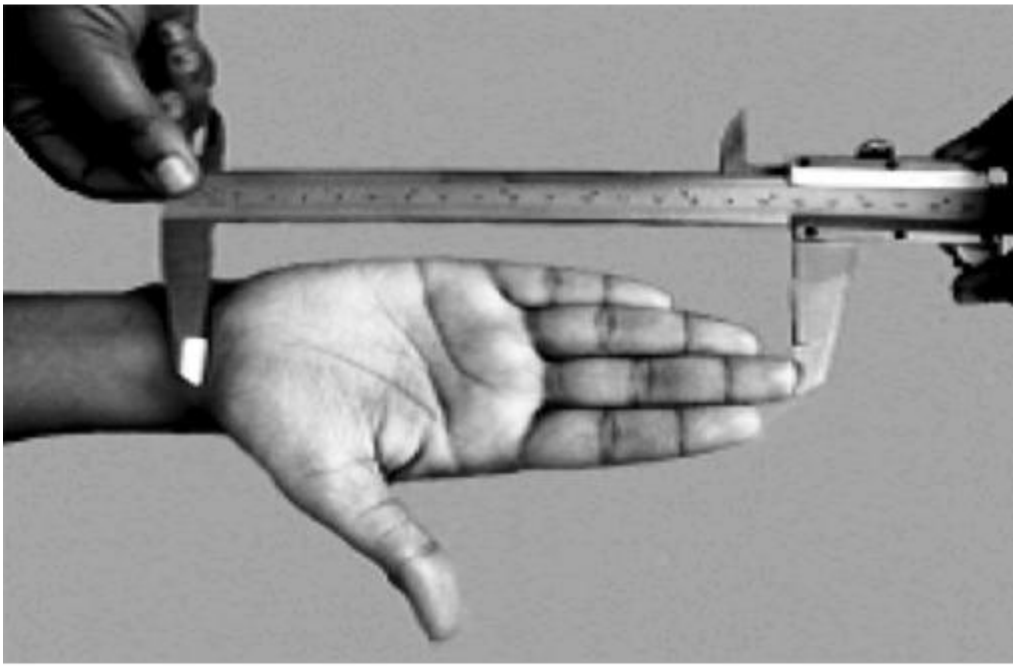

Plate II: Measurement of hand length (cm) using a digital calliper (Cescorf, Brazil).

Plate III: Measurement of standing height (cm) using an anthropometer (Belo Horizonte, Brazil).

Plate IV: Weight (kg) using a weighing balance (Tanita, USA).

Plate V: Measurement of demi span length (cm) using standard measuring tape (Tanita, USA).

Plate VI: Measurement of biaxillary length (cm) using standard measuring tape (Tanita, USA).

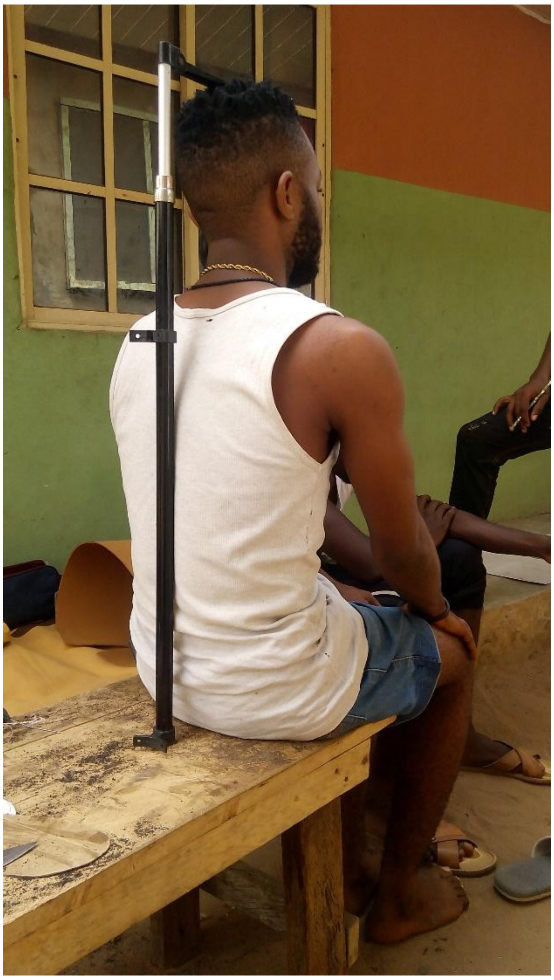

Plate VII: Measurement of sitting height (cm) using an anthropometer (Belo Horizonte, Brazil).

Plate VIII: Measurement of chest circumference (cm) using standard measuring tape (Tanita, USA).

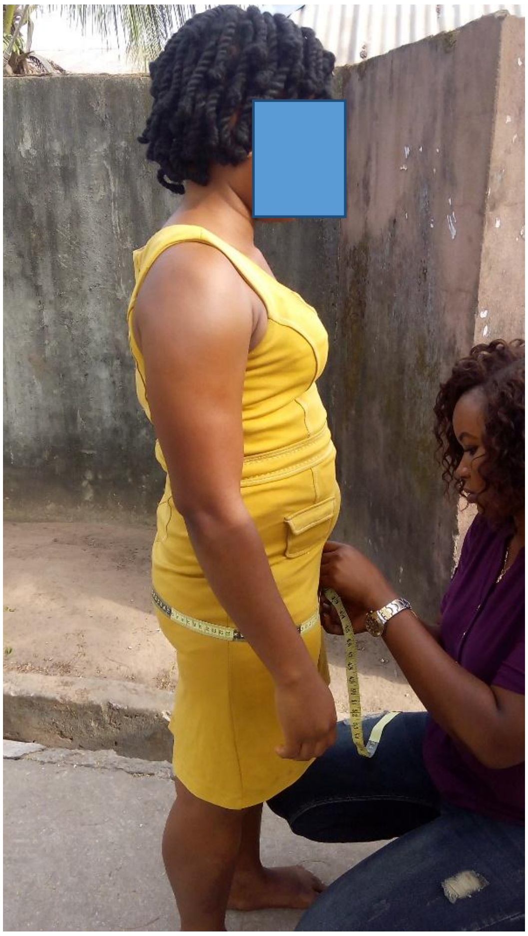

Plate IX: Measurement of hip circumference (cm) using standard measuring tape ((Tanita, USA).

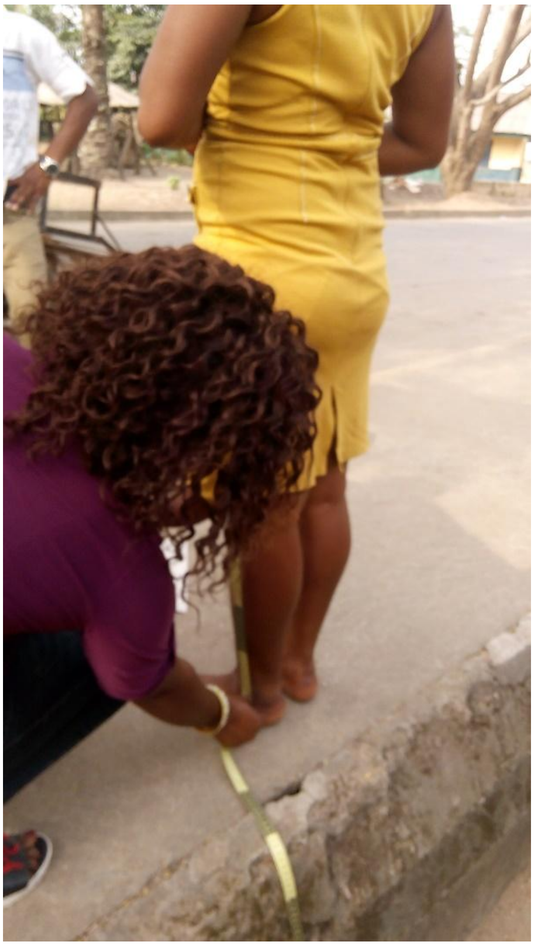

Plate X: Measurement of leg length (cm) using standard measuring tape (Tanita, USA).

xv. **Neck circumference (cm):** This circumference measure was taken at the level below the laryngeal prominence and perpendicular to the long axis of the neck, and the minimal circumference was recorded to the nearest 0.1cm (Rolland *et al.*, 2003).

xvi. **Chest circumference (cm):**This measurement was taken at the level of the middle of the sternum (breast-bone), with the tape passing under the arms. The tape was positioned, with the arms relaxed by the side, and the measurement was taken at the end of a normal expiration (Plate VIII).

xvii. **Waist circumference (cm):**The tape was used to circle the waist (like a belt would circle the waist) at the natural waistline (level of the umbilicus), which is midpoint between the lowest rib and the iliac crest.The subject was asked to stand erect while measurement was taken and recorded to the nearest 0.1cm (Lohman *et al.,* 1988).

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

xix. **Thigh circumference (cm):**This circumference measure was taken at the level of the mid-point on the lateral (outer side) surface of the thigh, midway between trochanter (top of the thigh, femur) and tibia lateral (top of the tibia bone), (Lohman *et al*., 1988).

xx. **Calf circumference (cm):** This circumference measure was taken in the sitting position with the knee flexed to 90 degrees, a tape measure was wrapped over the largest part of the calf (Rolland *et al*., 2003).

3.8ETHICAL APPROVAL

The study protocol was reviewed and approved by Health Research Ethics Committee on Human Subjects of the Ahmadu Bello University Zaria and permission to conduct the study was obtained from the authorities of participating towns/ communities. Only subjects who gave informed consent to participate in the research were included in this study.

3.9 INCLUSION AND EXCLUSION CRITERIA

3.9.1 Inclusion Criteria

The following were used as inclusion criteria:

i. subjects who are indigenes of Yakurr and must be from one of the ethnic groups within the study.

ii. subjects between the age range of 18-32 years.

iii. apparently healthy individuals with no obvious physical deformities.

iv. only subjects who gave informed consent.

3.9.2 Exclusion Criteria

The following were used as exclusion criteria:

i. subjects who are non-indigenes of Lokaa, Ayiga, Agoi and Ekoi ethnic groups.
ii. subjects below or above the stipulated age range
iii. subjects with physical deformities
iv. subjects not willing to participate.

3.10 STATISTICAL ANALYSES

Data were expressed as mean ± standard deviation (SD). Student's independent t-test was used to investigate significant difference between males and females. One-way ANOVA was used to test the differences in the means between Lokaa, Ayiga, Agoi and Ekoi ethnic groups. The Pearson's moment correlation was used to investigate relationship between anthropometric variables. Simple linear and multiple linear regression analyses were performed to derive population-specific equations for predicting stature in the four ethnic groups. $P < 0.05$ was deemed statistically significant. SigmaStat 3.5 (Systat, Inc, CA) for Windows and Microsoft Excel (Microsoft, Inc, WA) were used for the data analyses.

4.0 RESULTS

4.1 ANALYSIS OF STUDY POPULATION

A total of eight hundred subjects (students and non-students) participated in this study (n = 800). This study comprising of 400 males and 400 females from Agoi, Ayiga, Ekoi and Lokaa ethnic groups was conducted in Cross River State (Yakurr L.G.A.), Nigeria. The age range of the study subjects was 18 – 32 years, while the mean age was 24.75 ± 4.05 years.

4.2ANTHROPOMETRIC VARIABLES AND HEIGHT

Data were collected from subjects using proforma. Descriptive statistics of the entire sample population is shown in Table 4.1. The mean age and mean height of the entire population were 24.75 ± 4.05 years and 165.70 ± 6.26 cm. The minimum age of the population was 18years while the maximum age was 32years. Also, average ages of males to females for the study were 24.94 ± 3.94 and 24.55 ± 4.15 years respectively. The mean height for males to females were 169.11 ± 5.50 cm and 162.29 ± 4.99 cm respectively indicating that the males were significantly taller in stature when compared to the females ($t = -18.39$, $p < 0.001$).The mean anthropometric parameters were higher in males when compared to the females in Yakurr Local Government Area in Cross River State $p < 0.05$ except for thigh circumference, chest circumference, waist circumference and hip circumference ($t = 2.91$, $p = 0.004$), ($t = 7.37$, $p < 0.001$), ($t = 12.60$, $p < 0.001$) and ($t =17.44$, $p<0.001$) respectively which were significantly higher in the females than males. Also waist/height ratio values are insignificantly higher in the females ($t = 0.64$, $p = 0.521$).

Table 4.1: Descriptive statistics and sexual dimorphism inanthropometric parameters of all subjects in relation to gender

Variables	Male + Female (n = 800) Mean + SD	Min – Max	Males (n = 400) Mean + SD	Min - Max	Females (n = 400) Mean + SD	Min - Max	t	P
Age (years)	24.75 ± 4.05	18.00 – 32.00	24.94 ± 3.94	18.00 – 32.00	24.55 ± 4.15	18.00 – 32.00	-1.38	0.168
Height (cm)	165.70 ± 6.26	150.00-187.00	169.11 ± 5.50	155.00 – 187.00	162.29 ± 4.99	150.00 - 179.00	-18.39	<0.001
Weight (kg)	63.06 ± 7.58	40.00 – 91.00	64.26 ± 6.16	48.00 – 83.00	61.87 ± 8.62	40.00 – 91.00	- 4.52	<0.001
Body mass index (kg/m^2)	22.96 ± 2.48	15.24 – 33.43	23.50 ± 2.16	17.01 – 29.76	22.43 ± 2.66	15.24 – 33.43	- 6.27	<0.001
Demi span length (cm)	87.28 ± 4.98	69.00 – 101.00	90.16 ± 3.92	80.00 – 101.00	84.41 ± 4.20	69.00 – 97.00	-20.02	<0.001
Biaxillary length (cm)	35.92 ± 3.29	22.00 – 84.00	36.12 ± 2.47	31.00 – 43.00	35.71 ± 3.94	22.00 – 84.00	-1.78	0.075
Hand length (cm)	19.36 ± 1.17	13.00 – 25.00	19.97 ± 0.86	17.20 – 25.00	18.74 ± 1.11	13.00 – 22.00	-17.52	<0.001
Hand breadth (cm)	11.92 ± 1.16	0.50 – 19.00	12.41 ± 0.95	4.00 – 14.50	11.43 ± 1.14	0.50 – 19.00	-13.22	<0.001
Foot length (cm)	25.14 ± 2.27	17.00 – 72.00	25.88 ± 2.74	19.00 – 72.00	24.40 ± 1.31	17.00 – 34.00	-9.74	<0.001
Foot breadth (cm)	13.31 ± 0.98	11.00 – 17.00	13.77 ± 0.92	11.00 – 17.00	12.84 ± 0.81	11.00 – 15.00	-15.13	<0.001
Hand index	61.64 ± 5.45	2.70 – 10.56	62.20 ± 4.75	20.00 – 73.68	61.09 ± 6.03	2.70 – 10.56	-2.18	0.030
Foot index	53.10 ± 3.95	16.67 – 79.41	53.46 ± 4.01	16.67 – 67.46	52.74 ± 3.86	38.24 – 79.41	-8.96	<0.001
Thigh length (cm)	44.24 ± 2.63	38.00 – 52.00	45.14 ± 2.50	40.00 – 52.00	43.33 ± 2.43	38.00 – 50.00	-10.41	<0.001
Thigh circumference (cm)	53.12 ± 3.61	39.00 – 73.00	52.75 ± 2.97	45.00 – 63.00	53.49 ± 4.13	39.00 – 73.00	2.91	0.004
Calf circumference (cm)	35.81 ± 2.42	23.00 – 53.00	35.90 ± 2.49	23.00 – 53.00	35.73 ± 2.35	30.00 – 45.00	-0.99	0.324
Leg length (cm)	39.97 ± 2.20	33.00 – 49.00	40.53 ± 2.20	34.00 – 49.00	39.42 ± 2.05	33.00 – 47.00	-7.39	<0.001
Neck length (cm)	13.81 ± 1.05	11.00 – 24.00	13.89 ± 0.96	11.00 – 18.00	13.73 ± 1.12	11.00 – 24.00	-2.29	0.022
Chest circumference (cm)	88.80 ± 5.24	77.00 – 114.00	87.48 ± 4.47	77.00 – 101.00	90.13 ± 5.62	77.00 – 114.00	7.37	<0.001
Neck circumference (cm)	35.85 ± 3.11	30.00 – 82.00	36.98 ± 2.67	30.00 – 76.00	34.72 ± 3.11	30.00 – 82.00	-11.05	<0.001
Neck/height ratio	0.22 ± 0.02	0.19 – 0.51	0.22 ± 0.02	0.19 – 0.46	0.21 ± 0.02	0.19 – 0.51	1.43	0.153
Waist circumference (cm)	81.41 ± 6.07	66.00 – 110.00	78.94 ± 4.41	66.00 – 96.00	83.88 ± 6.48	66.00 – 110.00	12.60	<0.001
Hip circumference (cm)	93.93 ± 6.55	78.00 – 122.00	90.49 ± 4.87	78.00 – 108.00	97.37 ± 6.21	82.00 – 122.00	17.44	<0.001
Waist/hip ratio	0.87 ± 0.05	0.71 – 1.10	0.87 ± 0.04	0.71 – 0.98	0.86 ± 0.05	0.73 – 1.10	3.76	<0.001
Waist/height ratio	0.49 ± 0.04	0.38 – 0.66	0.47 ± 0.03	0.38 – 0.57	0.52 ± 0.04	0.41 – 0.66	0.64	0.521
Sitting height (cm)	81.58 ± 3.16	70.00 – 93.00	83.52 ± 2.61	75.00 – 93.00	79.63 ± 2.37	70.00 – 89.00	-22.09	<0.001
Sitting height/height ratio	0.49 ± 0.01	0.45 – 0.52	0.49 ± 0.01	0.46 – 0.52	0.49 ± 0.01	0.45 – 0.52	3.68	<0.001
Leg length/sitting height ratio	0.49 ± 0.03	0.39 – 0.62	0.49 ± 0.03	0.39 – 0.59	0.50 ± 0.02	0.42 – 0.62	-1.90	0.057

Table 4.2 shows digit anthropometric parameters in relation to gender in Yakurr Local Government Area which indicates that there are significant differences in the means of the anthropometric parameters in males to that of females except for R2D:4D and L2D:4D which were significantly higher in females to males.

Table 4.3 shows the descriptive statistics of the subjects in relation to ethnic groups in Yakurr Local Government Area in Cross River State. The average ages of the subjects from Agoi, Ayiga, Ekoi and Lokaa were 24.26 ± 4.35, 25.72 ± 3.58, 24.78 ± 4.21 and 24.23 ± 3.85 years respectively and also the mean height for Agoi, Ayiga, Ekoi and Lokaa ethnic groups were 162.61 ± 4.87, 166.00 ± 7.29, 167.15 ± 6.03 and 167.04 ±5.53 centimetres respectively indicating that the subjects from Ekoi ethnic group are significantly taller in height when compared to subjects from Agoi, Ayiga and Lokaa ethnic groups.

Table 4.2: Descriptive statisticsand sexual dimorphism in digit lengthsof all subjectsin relation to gender

Variables	Male + Female (n = 800) Mean + SD	Min - Max	Males (n = 400) Mean + SD	Min - Max	Females (n = 400) Mean + SD	Min - Max	t	P
Right digit 1 (mm)	59.27 ± 5.91	50.00 – 80.00	61.06 ± 6.14	50.00 – 80.00	57.49 ± 5.10	50.00 – 80.00	-8.95	<0.001
Right digit 2 (mm)	71.28 ± 5.02	60.00 – 88.00	72.14 ± 5.69	60.00 – 88.00	70.42 ± 4.08	60.00 – 86.00	-4.91	<0.001
Right digit 3 (mm)	82.52 ± 4.59	65.00 – 97.00	84.41 ± 4.49	65.00 – 97.00	80.63 ± 3.85	70.00 – 95.00	-12.79	<0.001
Right digit 4 (mm)	75.46 ± 4.91	60.00 – 92.00	77.07 ± 5.10	60.00 – 92.00	73.86 ± 4.13	60.00 – 86.00	-9.78	<0.001
Right digit 5 (mm)	59.27 ± 5.01	45.00 – 74.00	60.96 ± 4.60	50.00 – 74.00	57.57 ± 4.84	45.00 – 70.00	-10.17	<0.001
Right 2D:4D	0.95 ± 0.45	0.72 – 1.08	0.94 ± 0.06	0.72 – 1.07	0.95 ± 0.04	0.82 – 1.08	-1.96	0.05
Left digit 1 (mm)	59.25 ± 5.97	50.00 – 80.00	61.05 ± 6.16	50.00 – 80.00	57.44 ± 5.19	50.00 – 80.00	-8.95	<0.001
Left digit 2 (mm)	71.30 ± 4.95	60.00 – 88.00	72.15 ± 5.57	60.00 – 88.00	70.46 ± 4.07	60.00 – 86.00	-4.90	<0.001
Left digit 3 (mm)	82.49 ± 4.56	70.00 – 97.00	84.37 ± 4.43	70.00 – 97.00	80.62 ± 3.87	70.00 – 95.00	-12.77	<0.001
Left digit 4 (mm)	75.39 ± 4.93	60.00 – 95.00	77.02 ± 5.16	60.00 – 95.00	73.75 ± 4.08	60.00 – 87.00	-9.95	<0.001
Left digit 5 (mm)	59.23 ± 5.08	45.00 – 74.00	60.96 ± 4.67	45.00 – 74.00	57.50 ± 4.88	45.00 – 70.00	-10.26	<0.001
Left 2D:4D	0.95 ± 0.05	0.72 – 1.08	0.94 ± 0.06	0.72 – 1.08	0.96 ± 0.04	0.82 – 1.08	-3.92	<0.001

Table 4.3: Total descriptive statistics of subjects in relation to ethnic group

Variables	Agoi (n = 200) Mean + SD	Min - Max	Ayiga (n = 200) Mean + SD	Min - Max	Ekoi (n = 200) Mean + SD	Min - Max	Lokaa (n = 200) Mean + SD	Min - Max
Age (years)	24.26 ± 4.35	18.00 – 32.00	25.72 ± 3.58	18.00 – 32.00	24.78 ± 4.21	18.00 – 32.00	24.23 ± 3.85	18.00 – 32.00
HT (cm)	162.61 ± 4.87	151.00 – 174.00	166.00 ± 7.29	150.00 – 184.00	167.15 ± 6.03	155.00 – 180.00	167.04 ±5.53	152.00 – 187.00
WT (kg)	63.90 ± 5.34	50.00 – 82.00	61.84 ± 9.25	40.00 – 91.00	63.75 ± 6.83	51.00 – 77.00	62.77 ± 8.22	46.00 – 86.00
BMI (kg/m^2)	26.17 ± 1.79	18.10 – 29.80	22.39 ± 2.83	15.20 – 33.40	22.83 ± 2.29	18.10 – 29.60	22.46 ± 2.48	17.00 – 31.60
DSL (cm)	87.99 ± 3.26	81.00 – 95.00	83.62 ± 5.36	69.00 – 101.00	88.18 ± 3.79	81.00 – 99.00	89.35 ± 5.16	76.00 – 101.00
BL (cm)	35.50 ± 4.27	31.00 – 84.00	36.32 ± 3.10	30.00 – 72.00	36.57 ± 2.45	25.00 – 43.00	35.27 ± 2.92	22.00 – 46.00
HL (cm)	18.10 ± 0.95	17.00 – 20.30	19.12 ±1.14	13.50 – 22.30	19.69 ± 1.01	17.50 – 23.00	19.63 ± 1.38	13.00 – 25.00
HB (cm)	11.49 ± 0.95	10.00 – 14.00	12.05 ± 0.77	10.00 – 14.00	12.53 ± 1.12	10.00 – 14.50	11.61 ± 1.40	10.50 – 19.00
FL (cm)	24.26 ± 0.87	21.00 – 26.00	25.09 ± 1.31	21.00 – 29.00	25.29 ± 1.64	22.00 – 36.00	25.92 ± 3.75	17.00 – 72.00
FB (cm)	13.09 ± 0.92	11.00 – 15.00	12.92 ± 0.79	11.00 – 15.00	13.79 ± 0.90	11.50 – 16.00	13.43 ± 1.07	11.00 – 17.00
HI	60.45 ± 3.36	54.05 – 73.68	63.19 ± 4.64	54.55 – 88.89	63.67 ± 4.78	50.00 – 73.68	59.25 ± 7.07	52.70 – 105.56
FI	53.95 ± 2.92	46.81 – 65.22	51.52 ± 2.79	45.83 – 66.67	54.63 ± 3.28	38.24 – 64.00	52.30 ± 5.40	16.67 – 79.41
TL (cm)	43.57 ± 2.44	38.00 – 48.00	44.07 ± 3.31	38.00 – 52.00	44.79 ± 2.30	40.00 – 51.00	44.52 ± 2.15	40.00 – 50.00
TC (cm)	53.40 ± 3.08	47.00 – 63.00	52.99 ± 2.97	45.00 – 68.00	51.85 ± 3.27	45.00 – 61.00	54.25 ± 4.52	39.00 – 73.00
CC (cm)	35.83 ± 1.78	32.00 – 41.00	36.23 ± 2.16	30.00 – 53.00	35.95 ± 2.64	31.00 – 43.00	35.25 ± 2.87	23.00 – 45.00
LL (cm)	38.98 ± 2.01	33.00 – 43.00	39.64 ± 2.39	34.00 – 47.00	40.65 ± 2.01	34.00 – 45.00	40.63 ± 1.90	37.00 – 49.00
NL (cm)	13.84 ± 0.85	12.00 – 15.00	13.46 ± 0.91	11.00 – 16.00	13.96 ± 1.10	12.00 – 24.00	13.99 ± 1.20	11.00 – 18.00
ChC (cm)	88.88 ± 3.16	82.00 – 95.00	86.80 ± 5.95	80.00 – 112.00	89.50 ± 4.33	77.00 – 99.00	90.04 ± 6.34	77.00 – 114.00
NC (cm)	35.37 ± 1.99	31.00 – 41.00	36.46 ± 3.42	31.00 – 76.00	35.70 ± 1.95	30.00 – 39.00	35.87 ± 4.32	30.00 – 82.00
NHtR	0.22 ± 0.01	0.19 – 0.25	0.22 ± 0.02	0.19 – 0.46	0.21 ± 0.01	0.19 – 0.24	0.22 ± 0.03	0.19 – 0.51
WC (cm)	81.82 ± 4.59	73.00 – 96.00	82.67 ± 6.05	69.00 – 104.00	79.93 ± 5.09	66.00 – 94.00	81.21 ± 7.76	68.00 – 110.00
HC (cm)	95.90 ± 5.80	80.00 – 108.00	92.87 ± 6.05	82.00 – 113.00	92.18 ± 6.34	80.00 – 106.00	94.77 ± 7.29	78.00 – 122.00
WHR	0.85 ± 0.04	0.76 – 0.96	0.89 ± 0.05	0.73 – 0.99	0.87 ± 0.05	0.71 – 0.98	0.86 ± 0.05	0.76 – 1.10
WHtR	0.50 ± 0.03	0.43 – 0.58	0.50 ± 0.05	0.41 – 0.63	0.48 ± 0.04	0.38 – 0.58	0.49 ± 0.05	0.41 – 0.66
SHt (cm)	80.07 ± 2.14	76.00 – 85.00	82.10 ± 3.74	74.00 – 90.00	81.77 ± 2.43	75.00 – 90.00	82.37 ± 3.53	70.00 – 93.00
SHtHtR	0.49 ± 0.01	0.47 – 0.52	0.50 ± 0.01	0.45 – 0.52	0.49 ± 0.01	0.47 – 0.52	0.49 ± 0.01	0.45 – 0.52
LLSHtR	0.49 ± 0.03	0.42 – 0.55	0.48 ± 0.03	0.42 – 0.62	0.50 ± 0.02	0.39 – 0.54	0.49 ± 0.02	0.44 – 0.59

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; HI = Hand Index; FI = Foot Index; TL = Thigh Length; TC = Thigh Circumference; CC = Calf Circumference; LL = Leg Length; NL = Neck Length; ChC = Chest Circumference; NC = Neck Circumference; NHtR = Neck/Height Ratio; WC = Waist Circumference; HC = Hip Circumference; WHR = Waist/Hip Ratio; WHtR = Waist/Height Ratio; SHt = Sitting Height; SHtHtR = Sitting Height/Height Ratio; LLSHtR = Leg Length/Sitting Height Ratio.

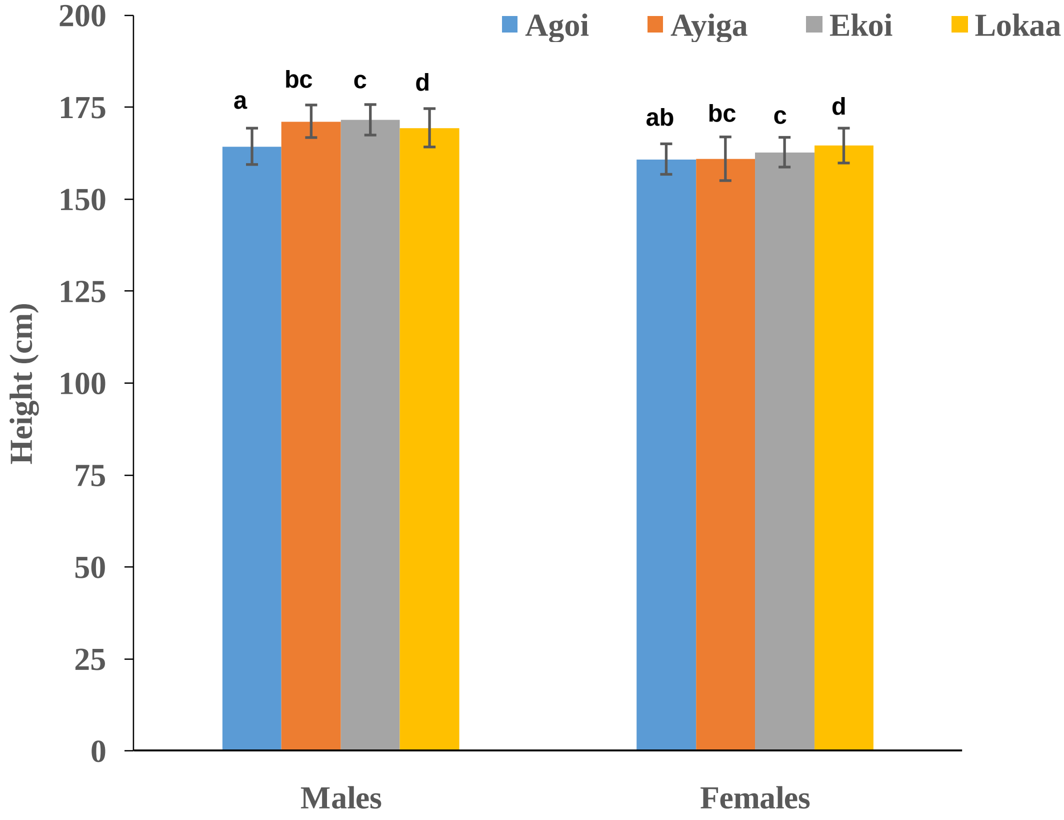

Fig. 4.1: Comparison of height in males and females in relation to ethnicity. In males, a higher value was observed in height of Lokaa than that of Agoi. There was no significant difference between Ayiga and Ekoi ethnic groups.In females, higher value was observed in height of Lokaa than that of Ekoi. There was no significant difference between Agoi and Ayiga, and between Ayiga and Ekoi ethnic groups. One-way analysis of variance indicates significant difference in height based on ethnicity, with $F = 49.81$ for males and $F = 13.24$ for females. $P < 0.05$ for the four categories. Height with different superscript are significantly different with $p < 0.05$.

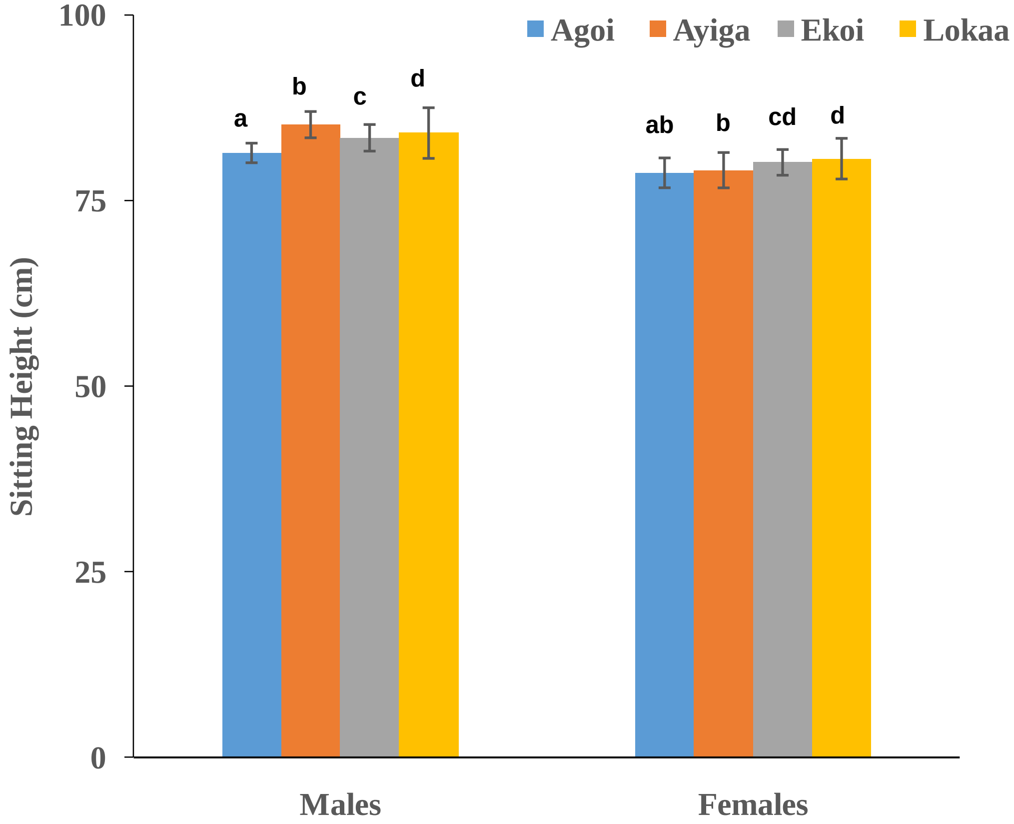

Fig. 4.2:Comparison of sitting height in males and females in relation to ethnicity. In males, a higher value was observed in sitting height of Ayiga than that of Lokaa, Ekoi and Agoi ethnic groups.In females, higher value was observed in sitting height of Ekoi and Lokaa than that of Agoi and Ayiga ethnic groups. There was no significant difference between Agoi and Ayiga, and between Ekoi and Lokaa ethnic groups. One-way analysis of variance indicates significant difference in sitting height based on ethnicity, with $F = 51.84$ for males and $F = 15.72$ for females. $P < 0.05$ for the four categories. Sitting height with different superscript are significantly different with $p < 0.05$.

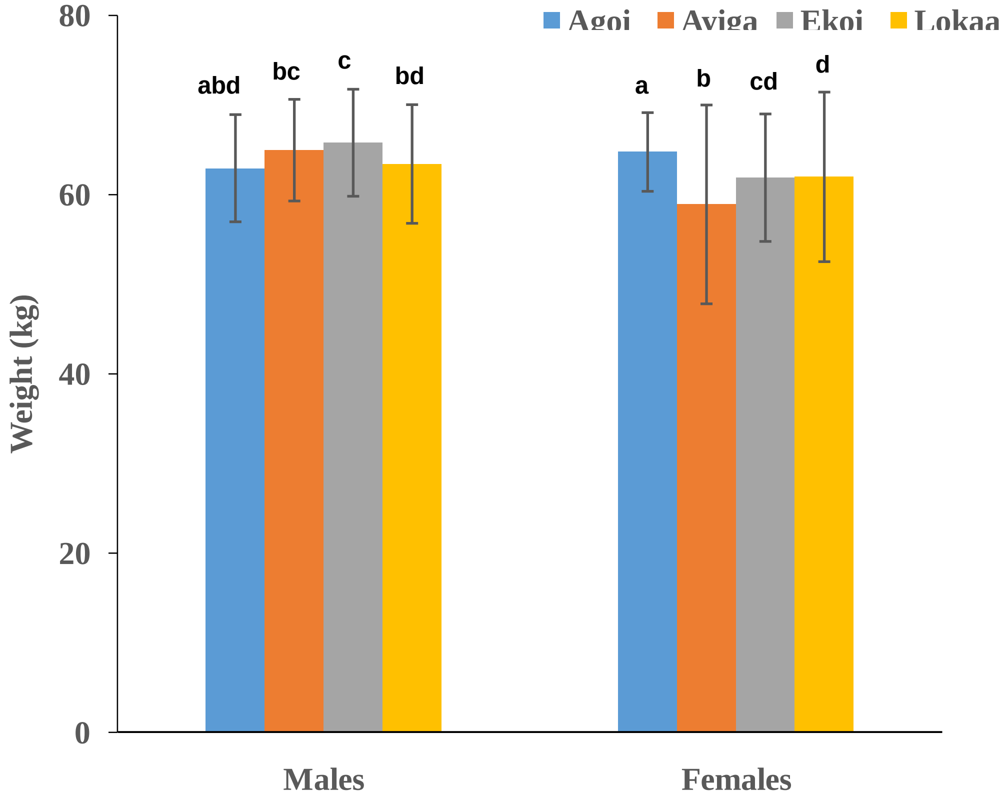

Fig. 4.3: Comparison of weight in males and females in relation to ethnicity. In males, a higher value was observed in the weight of Ayiga and Ekoi than that of Agoi and Lokaa. There was no significant difference between Agoi, Ayiga and Lokaa, and between Ayiga and Ekoi ethnic groups. In females, higher value was observed in the weight of Agoi than that of Ayiga, Ekoi and Lokaa. There was no significant difference between Ekoi and Lokaa ethnic groups.One-way analysis of variance indicates significant difference in weight based on ethnicity, with $F = 4.75$ for males and $F = 8.09$ for females. $P < 0.05$ for the four categories. weight with different superscript are significantly different with $p < 0.05$.

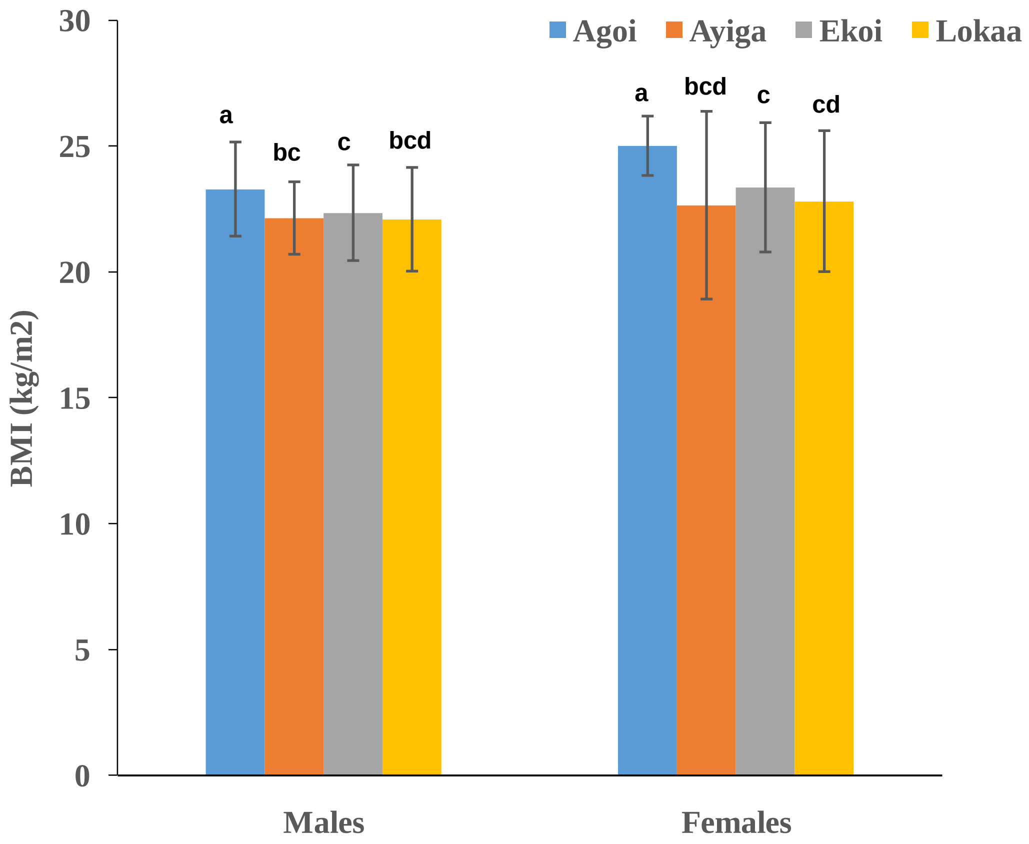

Fig. 4.4: Comparison of BMI parameter in males and females in relation to ethnicity. In males, a higher value was observed in BMI of Agoi than that of Ayiga, Ekoi and Lokaa ethnic groups. There was no significant difference between Ayiga and Lokaa, and between Ayiga, Ekoi and Lokaa. In females, higher value was observed in BMI of Agoi than that of Ayiga, Ekoi and Lokaa ethnic groups. There was no significant difference between Ayiga and Lokaa, and between Ayiga, Ekoi and Lokaa. One-way analysis of variance indicates significant difference in BMI based on ethnicity, with $F = 9.35$ for males and $F = 15.52$ for females. $P < 0.05$ for the four categories. BMI with different superscript are significantly different with $p < 0.05$.

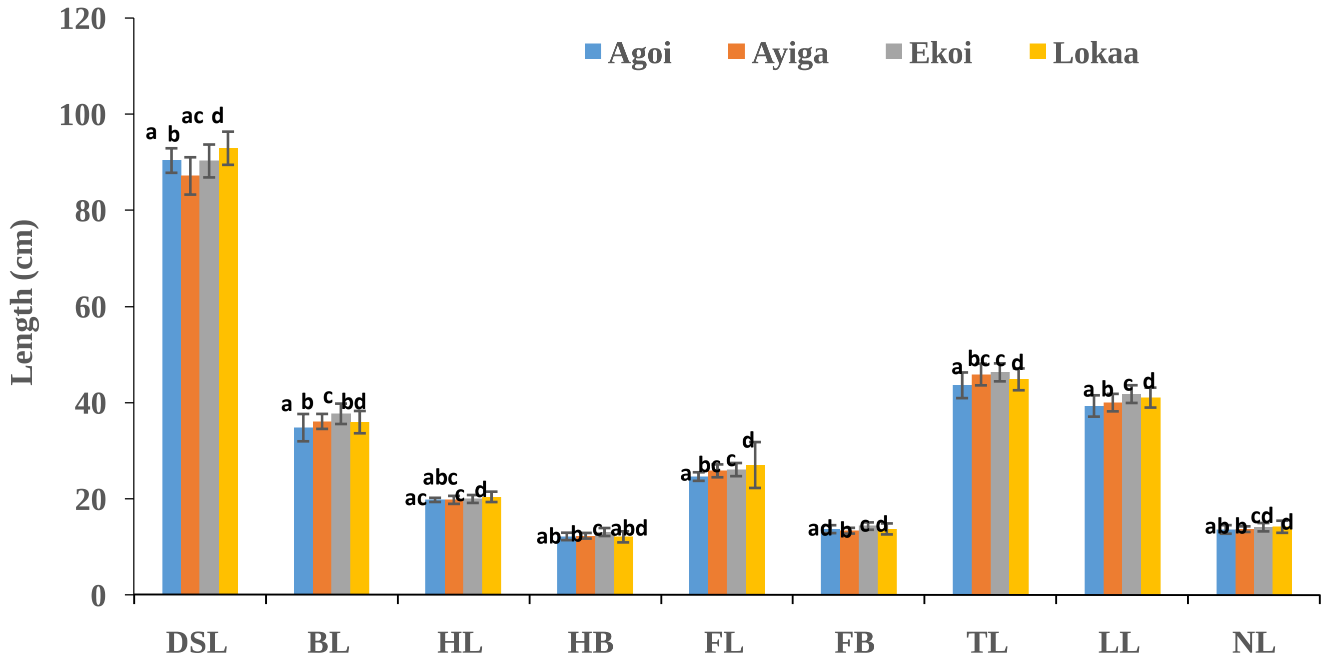

Fig. 4.5: Comparison of anthropometric variables of lengthin relation to ethnicity. One-way analysis of variance indicates significant difference in length based on ethnicity for males with F = 49.21, F = 27.47, F = 13.17, F = 29.16, F = 14.42, F = 21.96, F = 27.26, F = 30.03 and F = 9.22 for all the categories respectively. P <0.05 for the four categories. Length with different superscript are significantly different with p < 0.05.

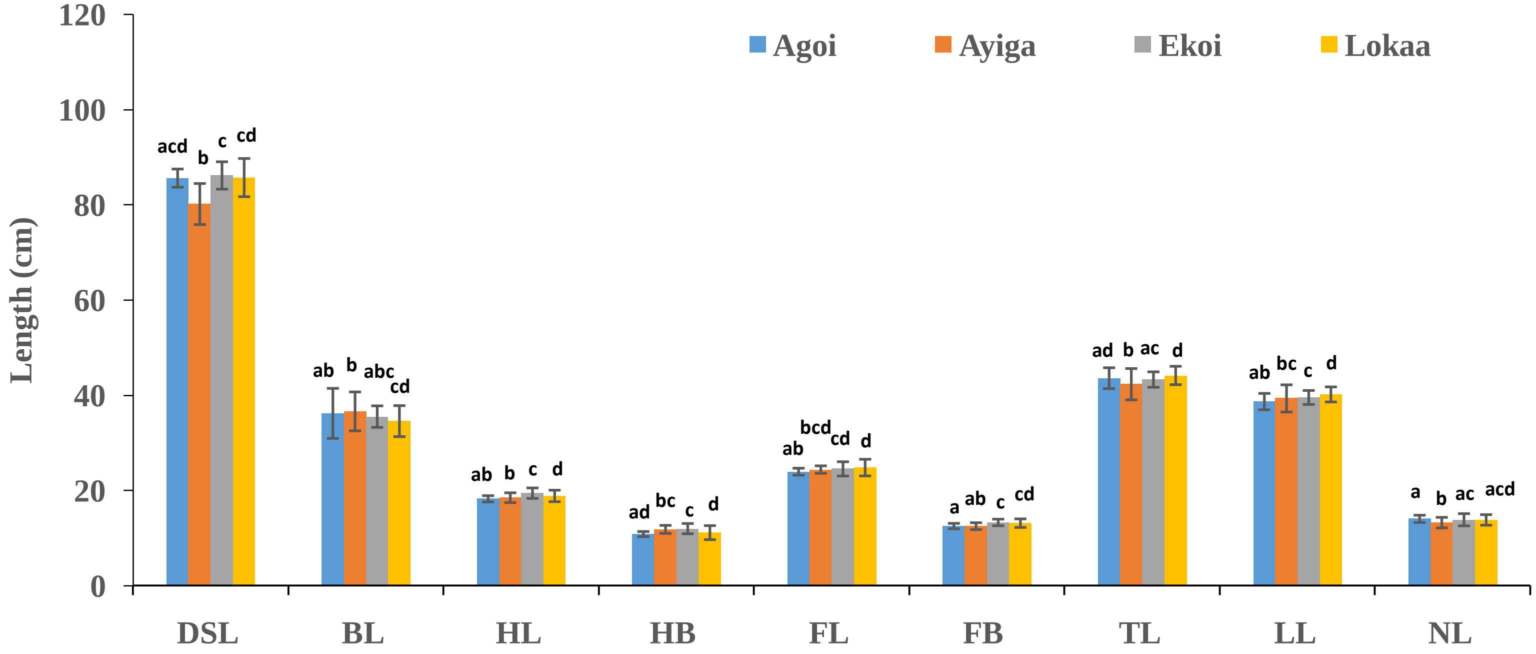

Fig.4.6:Comparison of anthropometric variables of length in relation to ethnicity. One-way analysis of variance indicates significant difference in length based on ethnicity for females with F = 69.31, F = 5.33, F = 25.52, F = 27.85, F = 8.03, F = 31.11, F = 10.64, F = 9.69 and F = 10.17 for all the categories respectively. P < 0.05 for the four categories. Length with different superscript are significantly different with p < 0.05.

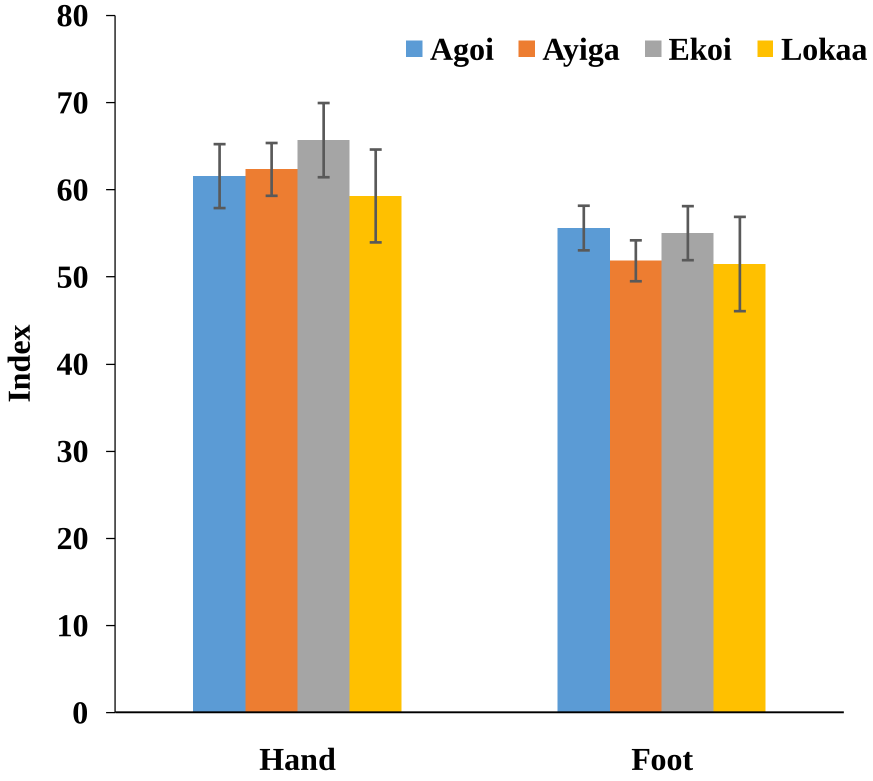

Fig. 4.7: Comparison of anthropometric variables of indices in relation to ethnicity, a highervalue was observed in hand index of Ekoi than that of Agoi, Ayiga and Lokaa ethnic groups. While Agoi has a higher foot index than Ayiga, Ekoi and Lokaa. One-way analysis of variance indicates no significant difference in index based on ethnicity for males, with F = 40.67 and F = 35.52 respectively. P <0.05 for the four categories.

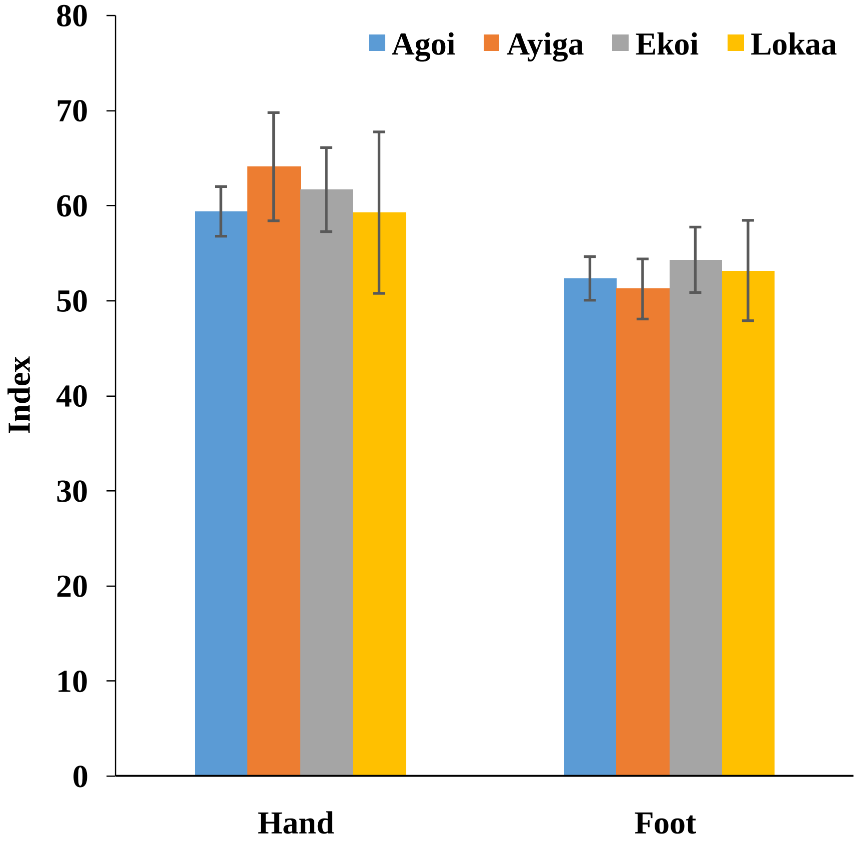

Fig. 4.8: Comparison of anthropometric variables of indices in relation to ethnicity, a higher value was observed in hand index of Ayiga than that of Agoi, Ekoi and Lokaa ethnic groups. While Ekoi has a higher foot index than Agoi, Ayiga, and Lokaa. One-way analysis of variance indicates no significant difference in index based on ethnicity for females, with F = 15.86 and F = 12.24 respectively. P < 0.05 for the four categories.

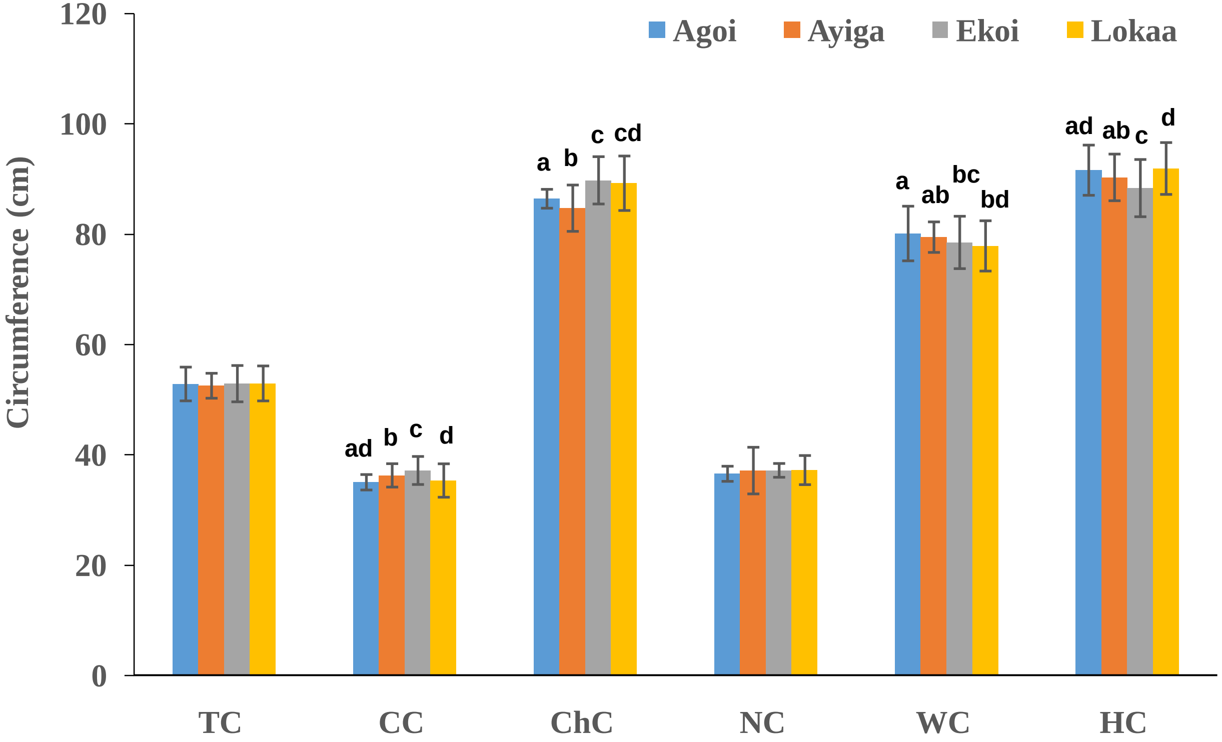

Fig. 4.9: Comparison of anthropometric variables of circumferencein relation to ethnicity. One-way analysis of variance indicates significant difference in circumference based on ethnicity for males with F = 0.41, F = 16.94, F = 35.87, F = 1.39, F = 5.30, F = 11.96for all the categories respectively.P <0.05 for the four categories.Circumference with different superscript are significantly different with p < 0.05.

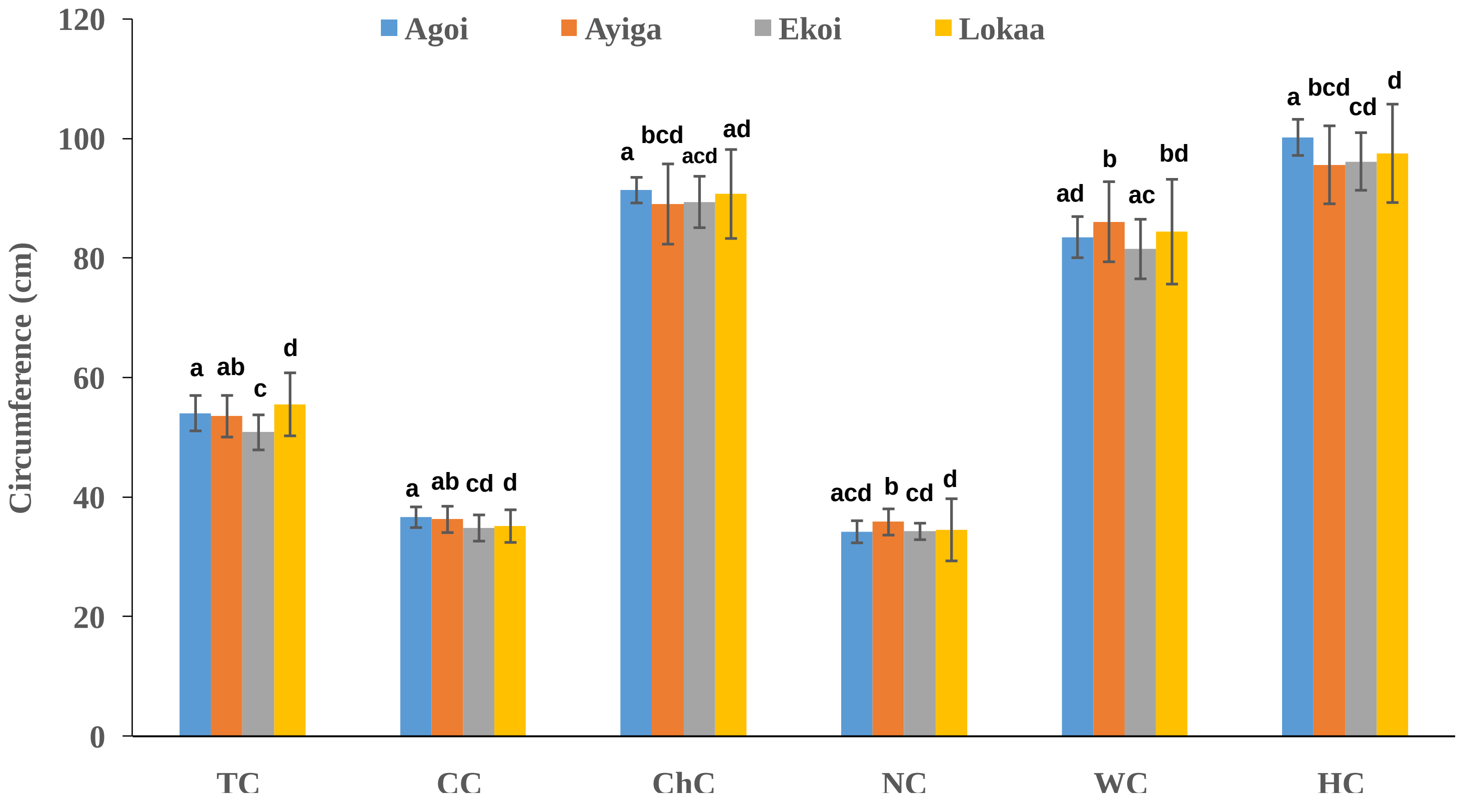

Fig. 4.10: Comparison of anthropometric variables of circumference in relation to ethnicity. One-way analysis of variance indicates significant difference in circumference based on ethnicity for females with F = 26.79, F = 14.99, F = 3.90, F = 6.37, F = 9.17, F = 11.76 for all the categories respectively. P < 0.05 for the four categories. Circumference with different superscript are significantly different with p < 0.05.

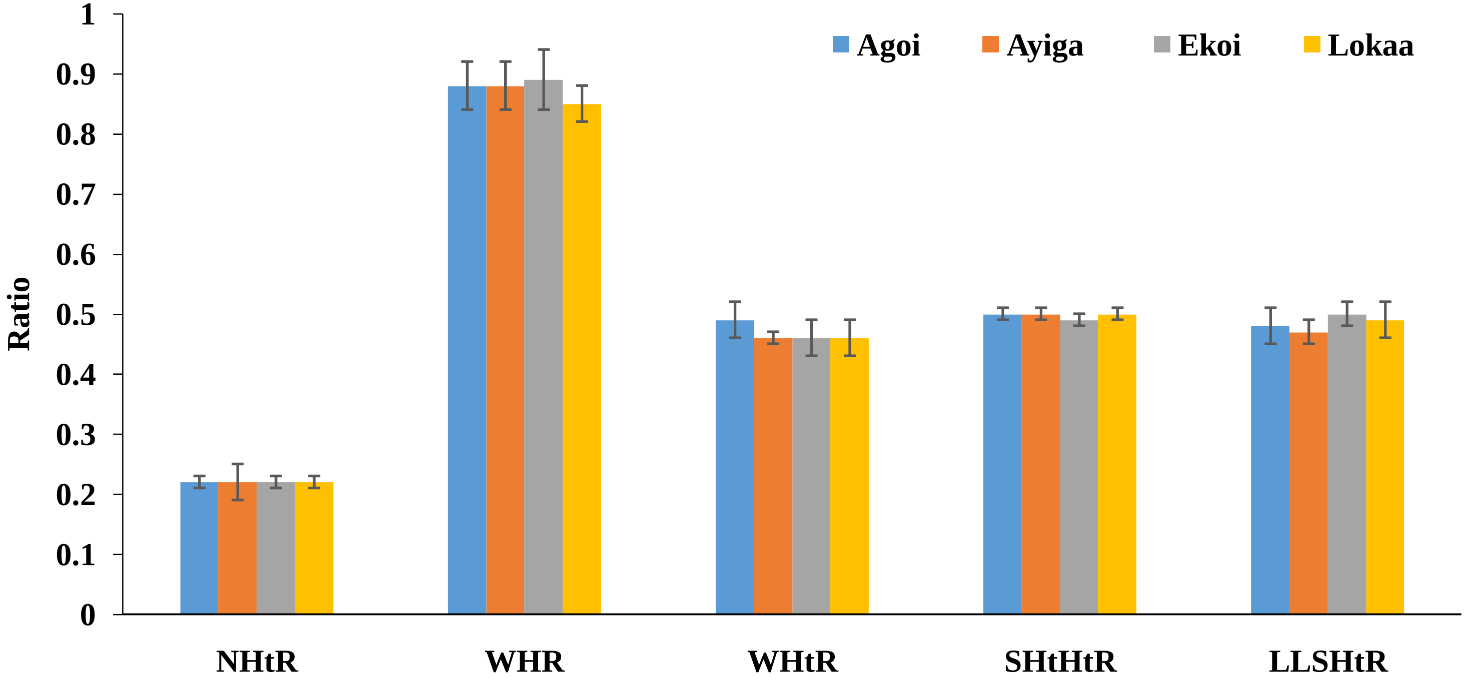

Fig. 4.11: Comparison of anthropometric variables of ratio in relation to ethnicity. One-way analysis of variance indicates no significant difference in ratio based on ethnicity for males with F = 2.82,F = 20.66, F = 34.86, F = 21.81 and F = 29.07 respectively. P <0.05 for the four categories.

.

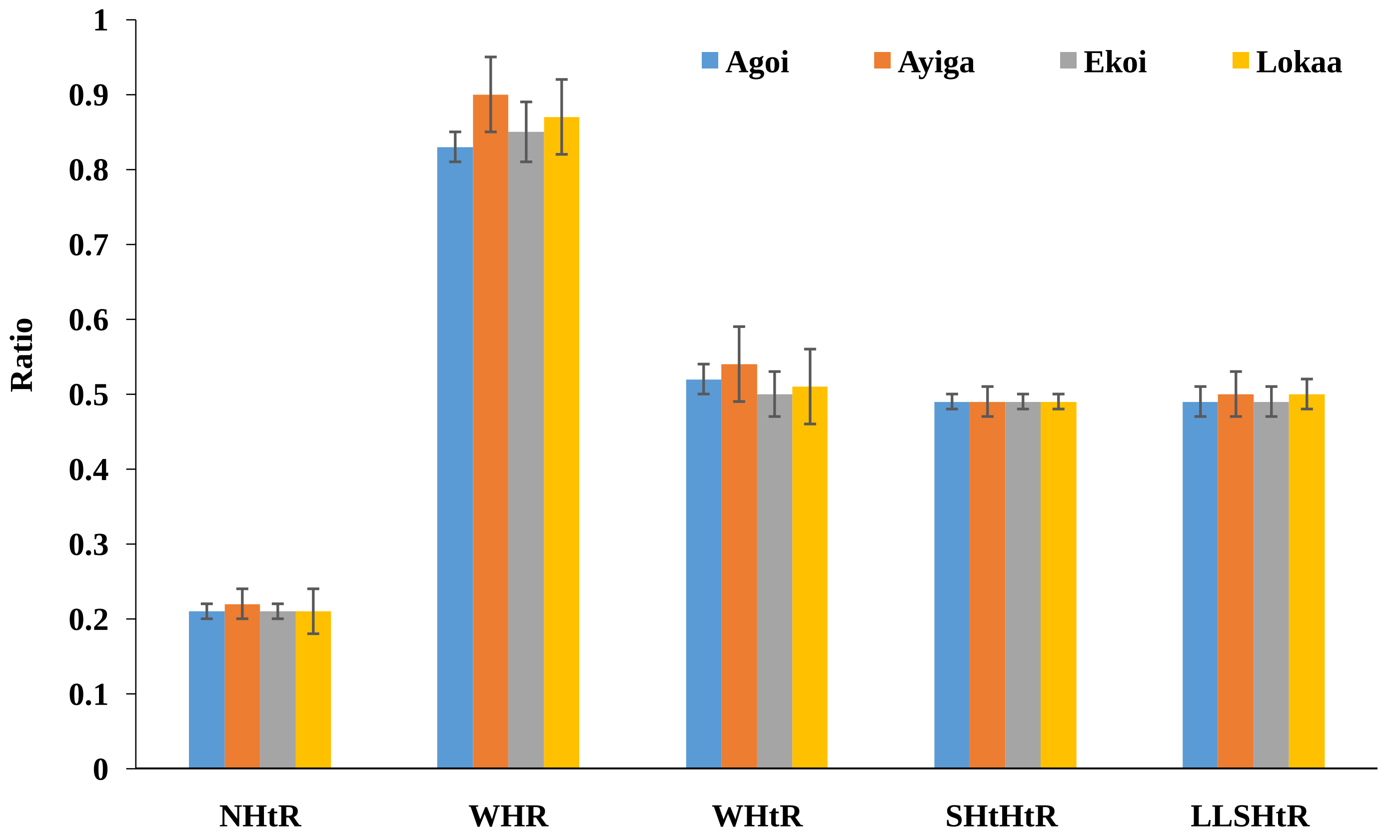

Fig. 4.12: Comparison of anthropometric variables of ratio in relation to ethnicity. One-way analysis of variance indicates no significant difference in ratio based on ethnicity for females with $F = 10.14$, $F = 45.19$, $F = 14.81$, $F = 1.60$ and $F = 2.33$ respectively. $P < 0.05$ for the four categories.

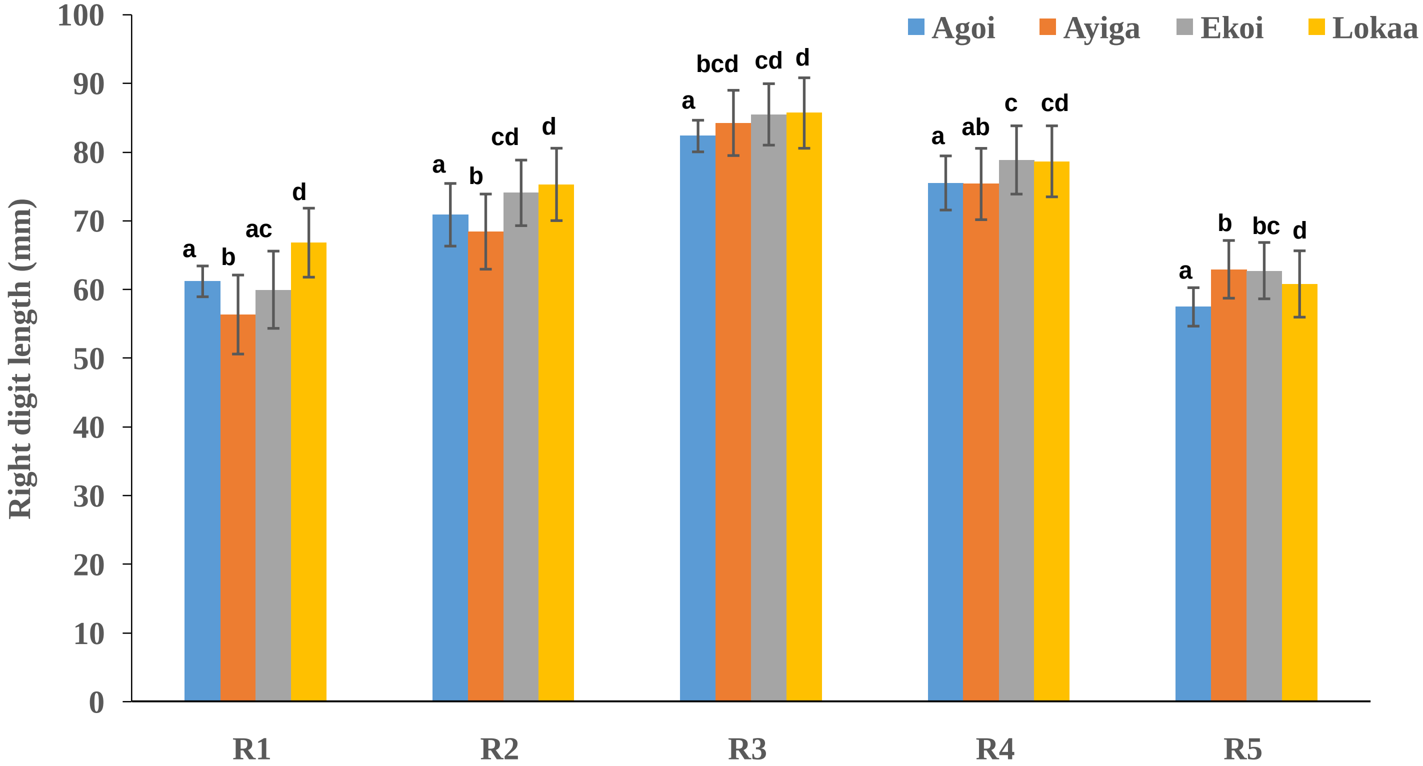

Fig. 4.13: Comparison of anthropometric variables of right digit lengthin relation to ethnicity, and higher values was observed in third right digit (R3) in all the ethnic groups but Lokaa shows a slightly higher value thanAyiga, Agoi and Ekoi ethnic groups. One-way analysis of variance indicates significant difference in right digit length based on ethnicity for males with F = 79.47, F = 38.25, F = 12.80, F = 15.76, and F = 39.22 for all the categories respectively. P <0.05 for the four categories. Right digit length with different superscript are significantly different with $p < 0.05$.

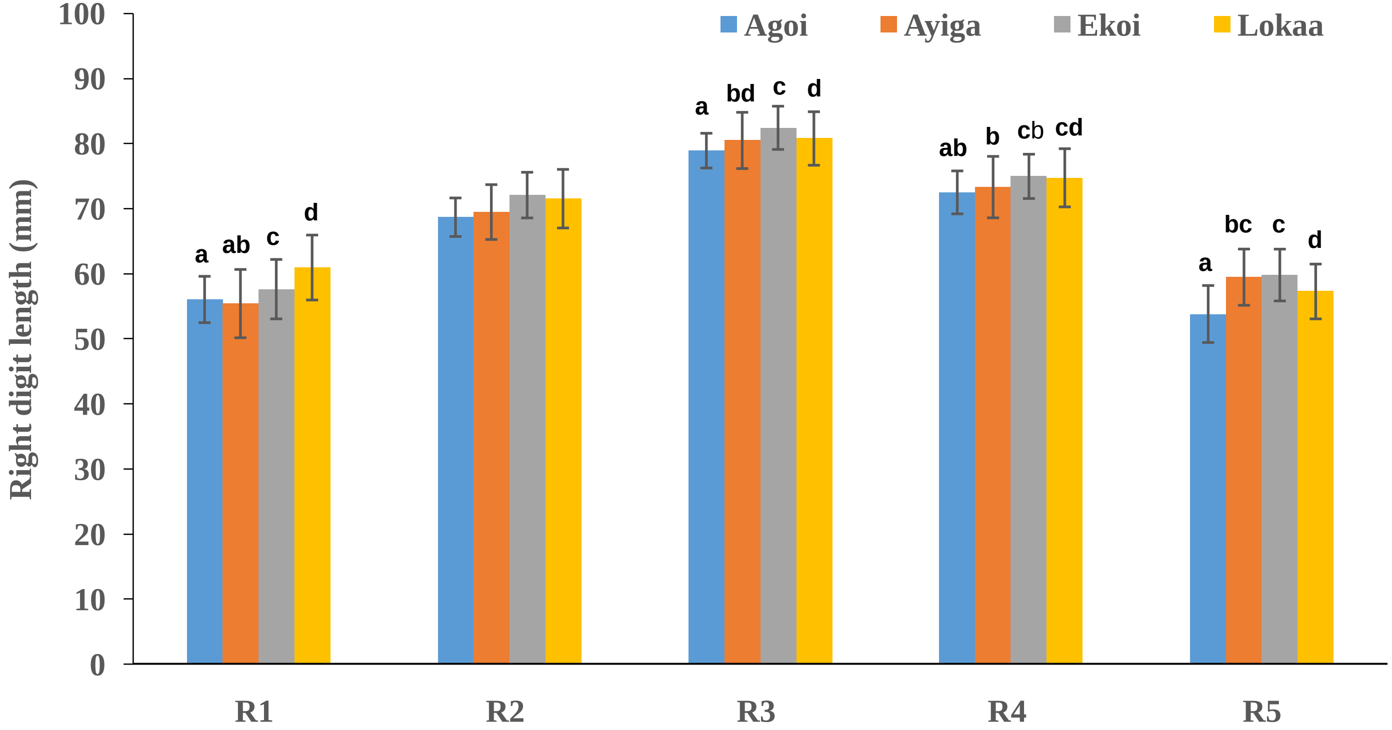

Fig. 4.14: Comparison of anthropometric variables of right digit length in relation to ethnicity, and higher values was observed in third right digit (R3) in all the ethnic groups but Ekoi shows a slightly higher value thanAyiga, Agoi and Lokaa ethnic groups. One-way analysis of variance indicates significant difference inright digit length based on ethnicity for females with F = 28.54, F = 17.83, F = 15.44, F = 8.53, and F = 42.63 for all the categories respectively. P < 0.05 for the four categories. Right digit length with different superscript are significantly different with p < 0.05.

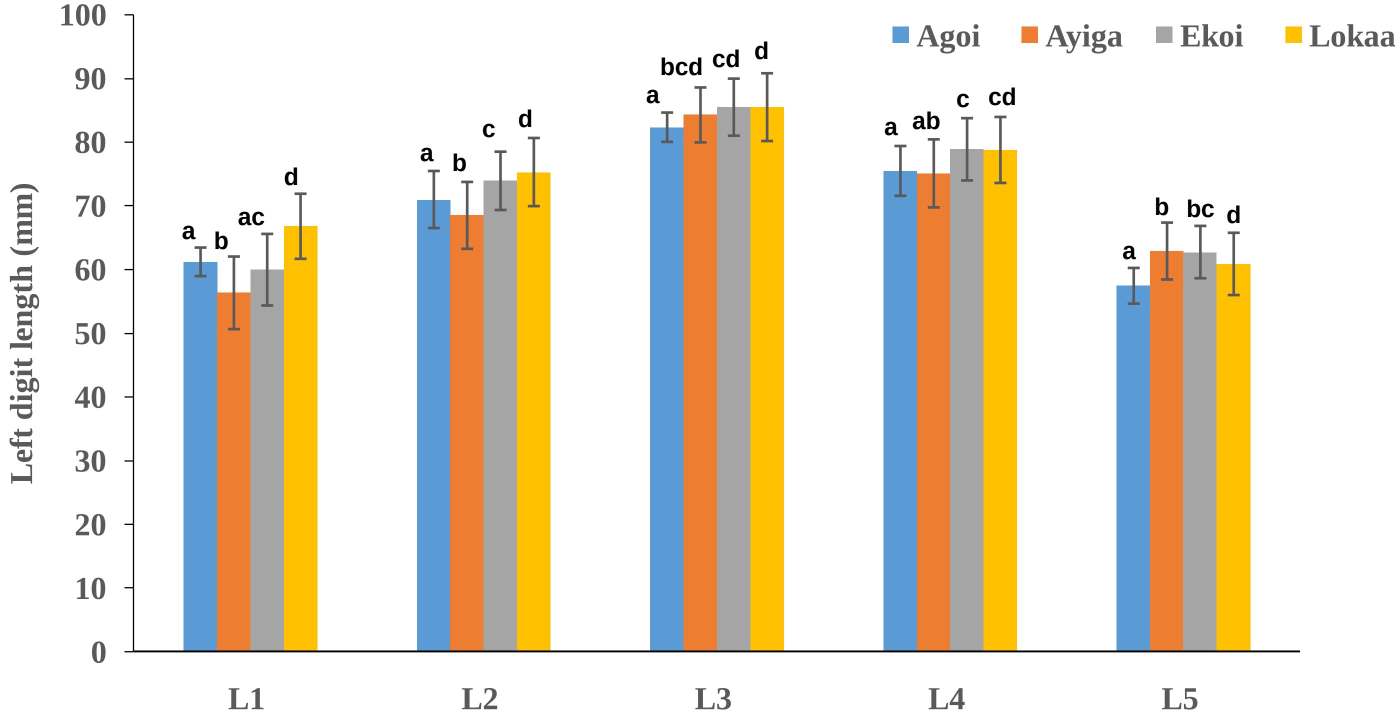

Fig. 4.15: Comparison of anthropometric variablesof left digit length in relation to ethnicity, and higher values are observed in third left digit (L3) in all the ethnic groups. One-way analysis of variance indicates significant difference in left digit lengthbased on ethnicity for males with F = 78.17, F = 38.03, F = 12.25, F = 17.73, andF = 37.43 for all the categories respectively. P <0.05 for the four categories. Left digit lengthwith different superscripts are significantly different with $p < 0.05$.

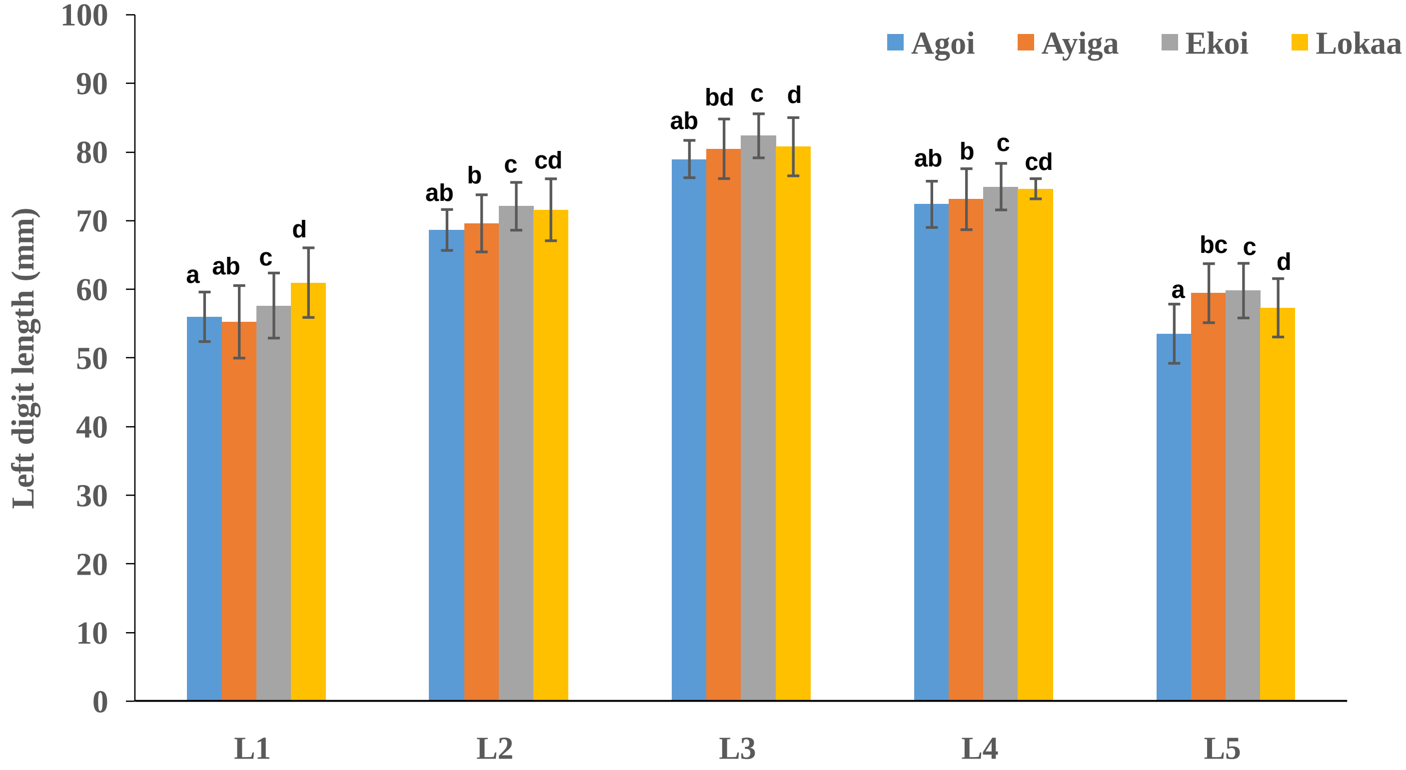

Fig. 4.16: Comparison of anthropometric variables of left digit length in relation to ethnicity, and higher values was observed in third left digit (L3) in all the ethnic groups, but Ekoi shows a slightly higher value thanAyiga, Agoi and Lokaa ethnic groups. One-way analysis of variance indicates significantdifference in left digit lengthbased on ethnicity for females with F = 28.97, F = 18.09, F = 14.09, F = 9.66, and F = 46.64 for all the categories respectively. $P < 0.05$ for the four categories. Left digit lengthwith different superscripts are significantly different with $p < 0.05$.

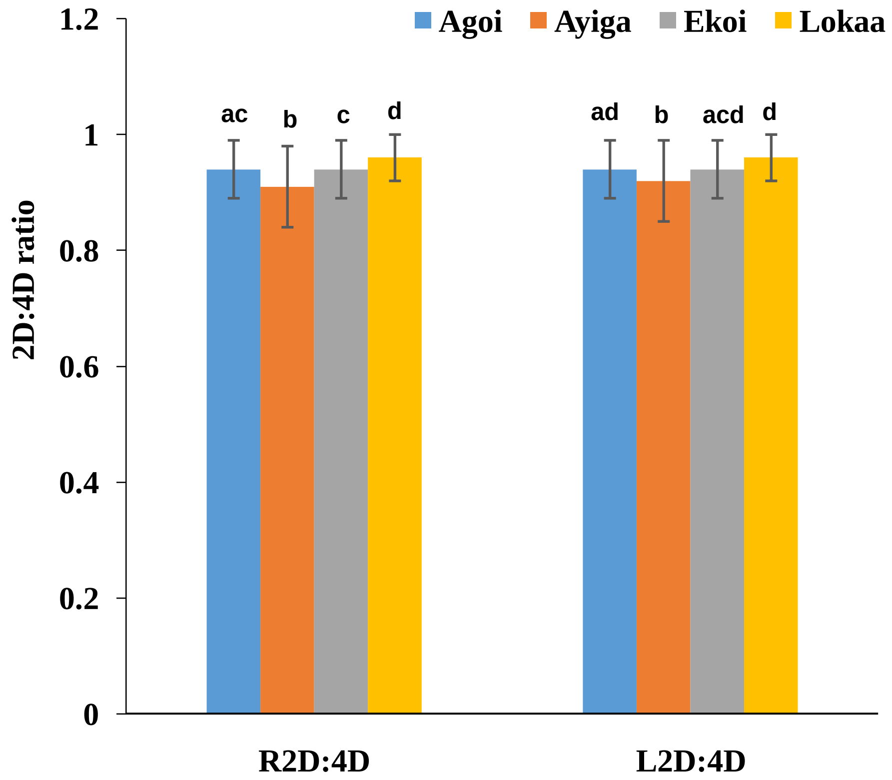

Fig.4.17: Comparison of anthropometric variables of 2D:4D ratioin relation to ethnicity, and higher value was observed in R 2D:4D of Lokaa than that of Agoi, Ayiga and Lokaaethnic groups, but similar length parameters are observed in L 2D:4D of Agoi, Ekoi and Lokaa ethnic groups.One-way analysis of variance indicates significant difference in 2D:4D ratio based on ethnicity for males with $F = 14.34$ and $F = 10.69$ respectively. $P < 0.05$ for the four categories. 2D:4D ratio with different superscripts are significantly different with $p < 0.05$.

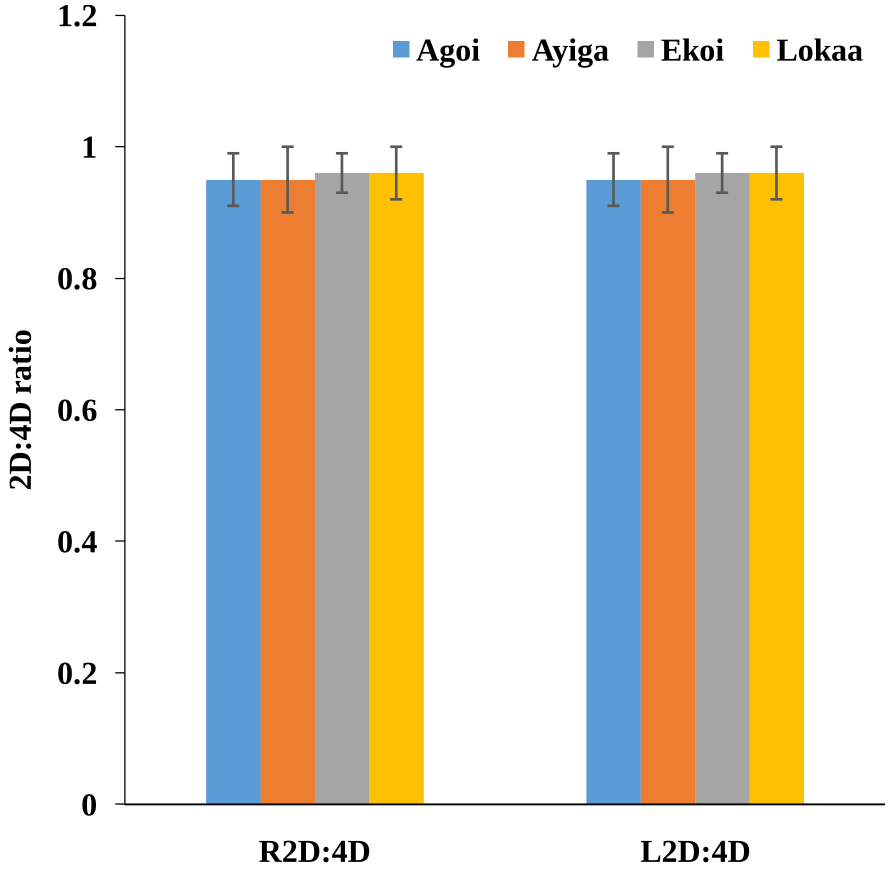

Fig.4.18: Comparison of anthropometric variables of 2D:4D ratio in relation to ethnicity.Similar length parameters were observed in R2D:4D and L 2D:4D ratios of Agoi and Ayiga,and between Ekoi and Lokaa. One-way analysis of variance indicates no significant difference in 2D:4D ratio based on ethnicity for females with F = 2.60 and F = 2.17 respectively. $P < 0.05$ for the four categories. 2D:4D ratio with different superscripts are significantly different with $p < 0.05$.

Table 4.4: Total descriptive statistics of digit lengths for subjects in relation to ethnic group

Variables	Agoi (n = 200) Mean + SD	Min - Max	Ayiga (n = 200) Mean + SD	Min - Max	Ekoi (n = 200) Mean + SD	Min - Max	Lokaa (n = 200) Mean + SD	Min - Max
R1 (mm)	58.62 ± 3.89	50.00 – 72.00	55.79 ± 5.49	50.00 – 80.00	58.75 ± 5.27	50.00 – 75.00	63.94 ± 5.71	50.00 – 80.00
R2 (mm)	69 76 ± 3.99	63.00 – 80.00	68.93 ± 4.90	60.00 – 88.00	76.54 ± 49.47	60.00 – 77.00	73.37 ± 5.24	60.00 – 86.00
R3 (mm)	80.60 ± 3.02	75.00 – 87.00	82.34 ± 4.90	65.00 – 95.00	83.93 ± 4.21	70.00 – 95.00	83.21 ± 5.24	70.00 – 97.00
R4 (mm)	73.97 ± 3.91	65.00 – 82.00	74.32 ± 5.06	60.00 – 90.00	76.90 ± 4.67	65.00 – 88.00	76.67 ± 5.20	65.00 – 92.00
R5 (mm)	55.58 ± 4.09	45.00 – 63.00	61.21 ± 4.57	50.00 – 70.00	61.27 ± 4.27	50.00 – 71.00	59.02 ± 4.85	50.00 – 74.00
R 2D:4D	0.94 ± 0.05	0.81 – 1.08	0.93 ± 0.06	0.72 – 1.07	0.99 ± 0.05	0.80 – 9.28	0.96 ± 0.04	0.85 – 1.00
L1 (mm)	58.60 ± 3.94	50.00 – 72.00	55.70 ± 5.53	50.00 – 80.00	58.75 ± 5.34	50.00 – 75.00	63.93 ± 5.77	50.00 – 80.00
L2 (mm)	69.79 ± 3.97	63.00 – 80.00	69.03 ± 4.76	60.00 – 88.00	73.01 ± 4.15	60.00 – 87.00	73.39 ± 5.28	60.00 – 86.00
L3 (mm)	80.63 ± 3.30	75.00 – 87.00	82.34 ± 4.72	70.00 – 95.00	83.90 ± 4.19	70.00 – 95.00	83.10 ± 5.35	70.00 – 97.00
L4 (mm)	73.89 ± 3.95	65.00 – 82.00	74 09 ± 5.00	60.00 – 90.00	76.90 ± 4.63	65.00 – 88.00	80.05 ± 4.90	65.00 – 75.00
L5 (mm)	55.43 ± 4.12	45.00 – 63.00	61.17 ± 4.69	45.00 – 70.00	61.26 ± 4.27	50.00 – 71.00	59.07 ± 4.90	50.00 – 74.00
L 2D:4D	0.95 ± 0.05	0.81 – 1.08	0.93 ± 0.06	0.72 – 1.08	0.95 ± 0.04	0.80 – 1.03	0.95 ± 0.07	0.09 – 1.03

R1 = 1stRight digit; R2 = 2nd Right Digit; R3 = 3rd Right Digit; R4 = 4th Right Digit; R5 = 5th Right Digit; R2D4D = Right 2D:4D Ratios; L1 = 1st Left Digit; L2 = 2nd Left Digit; L3 = 3rd Left Digit; L4 = 4th Left Digit; L5 = 5th Left Digit; L2D4D = Left 2D:4D Ratio.

Table 4.5: Descriptive statistics of Agoi ethnic group in relation to gender

Variables	Males (n =100) Mean + SD	Min - Max	Females (n = 100) Mean + SD	Min - Max
Age (years)	24.49 ± 4.49	18.00 – 32.00	24.02 ± 4.21	18.00 – 32.00
Height (cm)	164.34 ± 4.94	155.00 – 174.00	160.88 ± 4.15	151.00 – 170.00
Weight (kg)	62.93 ± 5.98	50.00 – 82.00	64.86 ± 4.42	56.00 – 76.00
Body mass index (kg/m^2)	23.29 ± 1.86	18.10 – 29.80	25.04 ± 1.18	22.30 – 28.10
Demi span length (cm)	90.34 ± 2.55	84.00 – 95.00	85.64 ± 1.92	81.00 – 89.00
Biaxillary length (cm)	34.79 ± 2.84	31.00 – 41.00	36.21 ± 5.25	32.00 – 84.00
Hand length (cm)	19.77 ± 0.43	19.00 – 20.30	18.22 ± 0.64	17.00 – 19.00
Hand breadth (cm)	12.17 ± 0.77	11.00 – 14.00	10.82 ± 0.54	10.00 – 12.50
Foot length (cm)	24.62 ± 0.89	23.00 – 26.00	23.91 ± 0.70	21.00 – 25.00
Foot breadth (cm)	13.68 ± 0.82	12.00 – 15.00	12.51 ± 0.57	11.00 – 14.00
Hand index	61.54 ± 3.67	55.00 – 73.68	59.37 ± 2.60	54.05 – 66.67
Foot index	55.58 ± 2.56	50.00 – 65.22	52.32 ± 2.29	46.81 – 64.29
Thigh length (cm)	43.60 ± 2.67	40.00 – 48.00	43.54 ± 2.19	38.00 – 48.00
Thigh circumference (cm)	52.79 ± 3.06	47.00 – 63.00	54.01 ± 3.00	47.00 – 60.00
Calf circumference (cm)	34.97 ± 1.40	32.00 – 38.00	36.68 ± 1.71	32.00 – 41.00
Leg length (cm)	39.30 ± 2.22	35.00 – 43.00	38.65 ± 1.71	33.00 – 42.00
Neck length (cm)	13.62 ± 0.89	12.00 – 15.00	14.05 ± 0.76	13.00 – 15.00
Chest circumference (cm)	86.37 ± 1.71	82.00 – 90.00	91.38 ± 2.12	85.00 – 95.00
Neck circumference (cm)	36.51 ± 1.37	33.00 – 41.00	34.22 ± 1.85	31.00 – 37.50
Neck/height ratio	0.22 ± 0.01	0.20 – 0.25	0.21 ± 0.01	0.19 – 0.23
Waist circumference (cm)	80.07 ± 4.95	73.00 – 96.00	83.56 ± 3.42	77.00 – 89.00
Hip circumference (cm)	91.55 ± 4.55	80.00 – 108.00	100.25 ± 2.95	96.00 – 106.00
Waist/hip ratio	0.88 ± 0.04	0.79 – 0.96	0.83 ± 0.02	0.76 – 0.90
Waist/height ratio	0.49 ± 0.03	0.43 – 0.58	0.52 ± 0.02	0.49 – 0.56
Sitting height (cm)	81.39 ± 1.32	78.00 – 84.00	78.75 ± 1.99	76.00 – 85.00
Sitting height/height ratio	0.50 ± 0.01	0.47 – 0.52	0.49 ± 0.01	0.47 – 0.51
Leg length/sitting height ratio	0.48 ± 0.03	0.43 – 0.55	0.49 ± 0.02	0.42 – 0.54

Table 4.6: Descriptive statistics of Ayiga ethnic group in relation to gender

Variables	Males (n =100) Mean + SD	Min - Max	Females (n = 100) Mean + SD	Min - max
Age (years)	25.46 ± 3.57	18.00 – 32.00	25.97 ± 3.60	18.00 – 32.00
Height (cm)	171.16 ± 4.43	160.00 – 184.00	160.84 ± 5.77	150.00 – 174.00
Weight (kg)	64.94 ± 5.67	51.00 – 83.00	58.74 ± 10.97	40.00 – 91.00
Body mass index (kg/m^2)	22.14 ± 1.44	18.40 – 25.60	22.63 ± 3.72	15.20 – 33.40
Demi span length (cm)	87.14 ± 3.88	80.00 – 101.00	80.09 ± 4.19	69.00 – 92.00
Biaxillary length (cm)	36.09 ± 1.56	31.00 – 42.00	36.55 ± 4.09	30.00 – 72.00
Hand length (cm)	19.77 ± 0.83	17.20 – 22.30	18.47 ± 1.03	13.50 – 20.10
Hand breadth (cm)	12.31 ± 0.59	11.00 – 14.00	11.80 ± 0.84	10.00 – 13.00
Foot length (cm)	25.81 ± 1.34	21.00 – 29.00	24.38 ± 0.81	21.50 – 27.00
Foot breadth (cm)	13.36 ± 0.60	12.00 – 15.00	12.48 ± 0.71	11.00 – 15.00
Hand index	62.31 ± 3.03	54.55 – 70.00	64.07 ± 5.69	54.73 – 88.89
Foot index	51.82 ± 2.35	48.15 – 61.91	51.21 ± 3.16	45.83 – 66.67
Thigh length (cm)	45.84 ± 2.26	40.00 – 52.00	42.29 ± 3.26	38.00 – 50.00
Thigh circumference (cm)	52.47 ± 2.26	45.00 – 61.00	53.50 ± 3.47	45.00 – 68.00
Calf circumference (cm)	36.2 ± 2.12	32.00 – 53.00	36.24 ± 2.20	30.00 – 42.00
Leg length (cm)	40.00 ± 1.82	35.00 – 46.00	39.28 ± 2.82	34.00 – 47.00
Neck length (cm)	13.69 ± 0.58	13.00 – 15.00	13.23 ± 1.11	11.00 – 16.00
Chest circumference (cm)	84.66 ± 4.20	80.00 – 101.00	88.94 ± 6.65	81.00 – 112.00
Neck circumference (cm)	37.09 ± 4.23	35.00 – 76.00	35.82 ± 2.20	31.00 – 40.00
Neck/height ratio	0.22 ± 0.03	0.20 – 0.46	0.22 ± 0.02	0.19 – 0.26
Waist circumference (cm)	79.41 ± 2.77	71.00 – 91.00	85.92 ± 6.68	69.00 – 104.00
Hip circumference (cm)	90.24 ± 4.23	83.00 – 107.00	95.49 ± 6.45	82.00 – 113.00
Waist/hip ratio	0.88 ± 0.04	0.81 – 0.98	0.90 ± 0.05	0.73 – 0.99
Waist/height ratio	0.46 ± 0.01	0.41 – 0.50	0.54 ± 0.05	0.42 – 0.63
Sitting height (cm)	85.20 ± 1.77	80.00 – 90.00	79.00 ± 2.37	74.00 – 85.00
Sitting height/height ratio	0.50 ± 0.01	0.47 – 0.52	0.49 ± 0.02	0.45 – 0.52
Leg length/sitting height ratio	0.47 ± 0.02	0.42 – 0.54	0.50 ± 0.03	0.43 – 0.62

Table 4.7: Descriptive statistics of Ekoi ethnic group in relation to gender

Variables	Males (n = 100) Mean + SD	Min - Max	Females (n = 100) Mean + SD	Min - Max
Age (years)	25.38 ± 4.01	18.00 – 32.00	24.18 ± 4.34	18.00 – 32.00
Height (cm)	171.56 ± 4.14	158.00 – 180.00	162.73 ± 4.05	155.00 – 170.00
Weight (kg)	65.77 ± 5.97	55.00 – 77.00	61.72 ± 7.05	51.00 – 77.00
Body mass index (kg/m^2)	22.35 ± 1.89	18.10 – 28.00	23.31 ± 2.54	18.60 – 29.60
Demi span length (cm)	90.25 ± 3.42	81.00 – 99.00	86.10 ± 2.90	81.00 – 96.00
Biaxillary length (cm)	37.67 ± 2.12	32.00 – 42.00	35.47 ± 2.26	25.00 – 43.00
Hand length (cm)	19.96 ± 0.82	18.00 – 23.00	19.41 ± 1.10	17.50 – 22.00
Hand breadth (cm)	13.09 ± 0.83	11.00 – 14.50	11.97 ± 1.08	10.00 – 14.00
Foot length (cm)	26.07 ± 1.37	23.00 – 36.00	24.51 ± 1.51	22.00 – 34.00
Foot breadth (cm)	14.32 ± 0.77	13.00 – 16.00	13.27 ± 0.69	11.50 – 15.00
Hand index	65.67 ± 4.26	54.73 – 73.68	61.66 ± 4.42	50.00 – 71.05
Foot index	54.99 ± 3.10	38.89 – 64.00	54.28 ± 3.44	38.24 – 60.87
Thigh length (cm)	46.29 ± 1.87	42.00 – 51.00	43.29 ± 1.62	40.00 – 60.00
Thigh circumference (cm)	52.85 ± 3.29	45.00 – 61.00	50.84 ± 2.93	47.00 – 60.00
Calf circumference (cm)	37.11 ± 2.54	31.00 – 43.00	34.78 ± 2.19	31.00 – 41.00
Leg length (cm)	41.77 ± 1.84	34.00 – 45.00	39.52 ± 1.47	36.00 – 42.00
Neck length (cm)	14.09 ± 0.87	12.00 – 16.00	13.83 ± 1.28	12.00 – 24.00
Chest circumference (cm)	89.71 ± 4.29	77.00 – 99.00	89.29 ± 4.38	78.00 – 98.00
Neck circumference (cm)	37.13 ± 1.25	32.20 – 39.00	34.26 ± 1.38	30.00 – 38.00
Neck/height ratio	0.22 ± 0.01	0.19 – 0.23	0.21 ± 0.01	0.19 – 0.24
Waist circumference (cm)	78.45 ± 4.75	66.00 – 94.00	81.42 ± 4.10	66.00 – 92.00
Hip circumference (cm)	88.30 ± 5.19	80.00 – 104.00	96.06 ± 4.84	86.00 – 106.00
Waist/hip ratio	0.89 ± 0.05	0.71 – 0.98	0.85 ± 0.04	0.77 – 0.95
Waist/height ratio	0.46 ± 0.03	0.38 – 0.56	0.50 ± 0.03	0.41 – 0.58
Sitting height (cm)	83.43 ± 1.79	79.00 – 90.00	80.10 ± 1.74	75.00 – 84.00
Sitting height/height ratio	0.49 ± 0.01	0.47 – 0.52	0.49 ± 0.01	0.47 – 0.51
Leg length/sitting height ratio	0.50 ± 0.02	0.39 – 0.54	0.49 ± 0.02	0.46 – 0.53

Table 4.8: Descriptive statistics of Lokaa ethnic group in relation to gender

Variables	Males (n = 100) Mean + SD	Min - Max	Females (n = 100) Mean + SD	Min - Max
Age (years)	24.44 ± 3.57	18.00 – 32.00	24.02 ± 4.12	18.00 – 32.00
Height (cm)	169.39 ± 5.22	160.00 – 187.00	164.70 ± 4.81	52.00 – 179.00
Weight (kg)	63.40 ± 6.62	48.00 – 79.00	62.14 ± 9.54	46.00 – 86.00
Body mass index (kg/m^2)	22.09 ± 2.06	17.00 – 29.30	22.84 ± 2.81	18.00 – 31.60
Demi span length (cm)	92.90 ± 3.45	83.50 – 101.00	85.80 ± 4.02	76.00 – 97.00
Biaxillary length (cm)	35.94 ± 2.32	31.00 – 43.00	34.60 ± 3.29	22.00 – 46.00
Hand length (cm)	20.40 ± 1.08	18.00 – 25.00	18.86 ± 1.21	13.00 – 21.00
Hand breadth (cm)	12.08 ± 1.15	4.00 – 14.00	11.14 ± 1.47	0.50 – 19.00
Foot length (cm)	27.02 ± 4.77	19.00 – 72.00	24.82 ± 1.74	17.00 – 32.00
Foot breadth (cm)	13.73 ± 1.14	11.00 – 17.00	13.13 ± 0.91	11.00 – 15.00
Hand index	59.26 ± 5.33	20.00 – 70.27	59.24 ± 8.49	2.70 – 105.56
Foot index	51.45 ± 5.41	16.67 – 67.46	53.15 ± 5.28	40.63 – 79.41
Thigh length (cm)	44.84 ± 2.28	40.00 – 50.00	44.19 ± 1.96	41.00 – 48.00
Thigh circumference (cm)	52.89 ± 3.17	46.00 – 61.00	55.61 ± 5.23	39.00 – 73.00
Calf circumference (cm)	35.29 ± 3.03	23.00 – 45.00	35.22 ± 2.72	30.00 – 45.00
Leg length (cm)	41.04 ± 2.07	37.00 – 49.00	40.21 ± 1.62	37.00 – 44.00
Neck length (cm)	14.18 ± 1.26	11.00 – 18.00	13.79 ± 1.11	11.00 – 17.00
Chest circumference (cm)	89.18 ± 4.94	77.00 – 100.00	90.89 ± 7.41	77.00 – 114.00
Neck circumference (cm)	37.18 ± 2.64	30.00 – 48.00	34.57 ± 5.20	30.00 – 82.00
Neck/height ratio	0.22 ± 0.01	0.19 – 0.28	0.21 ± 0.03	0.19 – 0.51
Waist circumference (cm)	77.82 ± 4.56	68.00 – 92.00	84.60 ± 8.78	68.00 – 110.00
Hip circumference (cm)	91.86 ± 4.70	78.00 – 104.00	97.67 ± 8.23	84.00 – 122.00
Waist/hip ratio	0.85 ± 0.03	0.76 – 0.97	0.87 ± 0.05	0.76 – 1.10
Waist/height ratio	0.46 ± 0.03	0.41 – 0.54	0.51 ± 0.05	0.43 – 0.66
Sitting height (cm)	84.07 ± 3.41	75.00 – 93.00	80.67 ± 2.74	70.00 – 89.00
Sitting height/height ratio	0.50 ± 0.01	0.46 – 0.52	0.49 ± 0.01	0.46 – 0.52
Leg length/sitting height ratio	0.49 ± 0.03	0.44 – 0.59	0.50 ± 0.02	0.45 – 0.55

From Table 4.9, there is a statistically significant difference between the anthropometric parameters in the males and females of Agoi ethnic group except for age, thigh length, R2D:4D and L2D:4D with p values of (0.446, 0.862, 0.132 and 0.158) respectively showing no statistically significant difference between these anthropometric parameters in males and females of Agoi ethnic groups.

Table 4.10 shows that there is a statistically significant difference between the anthropometric parameters of the males and females of Ayiga ethnic groups except for Age, Body mass index, biaxillary length, foot index, calf circumference, right digit 1, right digit 2, left digit 1 and left digit 2 with p values (0.316, 0.223, 0.295, 0.126, 0.948, 0.161, 0.127, 0.119 and 0.099) respectively which are not statistically significant different in Ayiga ethnic group.

From Table 4.11 it can be concluded that there is a statistically significant difference between the anthropometric parameter in the males and females in Ekoi ethnic groups except for foot index, chest circumference, right digit 2 and R2D:4D whose p value are (0.124, 0.494, 0.208, 0.463) respectively. These show that there is no statistically significant difference in the anthropometric characteristics (i.e. foot index, chest circumference, right digit 2 and R2D:4D) in males and females of Ekoi ethnic group of Yakurr Local government area.

Also in Table 4.12,there is a statistically significant difference in the anthropometric parameters between males and females in Lokaa ethnic groups in Yakurr Local Government Area except for Age, weight, hand index, calf circumference, chest circumference, R2D:4D, left digit 4 and L2D:4D with p values of (0.442, 0.279, 0.986, 0.854, 0.057, 0.910, 0.700 and 0.568) respectively which show that there is a statistically significant difference in the anthropometric characteristics in terms of gender in Lokaa ethnic group.

Table 4.9: Comparison of anthropometric parameters of Agoi ethnic group in relation to gender

Variables	Males (n = 100) Mean + SD	Females (n = 100) Mean + SD	t	P
Age (years)	24.49 ± 4.49	24.02 ± 4.21	- 0.76	0.446
Height (cm)	164.34 ± 4.94	160.88 ± 4.15	- 5.36	<0.001
Weight (kg)	62.93 ± 5.98	64.86 ± 4.42	2.59	0.010
Body mass index (kg/m^2)	23.29 ± 1.86	25.04 ± 1.18	7.94	<0.001
Demi span length (cm)	90.34 ± 2.55	85.64 ± 1.92	- 14.72	<0.001
Biaxillary length (cm)	34.79 ± 2.84	36.21 ± 5.25	2.38	0.019
Hand length (cm)	19.77 ± 0.43	18.22 ± 0.64	- 20.13	<0.001
Hand breadth (cm)	12.17 ± 0.77	10.82 ± 0.54	- 14.28	<0.001
Foot length (cm)	24.62 ± 0.89	23.91 ± 0.70	- 6.23	<0.001
Foot breadth (cm)	13.68 ± 0.82	12.51 ± 0.57	- 11.80	<0.001
Hand index	61.54 ± 3.67	59.37 ± 2.61	- 4.80	<0.001
Foot index	55.58 ± 2.56	52.32 ± 2.29	- 9.52	<0.001
Thigh length (cm)	43.60 ± 2.67	43.54 ± 2.19	- 0.17	0.862
Thigh circumference (cm)	52.79 ± 3.06	54.01 ± 3.00	2.85	0.005
Calf circumference (cm)	34.97 ± 1.40	36.68 ± 1.71	7.73	<0.001
Leg length (cm)	39.30 ± 2.22	38.65 ± 1.71	- 2.32	0.022
Neck length (cm)	13.62 ± 0.89	14.05 ± 0.76	3.69	<0.001
Chest circumference (cm)	86.37 ± 1.71	91.38 ± 2.12	18.41	<0.001
Neck circumference (cm)	36.51 ± 1.37	34.22 ± 1.85	- 9.94	<0.001
Neck/height ratio	0.22 ± 0.01	0.21 ± 0.01	- 8.09	<0.001
Waist circumference (cm)	80.07 ± 4.95	83.56 ± 3.42	5.81	<0.001
Hip circumference (cm)	91.55 ± 4.55	100.25 ± 2.95	16.04	<0.001
Waist/hip ratio	0.88 ± 0.04	0.83 ± 0.02	- 9.86	<0.001
Waist/height ratio	0.49 ± 0.03	0.52 ± 0.02	11.15	<0.001
Sitting height (cm)	81.39 ± 1.32	78.75 ± 1.99	- 11.06	<0.001
Sitting height/height ratio	0.50 ± 0.01	0.49 ± 0.01	- 4.10	<0.001
Leg length/sitting height ratio	0.48 ± 0.03	0.49 ± 0.02	2.33	0.021
Right digit 1 (mm)	61.16 ± 2.24	56.07 ± 3.51	- 12.23	<0.001
Right digit 2 (mm)	70.85 ± 4.56	68.66 ± 2.95	- 4.03	<0.001
Right digit 3 (mm)	82.31 ± 2.30	78.89 ± 2.67	- 9.71	<0.001
Right digit 4 (mm)	75.48 ± 3.94	72.45 ± 3.26	- 5.93	<0.001
Right digit 5 (mm)	57.44 ± 2.80	53.71 ± 4.33	- 7.23	<0.001
Right 2D:4D	0.94 ± 0.05	0.95 ± 0.04	1.51	0.132
Left digit 1 (mm)	61.18 ± 2.24	56.02 ± 3.56	- 12.27	<0.001
Left digit 2 (mm)	70.96 ± 4.48	68.62 ± 2.98	- 4.35	<0.001
Left digit 3 (mm)	82.31 ± 2.30	78.95 ± 2.72	- 9.43	<0.001
Left digit 4 (mm)	75.45 ± 3.91	72.32 ± 3.34	- 6.09	<0.001
Left digit 5 (mm)	57.42 ± 2.80	53.43 ± 4.26	- 7.82	<0.001
Left 2D:4D	0.94 ± 0.05	0.95 ± 0.04	1.42	0.158

Table 4.10: Comparison of anthropometric parameters of Ayiga ethnic group in relation to gender

Variables	Males (n =100) Mean + SD	Females (n = 100) Mean + SD	t	P
Age (years)	25.46 ± 3.57	25.97 ± 3.60	1.01	0.316
Height (cm)	171.16 ± 4.43	160.84 ± 5.77	- 14.19	<0.001
Weight (kg)	64.94 ± 5.67	58.74 ± 10.97	- 5.02	<0.001
Body mass index (kg/m^2)	22.14 ± 1.44	22.63 ± 3.72	1.23	0.223
Demi span length (cm)	87.14 ± 3.88	80.09 ± 4.19	- 12.35	<0.001
Biaxillary length (cm)	36.09 ± 1.56	36.55 ± 4.09	1.05	0.295
Hand length (cm)	19.77 ± 0.83	18.47 ± 1.03	- 9.82	<0.001
Hand breadth (cm)	12.31 ± 0.59	11.80 ± 0.84	- 4.93	<0.001
Foot length (cm)	25.81 ± 1.34	24.38 ± 0.81	- 9.17	<0.001
Foot breadth (cm)	13.36 ± 0.60	12.48 ± 0.71	- 9.51	<0.001
Hand index	62.31 ± 3.03	64.07 ± 5.69	2.73	0.007
Foot index	51.82 ± 2.35	51.21 ± 3.16	- 1.54	0.126
Thigh length (cm)	45.84 ± 2.26	42.29 ± 3.26	- 8.95	<0.001
Thigh circumference (cm)	52.47 ± 2.26	53.50 ± 3.47	2.49	0.014
Calf circumference (cm)	36.2 ± 2.12	36.24 ± 2.20	0.07	0.948
Leg length (cm)	40.00 ± 1.82	39.28 ± 2.82	- 2.15	0.033
Neck length (cm)	13.69 ± 0.58	13.23 ± 1.11	- 3.64	<0.001
Chest circumference (cm)	84.66 ± 4.20	88.94 ± 6.65	5.44	<0.001
Neck circumference (cm)	37.09 ± 4.23	35.82 ± 2.20	- 2.66	0.009
Neck/height ratio	0.22 ± 0.03	0.22 ± 0.02	2.00	0.047
Waist circumference (cm)	79.41 ± 2.77	85.92 ± 6.68	9.00	<0.001
Hip circumference (cm)	90.24 ± 4.23	95.49 ± 6.45	6.80	<0.001
Waist/hip ratio	0.88 ± 0.04	0.90 ± 0.05	3.04	0.003
Waist/height ratio	0.46 ± 0.01	0.54 ± 0.05	14.82	<0.001
Sitting height (cm)	85.20 ± 1.77	79.00 ± 2.37	- 20.99	<0.001
Sitting height/height ratio	0.50 ± 0.01	0.49 ± 0.02	- 3.35	0.001
Leg length/sitting height ratio	0.47 ± 0.02	0.50 ± 0.03	6.99	<0.001
Right digit 1 (mm)	56.33 ± 5.75	55.24 ± 5.19	- 1.41	0.161
Right digit 2 (mm)	68.40 ± 5.47	69.46 ± 4.21	1.53	0.127
Right digit 3 (mm)	84.22 ± 4.75	80.46 ± 4.32	- 5.86	<0.001
Right digit 4 (mm)	75.33 ± 5.19	73.31 ± 4.74	- 2.87	0.004
Right digit 5 (mm)	62.91 ± 4.20	59.50 ± 4.30	- 5.67	<0.001
Right 2D:4D	0.91 ± 0.07	0.95 ± 0.05	4.53	<0.001
Left digit 1 (mm)	56.31 ± 5.78	55.09 ± 5.22	- 1.57	0.119
Left digit 2 (mm)	68.47 ± 5.25	69.58 ± 4.16	1.66	0.099
Left digit 3 (mm)	84.24 ± 4.31	80.44 ± 4.34	- 6.21	<0.001
Left digit 4 (mm)	75.06 ± 5.34	73.12 ± 4.45	- 2.79	0.006
Left digit 5 (mm)	62.87 ± 4.47	59.46 ± 4.27	- 5.51	<0.001
Left 2D:4D	0.92 ± 0.07	0.95 ± 0.05	4.56	<0.001

Table 4.11: Comparison of anthropometric parametersof Ekoi ethnic group in relation to gender

Variables	Males (n = 100) Mean + SD	Females (n = 100) Mean + SD	t	P
Age (years)	25.38 ± 4.01	24.18 ± 4.34	- 2.03	0.043
Height (cm)	171.56 ± 4.14	162.73 ± 4.05	- 15.23	<0.001
Weight (kg)	65.77 ± 5.97	61.72 ± 7.05	- 4.38	<0.001
Body mass index (kg/m^2)	22.35 ± 1.89	23.31 ± 2.54	3.03	0.003
Demi span length (cm)	90.25 ± 3.42	86.10 ± 2.90	- 9.24	<0.001
Biaxillary length (cm)	37.67 ± 2.12	35.47 ± 2.26	- 7.09	<0.001
Hand length (cm)	19.96 ± 0.82	19.41 ± 1.10	- 3.93	<0.001
Hand breadth (cm)	13.09 ± 0.83	11.97 ± 1.08	- 8.22	<0.001
Foot length (cm)	26.07 ± 1.37	24.51 ± 1.51	- 7.66	<0.001
Foot breadth (cm)	14.32 ± 0.77	13.27 ± 0.69	- 10.12	<0.001
Hand index	65.67 ± 4.26	61.66 ± 4.42	- 6.54	<0.001
Foot index	54.99 ± 3.10	54.28 ± 3.44	- 1.55	0.124
Thigh length (cm)	46.29 ± 1.87	43.29 ± 1.62	- 12.15	<0.001
Thigh circumference (cm)	52.85 ± 3.29	50.84 ± 2.93	- 4.56	<0.001
Calf circumference (cm)	37.11 ± 2.54	34.78 ± 2.19	- 6.96	<0.001
Leg length (cm)	41.77 ± 1.84	39.52 ± 1.47	- 9.56	<0.001
Neck length (cm)	14.09 ± 0.87	13.83 ± 1.28	- 1.69	0.093
Chest circumference (cm)	89.71 ± 4.29	89.29 ± 4.38	- 0.69	0.494
Neck circumference (cm)	37.13 ± 1.25	34.26 ± 1.38	- 15.40	<0.001
Neck/height ratio	0.22 ± 0.01	0.21 ± 0.01	- 4.92	<0.001
Waist circumference (cm)	78.45 ± 4.75	81.42 ± 4.10	4.31	<0.001
Hip circumference (cm)	88.30 ± 5.19	96.06 ± 4.84	10.93	<0.001
Waist/hip ratio	0.89 ± 0.05	0.85 ± 0.04	- 6.55	<0.001
Waist/height ratio	0.46 ± 0.03	0.50 ± 0.03	10.65	<0.001
Sitting height (cm)	83.43 ± 1.79	80.10 ± 1.74	- 13.33	<0.001
Sitting height/height ratio	0.49 ± 0.01	0.49 ± 0.01	5.60	<0.001
Leg length/sitting height ratio	0.50 ± 0.02	0.49 ± 0.02	- 2.86	0.005
Right digit 1 (mm)	59.94 ± 5.62	57.56 ± 4.63	- 3.27	0.001
Right digit 2 (mm)	81.00 ± 69.80	72.11 ± 3.52	- 1.27	0.208
Right digit 3 (mm)	85.46 ± 4.47	82.40 ± 3.32	- 5.50	<0.001
Right digit 4 (mm)	78.83 ± 4.96	74.96 ± 3.41	- 6.43	<0.001
Right digit 5 (mm)	62.72 ± 4.10	59.81 ± 3.94	- 5.12	<0.001
Right 2D:4D	1.02 ± 0.84	0.96 ± 0.03	- 0.74	0.463
Left digit 1 (mm)	59.94 ± 5.62	57.56 ± 4.79	- 3.22	0.001
Left digit 2 (mm)	73.89 ± 4.57	72.12 ± 3.48	- 3.08	0.002
Left digit 3 (mm)	85.46 ± 4.48	82.33 ± 3.21	- 5.69	<0.001
Left digit 4 (mm)	78.84 ± 4.89	74.95 ± 3.40	- 6.53	<0.001
Left digit 5 (mm)	62.71 ± 4.11	59.81 ± 3.94	- 5.10	<0.001
Left 2D:4D	0.94 ± 0.05	0.96 ± 0.03	4.08	<0.001

Table 4.12: Comparison of anthropometric parameters of Lokaa ethnic group in relation to gender

Variables	Males (n = 100) Mean + SD	Females (n = 100) Mean + SD	t	P
Age (years)	24.44 ± 3.57	24.02 ± 4.12	- 0.77	0.442
Height (cm)	169.39 ± 5.22	164.70 ± 4.81	- 6.61	<0.001
Weight (kg)	63.40 ± 6.62	62.14 ± 9.54	- 1.09	0.279
Body mass index (kg/m^2)	22.09 ± 2.06	22.84 ± 2.81	2.13	0.034
Demi span length (cm)	92.90 ± 3.45	85.80 ± 4.02	- 13.41	<0.001
Biaxillary length (cm)	35.94 ± 2.32	34.60 ± 3.29	- 3.33	0.001
Hand length (cm)	20.40 ± 1.08	18.86 ± 1.21	- 9.48	<0.001
Hand breadth (cm)	12.08 ± 1.15	11.14 ± 1.47	- 5.04	<0.001
Foot length (cm)	27.02 ± 4.77	24.82 ± 1.74	- 4.35	<0.001
Foot breadth (cm)	13.73 ± 1.14	13.13 ± 0.91	- 4.13	<0.001
Hand index	59.26 ± 5.33	59.24 ± 8.49	- 0.02	0.986
Foot index	51.45 ± 5.41	53.15 ± 5.28	2.24	0.026
Thigh length (cm)	44.84 ± 2.28	44.19 ± 1.96	- 2.16	0.032
Thigh circumference (cm)	52.89 ± 3.17	55.61 ± 5.23	4.45	<0.001
Calf circumference (cm)	35.29 ± 3.03	35.22 ± 2.72	- 0.18	0.854
Leg length (cm)	41.04 ± 2.07	40.21 ± 1.62	- 3.15	0.002
Neck length (cm)	14.18 ± 1.26	13.79 ± 1.11	- 2.32	0.021
Chest circumference (cm)	89.18 ± 4.94	90.89 ± 7.41	1.92	0.057
Neck circumference (cm)	37.18 ± 2.64	34.57 ± 5.20	- 4.49	<0.001
Neck/height ratio	0.22 ± 0.01	0.21 ± 0.03	- 2.73	0.007
Waist circumference (cm)	77.82 ± 4.56	84.60 ± 8.78	6.85	<0.001
Hip circumference (cm)	91.86 ± 4.70	97.67 ± 8.23	6.13	<0.001
Waist/hip ratio	0.85 ± 0.03	0.87 ± 0.05	3.00	0.003
Waist/height ratio	0.46 ± 0.03	0.51 ± 0.05	9.97	<0.001
Sitting height (cm)	84.07 ± 3.41	80.67 ± 2.74	- 7.77	<0.001
Sitting height/height ratio	0.50 ± 0.01	0.49 ± 0.01	- 4.12	<0.001
Leg length/sitting height ratio	0.49 ± 0.03	0.50 ± 0.02	3.03	0.003
Right digit 1 (mm)	66.79 ± 5.02	61.08 ± 4.88	8.15	<0.001
Right digit 2 (mm)	75.27 ± 5.27	71.46 ± 4.49	-5.50	<0.001
Right digit 3 (mm)	85.66 ± 5.13	80.76 ± 4.10	-7.46	<0.001
Right digit 4 (mm)	78.63 ± 5.17	74.71 ± 4.46	-5.74	<0.001
Right digit 5 (mm)	60.78 ± 4.83	57.25 ± 4.21	-5.51	<0.001
Right 2D:4D	0.96 ± 0.04	0.96 ± 0.04	-0.11	0.910
Left digit 1 (mm)	66.76 ± 5.11	61.10 ± 4.96	-7.95	<0.001
Left digit 2 (mm)	75.27 ± 5.35	71.51 ± 4.50	-5.38	<0.001
Left digit 3 (mm)	85.46 ± 5.32	80.74 ± 4.24	-6.93	<0.001
Left digit 4 (mm)	78.74 ± 5.18	81.40 ± 67.70	0.39	0.700
Left digit 5 (mm)	60.85 ± 4.89	57.28 ± 4.25	-5.51	<0.001
Left 2D:4D	0.96 ± 0.04	0.95 ± 0.09	-0.57	0.568

4.3ONE-WAY ANALYSIS OF VARIANCE (ANOVA)

From Table 4.13 there was a statistically significant difference in the anthropometric parameters of all males in all the ethnic groups except for age, thigh circumference and chest circumference (0.12, 0.743 and 0.24) respectively which are insignificant in all the females of the ethnic groups.

Table 4.14shows a significant difference in all male digits in all the ethnic groups in yakurr Local Government Area.

Table 4.15, there was a statistically significant difference in the anthropometric features of all the females in the Local government area except for the sitting height/height ratio and leg length/sitting ratio which had p values greater than 0.05(0.190 and 0.074) respectively.

Table 4.16 shows the relationshipbetween height and anthropometric characteristics of female digits in all the ethnic groups in Yakurr local government area. It can be concluded that there is a statistically significant difference in the female digits in all the ethnic groups in the Yakurr since the P value is less than 0.05 except for the L2D:4D (p= 0.091) which is insignificant owing to the fact that it has a p value greater than 0.05.

Table 4.17-4.18 shows the relationship between height and anthropometric characteristics based onfather's level of education. There is no statistically significant difference based on father's level of education owing to the high p value except for age, foot length, foot breath, waist/hip ratio, Right Digit 4, Right Digit 5, Left Digit 2 and Left Digit 5 with p values of (0.052, 0.001, 0.021, 0.044, 0.002, 0.002, 0.023 and 0.004) respectively which are statistically significant.

Table 4.13: Height and anthropometric characteristics of males in relation to ethnic group

Variables	Agoi (n =100) Mean + SD	Ayiga (n =100) Mean + SD	Ekoi (n =100) Mean + SD	Lokaa (n =100) Mean + SD	F	P
Age (years)	24.49 ± 4.49	25.46 ± 3.57	25.38 ± 4.01	24.44 ± 3.57	1.98	0.12
Height (cm)	164.34 ± 4.94[a]	171.16 ± 4.43[bc]	171.56 ± 4.15[c]	169.39 ± 5.22[d]	49.81	<0.001
Weight (kg)	62.93 ± 5.98[abd]	64.94 ± 5.67[bc]	65.77 ± 5.97[c]	63.40 ± 6.62[bd]	4.75	0.003
Body mass index (kg/m^2)	23.29 ± 1.87[a]	22.14 ± 1.44[bc]	22.35 ± 1.90[c]	22.09 ± 2.06[bcd]	9.35	<0.001
Demi span length (cm)	90.34 ± 2.55[a]	87.14 ± 3.88[b]	90.25 ± 3.42[ac]	92.90 ±3.45[d]	49.21	<0.001
Biaxillary length (cm)	34.79 ± 2.84[a]	36.09 ± 1.56[b]	37.67 ± 2.12[c]	35.94 ±2.32[bd]	27.47	<0.001
Hand length (cm)	19.77 ± 0.43[ac]	19.77 ± 0.83[abc]	19.96 ± 0.82[c]	20.40 ± 1.08[d]	13.17	<0.001
Hand breadth (cm)	12.17 ± 0.77[ab]	12.31 ± 0.59[b]	13.09 ± 0.83[c]	12.08 ± 1.15[abd]	29.16	<0.001
Foot length (cm)	24.62 ± 0.89[a]	25.81 ± 1.34[bc]	26.07 ± 1.37[c]	27.02 ± 4.77[d]	14.42	<0.001
Foot breadth (cm)	13.68 ± 0.82[ad]	13.36 ± 0.60[b]	14.32 ± 0.77[c]	13.73 ± 1.14[d]	21.96	<0.001
Hand index	61.54 ± 3.67	62.31 ± 3.03	65.67 ± 4.26	59.26 ± 5.33	40.67	<0.001
Foot index	55.58 ± 2.56	51.82 ± 2.35	54.99 ± 3.10	51.45 ± 5.41	35.52	<0.001
Thigh length (cm)	43.60 ± 2.67[a]	45.84 ± 2.25[bc]	46.29 ± 1.87[c]	44.84 ± 2.27[d]	27.26	<0.001
Thigh circumference (cm)	52.79 ± 3.06	52.47 ± 2.26	52.85 ± 3.29	52.89 ± 3.17	0.41	0.743
Calf circumference (cm)	34.97 ± 1.40[ad]	36.22 ± 2.12[b]	37.11 ± 2.54[c]	35.29 ± 3.03[d]	16.94	<0.001
Leg length (cm)	39.30 ± 2.22[a]	40.00 ± 1.82[b]	41.77 ± 1.84[c]	41.04 ± 2.07[d]	30.03	<0.001
Neck length (cm)	36.62 ± 0.89[ab]	13.69 ± 0.58[b]	14.09 ± 0.87[cd]	14.18 ± 1.26[d]	9.22	<0.001
Chest circumference (cm)	86.37 ± 1.71[a]	84.66 ± 4.20[b]	89.71 ± 4.29[c]	89.18 ± 4.94[cd]	35.87	<0.001
Neck circumference (cm)	36.51 ± 1.37	37.09 ± 4.23	37.13 ± 1.25	37.18 ± 2.64	1.39	0.24
Neck/height ratio	0.22 ± 0.01	0.22 ± 0.03	0.22 ± 0.01	0.22 ± 0.01	2.82	0.039
Waist circumference (cm)	80.07 ± 4.95[a]	79.41 ± 2.77[ab]	78.45 ± 4.75[bc]	77.82 ± 4.56[bd]	5.30	0.001
Hip circumference (cm)	91.55 ± 4.55[ad]	90.24 ± 4.23[ab]	88.30 ± 5.19[c]	91.86 ± 4.70[d]	11.96	<0.001
Waist/hip ratio	0.88 ± 0.04	0.88 ± 0.04	0.89 ± 0.05	0.85 ± 0.03	20.66	<0.001
Waist/height ratio	0.49 ± 0.03	0.46 ± 0.01	0.46 ± 0.03	0.46 ± 0.03	34.86	<0.001
Sitting height (cm)	81.39 ± 1.32[a]	85.20 ± 1.77[b]	83.43 ± 1.79[c]	84.07 ± 3.41[d]	51.84	<0.001
Sitting height/height ratio	0.50 ± 0.01	0.50 ± 0.01	0.49 ± 0.01	0.50 ± 0.01	21.81	<0.001
Leg length/sitting height ratio	0.48 ± 0.03	0.47 ± 0.02	0.50 ± 0.02	0.49 ± 0.03	29.07	<0.001

Table 4.14: Height and anthropometric characteristics of digit lengths for males in relation to ethnic group

Variables	Agoi (n = 100) Mean + SD	Ayiga (n = 100) Mean + SD	Ekoi (n = 100) Mean + SD	Lokaa (n = 100) Mean + SD	F	P
Right digit 1 (mm)	61.16 ± 2.24[a]	56.33 ± 5.75[b]	59.94 ± 5.62[ac]	66.79 ± 5.02[d]	79.47	<0.001
Right digit 2 (mm)	70.85 ± 4.56[a]	68.40 ± 5.47[b]	74.04 ± 4.77[cd]	75.27 ± 5.27[d]	38.25	<0.001
Right digit 3 (mm)	82.31 ± 2.30[a]	84.22 ± 4.75[bcd]	85.46 ± 4.47[cd]	85.66 ±5.13[d]	12.80	<0.001
Right digit 4 (mm)	75.48 ± 3.94[a]	75.33 ± 5.19[ab]	78.83 ± 4.97[c]	78.63 ± 5.17[cd]	15.76	<0.001
Right digit 5 (mm)	57.44 ± 2.80[a]	62.91 ± 4.20[b]	62.72 ± 4.10[bc]	60.78 ± 4.83[d]	39.22	<0.001
Right 2D:4D	0.94 ± 0.05[ac]	0.91 ± 0.07[b]	0.94 ± 0.05[c]	0.96 ± 0.04[d]	14.34	<0.001
Left digit 1 (mm)	61.18 ± 2.24[a]	56.31 ± 5.7[8b]	59.94 ± 5.62[ac]	66.76 ± 5.11[d]	78.17	<0.001
Left digit 2 (mm)	70.96 ± 4.48[a]	68.47 ± 5.25[b]	73.89 ±4.58[c]	75.27 ± 5.35[d]	38.03	<0.001
Left digit 3 (mm)	82.31 ± 2.30[a]	84 24 ± 4.31[bcd]	85.46 ± 4.48[cd]	85.46 ± 5.32[d]	12.25	<0.001
Left digit 4 (mm)	75.45 ± 3.91[a]	75.06 ± 5.34[ab]	78.84 ± 4.89[c]	78.74 ± 5.18[cd]	17.73	<0.001
Left digit 5 (mm)	57.42 ± 2.80[a]	62.87 ± 4.47[b]	62.71 ± 4.11[bc]	60.85 ± 4.89[d]	37.43	<0.001
Left 2D:4D	0.94 ± 0.05[ad]	0.92 ± 0.07[b]	0.94 ± 0.05[acd]	0.96 ± 0.04[d]	10.69	<0.001

Means with different superscript are significantly different with p < 0.05

Table 4.15: Height and anthropometric characteristics offemales in relation to ethnic group

Variables	Agoi (n = 100) Mean + SD	Ayiga (n = 100) Mean + SD	Ekoi (n = 100) Mean + SD	Lokaa (n = 100) Mean + SD	F	P
Age (years)	24.08 ± 4.27[ac]	25.89 ± 3.58[b]	24.25 ± 4.29[c]	23.97 ± 4.16[acd]	4.88	0.002
Height (cm)	160.88 ± 4.15[ab]	160.97 ± 5.94[bc]	162.75 ± 4.04[c]	164.55 ± 4.72[d]	13.24	<0.001
Weight (kg)	64.74 ± 4.39[a]	58.89 ± 11.09[b]	61.87 ± 7.11[cd]	61.96 ± 9.46[d]	8.09	<0.001
Body mass index (kg/m^2)	25.01 ± 1.18a	22.65 ± 3.73bcd	23.36 ± 2.57c	22.81 ± 2.80cd	15.52	<0.001
Demi span length (cm)	85.60 ± 1.91[acd]	80.16 ± 4.31[b]	86.16 ± 2.88[c]	85.71 ± 4.01[cd]	69.31	<0.001
Biaxillary length (cm)	36.18 ± 5.26[ab]	36.60 ± 4.09[b]	35.50 ± 2.26[abc]	34.55 ± 3.26[cd]	5.33	0.001
Hand length (cm)	18.24 ± 0.66[ab]	18.47 ± 1.03[b]	19.42 ± 1.10[c]	18.84 ± 1.21[d]	25.52	<0.001
Hand breadth (cm)	10.82 ± 0.54[ad]	11.81 ± 0.84[bc]	11.97 ± 1.08[c]	11.13 ± 1.47[d]	27.85	<0.001
Foot length (cm)	23.93 ± 0.73[ab]	24.37 ± 0.79[bcd]	24.52 ± 1.50[cd]	24.79 ± 1.75[d]	8.03	<0.001
Foot breadth (cm)	12.51 ± 0.57[a]	12.49 ± 0.72[ab]	13.27 ± 0.69[c]	13.12 ± 0.90[cd]	31.11	<0.001
Hand index	59.37 ± 2.61	64.07 ± 5.69	61.66 ± 4.42	59.24 ± 8.49	15.86	<0.001
Foot index	52.32 ± 2.29	51.21 ± 3.16	54.28 ± 3.44	53.15 ± 5.28	12.24	<0.001
Thigh length (cm)	43.57 ± 2.20[ad]	42.31 ± 3.29[b]	43.29 ± 1.62[ac]	44.14 ± 1.93[d]	10.64	<0.001
Thigh circumference (cm)	54.05 ± 2.96[a]	53.54 ± 3.48[ab]	50.84 ± 2.93[c]	55.53 ± 5.27[d]	26.79	<0.001
Calf circumference (cm)	36.64 ± 1.73[a]	36.28 ± 2.20[ab]	34.84 ± 2.19[cd]	35.16 ± 2.73[d]	14.99	<0.001
Leg length (cm)	38.66 ± 1.72[ab]	39.32 ± 2.86[bc]	39.52 ± 1.47[c]	40.16 ± 1.58[d]	9.69	<0.001
Neck length (cm)	14.03 ± 0.76[a]	13.23 ± 1.11[b]	13.84 ± 1.28[ac]	13.80 ± 1.11[acd]	10.17	<0.001
Chest circumference (cm)	91.36 ± 2.14[a]	89.04 ± 6.71[bcd]	89.38 ± 4.30[acd]	90.72 ± 7.44[ad]	3.90	0.009
Neck circumference (cm)	34.21 ± 1.85[acd]	35.85 ± 2.19[b]	34.27 ± 1.38[cd]	34.54 ± 5.20[d]	6.37	<0.001
Neck/height ratio	0.21 ± 0.01	0.22 ± 0.02	0.21 ± 0.01	0.21 ± 0.03	10.14	<0.001
Waist circumference (cm)	83.50 ± 3.44[ad]	86.08 ± 6.70[b]	81.51 ± 4.98[ac]	84.41 ± 8.76[bd]	9.17	<0.001
Hip circumference (cm)	100.19 ± 3.02[a]	95.60 ± 6.52[bcd]	96.16 ± 4.82[cd]	97.52 ± 8.23[d]	11.76	<0.001
Waist/hip ratio	0.83 ± 0.02	0.90 ± 0.05	0.85 ± 0.04	0.87 ± 0.05	45.19	<0.001
Waist/height ratio	0.52 ± 0.02	0.54 ± 0.05	0.50 ± 0.03	0.51 ± 0.05	14.81	<0.001
Sitting height (cm)	78.71 ± 2.01[ab]	79.07 ± 2.38[b]	80.12 ± 1.73[cd]	80.62 ± 2.74[d]	15.72	<0.001
Sitting height/height ratio	0.49 ± 0.01	0.49 ± 0.02	0.49 ± 0.01	0.49 ± 0.01	1.60	0.190
Leg length/sitting height ratio	0.49 ± 0.02	0.50 ± 0.03	0.49 ± 0.02	0.50 ± 0.02	2.33	0.074

Table 4.16: Height and anthropometric characteristics of digit lengths forfemales in relation to ethnic group

Variables	Agoi (n = 100) Mean + SD	Ayiga (n = 100) Mean + SD	Ekoi (n = 100) Mean + SD	Lokaa (n = 100) Mean + SD	F	P
Right digit 1 (mm)	56.02 ± 3.56^{a}	55.39 ± 5.25^{ab}	57.61 ± 4.57^{c}	60.93 ± 4.99^{d}	28.54	<0.001
Right digit 2 (mm)	68.66 ± 2.96	69.46 ± 4.21	72.06 ± 3.51	71.51 ± 4.50	17.83	<0.001
Right digit 3 (mm)	78.89 ± 2.67^{a}	80.46 ± 4.32^{bd}	82.40 ± 3.32^{c}	80.76 ± 4.11^{d}	15.44	<0.001
Right digit 4 (mm)	72.48 ± 3.30^{ab}	73.29 ± 4.72^{b}	74.94 ± 3.40^{c}	74.72 ± 4.47^{cd}	8.53	<0.001
Right digit 5 (mm)	53.79 ± 4.38^{a}	59.45 ± 4.32^{bc}	59.78 ± 3.98^{c}	57.25 ± 4.21^{d}	42.63	<0.001
Right 2D:4D	0.95 ± 0.04	0.95 ± 0.05	0.96 ± 0.03	0.96 ± 0.04	2.60	0.052
Left digit 1 (mm)	55.97 ± 3.61^{a}	55.24 ± 5.28^{ab}	57.61 ± 4.74^{c}	60.95 ± 5.07^{d}	28.97	<0.001
Left digit 2 (mm)	68.62 ± 2.98^{ab}	69.58 ± 4.16^{b}	72.07 ± 3.48^{c}	71.56 ± 4.51^{cd}	18.09	<0.001
Left digit 3 (mm)	78.95 ± 2.72^{ab}	80.44 ± 4.34^{bd}	82.33 ± 3.21^{c}	80.74 ± 4.24^{d}	14.09	<0.001
Left digit 4 (mm)	72.35 ± 3.37^{ab}	73.10 ± 4.44^{b}	74.93 ± 3.39^{c}	74.62 ± 1.47^{cd}	9.66	<0.001
Left digit 5 (mm)	53.51 ± 4.31^{a}	59.41 ± 4.30^{bc}	59.78 ± 3.98^{c}	57.28 ± 4.25^{d}	46.63	<0.001
Left 2D:4D	0.95 ± 0.04	0.95 ± 0.05	0.96 ± 0.03	0.96 ± 0.04	2.17	0.091

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

Table 4.17: Height and anthropometric characteristics ofall subjects in relation to father's level of education

Variables	None (n = 800) Mean + SD	Primary (n = 800) Mean + SD	Secondary (n = 800) Mean + SD	Tertiary (n = 800) Mean + SD	F	P
Age (years)	26.50 ± 3.59	25.55 ± 4.15	24.21 ± 3.90	24.33 ± 4.37	2.59	0.052
Height (cm)	163.00 ± 4.07	162.27 ± 4.71	162.58 ± 5.37	161.93 ± 4.73	0.49	0.687
Weight (kg)	61.88 ± 9.97	61.91 ± 7.74	61.70 ± 8.98	62.03 ± 8.63	0.04	0.990
Body mass index (kg/m^2)	23.24 ± 3.49	23.48 ± 2.52	23.30 ± 2.95	23.63 ± 2.93	0.37	0.778
Demi span length (cm)	86.00 ± 3.78	84.81 ± 3.47	84.62 ± 4.19	83.88 ± 4.52	1.54	0.204
Biaxillary length (cm)	36.88 ± 2.42	36.22 ± 6.00	35.60 ± 3.93	35.51 ± 2.47	0.81	0.490
Hand length (cm)	18.08 ± 2.06	18.54 ± 1.02	18.75 ± 1.04	18.87 ± 1.14	2.50	0.059
Hand breadth (cm)	11.01 ± 0.88	11.42 ± 1.27	11.36 ± 1.25	11.54 ± 0.93	0.98	0.400
Foot length (cm)	25.26 ± 1.12	25.20 ± 1.34	25.67 ± 1.44	26.58 ± 4.10	5.59	0.001
Foot breadth (cm)	13.41 ± 0.92	13.74 ± 0.91	13.66 ± 0.94	13.95 ± 0.87	3.27	0.021
Hand index	61.62 ± 8.56	61.60 ± 6.15	60.71 ± 6.82	61.22 ± 4.79	0.44	0.726
Foot index	51.83 ± 6.18	52.66 ± 3.41	52.44 ± 3.81	53.16 ± 3.98	1.09	0.354
Thigh length (cm)	44.75 ± 2.55	43.76 ± 2.25	43.33 ± 2.49	43.04 ± 2.40	2.41	0.066
Thigh circumference (cm)	54.63 ± 4.24	53.95 ± 4.36	53.70 ± 4.19	52.97 ± 3.92	1.43	0.234
Calf circumference (cm)	35.25 ± 3.28	35.43 ± 2.25	35.82 ± 2.35	35.80 ± 2.36	0.63	0.597
Leg length (cm)	39.00 ± 2.07	39.27 ± 1.85	39.53 ± 2.19	39.38 ± 1.99	0.42	0.738
Neck length (cm)	13.50 ± 1.07	13.81 ± 0.95	13.68 ± 1.06	13.75 ± 1.27	0.34	0.799
Chest circumference (cm)	90.75 ± 5.04	90.22 ± 4.58	90.14 ± 5.80	90.03 ± 5.93	0.05	0.984
Neck circumference (cm)	34.38 ± 1.77	34.33 ± 1.68	34.89 ± 4.16	34.73 ± 2.19	0.59	0.623
Neck/height ratio	0.21 ± 0.01	0.21 ± 0.01	0.22 ± 0.03	0.22 ± 0.01	0.54	0.655
Waist circumference (cm)	81.75 ± 6.69	83.47 ± 4.75	84.15 ± 6.62	83.88 ± 7.06	0.48	0.697
Hip circumference (cm)	96.88 ± 7.04	98.45 ± 5.72	97.31 ± 6.14	96.93 ± 6.46	1.02	0.384
Waist/hip ratio	0.84 ± 0.02	0.85 ± 0.04	0.87 ± 0.05	0.87 ± 0.05	2.72	0.044
Waist/height ratio	0.50 ± 0.04	0.52 ± 0.03	0.52 ± 0.04	0.52 ± 0.04	0.59	0.623
Sitting height (cm)	79.00 ± 2.56	79.45 ± 2.62	79.79 ± 2.42	79.57 ± 2.17	0.63	0.599
Sitting height/height ratio	0.49 ± 0.02	0.49 ± 0.01	0.49 ± 0.01	0.49 ± 0.01	1.41	0.240
Leg length/sitting height ratio	0.49 ± 0.03	0.50 ± 0.02	0.50 ± 0.03	0.50 ± 0.02	0.03	0.991

Table 4.18: Height and anthropometric characteristics of digit lengths forall subjects in relation to father's level of education

Variables	None (n = 800) Mean + SD	Primary (n = 800) Mean + SD	Secondary (n = 800) Mean + SD	Tertiary (n = 800) Mean + SD	F	P
Right digit 1 (mm)	57.00 ± 5.26	56.87 ± 4.76	57.91 ± 5.11	57.35 ± 5.24	0.82	0.486
Right digit 2 (mm)	69.38 ± 4.17	69.43 ± 3.59	70.61 ± 4.13	70.76 ± 4.19	2.10	0.099
Right digit 3 (mm)	78.38 ± 3.93	79.91 ± 3.71	80.67 ± 3.81	81.06 ± 3.92	2.44	0.064
Right digit 4 (mm)	70.63 ± 4.96	72.78 ± 3.75	73.83 ± 4.30	74.59 ± 3.91	5.03	0.002
Right digit 5 (mm)	55.88 ± 5.54	55.80 ± 4.97	57.82 ± 4.76	58.25 ± 4.64	4.92	0.002
Right 2D:4D	0.98 ± 0.03	0.96 ± 0.04	0.96 ± 0.04	0.95 ± 0.05	2.37	0.070
Left digit 1 (mm)	57.00 ± 5.26	56.80 ± 4.82	57.91 ± 5.22	57.26 ± 5.34	0.92	0.432
Left digit 2 (mm)	69.38 ± 4.17	69.22 ± 3.62	70.71 ± 4.12	70.84 ± 4.13	3.20	0.023
Left digit 3 (mm)	78.38 ± 3.93	79.92 ± 3.63	80.64 ± 3.88	81.05 ± 3.92	2.34	0.073
Left digit 4 (mm)	70.63 ± 4.96	72.58 ± 3.69	77.79 ± 2.35	74.47 ± 3.80	0.53	0.660
Left digit 5 (mm)	55.88 ± 5.54	55.77 ± 4.95	57.74 ± 4.84	58.16 ± 4.69	4.56	0.004
Left 2D:4D	0.98 ± 0.03	0.95 ± 0.04	0.95 ± 0.08	0.95 ± 0.04	0.74	0.530

Table 4.19-4.20 shows the relationship between height anthropometric characteristics based onmother's level of education. It shows a statistically insignificant difference in anthropometric parameters in all the ethnic groups owing to the fact that p>0.05 except for foot length, right Digit 2, Right Digit 3, Right Digit 4, Right Digit 5, Left Digit 1 and Left Digit 5 with p values (<0.001, 0.050, 0.051, 0.003, <0.001, 0.050 and <0.001) respectively which are statistically significant.

Table 4.21-4.22 shows the relationship between height and anthropometric characteristics based on birth order. It can be shown from the table that there is no significant difference between anthropometric features based on birth orders owing to the fact that p>0.05 except for age, height, weight, body mass index, biaxillary length, hand breath, foot length, foot breath, hand index, thigh length, thigh circumference, calf circumference, chest circumference, waist circumference, hip circumference and waist/hip ratio with p values (<0.001, 0.029, <0.001, <0.001, <0.001, <0.001, 0.020, 0.034, 0.012, 0.008, 0.002, <0.001, 0.010, <0.001, <0.001 and <0.001) respectively which are statistically significant.

Table 4.19: Height and anthropometric characteristics ofall subjects in relation to mother's level of education

Variables	None (n = 800) Mean + SD	Primary (n = 800) Mean + SD	Secondary (n = 800) Mean + SD	Tertiary (n = 800) Mean + SD	F	P
Age (years)	24.67 ± 4.66	25.21 ± 4.20	24.05 ± 3.85	24.52 ± 4.31	1.75	0.156
Height (cm)	162.97 ± 4.37	162.10 ± 5.11	162.52 ± 5.11	161.88 ± 4.86	0.58	0.629
Weight (kg)	62.49 ± 8.68	61.67 ± 8.23	61.25 ± 8.94	62.94 ± 8.56	0.82	0.482
Body mass index (kg/m^2)	23.50 ± 2.94	23.43 ± 2.79	23.15 ± 2.94	23.98 ± 2.80	1.68	0.172
Demi span length (cm)	85.12 ± 3.35	84.53 ± 4.02	84.40 ± 4.24	84.01 ± 4.63	0.63	0.598
Biaxillary length (cm)	35.36 ± 2.36	36.17 ± 4.97	35.48 ± 3.86	35.62 ± 2.92	0.81	0.491
Hand length (cm)	18.40 ± 1.18	18.70 ± 1.05	18.78 ± 1.20	18.86 ± 0.97	1.55	0.201
Hand breadth (cm)	11.51 ± 1.55	11.43 ± 0.97	11.39 ± 0.89	11.48 ± 1.50	0.18	0.913
Foot length (cm)	25.79 ± 1.53	25.10 ± 1.32	25.96 ± 1.34	26.84 ± 5.28	6.84	<0.001
Foot breadth (cm)	13.61 ± 1.02	13.62 ± 0.87	13.82 ± 0.90	13.93 ± 0.96	2.38	0.070
Hand index	62.75 ± 9.18	61.17 ± 4.25	60.81 ± 5.26	60.86 ± 7.57	1.00	0.392
Foot index	52.62 ± 4.17	52.32 ± 3.60	52.78 ± 4.22	53.24 ± 3.39	1.00	0.391
Thigh length (cm)	43.79 ± 2.41	43.23 ± 2.48	43.50 ± 2.40	42.99 ± 2.41	1.34	0.262
Thigh circumference (cm)	53.79 ± 4.28	53.68 ± 4.01	53.61 ± 4.41	52.95 ± 3.76	0.72	0.541
Calf circumference (cm)	35.33 ± 2.69	35.78 ± 2.21	35.70 ± 2.34	35.85 ± 2.45	0.41	0.744
Leg length (cm)	39.39 ± 1.68	39.25 ± 2.11	39.67 ± 2.11	39.20 ± 1.97	1.40	0.244
Neck length (cm)	13.61 ± 0.86	13.72 ± 0.96	13.73 ± 1.08	13.77 ± 1.42	0.17	0.916
Chest circumference (cm)	89.79 ± 5.59	90.12 ± 4.73	89.83 ± 5.90	90.76 ± 6.17	0.58	0.628
Neck circumference (cm)	34.46 ± 1.77	34.55 ± 1.93	34.77 ± 4.30	34.93 ± 2.15	0.34	0.794
Neck/height ratio	0.21 ± 0.01	0.21 ± 0.01	0.21 ± 0.03	0.22 ± 0.01	0.49	0.687
Waist circumference (cm)	82.55 ± 6.20	84.21 ± 5.27	83.70 ± 6.90	84.23 ± 7.23	0.69	0.558
Hip circumference (cm)	96.82 ± 6.30	97.89 ± 5.38	97.21 ± 6.68	97.17 ± 6.37	0.42	0.736
Waist/hip ratio	0.85 ± 0.04	0.86 ± 0.05	0.86 ± 0.05	0.87 ± 0.06	0.72	0.540
Waist/height ratio	0.51 ± 0.04	0.52 ± 0.03	0.52 ± 0.04	0.52 ± 0.04	1.34	0.262
Sitting height (cm)	79.88 ± 2.21	79.70 ± 2.43	79.52 ± 2.43	79.65 ± 2.28	0.28	0.842
Sitting height/height ratio	0.49 ± 0.01	0.49 ± 0.01	0.49 ± 0.01	0.49 ± 0.01	1.81	0.145
Leg length/sitting height ratio	0.49 ± 0.02	0.49 ± 0.03	0.50 ± 0.02	0.49 ± 0.02	2.40	0.068

Table 4.20: Height and anthropometric characteristics of digit lengths forall subjects in relation to mother's level of education

Variables	None (n = 800) Mean + SD	Primary (n = 800) Mean + SD	Secondary (n = 800) Mean + SD	Tertiary (n = 800) Mean + SD	F	P
Right digit 1 (mm)	56.79 ± 5.02	57.03 ± 4.76	57.90 ± 5.42	57.61 ± 4.97	0.90	0.443
Right digit 2 (mm)	69.18 ± 3.75	69.88 ± 4.14	70.88 ± 4.02	70.77 ± 4.09	2.63	0.050
Right digit 3 (mm)	79.27 ± 3.73	80.21 ± 4.06	80.99 ± 3.69	81.01 ± 3.80	2.62	0.051
Right digit 4 (mm)	72.42 ± 4.09	73.07 ± 4.03	74.61 ± 4.10	74.09 ± 4.09	4.71	0.003
Right digit 5 (mm)	55.27 ± 3.73	56.64 ± 5.15	58.14 ± 4.60	58.58 ± 4.51	6.23	<0.001
Right 2D:4D	0.96 ± 0.04	0.96 ± 0.04	0.95 ± 0.04	0.96 ± 0.04	0.64	0.591
Left digit 1 (mm)	56.79 ± 5.02	57.07 ± 4.86	57.85 ± 5.54	57.45 ± 5.08	0.70	0.550
Left digit 2 (mm)	69.33 ± 3.81	69.86 ± 4.18	70.92 ± 3.99	70.82 ± 4.04	2.63	0.050
Left digit 3 (mm)	79.46 ± 3.83	80.13 ± 4.09	81.03 ± 3.70	80.94 ± 3.78	2.45	0.063
Left digit 4 (mm)	72.36 ± 3.92	72.90 ± 4.09	78.80 ± 4.05	74.04 ± 4.17	0.87	0.457
Left digit 5 (mm)	55.21 ± 4.72	56.50 ± 5.16	58.17 ± 4.62	58.41 ± 4.59	6.35	<0.001
Left 2D:4D	0.96 ± 0.04	0.96 ± 0.04	0.95 ± 0.08	0.96 ± 0.04	1.17	0.319

Table 4.21: Height and anthropometric characteristics of all subjects in relation to birth order

Variables	First birth (n = 800) Mean + SD	Second birth (n = 800) Mean + SD	Third birth (n = 800) Mean +SD	Later born (n = 800) Mean + SD	F	P
Age (years)	26.27 ± 4.20	25.84 ± 3.67	24.75 ± 4.03	22.47 ± 3.65	20.87	<0.001
Height (cm)	163.79 ± 4.94	162.17 ± 4.93	161.78 ± 4.73	161.88 ± 5.14	3.04	0.029
Weight (kg)	64.44 ± 7.83	63.25 ± 8.74	62.25 ± 8.85	59.07 ± 8.12	8.04	<0.001
Body mass index (kg/m^2)	24.01 ± 2.69	24.03 ± 3.00	23.74 ± 2.95	22.50 ± 2.59	7.61	<0.001
Demi span length (cm)	84.68 ± 4.48	84.02 ± 4.42	84.23 ± 4.19	84.66 ± 3.90	0.56	0.639
Biaxillary length (cm)	36.18 ± 2.32	36.64 ± 4.27	36.17 ± 5.40	34.41 ± 2.51	7.50	<0.001
Hand length (cm)	18.81 ± 1.19	18.68 ± 0.98	18.91 ± 1.11	18.61 ± 1.13	1.62	0.184
Hand breadth (cm)	11.52 ± 1.25	11.50 ± 0.91	11.74 ± 1.02	11.08 ± 1.23	7.20	<0.001
Foot length (cm)	26.57 ± 4.76	25.85 ± 1.08	25.59 ± 1.44	25.51 ± 1.51	3.32	0.020
Foot breadth (cm)	13.74 ± 0.88	13.94 ± 0.86	13.86 ± 0.97	13.59 ± 0.92	2.93	0.034
Hand index	61.37 ± 7.01	61.69 ± 5.42	62.08 ± 4.04	59.69 ± 6.91	3.68	0.012
Foot index	52.82 ± 4.68	52.94 ± 3.71	52.63 ± 3.03	52.65 ± 4.05	0.14	0.933
Thigh length (cm)	44.00 ± 2.28	43.15 ± 2.45	42.80 ± 2.24	43.48 ± 2.57	4.04	0.008
Thigh circumference (cm)	54.94 ± 4.85	53.76 ± 3.48	53.14 ± 3.79	52.73 ± 4.16	5.13	0.002
Calf circumference (cm)	36.14 ± 2.56	36.46 ± 2.07	35.84 ± 2.15	34.90 ± 2.34	9.58	<0.001
Leg length (cm)	39.78 ± 1.93	39.42 ± 2.07	39.31 ± 2.14	39.28 ± 2.02	1.09	0.352
Neck length (cm)	13.96 ± 0.99	13.81 ± 1.52	13.66 ± 0.88	13.58 ± 1.03	2.14	0.094
Chest circumference (cm)	91.60 ± 5.77	90.47 ± 5.54	90.18 ± 5.09	88.97 ± 5.80	3.80	0.010
Neck circumference (cm)	34.96 ± 1.94	35.22 ± 2.06	34.64 ± 1.82	34.30 ± 4.68	1.72	0.162
Neck/height ratio	0.21 ± 0.01	0.22 ± 0.01	0.21 ± 0.01	0.21 ± 0.03	1.26	0.287
Waist circumference (cm)	85.78 ± 6.86	84.83 ± 5.69	84.39 ± 5.71	81.67 ± 6.80	8.52	<0.001
Hip circumference (cm)	99.32 ± 7.05	98.20 ± 5.81	97.79 ± 5.23	95.28 ± 6.15	8.58	<0.001
Waist/hip ratio	0.86 ± 0.05	0.87 ± 0.05	0.86 ± 0.05	0.86 ± 0.05	0.53	0.659
Waist/height ratio	0.52 ± 0.04	0.52 ± 0.04	0.52 ± 0.04	0.51 ± 0.04	6.70	<0.001
Sitting height (cm)	80.04 ± 2.73	79.48 ± 2.27	79.68 ± 2.31	79.45 ± 2.24	1.15	0.327
Sitting height/height ratio	0.49 ± 0.01	0.49 ± 0.01	0.49 ± 0.01	0.49 ± 0.01	2.20	0.088
Leg length/sitting height ratio	0.50 ± 0.02	0.50 ± 0.02	0.49 ± 0.03	0.50 ± 0.02	0.45	0.715

Table 4.22: Height and anthropometric characteristics of digit lengths for all subjects in relation to birth order

Variables	First birth (n = 800) Mean + SD	Second birth (n = 800) Mean + SD	Third birth (n = 800) Mean +SD	Later born (n = 800) Mean + SD	F	P
Right digit 1 (mm)	58.21 ± 5.74	56.56 ± 4.34	57.19 ± 4.83	57.94 ± 5.31	1.96	0.119
Right digit 2 (mm)	71.05 ± 4.30	69.89 ± 3.60	70.34 ± 4.33	70.48 ± 4.03	1.14	0.331
Right digit 3 (mm)	80.82 ± 4.43	80.55 ± 3.42	80.96 ± 3.86	80.30 ± 3.78	0.66	0.576
Right digit 4 (mm)	74.38 ± 4.95	73.78 ± 3.96	73.70 ± 3.78	73.73 ± 4.02	0.51	0.678
Right digit 5 (mm)	56.92 ± 4.97	57.47 ± 4.78	58.43 ± 4.86	57.31 ± 4.75	1.73	0.160
Right 2D:4D	0.96 ± 0.04	0.95 ± 0.04	0.96 ± 0.04	0.96 ± 0.04	0.86	0.461
Left digit 1 (mm)	58.13 ± 5.80	56.56 ± 4.34	56.96 ± 5.05	58.03 ± 5.38	2.18	0.090
Left digit 2 (mm)	71.01 ± 4.28	69.93 ± 3.74	70.47 ± 4.15	70.47 ± 4.09	0.97	0.407
Left digit 3 (mm)	80.79 ± 4.54	80.47 ± 3.38	80.95 ± 3.84	80.33 ± 3.79	0.59	0.620
Left digit 4 (mm)	82.91 ± 7.16	73.77 ± 3.80	73.64 ± 3.81	73.59 ± 4.12	1.54	0.205
Left digit 5 (mm)	56.58 ± 4.91	57.51 ± 4.82	58.42 ± 4.88	57.27 ± 4.84	2.26	0.081
Left 2D:4D	0.95 ± 0.11	0.95 ± 0.04	0.96 ± 0.04	0.96 ± 0.04	0.86	0.463

4.4.CORRELATION BETWEEN ANTHROPOMETRIC VARIABLES

Table 4.23 shows the overall correlation matrix of the studied subjects and their anthropometric characteristics. Pearson's correlation coefficient was used to correlate height to the other parameters. Ninety-nine percent (99%) of the parameters correlated at $p < 0.01$ and $p < 0.05$. Height showed an inverse correlation which is insignificant with HI, NHtR, SHtHtR, LLSHtR, WC and an inverse correlation which is significant with HC and WHR, while SHt showed the strongest correlation with height than the other parameters followed by TL, LL, DSL, HL, WT, FB, HB, FL, NL, NC, CC, BL, BMI, TC, ChC and FI respectively. Age showed an insignificant inverse weak correlation with HI, FI, NHtR, WHR and LLSHtR and a significant positive correlation with the other anthropometric parameters.BMI showed an insignificant inverse weak correlation with TC, WHR, SHtHtR and positive relationship with the other parameters.

Table 4.23:Correlation matrix of anthropometric characteristics of all subjects (n = 800)

	Age	HT	WT	BMI	DSL	BL	HL	HB	FL	FB	HI	FI	TL	TC	CC	LL	NL	ChC	NC	NHtR	WC	HC	WHR	WHtR	SH	SHtHtR	LLSHtR
Age	-	0.34	0.38	0.05	0.15[b]	0.31	0.12[b]	0.33	0.16[b]	0.20	-0.01[c]	-0.01[c]	0.30	0.28	0.26	0.27	0.21	0.21	0.24	-0.02[c]	0.37	0.25	-0.01[c]	0.09	0.22	0.05	-0.01[c]
HT		-	0.50	0.21	0.60	0.26	0.53	0.43	0.42	0.50	-0.03[c]	0.10	0.77	0.20	0.28	0.75	0.34	0.16[b]	0.31	-0.01[c]	-0.02[c]	-0.08[c]	-0.11[c]	0.13b	0.82	-0.01[c]	-0.01[c]
WT			-	0.07	0.38	0.31	0.29	0.28	0.19[b]	0.35	0.08	-0.01[c]	0.41	0.38	0.45	0.39	0.35	0.53	0.28	0.03[a]	0.40	0.40	-0.04[c]	-0.02[c]	0.38	0.05	-0.08[c]
BMI				-	0.08	0.04[a]	0.12[b]	0.16[b]	0.09	0.05	0.04[a]	0.11[b]	0.15[b]	-0.02[c]	0.02[a]	0.07	0.05	-0.08[c]	0.14[b]	0.15[b]	-0.07[c]	-0.12[c]	-0.01[c]	0.46	0.22	-0.02[c]	0.02[a]
DSL					-	0.10[b]	0.60	0.30	0.37	0.52	0.11[b]	0.14[b]	0.48	0.08	0.08	0.46	0.37	0.13[b]	0.19[b]	0.10[b]	-0.19[c]	-0.08[c]	0.03[a]	-0.11[c]	0.51	0.05	-0.06[c]
BL						-	0.15[b]	0.28	0.08	0.23	-0.07[c]	0.05	0.20	0.20	0.37	0.23	0.19[b]	0.26	0.20	-0.06[c]	0.25	0.17	-0.01[c]	0.08	0.18	-0.01[c]	0.01[a]
HL							-	0.48	0.43	0.51	0.08	0.14[b]	0.33	0.02[a]	0.11[b]	0.39	0.23	0.01[a]	0.24	0.06	-0.16[c]	-0.15[c]	0.01[a]	0.06	0.52	-0.06[c]	0.05
HB								-	0.24	0.45	0.13[b]	0.15[b]	0.26	-0.01[c]	0.23	0.31	0.16[b]	0.04[a]	0.32	-0.01[c]	0.04[a]	-0.14[c]	-0.01[c]	0.21	0.41	-0.09[c]	0.13[b]
FL									-	0.28	-0.04[c]	0.07	0.22	0.07	0.09	0.35	0.20	0.04[a]	0.16[b]	0.01[a]	-0.07[c]	-0.07[c]	-0.10[c]	0.05	0.40	0.02[a]	-0.01[c]
FB										-	0.09	0.16[b]	0.39	0.07	0.25	0.40	0.28	0.15[b]	0.27	0.03[a]	-0.02[c]	-0.07[c]	-0.01[c]	0.04[a]	0.42	-0.06[c]	0.08
HI											-	0.15[b]	-0.05[c]	-0.07	0.01[a]	-0.01[c]	0.07	-0.01[c]	0.05	0.15[b]	-0.04[c]	-0.01[c]	0.29	0.09	-0.03[c]	-0.02[c]	0.01[a]
FI												-	0.04[a]	-0.05[c]	-0.01[c]	0.09	-0.03[c]	-0.06[c]	0.20	0.07	-0.12[c]	-0.16[c]	0.04[a]	0.02[a]	0.09	-0.07[c]	0.03[a]
TL													-	0.21	0.21	0.51	0.29	0.16[b]	0.18[b]	-0.02[c]	-0.03[c]	-0.03[c]	-0.07[c]	0.08	0.39	0.04[a]	-0.04[c]
TC														-	0.41	0.15[b]	0.23	0.47	0.14[b]	-0.08[c]	0.49	0.48	-0.10[c]	-0.15c	0.12[b]	0.04[a]	-0.02[c]
CC															-	0.23	0.27	0.44	0.23	-0.11[c]	0.44	0.38	-0.10[c]	0.01[a]	0.21	0.03[a]	-0.03[c]
L L																-	0.31	0.23	0.15[b]	-0.01[c]	0.05	0.02[a]	-0.06[c]	0.07	0.42	0.05	-0.03[c]
NL																	-	0.30	0.14[b]	0.08	0.14[b]	0.22	0.05	0.01[a]	0.25	0.10[b]	-0.09[c]
ChC																		-	0.15[b]	0.05	0.62	0.64	0.04[a]	-0.05[c]	0.04[a]	0.12[b]	-0.09[c]
NC																			-	0.02[a]	0.14[b]	-0.01[c]	-0.09[c]	0.08	0.36	-0.07[c]	0.07
NHtR																				-	-0.06[c]	0.04[a]	0.19[b]	0.20	0.02[a]	0.22	-0.20[c]
WC																					-	0.72	-0.03[c]	-0.05[c]	-0.06[c]	0.06	-0.01[c]
HC																						-	0.07	-0.11[c]	-0.14[c]	0.11[b]	-0.10[c]
WHR																							-	0.36	-0.13[c]	0.04[a]	-0.03[c]
WHtR																								-	0.12[b]	0.06	-0.01[c]
SHt																									-	-0.05[c]	0.02
SHtHtR																										-	-0.79[c]
LLSHtR																											-

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; HI = Hand Index; FI = Foot Index; TL = Thigh Length; TC = Thigh Circumference; CC = Calf Circumference; LL = Leg Length; NL = Neck Length; ChC = Chest Circumference; NC = Neck Circumference; NHtR = Neck/Height Ratio; WC = Waist Circumference; HC = Hip Circumference; WHR = Waist/Hip Ratio; WHtR = Waist/Height Ratio; SHt = Sitting Height; SHtHtR = Sitting Height/Height Ratio; LLSHtR = Leg Length/Sitting Height Ratio; a = correlation is significant at the 0.05 level (2-tailed); b = correlation is significant at the 0.01 level (2-tailed); c = correlation is significant at the 0.001 level (2-tailed).

Table 4.24 showed the overall correlation matrix based on sex (males) correlated at $p < 0.05$. Height showed an inverse correlation with BMI, FI, NHtR, WHtR, SHtHtR and LLSHtR, also height showed a weak positive significant correlation with the other parameters other than TL, LL and SHt which showed significant strong positive correlation with height. Thigh length (TL) showed positive strongest correlation with height than all the other parameters ($r = 0.77$, $p< 0.05$). There was strong positive correlation between weight (WT) with BMI, so also there were weak positive correlation between weight and other parameters. There were inverse and insignificant weak correlation between BMI and FL and also an insignificant correlation was observed between BMI and WHR.

Table 4.25 showed the overall correlation matrix based on sex (females). Height showed an inverse and significant weak correlation with HI, NHtR, WHtR and SHtHtR. Leg length(LL) showed the strongest and positive correlation with height than all other parameters ($r = 0.775$, $p < 0.05$), followed by SHtHtR and TL respectively. There was an inverse significant weak correlation between age and sitting Height/Height Ratio (SHtHtR). However, there were strong and significant positive correlation between weight and BMI. However, there was significantly weak correlation between weight and other parameters. There was also a positive significant strong correlation between hand breadth (HB) and foot breadth (FB). Neck circumference (NC) showed a positive significant strong correlation with NHtR. Also there was a strong positive significant correlation between Hip circumference (HC) with chest circumference (ChC). An inverse significant strong correlation was shown between LLSHtR and SHt.

Table 4.24:Correlation matrix of anthropometric characteristics of total males (n = 400)

	Age	**HT**	**WT**	**BMI**	**DSL**	**BL**	**HL**	**HB**	**FL**	**FB**	**HI**	**FI**	**TL**	**TC**	**CC**	**LL**	**NL**	**ChC**	**NC**	**NHtR**	**WC**	**HC**	**WHR**	**WHtR**	**SHt**	**SHtHtR**	**LLSHtR**
Age	-	0.43	0.44	0.18[b]	0.27	0.36	0.06	0.38	0.15[b]	0.22	0.35	0.02[a]	0.44	0.24	0.22	0.29	0.28	0.24	0.16[b]	-0.03[c]	0.51	0.33	0.22	0.26	0.23	-0.30[c]	0.16[b]
HT		-	0.52	-0.19[c]	0.34	0.52	0.33	0.43	0.35	0.34	0.25	-0.15[c]	0.77	0.28	0.41	0.74	0.37	0.38	0.22	-0.23[c]	0.30	0.26	0.07	-0.28[c]	0.71	-0.43[c]	0.33
WT			-	0.74	0.37	0.51	0.30	0.46	0.19[b]	0.40	0.29	0.06	0.44	0.36	0.44	0.35	0.36	0.50	0.32	0.09	0.54	0.50	0.07	0.24	0.38	-0.22[c]	0.13[b]
BMI				-	0.16[b]	0.17[b]	0.08	0.19[b]	-0.05[c]	0.20	0.15[b]	0.19[b]	-0.10[c]	0.19[b]	0.18[b]	-0.18[c]	0.12[b]	0.28	0.19[b]	0.28	0.38	0.37	0.02	0.49	-0.13[c]	0.09	-0.11[c]
DSL					-	0.26	0.54	0.20	0.25	0.36	-0.10[c]	-0.01[c]	0.26	0.27	0.13[b]	0.43	0.38	0.48	0.14[b]	-0.02[c]	0.24	0.40	-0.17[c]	0.04[a]	0.17[b]	-0.24[c]	0.34
BL						-	0.28	0.46	0.11[b]	0.43	0.31	0.13[b]	0.51	0.26	0.43	0.43	0.28	0.44	0.23	-0.01[c]	0.35	0.21	0.18[b]	0.04[a]	0.24	-0.39[c]	0.29
HL							-	0.28	0.30	0.31	-0.28[c]	-0.07[c]	0.22	0.17[b]	0.14[b]	0.37	0.32	0.30	0.13[b]	-0.02[c]	0.07	0.30	-0.25[c]	-0.13[c]	0.22	-0.16[c]	0.24
HB								-	0.11[b]	0.38	0.84	0.17[b]	0.40	0.17[b]	0.34	0.38	0.29	0.33	0.18[b]	-0.01[c]	0.37	0.19[b]	0.22	0.12[b]	0.19[b]	-0.33[c]	0.27
FL									-	0.13[b]	-0.06[c]	-0.60[c]	0.15[b]	0.07	0.08	0.34	0.25	0.18[b]	0.08	-0.08[c]	0.03[a]	0.15[b]	-0.13[c]	-0.17[c]	0.29	-0.11[c]	0.18[b]
FB										-	0.21	0.62	0.37	0.22	0.34	0.38	0.35	0.44	0.16[b]	0.01[a]	0.29	0.27	0.04[a]	0.09	0.05	-0.39[c]	0.36
HI											-	0.20	0.27	0.07	0.26	0.18[b]	0.11[b]	0.16[b]	0.11[b]	0.01[a]	0.33	0.02[a]	0.35	0.19[b]	0.07	-0.24[c]	0.14[b]
FI												-	0.03[a]	0.07	0.12[b]	-0.06[c]	0.01[a]	0.13[b]	0.03[a]	0.10[b]	0.17[b]	0.03[a]	0.17[b]	0.26	-0.29[c]	-0.17[c]	0.11[b]
TL													-	0.25	0.37	0.51	0.34	0.28	0.13[b]	-0.22[c]	0.29	0.17[b]	0.15[b]	-0.16[c]	0.28	-0.68[c]	0.36
T C														-	0.32	0.15[b]	0.33	0.35	0.15[b]	0.02[a]	0.35	0.39	-0.02[c]	0.19[b]	0.23	-0.07[c]	0.02[a]
CC															-	0.31	0.34	0.43	0.20	0.02[a]	0.36	0.29	0.10[b]	0.12[b]	0.26	-0.22[c]	0.16[b]
L L																-	0.37	0.39	0.13[b]	-0.20[c]	0.15[b]	0.17[b]	0.01[a]	-0.28[c]	0.28	-0.63[c]	0.84
NL																	-	0.34	0.16[b]	-0.01[c]	0.22	0.25	-0.02[c]	0.01[a]	0.21	-0.23[c]	0.25
ChC																		-	0.37	0.20	0.40	0.44	-0.03[c]	0.18[b]	0.21	-0.24[c]	0.27
NC																			-	0.90	0.31	0.26	0.07	0.18[b]	0.23	-0.01[c]	-0.01[c]
NHtR																				-	0.17[b]	0.14[b]	0.04[a]	0.31	-0.09[c]	0.19[b]	-0.15[c]
WC																					-	0.60	0.48	0.83	0.20	-0.15[c]	0.04[a]
HC																						-	-0.41[c]	0.45	0.25	-0.03[c]	0.03[a]
WHR																							-	0.44	-0.03[c]	-0.14[c]	0.02[a]
WHtR																								-	-0.21[c]	0.11[b]	-0.16[c]
SHt																									-	0.33	-0.29[c]
SHtHtR																										-	-0.82[c]
LLSHtR																											-

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; Hand Index; Foot Index; TL = Thigh Length; TC = Thigh Circumference; CC = Calf Circumference; LL = Leg Length; NL = Neck Length; ChC = Chest Circumference; NC = Neck Circumference; NHtR = Neck/Height Ratio; WC = Waist Circumference; HC = Hip Circumference; WHR = Waist/Hip Ratio; WHtR = Waist/Height Ratio; SHt = Sitting Height; SHtHtR = Sitting Height/Height Ratio; LLSHtR = Leg Length/Sitting Height Ratio; a = correlation is significant at the 0.05 level (2-tailed); b = correlation is significant at the 0.01 level (2-tailed); c = correlation is significant at the 0.001 level (2-tailed).

Table 4.25: Correlation matrix of anthropometric characteristics of total females (n = 400)

	Age	HT	WT	BMI	DSL	BL	HL	HB	FL	FB	HI	FI	TL	TC	CC	LL	NL	ChC	NC	NHtR	WC	HC	WHR	WHtR	SHt	SHtHtR	LLSHtR
Age	-	0.32	0.34	0.22	0.03	0.29	0.15[b]	0.32	0.20	0.18[b]	0.24	0.01[a]	0.16[b]	0.31	0.30	0.26	0.14[b]	0.23	0.29	0.18[b]	0.39	0.31	0.18[b]	0.27	0.26	-0.10[c]	0.12[b]
HT		-	0.50	0.07	0.50	0.11[b]	0.36	0.11[b]	0.25	0.32	-0.10[c]	0.10[b]	0.69	0.33	0.18[b]	0.78	0.35	0.38	0.08	-0.26[c]	0.25	0.34	-0.05[c]	-0.16[c]	0.75	-0.40[c]	0.38
WT			-	0.90	0.36	0.21	0.22	0.11[b]	0.15[b]	0.26	-0.02[c]	0.12[b]	0.35	0.42	0.47	0.39	0.34	0.64	0.20	0.02[a]	0.51	0.61	-0.01[c]	0.31	0.37	-0.21[c]	0.20
BMI				-	0.17[b]	0.18[b]	0.07	0.07	0.04[a]	0.14[b]	0.02[a]	0.09	0.05	0.30	0.44	0.07	0.22	0.53	0.17[b]	0.14[b]	0.44	0.52	0.01[a]	0.41	0.04[a]	-0.05[c]	0.05
DSL					-	-0.02[c]	0.36	-0.03[c]	0.25	0.32	-0.24[c]	0.08	0.47	0.10[b]	0.02[a]	0.35	0.42	0.26	-0.15[c]	-0.32[c]	-0.06[c]	0.27	-0.39[c]	-0.27[c]	0.33	-0.27[c]	0.18[b]
BL						-	0.06	0.19[b]	0.02[a]	0.11[b]	0.15[b]	0.08	-0.01[c]	0.19[b]	0.34	0.09	0.13[b]	0.21	0.17[b]	0.13[b]	0.28	0.26	0.10[b]	0.25	0.14[b]	0.05	0.01[a]
HL							-	0.37	0.45	0.40	-0.27[c]	-0.01[c]	0.17[b]	0.04[a]	0.08	0.27	0.15[b]	0.08	0.02[a]	-0.10[c]	0.08	0.11[b]	-0.01[c]	-0.06[c]	0.37	-0.01[c]	0.07
HB								-	0.18[b]	0.26	0.79	0.09	-0.09[c]	-0.03[c]	0.15[b]	0.09	0.03[a]	0.06	0.21	0.17[b]	0.20	0.05	0.22	0.17[b]	0.23	0.17[b]	-0.05[c]
FL									-	0.24	-0.09[c]	-0.52[c]	0.07	0.20	0.10[b]	0.23	0.10[b]	0.08	0.01[a]	-0.07[c]	0.17[b]	0.11[b]	0.10[b]	0.07	0.25	-0.01[c]	0.09
FB										-	0.03[a]	0.70	0.17[b]	0.08	0.16[b]	0.25	0.21	0.21	0.08	-0.03[c]	0.17[b]	0.23	-0.02[c]	0.04[a]	0.35	0.02[a]	0.05
HI											-	0.10[b]	-0.19[c]	-0.05[c]	0.10[b]	-0.07[c]	-0.06[c]	0.02[a]	0.20	0.23	0.15[b]	-0.02[c]	0.23	0.20[a]	0.01[a]	0.16[b]	-0.08[c]
FI												-	0.09	-0.08[c]	0.06	0.04[a]	0.11[b]	0.13[b]	0.05	0.02[a]	0.03[a]	0.12[b]	-0.09[c]	-0.01[c]	0.12[b]	0.02[a]	-0.03[c]
TL													-	0.28	0.03[a]	0.41	0.24	0.28	-0.01[c]	-0.24[c]	0.02[a]	0.22	-0.22[c]	-0.27[c]	0.21	-0.70[c]	0.32
T C														-	0.50	0.21	0.19[b]	0.53	0.22	0.11[b]	0.56	0.57	0.12[b]	0.43	0.25	-0.13[c]	0.08
CC															-	0.13[b]	0.20	0.50	0.26	0.19[b]	0.62	0.62	0.15[b]	0.56	0.22	0.05	0.01[a]
LL																-	0.24	0.26	0.01[a]	-0.26[c]	0.19[b]	0.21	0.01[b]	-0.13[c]	0.44	-0.51[c]	0.82
NL																	-	0.32	0.09	-0.04[c]	0.18[b]	0.34	-0.15[c]	0.03[a]	0.30	-0.09[c]	0.08
ChC																		-	0.19[b]	0.06	0.69	0.73	0.10[b]	0.54	0.30	-0.13[c]	0.09
NC																			-	0.94	0.36	0.20	0.26	0.34	0.14[b]	0.09	-0.09[c]
NHtR																				-	0.27	0.08	0.28	0.38	-0.11[c]	0.22	-0.22[c]
WC																					-	0.69	0.58	0.92	0.32	0.08	0.01[a]
HC																						-	-0.20[c]	0.56	0.31	-0.06[c]	0.03[a]
WHR																							-	0.61	0.07	0.18[b]	-0.03[c]
WHtR																								-	0.02[a]	0.25	-0.15[c]
SHt																									-	0.31	-0.15[c]
SHtHtR																										-	-0.75[c]
LLSHtR																											-

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; Hand Index; Foot Index; TL = Thigh Length; TC = Thigh Circumference; CC = Calf Circumference; LL = Leg Length; NL = Neck Length; ChC = Chest Circumference; NC = Neck Circumference; NHR = Neck/Height Ratio; WC = Waist Circumference; HC = Hip Circumference; WHR = Waist/Hip Ratio; WHtR = Waist/Height Ratio; SHt = Sitting Height; SHtHtR = Sitting Height/Height Ratio; LLSHtR = Leg Length/Sitting Height Ratio; a = correlation is significant at the 0.05 level (2-tailed); b = correlation is significant at the 0.01 level (2-tailed); c = correlation is significant at the 0.001 level (2-tailed).

Table 4.26 shows the correlation matrix of length parameters and anthropometric characteristics of all subject n = 800. Ninety-nine percent (99%) of the parameters correlated at $p < 0.01$ and $p < 0.05$. Height showed a strong positive correlation with SHt, TL, and LL respectively. There were weak and positive correlation between height and BMI, biaxillary length, R2, L2. R5 showed the strongest and positive correlation with L5. Also R2 showed a very strong positive significant correlation with L2, L4, R4, R3, L3 and L1 respectively. R3 showed a strong positive significant correlation with L3, R4, L4, L2, R5 and L5 respectively.

Table 4.27 shows the correlation matrix of length parameters and anthropometric characteristics males n = 400.Height showed an inverse weak significant correlation with BMI and a strong positive significant correlation with thigh length (TL), leg length(LL) and Sitting height (SHt) respectively. There was also a strong positive significant correlation between weight (WT) and BMI while a weak positive significant correlation was shown with other parameters.BMI showed weak correlation with the rest of the parameters. The strongest positive significant correlation was shown between R4 and L5. Also R2D:4D showed a very strong positive correlation with 2D:4D. Age showed weak correlation with all the parameters. There was also strong positive significant correlation between R2 and L2, L4, R4, L1, R3, L3 and 2D:4DR. L3 showed a strong positive significant correlation with L4. Also R4 showed a strong positive significant correlation with L4, L3 and L2. Biaxillary length showed a weak correlation hand breadth, hand length, foot length, foot breadth, thigh length.leg length, sitting height, neck length.

Table 4.26:Correlation matrix of length parameters and anthropometric characteristics of all subjects (n = 800)

	Age	**HT**	**WT**	**BMI**	**DSL**	**BL**	**HL**	**HB**	**FL**	**FB**	**TL**	**LL**	**NL**	**SH**	**R1**	**R2**	**R3**	**R4**	**R5**	**L1**	**L2**	**L3**	**L4**	**L5**
Age	-	0.34	0.38	0.05	0.15^{b}	0.31	0.12^{b}	0.33	0.16^{b}	0.20	0.30	0.27	0.21	0.22	-0.04^{c}	0.06	0.11^{b}	0.10^{b}	0.13^{b}	-0.03^{c}	0.07	0.10^{b}	0.09	0.12^{b}
HT		-	0.50	0.21	0.60	0.26	0.53	0.43	0.42	0.50	0.77	0.75	0.34	0.82	0.33	0.27	0.47	0.38	0.40	0.33	0.27	0.47	0.38	0.39
WT			-	0.07	0.38	0.31	0.29	0.28	0.19^{b}	0.35	0.41	0.39	0.35	0.38	0.16^{b}	0.17^{b}	0.23	0.21	0.14^{b}	0.16^{b}	0.18^{b}	0.23	0.21	0.13^{b}
BMI				-	0.08	0.04^{a}	0.12^{b}	0.16^{b}	0.09	0.05	0.15^{b}	0.07	0.05	0.22	-0.01^{c}	-0.01^{c}	0.13^{b}	0.02^{a}	0.17^{b}	-0.02^{c}	-0.01^{c}	0.11^{b}	0.03^{a}	0.17^{b}
DSL					-	0.10^{b}	0.60	0.30	0.37	0.52	0.48	0.46	0.37	0.51	0.55	0.44	0.45	0.42	0.22	0.55	0.45	0.45	0.44	0.21
BL						-	0.15^{b}	0.28	0.08	0.23	0.20	0.23	0.19^{b}	0.18^{b}	-0.04^{c}	0.08	0.15^{b}	0.14^{b}	0.15^{b}	-0.04^{c}	0.08	0.15^{b}	0.13^{b}	0.14^{b}
HL							-	0.48	0.43	0.51	0.33	0.39	0.23	0.52	0.43	0.42	0.55	0.47	0.45	0.43	0.42	0.55	0.45	0.45
HB								-	0.24	0.45	0.26	0.30	0.16^{b}	0.41	0.10^{b}	0.28	0.42	0.37	0.42	0.10^{b}	0.28	0.42	0.37	0.42
FL									-	0.28	0.22	0.35	0.20	0.40	0.32	0.28	0.34	0.31	0.31	0.32	0.29	0.34	0.31	0.30
FB										-	0.39	0.40	0.28	0.42	0.29	0.33	0.43	0.41	0.31	0.29	0.33	0.42	0.42	0.31
TL											-	0.51	0.29	0.39	0.22	0.15^{b}	0.28	0.25	0.20	0.22	0.15^{b}	0.27	0.24	0.20
LL												-	0.31	0.42	0.30	0.32	0.35	0.33	0.27	0.30	0.32	0.35	0.33	0.27
NL													-	0.25	0.23	0.20	0.18^{b}	0.20	0.09	0.22	0.19^{b}	0.18^{b}	0.20	0.09
SHt														-	0.31	0.21	0.46	0.35	0.44	0.31	0.21	0.46	0.35	0.44
R1															-	0.57	0.42	0.43	0.25	0.10^{b}	0.57	0.42	0.44	0.25
R2																-	0.64	0.70	0.40	0.56	0.98	0.63	0.70	0.40
R3																	-	0.79	0.59	0.42	0.64	0.97	0.79	0.59
R4																		-	0.55	0.43	0.70	0.79	0.98	0.55
R5																			-	0.24	0.40	0.59	0.56	0.99
L1																				-	0.57	0.42	0.44	0.24
L2																					-	0.64	0.70	0.40
L3																						-	0.78	0.59
L4																							-	0.56
L5																								-

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; Hand Index; Foot Index; TL = Thigh Length; LL = Leg Length; NL = Neck Length; SHt = Sitting Height; R1 = 1st Right digit; R2 = 2nd Right Digit; R3 = 3rd Right Digit; R4 = 4th Right Digit; R5 = 5th Right Digit; L1 = 1st Left Digit; L2 = 2nd Left Digit; L3 = 3rd Left Digit; L4 = 4th Left Digit; L5 = 5th Left Digit; a = correlation is significant at the 0.05 level (2-tailed); b = correlation is significant at the 0.01 level (2-tailed); c = correlation is significant at the 0.001 level (2-tailed).

Table 4.27: Correlation matrix of length parameters and anthropometric characteristics of total males (n = 400)

	Age	HT	WT	BMI	DSL	BL	HL	HB	FL	FB	TL	LL	NL	SH	R1	R2	R3	R4	R5	2D:4D R	L1	L2	L3	L4	L5	2D:4D L
Age	-	0.43	0.44	0.18	0.27	0.36	0.06	0.38	0.15[b]	0.22	0.44	0.29	0.28	0.23	-0.10[c]	0.04[a]	0.10[b]	0.07	0.11[b]	-0.05[c]	-0.09[c]	0.05	0.08	0.06	0.10[b]	0.01[a]
HT		-	0.52	-0.19[c]	0.34	0.52	0.33	0.43	0.35	0.34	0.77	0.74	0.37	0.71	0.08	0.23	0.38	0.31	0.43	0.09	0.09	0.24	0.38	0.30	0.42	-0.02[c]
WT			-	0.74	0.37	0.51	0.30	0.46	0.19[b]	0.40	0.44	0.35	0.36	0.38	0.06	0.20	0.24	0.25	0.24	0.10[b]	0.06	0.21	0.24	0.25	0.24	-0.01[c]
BMI				-	0.16[b]	0.17[b]	0.08	0.19[b]	-0.05[c]	0.20	-0.10[c]	-0.18[c]	0.12[b]	-0.13[c]	0.01[a]	0.04[a]	-0.03[c]	0.04[a]	-0.07[c]	0.04[a]	0.01[a]	0.05	-0.03[c]	0.05	-0.07[c]	0.01[a]
DSL					-	0.26	0.54	0.20	0.25	0.36	0.26	0.43	0.38	0.17[b]	0.57	0.51	0.34	0.37	0.07	0.12[b]	0.57	0.53	0.34	0.38	0.07	0.26
BL						-	0.28	0.46	0.11[b]	0.43	0.51	0.37	0.28	0.24	-0.01[c]	0.20	0.30	0.34	0.34	0.04[a]	-0.02[c]	0.20	0.30	0.33	0.34	-0.11[c]
HL							-	0.28	0.30	0.31	0.22	0.37	0.32	0.22	0.38	0.39	0.47	0.42	0.33	0.08	0.38	0.41	0.47	0.41	0.33	0.06
HB								-	0.11[b]	0.38	0.40	0.38	0.29	0.19[b]	-0.03[c]	0.26	0.31	0.33	0.28	0.28	-0.03[c]	0.26	0.32	0.33	0.28	-0.03[c]
FL									-	0.13[b]	0.15[b]	0.34	0.25	0.29	0.22	0.21	0.23	0.23	0.23	0.04[a]	0.22	0.22	0.23	0.23	0.23	0.03[a]
FB										-	0.37	0.38	0.35	0.05	0.13[b]	0.30	0.29	0.33	0.19[b]	0.13[b]	0.13[b]	0.31	0.28	0.33	0.18[b]	0.04[a]
TL											-	0.51	0.34	0.28	-0.04[c]	0.13[b]	0.26	0.24	0.30	0.08	-0.03[c]	0.14[b]	0.25	0.22	0.29	-0.07[c]
LL												-	0.37	0.28	0.19[b]	0.34	0.34	0.33	0.30	0.11[b]	0.19[b]	0.34	0.35	0.32	0.28	0.09
NL													-	0.21	0.27	0.24	0.24	0.27	0.22	0.11[b]	0.27	0.25	0.23	0.27	0.21	0.03[a]
SHt														-	0.12[b]	0.11[b]	0.28	0.19[b]	0.40	0.02[a]	0.12[b]	0.11[b]	0.29	0.18[b]	0.39	-0.05[c]
R1															-	0.63	0.40	0.43	0.13[b]	0.37	0.10[b]	0.64	0.40	0.44	0.12[b]	0.34
R2																-	0.63	0.68	0.32	0.57	0.63	0.97	0.62	0.68	0.32	0.50
R3																	-	0.76	0.51	-0.01[c]	0.40	0.63	0.95	0.75	0.52	-0.03[c]
R4																		-	0.51	-0.21[c]	0.43	0.67	0.76	0.98	0.51	-0.23[c]
R5																			-	-0.14[c]	0.12[b]	0.30	0.51	0.51	0.99	-0.18[c]
R2:4																				-	0.36	0.54	-0.03[c]	-0.18[c]	-0.15[c]	0.92
L1																					-	0.64	0.40	0.44	0.12[b]	0.34
L2																						-	0.63	0.67	0.30	0.54
L3																							-	0.74	0.52	-0.02[c]
L4																								-	0.52	-0.26[c]
L5																									-	-0.19[c]
L2:4																										-

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; TL = Thigh Length; LL = Leg Length; NL = Neck Length; SHt = Sitting Height; R1 = 1st Right digit; R2 = 2nd Right Digit; R3 = 3rd Right Digit; R4 = 4th Right Digit; R5 = 5th Right Digit; R 2D:4D = Right 2D:4D Ratios; L1 = 1st Left Digit; L2 = 2nd Left Digit; L3 = 3rd Left Digit; L4 = 4th Left Digit; L5 = 5th Left Digit; L 2D:4D = Left 2D:4D Ratios; a = correlation is significant at the 0.05 level (2-tailed); b = correlation is significant at the 0.01 level (2-tailed); c = correlation is significant at the 0.001 level (2-tailed).

Table 4.28 shows correlation matrix of length and anthropometric characteristics of all females. Height showed a strong positive correlation with Leg length, sitting height and thigh length respectively while weak correlation was observed with other parameters. Weight showed a strong positive significant correlation with BMI and a weak correlation was observed with other parameters. Also BMI showed a weak correlation with the rest of the parameters. Biaxillary length showed weak correlation with all the parameters. Demispan length showed weak and inverse insignificant correlation with biaxillary length, hand breadth, R5 and L5. There was also a very strong positive correlation between R2 and L2, L4, R4, R3 and L3. Also L5 showed a very strong positive significant correlation with R5. Age also showed weak correlation with all the parameters.

Table 4.28: Correlation matrix of length parameters and anthropometric characteristics of total females (n = 400)

	Age	**HT**	**WT**	**BMI**	**DSL**	**BL**	**HL**	**HB**	**FL**	**FB**	**TL**	**LL**	**NL**	**SH**	**R1**	**R2**	**R3**	**R4**	**R5**	**2D:4D R**	**L1**	**L2**	**L3**	**L4**	**L5**	**2D:4D L**
Age	-	0.32	0.34	0.22	0.03[a]	0.29	0.15[b]	0.32	0.20	0.18[b]	0.16[b]	0.26	0.14[b]	0.26	-0.01[c]	0.07	0.11[b]	0.10[b]	0.13[b]	-0.03[c]	-0.01[c]	0.09	0.11[b]	0.10[b]	0.12[b]	-0.01[c]
HT		-	0.50	0.07	0.50	0.11[b]	0.36	0.11[b]	0.25	0.32	0.69	0.78	0.35	0.75	0.38	0.20	0.23	0.19[b]	0.11[b]	0.02[a]	0.37	0.19[b]	0.23	0.20	0.10[b]	-0.02[c]
WT			-	0.90	0.36	0.21	0.22	0.11[b]	0.15[b]	0.26	0.35	0.39	0.34	0.37	0.18[b]	0.12[b]	0.15[b]	0.11[b]	-0.01[c]	0.03[a]	0.18[b]	0.13[b]	0.15[b]	0.12[b]	-0.02[c]	0.05
BMI				-	0.17[b]	0.18[b]	0.07	0.07	0.04[a]	0.14[b]	0.05	0.07	0.22	0.04[a]	0.02[a]	0.04[a]	0.04[a]	0.02[a]	-0.06[c]	0.03[a]	0.02[a]	0.05	0.04[a]	0.03[a]	-0.08[c]	0.06
DSL					-	-0.02[c]	0.36	-0.03[c]	0.25	0.32	0.47	0.35	0.42	0.33	0.40	0.32	0.22	0.23	-0.02[c]	0.13[b]	0.40	0.32	0.23	0.24	-0.02[c]	0.04[a]
BL						-	0.06	0.19[b]	0.02[a]	0.11[b]	-0.01[c]	0.09	0.13[b]	0.14[b]	-0.10[c]	-0.04[c]	0.03[a]	-0.04[c]	0.02[a]	-0.01[c]	-0.09[c]	-0.03[c]	0.03[a]	-0.04[c]	0.01[a]	-0.01[c]
HL							-	0.37	0.45	0.40	0.17[b]	0.27	0.15[b]	0.37	0.31	0.42	0.42	0.35	0.35	0.11[b]	0.31	0.41	0.41	0.36	0.35	0.02[a]
HB								-	0.18[b]	0.26	-0.09[c]	0.09	0.03[a]	0.23	-0.04[c]	0.23	0.29	0.22	0.36	0.02[a]	-0.05[c]	0.23	0.29	0.21	0.36	0.02[a]
FL									-	0.24	0.07	0.23	0.10[b]	0.25	0.32	0.34	0.30	0.23	0.23	0.15[b]	0.33	0.35	0.29	0.25	0.23	0.06
FB										-	0.17[b]	0.25	0.21	0.35	0.22	0.26	0.29	0.28	0.18[b]	-0.01[c]	0.22	0.26	0.28	0.30	0.17[b]	-0.08[c]
TL											-	0.41	0.24	0.21	0.33	0.06	0.04[a]	0.05	-0.12[c]	0.02[a]	0.33	0.04	0.04[a]	0.05	0.11[b]	-0.01[c]
LL												-	0.24	0.44	0.32	0.22	0.20	0.19[b]	0.12[b]	0.05	0.31	0.22	0.20	0.20	0.11[b]	0.01[a]
NL													-	0.30	0.16[b]	0.13[b]	0.09	0.10[b]	-0.06[c]	0.04[a]	0.15[b]	0.11[b]	0.08	0.11[b]	-0.06[c]	-0.01[c]
SHt														-	0.23	0.18[b]	0.29	0.21	0.23	-0.04[c]	0.22	0.18[b]	0.29	0.23	0.22	-0.05[c]
R1															-	0.41	0.26	0.28	0.21	0.17[b]	0.99	0.41	0.25	0.29	0.21	0.06
R2																-	0.65	0.71	0.45	0.41	0.41	0.99	0.65	0.72	0.45	0.27
R3																	-	0.76	0.55	-0.13[c]	0.26	0.65	0.99	0.76	0.55	-0.07[c]
R4																		-	0.49	-0.35[c]	0.28	0.72	0.77	0.97	0.49	-0.22[c]
R5																			-	-0.04[c]	0.20	0.46	0.54	0.50	0.98	-0.04[c]
2D:4D R																				-	0.18[b]	0.38	-0.13[c]	-0.06[c]	-0.03[c]	0.65
L1																					-	0.41	0.25	0.29	0.21	0.07
L2																						-	0.65	0.73	0.46	0.28
L3																							-	0.76	0.54	-0.08[c]
L4																								-	0.49	-0.76[c]
L5																									-	-0.04[c]
2D:4D L																										-

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; TL = Thigh Length; LL = Leg Length; NL = Neck Length; SHt = Sitting Height; R1 = 1st Right digit; R2 = 2nd Right Digit; R3 = 3rd Right Digit; R4 = 4th Right Digit; R5 = 5th Right Digit; R 2D:4D = Right 2D:4D Ratios; L1 = 1st Left Digit; L2 = 2nd Left Digit; L3 = 3rd Left Digit; L4 = 4th Left Digit; L5 = 5th Left Digit; L 2D:4D = Left 2D:4D Ratios; a = correlation is significant at the 0.05 level (2-tailed); b = correlation is significant at the 0.01 level (2-tailed); c = correlation is significant at the 0.001 level (2-tailed).

4.5LINEAR REGRESSION MODELS FOR THE ANTHROPOMETRIC VARIABLES

Table 4.29 shows derived equations that can be used in the estimation of height from measurement of body lengths. The range of correlation coefficient was (0-0.77). The thigh length has the strongest predictions ability and small standard error of estimate than all the other parameters.

Females presented with statistically significant higher mean values compared to males with regards to height and all measurement of the body lengths (Table 4.30and Table 4.31). In males, the range of correlation coefficient was (0.02-0.77). Thigh length has the strongest estimation ability and the smallest standard error of estimate (SEE) than the rest of the parameters. A moderate to weak correlation was observed in most of the parameters, strong correlation was observed with leg length and sitting height. It was evident from this research that the height can be estimated from all of the measured parameters in males of Agoi, Ayiga, Ekoi and Lokaa ethnic groups of Yakurr Local Government of Cross River State, but with more prediction ability with the aforementioned parameters (Table 4.29). In females, the range of correlation coefficient was (0.01-0.78). The thigh length showed the strongest correlation compared to the other parameters in female Agoi, Ayiga, Ekoi and Lokaa ethnic groups, a moderate to weak correlation was observed in most of the other parameters (Table 4.31).

Table 4.29: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups (n = 800)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 152.72 + (0.523*Age)	0.34	0.12	5.89	10.19	<0.001
Weight (kg)	HT = 139.85 + (0.410*WT)	0.50	0.25	5.44	16.16	<0.001
Body mass index (kg/m^2)	HT = 153.57 + (0.528*BMI)	0.21	0.04	6.13	6.04	<0.001
Demispan length (cm)	HT = 99.70 + (0.756*DSL)	0.60	0.36	5.01	21.25	<0.001
Biaxillary length (cm)	HT = 148.21 + (0.487*BL)	0.26	0.07	6.05	7.48	<0.001
Hand length (cm)	HT = 110.82 + (2.835*HL)	0.53	0.28	5.32	17.61	<0.001
Hand breadth (cm)	HT = 138.14 + (2.312*HB)	0.43	0.18	5.66	13.33	<0.001
Foot length (cm)	HT = 136.51 + (1.161*FL)	0.42	0.18	5.68	13.08	<0.001
Foot breadth (cm)	HT = 123.11 + (3.201*FB)	0.50	0.25	5.42	16.38	<0.001
Hand index	HT = 168.13 – (0.039*HI)	0.03	0.00	6.26	-0.97	0.333
Foot index	HT = 157.27 + (0.159*FI)	0.10	0.01	6.23	2.84	0.005
Thigh length (cm)	HT = 85.03 + (1.824*TL)	0.77	0.59	4.03	33.57	<0.001
Leg length (cm)	HT = 80.43 + (2.133*LL)	0.75	0.56	4.15	31.95	<0.001
Neck length (cm)	HT = 137.37 + (2.051*NL)	0.34	0.12	5.88	10.30	<0.001
Neck/height ratio	HT = 166.44 – (3.407*NHtR)	0.01	0.00	6.26	-0.28	0.780
Waist/height ratio	HT = 155.97 + (19.772*WHtR)	0.13	0.02	6.21	3.74	<0.001
Sitting height (cm)	HT = 33.73 + (1.618*SHt)	0.82	0.67	3.61	40.05	<0.001
Sitting height/height ratio	HT = 166.69 – (2.005*SHtHtR)	0.00	0.00	6.26	-0.10	0.918
Leg length/sitting height ratio	HT = 166.14 – (0.892*LLSHtR)	0.00	0.00	6.26	-0.10	0.918
Right digit 1 (mm)	HT = 144.88 + (0.351*R1)	0.33	0.11	5.91	9.94	<0.001
Right digit 2 (mm)	HT = 141.46 + (0.340*R2)	0.27	0.08	6.03	8.02	<0.001
Right digit 3 (mm)	HT = 113.16 + (0.637*R3)	0.47	0.22	5.54	14.92	<0.001
Right digit 4 (mm)	HT = 128.73 + (0.490*R4)	0.38	0.15	5.78	11.76	<0.001
Right digit 5 (mm)	HT = 136.12 + (0.499*R5)	0.40	0.16	5.74	12.32	<0.001
Left digit 1 (mm)	HT = 145.19 + (0.346*L1)	0.33	0.11	5.91	9.89	<0.001
Left digit 2 (mm)	HT = 140.99 + (0.347*L2)	0.27	0.08	6.02	8.05	<0.001
Left digit 3 (mm)	HT = 113.00 + (0.639*L3)	0.47	0.22	5.54	14.85	<0.001
Left digit 4 (mm)	HT = 128.95 + (0.487*L4)	0.38	0.15	5.78	11.74	<0.001
Left digit 5 (mm)	HT = 136.95 + (0.485*L5)	0.39	0.16	5.76	12.11	<0.001

HT = Height; WT = Weight; BMI = Body Mass Index; DSL = Demispan Length; BL = Biaxillary Length; HL = Hand Length; HB = Hand Breadth; FL = Foot Length; FB = Foot Breadth; Hand Index; Foot Index; TL = Thigh Length; TC = Thigh Circumference; CC = Calf Circumference; LL = Leg Length; NL = Neck Length; ChC = Chest Circumference; NC = Neck Circumference; NHR = Neck/Height Ratio; WC = Waist Circumference; HC = Hip Circumference; WHR = Waist/Hip Ratio; WHtR = Waist/Height Ratio; SHt = Sitting Height; SHtHtR = Sitting Height/Height Ratio; LLSHtR = Leg Length/Sitting Height Ratio.

Table 4.30: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups for males (n = 400)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 154.17 + (0.599*Age)	0.43	0.19	4.97	9.49	<0.001
Weight (kg)	HT = 139.25 + (0.465*WT)	0.52	0.27	4.70	12.16	<0.001
Body mass index (kg/m^2)	HT = 181.39 – (0.547*BMI)	0.19	0.04	5.41	-3.81	<0.001
Demispan length (cm)	HT = 126.35 + (0.474*DSL)	0.34	0.12	5.18	7.17	<0.001
Biaxillary length (cm)	HT = 127.37 + (1.156*BL)	0.52	0.27	4.70	12.13	<0.001
Hand length (cm)	HT = 126.89 + (2.114*HL)	0.33	0.11	5.19	7.00	<0.001
Hand breadth (cm)	HT = 138.24 + (2.49*HB)	0.43	0.18	4.97	9.45	<0.001
Foot length (cm)	HT = 150.82 + (0.707*FL)	0.35	0.12	5.15	7.50	<0.001
Foot breadth (cm)	HT = 141.35 + (2.016*FB)	0.34	0.11	5.18	7.13	<0.001
Hand index	HT = 151.46 + (0.284*HI)	0.25	0.06	5.34	5.04	<0.001
Foot index	HT = 180.11 – (0.206*FI)	0.15	0.02	5.44	-3.02	0.003
Thigh length (cm)	HT = 92.72 + (1.692*TL)	0.77	0.59	3.51	24.08	<0.001
Leg length (cm)	HT = 94.82 + (1.833*LL)	0.74	0.54	3.73	21.62	<0.001
Neck length (cm)	HT = 139.91 + (2.102*NL)	0.37	0.14	5.12	7.87	<0.001
Neck/height ratio	HT = 186.12 – (77.738*NHtR)	0.23	0.05	5.36	-4.65	<0.001
Waist/height ratio	HT = 197.03 – (59.773*WHtR)	0.28	0.08	5.28	-5.88	<0.001
Sitting height (cm)	HT = 43.71 + (1.501*SHt)	0.71	0.51	3.86	20.29	<0.001
Sitting height/height ratio	HT = 266.90 – (197.932*SHtHtR)	0.43	0.19	4.97	-9.51	<0.001
Leg length/sitting height ratio	HT = 135.89 + (68.429*LLSHtHtR)	0.33	0.11	5.20	6.96	<0.001
Right digit 1 (mm)	HT = 164.50 + (0.076*R1)	0.08	0.01	5.49	1.69	0.092
Right digit 2 (mm)	HT = 152.89 + (0.225*R2)	0.23	0.05	5.35	4.78	<0.001
Right digit 3 (mm)	HT = 129.62 + (0.468*R3)	0.38	0.15	5.09	8.25	<0.001
Right digit 4 (mm)	HT = 143.14 + (0.337*R4)	0.31	0.10	5.23	6.57	<0.001
Right digit 5 (mm)	HT = 137.49 + (0.519*R5)	0.43	0.19	4.96	9.61	<0.001
Right 2D:4D	HT = 172.80 – 3.932*R2D:4D)	0.04	0.00	5.50	-0.78	0.435
Left digit 1 (mm)	HT = 164.44 + (0.077*L1)	0.09	0.01	5.48	1.72	0.087
Left digit 2 (mm)	HT = 151.85 + (0.239*L2)	0.24	0.06	5.34	4.99	<0.001
Left digit 3 (mm)	HT = 129.02 + (0.475*L3)	0.38	0.15	5.09	8.26	<0.001
Left digit 4 (mm)	HT = 144.78 + (0.316*L4)	0.30	0.09	5.26	6.19	<0.001
Left digit 5 (mm)	HT = 138.88 + (0.496*L5)	0.42	0.18	4.99	9.28	<0.001
Left 2D:4D	HT = 170.60 – (1.587*L2D:4D)	0.02	0.00	5.50	-0.32	0.752

Table 4.31: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups for females (n = 400)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 152.93 + (0.381*Age)	0.32	0.10	4.74	6.66	<0.001
Weight (kg)	HT = 144.50 + (0.288*WT)	0.50	0.25	4.33	11.42	<0.001
Body mass index (kg/m^2)	HT = 159.46 + (0.120*BMI)	0.07	0.01	4.98	1.39	0.166
Demispan length (cm)	HT = 111.88 + (0.597*DSL)	0.50	0.25	4.32	11.60	<0.001
Biaxillary length (cm)	HT = 157.47 + (0.135*BL)	0.11	0.01	4.97	2.14	0.033
Hand length (cm)	HT = 132.36 + (1.597*HL)	0.36	0.13	4.67	7.58	<0.001
Hand breadth (cm)	HT = 156.95 + (0.467*HB)	0.11	0.01	4.97	2.14	0.033
Foot length (cm)	HT = 139.43 + (0.937*FL)	0.25	0.06	4.84	5.04	<0.001
Foot breadth (cm)	HT = 136.75 + (1.989*FB)	0.32	0.10	4.73	6.80	<0.001
Hand index	HT = 167.28 – (0.082*HI)	0.10	0.01	4.97	-1.98	0.048
Foot index	HT = 155.74 + (0.124*FI)	0.10	0.01	4.97	1.92	0.055
Thigh length (cm)	HT = 100.72 + (1.421*TL)	0.69	0.48	3.61	19.12	<0.001
Leg length (cm)	HT = 87.83 + (1.889*LL)	0.78	0.60	3.15	24.54	<0.001
Neck length (cm)	HT = 140.66 + (1.576*NL)	0.35	0.13	4.67	7.54	<0.001
Neck/height ratio	HT = 176.19 – (64.921*NHtR)	0.26	0.07	4.83	-5.34	<0.001
Waist/height ratio	HT = 172.76 – (20.248*WHtR)	0.16	0.03	4.93	-3.20	0.001
Sitting height (cm)	HT = 36.84 + (1.575*SHt)	0.75	0.56	3.32	22.47	<0.001
Sitting height/height ratio	HT = 255.17 – (189.249*SHtHtR)	0.40	0.16	4.58	-8.71	<0.001
Leg length/sitting height ratio	HT = 122.21 + (80.944*LLSHtR)	0.38	0.15	4.61	8.28	<0.001
Right digit 1 (mm)	HT = 141.17 + (0.367*R1)	0.38	0.14	4.63	8.08	<0.001
Right digit 2 (mm)	HT = 145.27 + (0.242*R2)	0.20	0.04	4.90	4.02	<0.001
Right digit 3 (mm)	HT = 137.93 + (0.302*R3)	0.23	0.06	4.86	4.79	<0.001
Right digit 4 (mm)	HT = 145.44 + (0.228*R4)	0.19	0.04	4.90	3.84	<0.001
Right digit 5 (mm)	HT = 156.04 + (0.108*R5)	0.11	0.01	4.97	2.11	0.035
Right 2D:4D	HT = 160.00 + (2.394*R2D:4D)	0.02	0.00	4.99	0.39	0.695
Left digit 1 (mm)	HT = 142.07 + (0.352*L1)	0.37	0.13	4.65	7.85	<0.001
Left digit 2 (mm)	HT = 146.19 + (0.229*L2)	0.19	0.04	4.91	3.79	<0.001
Left digit 3 (mm)	HT = 138.39 + (0.296*L3)	0.23	0.05	4.86	4.71	<0.001
Left digit 4 (mm)	HT = 144.10 + (0.247*L4)	0.20	0.04	4.89	4.11	<0.001
Left digit 5 (mm)	HT = 156.51 + (0.101*L5)	0.10	0.01	4.97	1.97	0.049
Left 2D:4D	HT = 163.43 – (1.195*L2D:4D)	0.01	0.00	4.99	-0.19	0.850

Table 4.32 shows the equations that could be used in the estimation of height from body length parameters in Agoi ethnic group. The correlation coefficient ranges between (0.06-0.75). The thigh length showed the strongest correlation coefficient and low standard error of estimate (SEE) indicating its strong estimation ability than other parameters. Leg length, sitting height and hand breadth also showed high prediction ability. Moderate to weak correlation were observed with other parameters.

Table 4.35 shows the equation that could be used for height estimation in Ayiga ethnic group. Thigh length showed the highest correlation and lower standard error of estimates (SEE) indicating a higher estimation ability than the other parameters in Ayiga ethnic group which is in agreement to Agoi ethnic group (Table 4.32) that also showed thigh length as the highest predictive variable than the other parameters. Moderate to weak correlations were observed between height and other parameters in Ayiga ethnic group.

Table 4.32: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, ethnic group (n = 200)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 142.50 + (0.829*Age)	0.74	0.55	3.28	15.51	<0.001
Weight (kg)	HT = 133.69 + (0.453*WT)	0.50	0.25	4.24	8.04	<0.001
Body mass index (kg/m^2)	HT = 178.44 – (0.655*BMI)	0.24	0.06	4.74	-3.48	<0.001
Demispan length (cm)	HT = 73.51 + (1.013*DSL)	0.68	0.46	3.59	12.95	<0.001
Biaxillary length (cm)	HT = 149.90 + (0.358*BL)	0.31	0.10	4.63	4.65	<0.001
Hand length (cm)	HT = 111.21 + (2.706*HL)	0.53	0.28	4.15	8.69	<0.001
Hand breadth (cm)	HT = 121.36 + (3.590*HB)	0.70	0.49	3.49	13.79	<0.001
Foot length (cm)	HT = 80.27 + (3.394*FL)	0.61	0.37	3.87	10.80	<0.001
Foot breadth (cm)	HT = 118.04 + (3.404*FB)	0.64	0.41	3.74	11.78	<0.001
Hand index	HT = 113.35 + (0.815*HI)	0.56	0.32	4.04	9.56	<0.001
Foot index	HT = 124.40 + (0.708*FI)	0.43	0.18	4.42	6.60	<0.001
Thigh length (cm)	HT = 97.74 + (1.489*TL)	0.75	0.56	3.25	15.75	<0.001
Leg length (cm)	HT = 93.94 + (1.762*LL)	0.73	0.53	3.36	14.85	<0.001
Neck length (cm)	HT = 127.23 + (2.557*NL)	0.45	0.20	4.37	7.01	<0.001
Neck/height ratio	HT = 148.72 + (63.874*NHtR)	0.13	0.02	4.84	1.80	0.074
Waist/height ratio	HT = 175.90 – (26..416*WHtR)	0.14	0.02	4.83	-2.00	0.046
Sitting height (cm)	HT = 33.57 + (1.612*SHt)	0.71	0.50	3.44	14.15	<0.001
Sitting height/height ratio	HT = 273.49 – (225.106*SHtHtR)	0.50	0.25	4.23	-8.10	<0.001
Leg length/sitting height ratio	HT = 127.87 + (71.342*LLSHtR)	0.36	0.13	4.56	5.42	<0.001
Right digit 1 (mm)	HT = 138.42 + (0.413*R1)	0.33	0.11	4.61	4.92	<0.001
Right digit 2 (mm)	HT = 138.81 + (0.341*R2)	0.28	0.08	4.69	4.10	<0.001
Right digit 3 (mm)	HT = 108.04 + (0.677*R3)	0.42	0.18	4.43	6.51	<0.001
Right digit 4 (mm)	HT = 129.76 + (0.444*R4)	0.36	0.13	4.56	5.38	<0.001
Right digit 5 (mm)	HT = 147.65 + (0.269*R5)	0.23	0.05	4.76	3.27	0.001
Right 2D:4D	HT = 169.42 – (7.211*R2D:4D)	0.07	0.01	4.87	-0.94	0.348
Left digit 1 (mm)	HT = 138.43 + (0.413*L1)	0.33	0.11	4.60	4.98	<0.001
Left digit 2 (mm)	HT = 137.96 + (0.353*L2)	0.29	0.08	4.67	4.24	<0.001
Left digit 3 (mm)	HT = 107.10 + (0.677*L3)	0.42	0.18	4.43	6.53	<0.001
Left digit 4 (mm)	HT = 130.03 + (0.441*L4)	0.36	0.13	4.56	5.39	<0.001
Left digit 5 (mm)	HT = 149.08 + (0.244*L5)	0.21	0.04	4.78	2.97	0.003
Left 2D:4D	HT = 169.19 – (6.964*L2D:4D)	0.06	0.00	4.87	-0.90	0.370

Table 4.33: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, ethnic group for males (n = 100)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 143.89 + (0.835*Age)	0.76	0.58	3.23	11.57	<0.001
Weight (kg)	HT = 135.93 + (0.452*WT)	0.55	0.30	4.16	6.47	<0.001
Body mass index (kg/m^2)	HT = 170.10 – (0.247*BMI)	0.09	0.01	4.94	-0.93	0.357
Demispan length (cm)	HT = 59.08 + (1.165*DSL)	0.60	0.36	3.96	7.46	<0.001
Biaxillary length (cm)	HT = 125.46 + (1.117*BL)	0.64	0.41	3.81	8.29	<0.001
Hand length (cm)	HT = 88.12 + (3.856*HL)	0.34	0.11	4.67	3.54	<0.001
Hand breadth (cm)	HT = 109.82 + (4.482* HB)	0.70	0.49	3.54	9.74	<0.001
Foot length (cm)	HT = 86.63 + (3.43*FL)	0.57	0.32	4.08	6.85	<0.001
Foot breadth (cm)	HT = 117.37 + (3.43*FB)	0.57	0.32	4.08	6.85	<0.001
Hand index	HT = 112.36 + (0.845*HI)	0.63	0.40	3.86	7.10	<0.001
Foot index	HT = 132.41 + (0.574*FI)	0.30	0.09	4.74	3.08	0.003
Thigh length (cm)	HT = 91.76 + (1.665*TL)	0.90	0.81	2.15	20.62	<0.001
Leg length (cm)	HT = 92.99 + (1.816*LL)	0.82	0.67	2.86	14.03	<0.001
Neck length (cm)	HT = 115.36 + (3.596*NL)	0.65	0.42	3.80	8.35	<0.001
Neck/height ratio	HT = 214.93 + (227.643*NHtR)	0.37	0.14	4.61	-3.93	<0.001
Waist/height ratio	HT = 153.83 + (21.583*WHtR)	0.11	0.01	4.94	1.07	0.286
Sitting height (cm)	HT = 6.22 + (1.943*SHt)	0.52	0.27	4.25	5.10	<0.001
Sitting height/height ratio	HT = 326.17 – (326.544*SHtHtR)	0.85	0.72	2.65	-15.69	<0.001
Leg length/sitting height ratio	HT = 105.39 + (122.078*LLSHtR)	0.67	0.45	3.67	9.01	<0.001
Right digit 1 (mm)	HT = 154.56 + (0.160*R1)	0.07	0.01	4.95	0.72	0.473
Right digit 2 (mm)	HT = 148.11 + (0.229*R2)	0.21	0.05	4.85	2.14	0.035
Right digit 3 (mm)	HT = 117.25 + (0.572*R3)	0.27	0.07	4.78	2.74	0.007
Right digit 4 (mm)	HT = 136.46 + (0.369*R4)	0.30	0.09	4.74	3.05	0.003
Right digit 5 (mm)	HT = 152.50 + (0.206*R5)	0.12	0.01	4.93	1.17	0.247
Right 2D:4D	HT = 167.96 + (3.857*R2D:4D)	0.04	0.00	4.96	-0.36	0.719
Left digit 1 (mm)	HT = 153.64 + (0.175*L1)	0.08	0.01	4.95	0.79	0.433
Left digit 2 (mm)	HT = 146.21 + (0.255*L2)	0.23	0.05	4.83	2.36	0.020
Left digit 3 (mm)	HT = 117.25 + (0.572*L3)	0.27	0.07	4.78	2.74	0.007
Left digit 4 (mm)	HT = 137.62 + (0.354*L4)	0.28	0.08	4.77	2.89	0.005
Left digit 5 (mm)	HT = 152.93 + (0.199*L5)	0.11	0.01	4.93	1.12	0.264
Left 2D:4D	HT = 164.16 + (0.190*L2D:4D)	0.00	0.00	4.96	0.02	0.986

Table 4.34: Linear regression equations for estimation of height from anthropometric length parameters of Agoi, ethnic group for females (n = 100)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 142.12 + (0.781*Age)	0.79	0.63	2.54	12.87	<0.001
Weight (kg)	HT = 117.37 + (0.671*WT)	0.72	0.51	2.92	10.11	<0.001
Body mass index (kg/m^2)	HT = 165.96 – (0.203*BMI)	0.06	0.00	4.16	-0.57	0.568
Demispan length (cm)	HT = 25.55 + (1.580*DSL)	0.73	0.53	2.85	10.55	<0.001
Biaxillary length (cm)	HT = 152.20 + (0.240*BL)	0.30	0.09	3.97	3.15	0.002
Hand length (cm)	HT = 95.75 + (3.574*HL)	0.55	0.30	3.49	6.47	<0.001
Hand breadth (cm)	HT = 107.02 + (4.980* HB)	0.65	0.42	3.16	8.50	<0.001
Foot length (cm)	HT = 89.14 + (3.001*FL)	0.51	0.26	3.60	5.81	<0.001
Foot breadth (cm)	HT = 106.57 + (4.343*FB)	0.60	0.36	3.35	7.37	<0.001
Hand index	HT = 132.21 + (0.483*HI)	0.30	0.09	3.97	3.15	0.002
Foot index	HT = 134..02 + (0.513*FI)	0.28	0.08	4.00	2.92	0.004
Thigh length (cm)	HT = 108.39 + (1.206*TL)	0.64	0.41	3.22	8.17	<0.001
Leg length (cm)	HT = 106.27 + (1.413*LL)	0.58	0.34	3.39	7.11	<0.001
Neck length (cm)	HT = 120.62 + (2.865*NL)	0.52	0.27	3.56	6.07	<0.001
Neck/height ratio	HT = 133.98 + (126.522*NHtR)	0.27	0.07	4.02	2.75	0.007
Waist/height ratio	HT = 144.15 + (32.213*WHtR)	0.12	0.01	4.14	1.17	0.246
Sitting height (cm)	HT = 24.33 + (1.734*SHt)	0.83	0.69	2.31	14.86	<0.001
Sitting height/height ratio	HT = 252.75 – (187.656*SHtHtR)	0.33	0.11	3.94	-3.42	<0.001
Leg length/sitting height ratio	HT = 149.87 + (22.421*LLSHtR)	0.11	0.01	4.14	1.13	0.264
Right digit 1 (mm)	HT = 147.87 + (0.232*R1)	0.20	0.04	4.09	1.98	0.050
Right digit 2 (mm)	HT = 142.70 + (0.265*R2)	0.19	0.04	4.10	1.90	0.060
Right digit 3 (mm)	HT = 123.25 + (0.477*R3)	0.31	0.09	3.97	3.19	0.002
Right digit 4 (mm)	HT = 142.86 + (0.249*R4)	0.20	0.04	4.09	1.97	0.051
Right digit 5 (mm)	HT = 158.24 + (0.049*R5)	0.05	0.00	4.17	0.51	0.611
Right 2D:4D	HT = 163.05– (2.291*R2D:4D)	0.02	0.00	4.17	-0.24	0.814
Left digit 1 (mm)	HT = 147.82 + (0.233*L1)	0.20	0.04	4.09	2.02	0.046
Left digit 2 (mm)	HT = 145.51 + (0.224*L2)	0.16	0.03	4.12	1.62	0.109
Left digit 3 (mm)	HT = 122.91 + (0.481*L3)	0.32	0.10	3.96	3.29	0.001
Left digit 4 (mm)	HT = 141.72 + (0.265*L4)	0.21	0.05	4.08	2.16	0.033
Left digit 5 (mm)	HT = 161.53– (0.012*L5)	0.01	0.00	4.17	-0.12	0.902
Left 2D:4D	HT = 167.46– (6.925*L2D:4D)	0.07	0.01	4.16	-0.71	0.482

Table 4.35:Linear regression equations for estimation of height from anthropometric length parameters of Ayiga, ethnic group (n = 200)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 154.49 + (0.447*Age)	0.22	0.05	7.13	3.18	0.002
Weight (kg)	HT = 136.52 + (0.477*WT)	0.61	0.37	5.82	10.69	<0.001
Body mass index (kg/m^2)	HT = 163.49 + (0.112*BMI)	0.04	0.00	7.30	0.61	0.541
Demispan length (cm)	HT = 73.74 + (1.103*DSL)	0.81	0.66	4.27	19.53	<0.001
Biaxillary length (cm)	HT = 165.58 + (0.012*BL)	0.01	0.00	7.30	0.07	0.945
Hand length (cm)	HT = 94.59 + (3.735*HL)	0.58	0.34	5.94	10.07	<0.001
Hand breadth (cm)	HT = 135.31 + (2.547*HB)	0.27	0.07	7.04	3.92	<0.001
Foot length (cm)	HT = 82.16 + (3.341*FL)	0.60	0.36	5.83	10.62	<0.001
Foot breadth (cm)	HT = 96.12 + (5.411*FB)	0.59	0.34	5.92	10.15	<0.001
Hand index	HT = 189.06 – (0.365*HI)	0.23	0.05	7.11	-3.36	<0.001
Foot index	HT = 155.09 + (0.212*FI)	0.08	0.01	7.28	1.15	0.253
Thigh length (cm)	HT = 86.36 + (1.807*TL)	0.82	0.68	4.16	20.32	<0.001
Leg length (cm)	HT = 83.84 + (2.073*LL)	0.68	0.46	5.35	13.08	<0.001
Neck length (cm)	HT = 111.77 + (4.030*NL)	0.50	0.25	6.31	8.22	<0.001
Neck/height ratio	HT = 191.97 – (118.083*NHtR)	0.36	0.13	6.81	-5.46	<0.001
Waist/height ratio	HT = 217.83 – (103.772*WHtR)	0.70	0.49	5.23	-13.71	<0.001
Sitting height (cm)	HT = 36.96 + (1.572*SHt)	0.81	0.65	4.31	19.24	<0.001
Sitting height/height ratio	HT = 234.55 – (138.550*SHtHtR)	0.26	0.07	7.05	-3.84	<0.001
Leg length/sitting height ratio	HT = 157.49 + (17.612*LLSHtR)	0.08	0.01	7.28	1.07	0.287
Right digit 1 (mm)	HT = 145.13 + (0.374*R1)	0.28	0.08	7.01	4.13	<0.001
Right digit 2 (mm)	HT = 160.65 + (0.078*R2)	0.05	0.00	7.29	0.74	0.463
Right digit 3 (mm)	HT = 119.02 + (0.571*R3)	0.38	0.15	6.74	5.85	<0.001
Right digit 4 (mm)	HT = 140.31 + (0.346*R4)	0.24	0.06	7.09	3.48	<0.001
Right digit 5 (mm)	HT = 140.19 + (0.422*R5)	0.27	0.07	7.04	3.86	<0.001
Right 2D:4D	HT = 185.73 – (21.229*R2D:4D)	0.19	0.03	7.18	-2.66	0.009
Left digit 1 (mm)	HT = 144.79 + (0.381*L1)	0.29	0.08	6.99	4.25	<0.001
Left digit 2 (mm)	HT = 160.05 + (0.086*L2)	0.06	0.00	7.29	0.79	0.428
Left digit 3 (mm)	HT = 116.86 + (0.597*L3)	0.39	0.15	6.74	5.89	<0.001
Left digit 4 (mm)	HT = 141.21 + (0.335*L4)	0.23	0.05	7.11	3.32	0.001
Left digit 5 (mm)	HT = 142.27 + (0.388*L5)	0.25	0.06	7.07	3.63	<0.001
Left 2D:4D	HT = 184.88 – (20.218*L2D:4D)	0.17	0.03	7.20	-2.46	0.015

Table 4.36:Linear regression equations for estimation of height from anthropometric length parameters of Ayiga, ethnic group for males (n = 100)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 152.81 + (0.721*Age)	0.58	0.34	3.63	7.05	<0.001
Weight (kg)	HT = 137.16 + (0.524*WT)	0.67	0.45	3.31	8.94	<0.001
Body mass index (kg/m^2)	HT = 163.47 + (0.347*BMI)	0.11	0.01	4.43	1.12	0.265
Demispan length (cm)	HT = 103.60 + (0.775*DSL)	0.68	0.46	3.28	9.13	<0.001
Biaxillary length (cm)	HT = 124.29 + (1.299*BL)	0.46	0.21	3.96	5.10	<0.001
Hand length (cm)	HT = 104.56 + (3.369*HL)	0.63	0.39	3.47	7.96	<0.001
Hand breadth (cm)	HT = 132.70 + (3.125* HB)	0.42	0.17	4.05	4.53	<0.001
Foot length (cm)	HT = 115.81 + (2.145*FL)	0.65	0.42	3.40	8.38	<0.001
Foot breadth (cm)	HT = 113.35 + (4.329*FB)	0.59	0.34	3.61	7.16	<0.001
Hand index	HT = 182.08 – (0.175*HI)	0.12	0.01	4.42	-1.20	0.235
Foot index	HT = 187.40 – (0.313*FI)	0.17	0.03	4.39	-1.67	0.098
Thigh length (cm)	HT = 98.81 + (1.578*TL)	0.80	0.65	2.66	13.33	<0.001
Leg length (cm)	HT = 97.62 + (1.838*LL)	0.76	0.57	2.92	11.39	<0.001
Neck length (cm)	HT = 123.51 + (3.482*NL)	0.46	0.21	3.97	5.07	<0.001
Neck/height ratio	HT = 178.39 – (33.329*NHtR)	0.20	0.04	4.37	-1.99	0.050
Waist/height ratio	HT = 205.49 – (73.991*WHtR)	0.23	0.05	4.34	-2.34	0.021
Sitting height (cm)	HT = 28.85 + (1.670*SHt)	0.67	0.45	3.32	8.86	<0.001
Sitting height/height ratio	HT = 310.56 – (279.954*SHtHtR)	0.61	0.38	3.52	-7.69	<0.001
Leg length/sitting height ratio	HT = 122.20 + (104.283*LLSHtR)	0.48	0.23	3.92	5.35	<0.001
Right digit 1 (mm)	HT = 160.51 + (0.189*R1)	0.25	0.06	4.32	2.50	0.014
Right digit 2 (mm)	HT = 155.86 + (0.224*R2)	0.28	0.08	4.28	2.85	0.005
Right digit 3 (mm)	HT = 146.48 + (0.293*R3)	0.31	0.10	4.23	3.27	0.001
Right digit 4 (mm)	HT = 156.87 + (0.190*R4)	0.22	0.05	4.34	2.26	0.026
Right digit 5 (mm)	HT = 161.10 + (0.160*R5)	0.15	0.02	4.40	1.52	0.132
Right 2D:4D	HT = 167.18 + (4.378*R2D:4D)	0.07	0.01	4.45	0.69	0.491
Left digit 1 (mm)	HT = 160.43 + (0.190*L1)	0.25	0.06	4.32	2.54	0.001
Left digit 2 (mm)	HT = 152.65 + (0.270*L2)	0.32	0.10	4.22	3.35	0.001
Left digit 3 (mm)	HT = 146.05 + (0.298*L3)	0.29	0.08	4.26	3.00	0.003
Left digit 4 (mm)	HT = 159.38 + (0.157*L4)	0.19	0.04	4.38	1.91	0.060
Left digit 5 (mm)	HT = 164.240+ (0.110*L5)	0.11	0.01	4.43	1.11	0.271
Left 2D:4D	HT = 163.76+ (8.094*L2D:4D)	0.13	0.02	4.42	1.28	0.204

Table 4.37: Linear regression equations for estimation of height from anthropometric length parameters of Ayiga, ethnic group for females (n = 100)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 150.75 + (0.389*Age)	0.24	0.06	5.62	2.48	0.015
Weight (kg)	HT = 144.84 + (0.274*WT)	0.52	0.27	4.96	5.10	<0.001
Body mass index (kg/m^2)	HT = 154.91 + (0.262*BMI)	0.17	0.03	5.71	1.70	0.093
Demispan length (cm)	HT = 91.24 + (0.869*DSL)	0.63	0.40	4.50	8.06	<0.001
Biaxillary length (cm)	HT = 162.06 – (0.033*BL)	0.02	0.01	5.80	-0.23	0.815
Hand length (cm)	HT = 149.85 + (0.595*HL)	0.11	0.01	5.76	1.06	0.292
Hand breadth (cm)	HT = 172.67 – (1.003* HB)	0.15	0.02	5.74	-1.46	0.147
Foot length (cm)	HT = 149.34 + (0.472*FL)	0.07	0.00	5.78	0.66	0.514
Foot breadth (cm)	HT = 145.60 + (1.222*FB)	0.15	0.02	5.73	0.50	0.138
Hand index	HT = 170.67 – (0.153*HI)	0.15	0.02	5.73	-1.52	0.133
Foot index	HT = 151.05 + (0.191*FI)	0.11	0.01	5.77	1.04	0.301
Thigh length (cm)	HT = 107.62 + (1.258*TL)	0.71	0.51	4.07	10.02	<0.001
Leg length (cm)	HT = 91.47 + (1.766*LL)	0.86	0.75	2.93	16.90	<0.001
Neck length (cm)	HT = 126.53 + (2.594*NL)	0.50	0.25	5.03	5.69	<0.001
Neck/height ratio	HT = 208.07 – (211.718*NHtR)	0.63	0.40	4.49	-8.08	<0.001
Waist/height ratio	HT = 190.73 – (55.884*WHtR)	0.44	0.20	5.20	-4.90	<0.001
Sitting height (cm)	HT = 66.44 + (1.195*SHt)	0.49	0.24	5.05	5.57	<0.001
Sitting height/height ratio	HT = 270.57 – (223.235*SHtHtR)	0.64	0.40	4.48	-8.15	<0.001
Leg length/sitting height ratio	HT = 102.64 + (117.034*LLSHtR)	0.69	0.48	4.18	9.54	<0.001
Right digit 1 (mm)	HT = 138.82 + (0.399*R1)	0.36	0.13	5.41	3.80	<0.001
Right digit 2 (mm)	HT = 150.78 + (0.145*R2)	0.11	0.01	5.77	1.05	0.295
Right digit 3 (mm)	HT = 154.94 + (0.073*R3)	0.06	0.00	5.79	0.54	0.587
Right digit 4 (mm)	HT = 153.85 + (0.095*R4)	0.08	0.01	5.78	0.78	0.438
Right digit 5 (mm)	HT = 170.15 – (0.157*R5)	0.12	0.01	5.76	-1.16	0.248
Right 2D:4D	HT = 157.68 + (3.334*R2D:4D)	0.03	0.00	5.80	0.28	0.779
Left digit 1 (mm)	HT = 139.28 + (0.391*L1)	0.35	0.13	5.42	3.75	<0.001
Left digit 2 (mm)	HT = 151.79 + (0.130*L2)	0.09	0.01	5.77	0.93	0.353
Left digit 3 (mm)	HT = 155.18 + (0.070*L3)	0.05	0.00	5.79	0.53	0.601
Left digit 4 (mm)	HT = 152.62 + (0.112*L4)	0.09	0.01	5.78	0.86	0.390
Left digit 5 (mm)	HT = 170.10– (0.156*L5)	0.12	0.01	5.76	-1.15	0.253
Left 2D:4D	HT = 159.56+ (1.328*L2D:4D)	0.01	0.00	5.80	0.10	0.918

Table 4.38 shows the equations for the estimation of height in Ekoi ethnic group. The correlation coefficient ranges between (0.02-89). The sitting height showed the highest correlation and lower standard error of estimates (SEE) indicating a higher estimation ability than the other parameters which is in contrast to Agoi and Ayiga which showed thigh length as a better predictive parameter. Moderate to weak correlations were observed with the remaining parameters.

Table 4.41 shows the predictive equation for height in Lokaa ethnic group. The correlation coefficient ranges between (0.01-84). The sitting height showed the strongest correlation coefficient and low standard error of estimate (SEE) indicating stronger estimation ability than other parameters. This is in line with what was observed in Ekoi ethnic group but contrast to Agoi and Ayiga ethnic groups which showed Thigh length instead as the better predictive parameter. Moderate to weak correlations were observed with the other parameters.

Table 4.38: Linear regression equations for estimation of height from anthropometric length parameters of Ekoi, ethnic group (n = 200)

Parameters	Predictive Equations	R	R^2	SEE	t	p
Age (years)	HT = 157.50 + (0.389*Age)	0.27	0.07	5.81	3.97	<0.001
Weight (kg)	HT = 141.82 + (0.397*WT)	0.45	0.20	5.40	7.09	<0.001
Body mass index (kg/m^2)	HT = 182.09 – (0.655*BMI)	0.25	0.06	5.85	-3.61	<0.001
Demispan length (cm)	HT = 66.72 + (1.139*DSL)	0.72	0.51	4.22	14.44	<0.001
Biaxillary length (cm)	HT = 117.90 + (1.347*BL)	0.55	0.30	5.06	9.19	<0.001
Hand length (cm)	HT = 109.75 + (2.916*HL)	0.49	0.24	5.27	7.86	<0.001
Hand breadth (cm)	HT = 129.94 + (2.969*HB)	0.55	0.30	5.05	9.26	<0.001
Foot length (cm)	HT = 120.41 + (1.848*FL)	0.50	0.25	5.22	8.17	<0.001
Foot breadth (cm)	HT = 114.43 + (3.822*FB)	0.57	0.32	4.97	9.74	<0.001
Hand index	HT = 141.13 + (0.409*HI)	0.32	0.11	5.72	4.82	<0.001
Foot index	HT = 161.76 + (0.099*FI)	0.05	0.00	6.03	0.76	0.450
Thigh length (cm)	HT = 64.86 + (2.284*TL)	0.87	0.76	2.96	25.06	<0.001
Leg length (cm)	HT = 63.57 + (2.548*LL)	0.85	0.72	3.19	22.61	<0.001
Neck length (cm)	HT = 139.08 + (2.010*NL)	0.37	0.13	5.62	5.55	<0.001
Neck/height ratio	HT = 169.27 – (9.929*NHtR)	0.02	0.00	6.04	-0.21	0.836
Waist/height ratio	HT = 209.18 – (87.779*WHtR)	0.52	0.27	5.15	-8.62	<0.001
Sitting height (cm)	HT = -14.03 + (2.216*SHt)	0.89	0.80	2.73	27.83	<0.001
Sitting height/height ratio	HT = 381.48 – (438.003*SHtHtR)	0.58	0.34	4.92	-10.03	<0.001
Leg length/sitting height ratio	HT = 100.68 + (133.719*LLSHtR)	0.41	0.17	5.50	6.38	<0.001
Right digit 1 (mm)	HT = 143.19 + (0.408*R1)	0.36	0.13	5.64	5.37	<0.001
Right digit 2 (mm)	HT = 165.50 + (0.022*R2)	0.18	0.03	5.95	2.52	0.013
Right digit 3 (mm)	HT = 110.77 + (0.672*R3)	0.47	0.22	5.33	7.49	<0.001
Right digit 4 (mm)	HT = 122.30 + (0.583*R4)	0.45	0.20	5.39	7.13	<0.001
Right digit 5 (mm)	HT = 129.55 + (0.614*R5)	0.44	0.19	5.44	6.79	<0.001
Right 2D:4D	HT = 165.76 + (1.397*R2D:4D)	0.14	0.02	5.98	1.94	0.053
Left digit 1 (mm)	HT = 144.55 + (0.385*L1)	0.34	0.12	5.68	5.10	<0.001
Left digit 2 (mm)	HT = 137.19 + (0.410*L2)	0.28	0.08	5.79	4.15	<0.001
Left digit 3 (mm)	HT = 108.84 + (0.695*L3)	0.48	0.23	5.29	7.76	<0.001
Left digit 4 (mm)	HT = 122.44 + (0.581*L4)	0.45	0.20	5.40	7.03	<0.001
Left digit 5 (mm)	HT = 129.75 + (0.610*L5)	0.43	0.19	5.45	6.75	<0.001
Left 2D:4D	HT = 196.58 – (30.967*L2D:4D)	0.22	0.05	5.89	-3.22	0.002

Table 4.39: Linear regression equations for estimation of height from anthropometric length parameters of Ekoi, ethnic group for males (n = 100)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 164.72 + (0.270*Age)	0.26	0.07	4.02	2.67	0.009
Weight (kg)	HT = 153.07 + (0.281*WT)	0.41	0.16	3.81	4.38	<0.001
Body mass index (kg/m^2)	HT = 179.39 – (0.350*BMI)	0.16	0.03	4.11	-1.60	0.112
Demispan length (cm)	HT = 106.64 + (0.719*DSL)	0.59	0.35	3.35	7.32	<0.001
Biaxillary length (cm)	HT = 141.21+ (0.806*BL)	0.41	0.17	3.80	4.47	<0.001
Hand length (cm)	HT = 133.29 + (1.918*HL)	0.38	0.15	3.85	4.07	<0.001
Hand breadth (cm)	HT = 147.19 + (1.862*HB)	0.37	0.14	3.86	3.99	<0.001
Foot length (cm)	HT = 149.63 + (0.841*FL)	0.28	0.08	4.00	2.87	0.005
Foot breadth (cm)	HT = 142.51 + (2.029*FB)	0.38	0.14	3.86	4.02	<0.001
Hand index	HT = 163.76 + (0.119*HI)	0.12	0.02	4.13	1.22	0.226
Foot index	HT = 165.66 + (0.107*FI)	0.08	0.01	4.15	0.80	0.427
Thigh length (cm)	HT = 91.66 + (1.726*TL)	0.78	0.60	2.62	12.22	<0.001
Leg length (cm)	HT = 100.03 + (1.712*LL)	0.76	0.58	2.70	11.61	<0.001
Neck length (cm)	HT = 132.57 + (2.767*NL)	0.58	0.34	3.39	7.09	<0.001
Neck/height ratio	HT = 220.39 – (225.540*NHtR)	0.42	0.18	3.78	-4.60	<0.001
Waist/height ratio	HT = 178.55 – (15.289*WHtR)	0.10	0.01	4.15	-0.98	0.331
Sitting height (cm)	HT = 37.73 + (1.604*SHt)	0.69	0.48	2.10	9.55	<0.001
Sitting height/height ratio	HT = 287.76 – (238.889*SHtHtR)	0.51	0.26	3.59	-5.81	<0.001
Leg length/sitting height ratio	HT = 129.41 + (84.172*LLSHtR)	0.44	0.19	3.75	4.78	<0.001
Right digit 1 (mm)	HT = 158.46 + (0.219*R1)	0.30	0.09	3.98	3.07	0.003
Right digit 2 (mm)	HT = 170.51 + (0.013*R2)	0.22	0.05	4.07	2.20	0.030
Right digit 3 (mm)	HT = 147.01 + (0.287*R3)	0.31	0.10	3.96	3.22	0.002
Right digit 4 (mm)	HT = 156.17 + (0.195*R4)	0.23	0.06	4.05	2.38	0.019
Right digit 5 (mm)	HT = 150.49 + (0.336*R5)	0.33	0.11	3.93	3.49	<0.001
Right 2D:4D	HT = 170.52 + (1.012*R2D:4D)	0.20	0.04	4.08	2.06	0.042
Left digit 1 (mm)	HT = 158.46 + (0.219*L1)	0.30	0.09	3.98	3.07	0.003
Left digit 2 (mm)	HT = 158.72 + (0.174*L2)	0.19	0.04	4.09	1.94	0.056
Left digit 3 (mm)	HT = 145.78 + (0.302*L3)	0.33	0.11	3.94	3.41	<0.001
Left digit 4 (mm)	HT = 157.03 + (0.184*L4)	0.22	0.05	4.07	2.21	0.030
Left digit 5 (mm)	HT = 150.81 + (0.331*L5)	0.33	0.11	3.94	3.44	<0.001
Left 2D:4D	HT = 172.80 – (1.318*L2D:4D)	0.02	0.00	4.17	-0.16	0.876

Table 4.40: Linear regression equations for estimation of height from anthropometric length parameters of Ekoi, ethnic group for females (n = 100)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 157.37 + (0.222*Age)	0.24	0.06	3.96	2.42	0.017
Weight (kg)	HT = 151.41 + (0.183*WT)	0.32	0.10	3.86	3.33	0.001
Body mass index (kg/m^2)	HT = 167.55 – (0.207*BMI)	0.13	0.02	4.04	-1.29	0.199
Demispan length (cm)	HT = 102.23 + (0.703*DSL)	0.50	0.25	3.52	5.77	<0.001
Biaxillary length (cm)	HT = 143.30+ (0.548*BL)	0.31	0.09	3.88	3.18	0.002
Hand length (cm)	HT = 126.98 + (1.841*HL)	0.50	0.25	3.52	5.73	<0.001
Hand breadth (cm)	HT = 151.16 + (0.966*HB)	0.26	0.07	3.94	2.65	0.009
Foot length (cm)	HT = 147.55 + (0.619*FL)	0.23	0.05	3.96	2.35	0.021
Foot breadth (cm)	HT = 153.65 + (0.684*FB)	0.12	0.01	4.05	1.16	0.248
Hand index	HT = 166.97 – (0.069*HI)	0.08	0.01	4.06	-0.74	0.459
Foot index	HT = 172.31 – (0.176*FI)	0.15	0.02	4.03	-1.50	0.137
Thigh length (cm)	HT = 81.40 + (1.879*TL)	0.75	0.56	2.70	11.20	<0.001
Leg length (cm)	HT = 74.58 + (2.231*LL)	0.81	0.65	2.40	13.53	<0.001
Neck length (cm)	HT = 149.08 + (0.987*NL)	0.31	0.10	3.87	3.24	0.002
Neck/height ratio	HT = 199.03 – (172.340*NHtR)	0.39	0.15	3.75	-4.17	<0.001
Waist/height ratio	HT = 175.34 – (25.195*WHtR)	0.19	0.04	3.10	-1.92	0.058
Sitting height (cm)	HT = -2.21 + (2.059*SHt)	0.88	0.78	1.91	18.63	<0.001
Sitting height/height ratio	HT = 330.90 – (341.610*SHtHtR)	0.49	0.24	3.55	-5.54	<0.001
Leg length/sitting height ratio	HT = 112.137 + (102.546*LLSHtR)	0.37	0.14	3.79	3.91	<0.001
Right digit 1 (mm)	HT = 148.61 + (0.245*R1)	0.28	0.08	3.91	2.89	0.005
Right digit 2 (mm)	HT = 144.35 + (0.255*R2)	0.22	0.05	3.97	2.25	0.027
Right digit 3 (mm)	HT = 128.35 + (0.417*R3)	0.34	0.12	3.83	3.60	<0.001
Right digit 4 (mm)	HT = 140.27 + (0.300*R4)	0.25	0.06	3.94	2.58	0.012
Right digit 5 (mm)	HT = 147.95 + (0.247*R5)	0.24	0.06	3.95	2.45	0.016
Right 2D:4D	HT = 164.64 – (1.981*R2D:4D)	0.02	0.00	4.07	-0.16	0.877
Left digit 1 (mm)	HT = 151.32 + (0.198*L1)	0.23	0.06	3.96	2.39	0.019
Left digit 2 (mm)	HT = 146.80 + (0.221*L2)	0.19	0.04	3.10	1.91	0.058
Left digit 3 (mm)	HT = 126.67 + (0.438*L3)	0.35	0.12	3.82	3.66	<0.001
Left digit 4 (mm)	HT = 141.15 + (0.288*L4)	0.24	0.06	3.95	2.47	0.015
Left digit 5 (mm)	HT = 147.95 + (0.247*L5)	0.24	0.06	3.95	2.45	0.016
Left 2D:4D	HT = 168.83 – (6.336*L2D:4D)	0.05	0.00	4.07	-0.50	0.620

Table 4.41: Linear regression equations for estimation of height from anthropometric length parameters of Lokaa, ethnic group (n = 200)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 158.86 + (0.338*Age)	0.24	0.06	5.39	3.40	<0.001
Weight (kg)	HT = 143.97 + (0.368*WT)	0.55	0.30	4.65	9.17	<0.001
Body mass index (kg/m^2)	HT = 164.31 + (0.122*BMI)	0.06	0.00	5.54	0.77	0.441
Demispan length (cm)	HT = 114.64 + (0.587*DSL)	0.55	0.30	4.64	9.20	<0.001
Biaxillary length (cm)	HT = 146.35 + (0.587*BL)	0.31	0.10	5.27	4.58	<0.001
Hand length (cm)	HT = 131.69 + (1.801*HL)	0.45	0.20	4.95	7.08	<0.001
Hand breadth (cm)	HT = 154.42 + (1.087*HB)	0.28	0.08	5.33	4.02	<0.001
Foot length (cm)	HT = 154.77 + (0.473*FL)	0.32	0.10	5.25	4.76	<0.001
Foot breadth (cm)	HT = 147.67 + (1.443*FB)	0.28	0.08	5.33	4.09	<0.001
Hand index	HT = 167.13 – (0.001*HI)	0.00	0.00	5.55	-0.03	0.980
Foot index	HT = 175.56 – (0.163*FI)	0.16	0.03	5.48	-2.27	0.025
Thigh length (cm)	HT = 104.14 + (1.413*TL)	0.55	0.30	4.64	9.22	<0.001
Leg length (cm)	HT = 85.25 + (2.013*LL)	0.69	0.48	3.10	13.52	<0.001
Neck length (cm)	HT = 156.41 + (0.761*NL)	0.17	0.03	5.47	2.36	0.019
Neck/height ratio	HT = 166.03 + (4.731*NHtR)	0.02	0.00	5.54	0.30	0.762
Waist/height ratio	HT = 177.54 – (21.567*WHtR)	0.18	0.03	5.45	-2.60	0.010
Sitting height (cm)	HT = 59.08 + (1.311*SHt)	0.84	0.70	3.05	21.41	<0.001
Sitting height/height ratio	HT = 139.92 + (55.007*SHtHtR)	0.12	0.01	5.51	1.63	0.105
Leg length/sitting height ratio	HT = 174.37 – (14.831*LLSHtR)	0.06	0.00	5.53	-0.91	0.366
Right digit 1 (mm)	HT = 139.71 + (0.428*R1)	0.44	0.20	4.98	6.92	<0.001
Right digit 2 (mm)	HT = 140.40 + (0.363*R2)	0.34	0.12	5.21	5.16	<0.001
Right digit 3 (mm)	HT = 127.17 + (0.479*R3)	0.45	0.21	4.94	7.18	<0.001
Right digit 4 (mm)	HT = 135.68 + (0.409*R4)	0.39	0.15	5.12	5.86	<0.001
Right digit 5 (mm)	HT = 138.80 + (0.479*R5)	0.42	0.18	5.03	6.51	<0.001
Right 2D:4D	HT = 171.61 – (4.769*R2D:4D)	0.03	0.00	5.54	-0.44	0.659
Left digit 1 (mm)	HT = 140.10 + (0.422*L1)	0.44	0.19	4.98	6.89	<0.001
Left digit 2 (mm)	HT = 140.24 + (0.365*L2)	0.35	0.12	5.20	5.23	<0.001
Left digit 3 (mm)	HT = 129.21 + (0.455*L3)	0.44	0.19	4.98	6.91	<0.001
Left digit 4 (mm)	HT = 167.00 + (0.00*L4)	0.01	0.00	5.55	0.07	0.946
Left digit 5 (mm)	HT = 139.01 + (0.475*L5)	0.42	0.18	5.03	6.53	<0.001
Left 2D:4D	HT = 166.57 + (0.503*L2D:4D)	0.01	0.00	5.55	0.09	0.926

Table 4.42: Linear regression equations for estimation of height from anthropometric length parameters of Lokaa, ethnic group for males (n = 100)

Parameters	**Predictive Equations**	**R**	R^2	**SEE**	**t**	**p**
Age (years)	HT = 163.70 + (0.233*Age)	0.16	0.03	5.18	1.60	0.114
Weight (kg)	HT = 145.30 + (0.380*WT)	0.48	0.23	4.59	5.45	<0.001
Body mass index (kg/m^2)	HT = 176.67 – (0.330*BMI)	0.13	0.02	5.20	-1.30	0.197
Demispan length (cm)	HT = 108.14 + (0.659*DSL)	0.44	0.19	4.72	4.79	<0.001
Biaxillary length (cm)	HT = 152.53 + (0.469*BL)	0.21	0.04	5.13	2.11	0.037
Hand length (cm)	HT = 145.45 + (1.173*HL)	0.24	0.06	5.09	2.49	0.014
Hand breadth (cm)	HT = 156.94 + (1.031*HB)	0.23	0.05	5.11	2.31	0.023
Foot length (cm)	HT = 161.45 + (0.294*FL)	0.27	0.07	5.05	2.76	0.007
Foot breadth (cm)	HT = 159.96 + (0.687*FB)	0.15	0.02	5.18	1.50	0.137
Hand index	HT = 163.97 + (0.091*HI)	0.09	0.01	5.22	0.93	0.355
Foot index	HT = 179.86 – (0.203*FI)	0.21	0.05	5.13	-2.14	0.035
Thigh length (cm)	HT = 125.18 + (0.986*TL)	0.43	0.19	4.73	4.72	<0.001
Leg length (cm)	HT = 102.85 + (1.621*LL)	0.65	0.42	4.01	8.35	<0.001
Neck length (cm)	HT = 167.18 + (0.156*NL)	0.04	0.00	5.24	0.37	0.710
Neck/height ratio	HT = 173..17 – (17.207*NHtR)	0.05	0.00	5.24	-0.47	0.640
Waist/height ratio	HT = 184.86 – (33.654*WHtR)	0.17	0.03	5.17	-1.65	0.102
Sitting height (cm)	HT = 69.65 + (1.186*SHt)	0.78	0.60	3.31	12.18	<0.001
Sitting height/height ratio	HT = 163.64 + (11.58*SHtHtR)	0.03	0.01	5.24	0.28	0.78
Leg length/sitting height ratio	HT = 166.93+ (5.033*LLSHtR)	0.03	0.01	5.24	0.25	0.800
Right digit 1 (mm)	HT = 145.62 + (0.356*R1)	0.34	0.12	4.93	3.61	<0.001
Right digit 2 (mm)	HT = 142.08 + (0.363*R2)	0.37	0.13	4.88	3.90	<0.001
Right digit 3 (mm)	HT = 136.89 + (0.379*R3)	0.37	0.14	4.86	3.98	<0.001
Right digit 4 (mm)	HT = 137.35 + (0.408*R4)	0.40	0.16	4.80	4.37	<0.001
Right digit 5 (mm)	HT = 146.49 + (0.377*R5)	0.35	0.12	4.91	3.69	<0.001
Right 2D:4D	HT = 171.23 – (1.924*R2D:4D)	0.01	0.01	5.24	-0.13	0.895
Left digit 1 (mm)	HT = 146.00 + (0.350*L1)	0.35	0.12	4.93	3.62	<0.001
Left digit 2 (mm)	HT = 141.94 + (0.365*L2)	0.37	0.14	4.86	3.99	<0.001
Left digit 3 (mm)	HT = 138.50 + (0.361*L3)	0.37	0.14	4.87	3.93	<0.001
Left digit 4 (mm)	HT = 136.83 + (0.414*L4)	0.41	0.17	4.78	4.46	<0.001
Left digit 5 (mm)	HT = 146.42 + (0.377*L5)	0.35	0.13	4.90	3.74	<0.001
Left 2D:4D	HT = 169.24 + (0.160*L2D:4D)	0.01	0.01	5.24	0.01	0.990

Table 4.43: Linear regression equations for estimation of height from anthropometric length parameters of Lokaa, ethnic group for females (n = 100)

Parameters	**Predictive Equations**	**R**	**R^2**	**SEE**	**t**	**p**
Age (years)	HT = 156.07 + (0.359*Age)	0.31	0.10	4.60	3.20	0.002
Weight (kg)	HT = 144.06 + (0.332*WT)	0.66	0.43	3.64	8.65	<0.001
Body mass index (kg/m^2)	HT = 151.16 + (0.593*BMI)	0.35	0.12	4.54	3.64	<0.001
Demispan length (cm)	HT = 128.92 + (0.417*DSL)	0.35	0.12	4.54	3.68	<0.001
Biaxillary length (cm)	HT = 150.83 + (0.401*BL)	0.27	0.08	4.65	2.82	0.006
Hand length (cm)	HT = 140.46 + (1.285*HL)	0.32	0.10	4.58	3.37	0.001
Hand breadth (cm)	HT = 161.18 + (0.316*HB)	0.10	0.01	4.82	0.96	0.339
Foot length (cm)	HT = 152.77 + (0.481*FL)	0.17	0.03	4.77	1.74	0.085
Foot breadth (cm)	HT = 148.67 + (1.221*FB)	0.23	0.05	4.71	2.34	0.021
Hand index	HT = 166.99 – (0.039*HI)	0.07	0.01	4.83	-0.68	0.500
Foot index	HT = 163.89 + (0.015*FI)	0.02	0.00	4.84	0.17	0.869
Thigh length (cm)	HT = 91.04 + (1.667*TL)	0.68	0.46	3.55	9.17	<0.001
Leg length (cm)	HT = 77.32 + (2.173*LL)	0.73	0.54	3.30	10.65	<0.001
Neck length (cm)	HT = 153.15 + (0.838*NL)	0.19	0.04	4.75	1.95	0.054
Neck/height ratio	HT = 167.39 – (12.833*NHtR)	0.09	0.01	4.82	-0.85	0.400
Waist/height ratio	HT = 152.18 + (24.388*WHtR)	0.24	0.06	4.70	2.46	0.016
Sitting height (cm)	HT = 47.71 + (1.450*SHt)	0.83	0.68	2.73	14.49	<0.001
Sitting height/height ratio	HT = 178.26 – (27.69*SHtHtR)	0.05	0.00	4.83	-0.54	0.594
Leg length/sitting height ratio	HT = 160.69+ (8.042*LLSHtR)	0.03	0.00	4.84	0.33	0.743
Right digit 1 (mm)	HT = 150.57 + (0.231*R1)	0.24	0.06	4.70	2.39	0.019
Right digit 2 (mm)	HT = 161.27 + (0.048*R2)	0.05	0.00	4.83	0.44	0.658
Right digit 3 (mm)	HT = 141.18 + (0.291*R3)	0.25	0.06	4.69	2.54	0.013
Right digit 4 (mm)	HT = 156.92 + (0.104*R4)	0.10	0.01	4.82	0.96	0.339
Right digit 5 (mm)	HT = 146.93 + (0.310*R5)	0.27	0.07	4.66	2.79	0.006
Right 2D:4D	HT = 172.94 – (8.608*R2D:4D)	0.07	0.00	4.83	-0.65	0.517
Left digit 1 (mm)	HT = 150.69 + (0.229*L1)	0.24	0.06	4.70	2.41	0.018
Left digit 2 (mm)	HT = 160.77 + (0.055*L2)	0.05	0.00	4.83	0.51	0.611
Left digit 3 (mm)	HT = 143.18 + (0.266*L3)	0.24	0.06	4.70	2.39	0.019
Left digit 4 (mm)	HT = 164.74 – (0.001*L4)	0.01	0.00	4.84	-0.07	0.944
Left digit 5 (mm)	HT = 147.31 + (0.304*L5)	0.27	0.07	4.66	2.75	0.007
Left 2D:4D	HT = 165.66 – (1.008*L2D:4D)	0.02	0.00	4.84	-0.19	0.846

Table 4.43-4.50 shows the single and multiple regression with the parameters that had the highest correlation coefficients. It is clear from the equations that combining the two parameters tends to give better estimations and lower standard error of estimates than using one parameter, so also combining three or more parameters gives better estimations with lower standard error of estimates. That is to say the more the parameters used the better the estimation and the lower the standard error of estimates. The reason for this is that better correlation coefficient was observed with the double and triple parameter equations respectively. Parameters with higher correlation coefficient were chosen in order to have a better precision of the equations.

Table 4.44: Multiple and simple linear regressions for predictions of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups (n = 800)

Parameters	**Regression Equations**	**R**	**R^2**	**SEE**	**t**	**p**
SHt	HT = 33.73 + (1.618*SHt)	0.82	0.67	3.61	40.05	<0.001
TL	HT = 85.03 + (1.824*TL)	0.77	0.59	4.03	33.57	<0.001
LL	HT = 80.43 + (2.133*LL)	0.75	0.56	4.15	31.95	<0.001
SHt + TL	HT = 11.75 + (1.209*SHt) + (1.251*TL)	0.95	0.90	1.98	6.27	<0.001
SHt + TL + LL	HT = 2.42 + (1.037*SHt) + (0.935*TL) + (0.933*LL)	0.99	0.97	1.01	2.47	<0.001

HT = Height;SHt = Sitting Height; TL = Thigh Length;LL = Leg Length;

Table 4.45: Multiple and simple linear regressions for predictions of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups (n = 400) in males

Parameters	**Regression equations**	**R**	**R^2**	**SEE**	**t**	**p**
TL	HT = 92.72 + (1.692*TL)	0.77	0.59	3.51	24.08	<0.001
LL	HT = 94.82 + (1.833*LL)	0.74	0.54	3.73	21.62	<0.001
SHt	HT = 43.71 + (1.501*SHt)	0.71	0.51	3.86	20.29	<0.001
TL + LL	HT = 69.55 + (1.173*TL) + (1.151*LL)	0.87	0.75	2.76	24.03	<0.001
TL + LL + SHt	HT = 1.76 + (0.980*TL) + (0.925*LL) + (1.025*SHt)	0.98	0.96	1.06	0.97	<0.001

HT = Height; TL = Thigh Length;LL = Leg Length; SHt = Sitting Height;

Table 4.46: Multiple and simple linear regressions for predictions of height from anthropometric length parameters of Agoi, Ayiga, Ekoi and Lokaa ethnic groups (n = 400) in females

Parameters	**Regression equations**	**R**	**R^2**	**SEE**	**t**	**p**
LL	HT = 87.83 + (1.889*LL)	0.78	0.60	3.15	24.54	<0.001
SHt	HT = 36.84 + (1.575*SHt)	0.75	0.56	3.32	22.47	<0.001
TL	HT = 100.72 + (1.421*TL)	0.69	0.48	3.61	19.12	<0.001
LL + SH	HT = 24.39 + (1.250*) + (1.063*SHt)	0.90	0.81	2.19	6.54	<0.001
LL + SH + TL	HT = 4.87 + (0.937*LL) + (1.030*SHt) + (0.888*TL)	0.98	0.96	0.96	2.87	<0.001

HT = Height; LL = Leg Length; SHt = Sitting Height; TL = Thigh Length;

Table 4.47: Multiple and simple linear regressions for predictions of height from anthropometric length parameters of Agoi ethnic group (n = 200)

Parameters	Regression equations	R	R^2	SEE	t	p
TL	HT = 97.74 + (1.489*TL)	0.75	0.56	3.25	15.75	<0.001
Age	HT = 142.50 + (0.829*Age)	0.74	0.55	3.28	15.51	<0.001
LL	HT = 93.94 + (1.762*LL)	0.73	0.53	3.36	14.85	<0.001
SHt	HT = 33.57 + (1.612*SHt)	0.71	0.50	3.44	14.15	<0.001
HB	HT = 121.36 + (3.590*HB)	0.70	0.49	3.49	13.79	<0.001
TL + Age	HT = 109.47 + (0.936*TL) + (0.510*Age)	0.83	0.69	2.74	29.54	<0.001
TL + Age + LL	HT = 77.45 + (0.821*TL) + (0.317*Age) + (1.070*LL)	0.91	0.84	1.99	21.51	<0.001
TL + Age + LL + SHt	HT = 1.39 + (0.911*TL) + (0.044*Age) + (0.985*LL) + (1.025*SHt)	0.99	0.98	0.64	0.64	<0.001
TL + Age + LL + SHt + HB	HT = 2.33 + (0.908*TL) + (0.040*Age) + (0.981*LL) + (I.007*SHt) +(0.074*HB)	0.99	0.98	0.64	0.98	<0.001

HT = Height; TL = Thigh Length; LL = Leg Length; SHt = Sitting Height; HB = Hand Breadth

Table 4.48: Multiple and simple linear regressions for predictions of height from anthropometric length parameters of Ayiga ethnic group (n = 200)

Parameters	**Regression equations**	**R**	**R^2**	**SEE**	**t**	**p**
TL	HT = 86.36 + (1.807*TL)	0.82	0.68	4.16	20.32	<0.001
DSL	HT = 73.74 + (1.103*DSL)	0.81	0.66	4.27	19.53	<0.001
SHt	HT = 36.96 + (1.572*SHt)	0.81	0.65	4.31	19.24	<0.001
WHtR	HT = 217.83 – (103.772*WHtR)	0.70	0.49	5.23	-13.71	<0.001
TL + DSL	HT = 67.10 + (1.081*TL) + (0.613*DSL)	0.88	0.77	3.51	16.98	<0.001
TL + DSL + SHt	HT = 22.80 + (1.173*TL) + (0.107*DSL) + (1.006*SHt)	0.96	0.92	2.09	6.90	<0.001
TL + DSL + SHt + WHtR	HT = 19.73 + (1.190*TL) + (0.108*DSL) + (1.018*SHt) + (2.523*WHtR)	0.96	0.92	2.09	3.10	<0.001

HT = Height; TL = Thigh Length; DSL = Demispan Length; SHt = Sitting Height; WHtR = Waist/Height Ratio

Table 4.49: Multiple and simple linear regressions for predictions of height from anthropometric length parameters of Ekoi ethnic group (n = 200)

Parameters	**Regression equations**	**R**	**R^2**	**SEE**	**t**	**p**
SHt	HT = -14.03 + (2.216*SHt)	0.89	0.80	2.73	27.83	<0.001
TL	HT = 64.86 + (2.284*TL)	0.87	0.76	2.96	25.06	<0.001
LL	HT = 63.57 + (2.548*LL)	0.85	0.72	3.19	22.61	<0.001
DSL	HT = 66.72 + (1.139*DSL)	0.72	0.51	4.22	14.44	<0.001
SHt + TL	HT = -1.90 + (1.373*SHt) + (1.268*TL)	0.96	0.92	1.76	-0.44	<0.001
SHt + TL + LL	HT = -4.28 + (1.161*SHt) + (0.793*TL) + (1.007*LL)	0.98	0.97	1.11	-1.58	<0.001
SHt + TL + LL + DSL	HT = -5.08 + (1.097*SHt) + (0.767*TL) + (0.967*LL) + (0.101*DSL)	0.98	0.97	1.08	-1.93	<0.001

HT = Height; SHt = Sitting Height; TL = Thigh Length; LL = Leg Length; DSL = Demispan Length

Table 4.50: Multiple and simple linear regressions for predictions of height from anthropometric length parameters of Lokaa ethnic group (n = 200)

Parameters	**Regression equations**	**R**	**R^2**	**SEE**	**t**	**p**
SHt	HT = 59.08 + (1.311*SHt)	0.84	0.70	3.05	21.41	<0.001
LL	HT = 85.25 + (2.013*LL)	0.69	0.48	3.10	13.52	<0.001
SHt + LL	HT = 30.85 + (1.043*SHt) + (1.238*LL)	0.92	0.85	2.15	7.56	<0.001

HT = Height; SHt = Sitting Height; LL = Leg Length

5.0DISCUSSION

Stature estimation is considered as one of the basic parameters of the investigation process in unknown and commingled human remains in medico-legal case work. Race, age and sex are the other parameters which help in this process. Stature estimation is of the utmost importance as it completes the biological profile of a person along with the other three parameters of identification (Danborno *et al.,* 2009). Though stature is an important parameter in clinical practicethere are limitations in some clinical situations (Chittanatarat *et al.,* 2012). Anthropometric measurements for stature prediction were suggested to solve this problem and many formulae have been reported(Chittanatarat *et al.,* 2012). These measurements included demispan length, sitting height, leg length, foot length and hand dimensions (Joshiet *et al.,* 1964; Chumlea *et al.,* 1985; Bassey, 1986; Brown *et al.,* 2000; Kwok *et al.,* 2002; Gauld *et al.,* 2004; Fatmah, 2009). However, ethnic differences, gender and age are a major concern in this regard for application and external validation for other populations. The results of the descriptive statistics showed that males presented with statistically significant higher mean value of total stature than females. It can therefore be inferredthatmales are generally taller than females, which agrees with previous studies on stature estimation in Nigeria (Danborno and Elukpo, 2008; Danborno *et al.*, 2008; Ebite *et al.*, 2009; Numan *et al.*, 2013; Ibegbu *et al.,* 2014; Oria *et al.*, 2016). Males also showed higher mean values compared to females for all the anthropometric measurementsp < 0.05 except for thigh circumference, chest circumference, waist circumference and hip circumference respectively which were significantly higher in the females than males. Also waist/height ratio values are insignificantly higher in the females.

This confirms sexual dimorphism of anthropometric dimensions as reported in earlier studies (Steyn and Iscan 1997; Danborno and Elukpo, 2008; Danborno *et al.,* 2008;Igbebu *et al.,* 2014; Oria *et al.,* 2016).This study also showed the existence of sexual dimorphism in hand dimensions. These sex differences in physical characteristics are often related to hormonal, genetic, and environmental factors (Hasegawa *et al.,* 2009). We observed that the males had higher values of hand length and handbreadth than their female counterparts, and these dimensions were all statistically significant ($P < 0.05$). This finding is in consonance with that of (Numan *et al*., 2013) who conducted a study on major ethnic groups in Nigeria namelyIgbo, Hausa, and Yoruba. They reported significantly higher values of hand length in males when compared to females. In that work, Hausa males had longer hands than Igbo and Yoruba males. It is also noteworthy that the values of length of the hand reported by (Numan *et al*., 2013) for Hausa, Igbo, and Yoruba males were all higher than those obtained for Yakurr males in this study. Their study also showed that the Igbo females have longer hands than Hausa and Yoruba females, and all the dimensions of length of the hand obtained from the three ethnic groups were higher than that of the Yakurr females obtained in the present work. Their findings were confirmed by (Ilayperuma *et al*., 2009) in their work on Sri Lankans who also reportedsignificantly ($P < 0.01$) higher mean values of hand length and breadth in males when compared to females. The results obtained in the current study is also in agreement with the findings of (Ozaslan *et al*., 2012) who reported significantly higher mean values of hand length and breadth in male than in the female subjects of Turkish decent in their study. Thus, their result also reaffirmed the existence of sexual dimorphism in hand dimensions. However, we observed that the values obtained for all the Nigerian populations studied previously as well as for Yakurr subjects in the present study were higher than those obtained for the Sri Lankans and the Turks. This difference could be explained by the fact that, all the Nigerian populations studied belong to the Negroid race. It is evident from this study that the anthropometric parameters considered in this study were higher in males than females in all the ethnic groups $p < 0.05$ except for thigh circumference, chest circumference, waist circumference and hip circumference which were significantly higher in the females than males. Also waist/heightratio values are insignificantly higher in the females and BMI, which is higher in females than males in the four ethnicities, this could be due to sedentary life styles and less physical activities engaged by the females than males. This is in line with the work done by Danborno *et al*. (2008) which shows no statistically significant difference (with respect to the Hausas), though the mean values in females are slightly greater than those in males. The reason being that sexual dimorphism in human body size and composition is well established, and apparent in diverse populations. Average stature and lean mass tend to be greater in males than females, whereas average adiposity tends to be greater in females than males (Wells, 2007; Gustafsson and Lindenfors, 2009). This is in contrary to the report of Goswami (2013), which says that, the mean BMI of the Juang males (19.40 kg/m^2) is appreciably higher than the females (18.30 kg/m^2) and Smolej *et al.* (2013). Biaxillary length is higher in Agoi and Ayiga females than males except for Ekoi and Lokaa which showed higher values in males than females. This is in line with the report of Danborno *et al.* (2008) on the estimation of height and weight from the length of second and fourth digits in Nigeria, who reported that male generally, have higher anthropometric values than females.

The results indicate that one can successfully estimate stature from different parts of the body with a prescribed mean error using division factor method and regression analysis. However, it must always be kept in mind that precise prediction of stature from an individual's body parts may be an unachievable and unnecessary goal, there would always be an estimation error of a few centimeters. In the present study, the reason for taking the adult sample ranging in age from 18 to 32 years (average being 24.75 years) may be attributed to the fact that stature attains its maximum limits at around 21 years of age and senility related changes of stature start appearing after 32 years(Jakhar *et al.*, 2008).According to Roche (1986), generally stature at 18 years is accepted as adult although there are small increments in stature after this. The median age for attaining height in males is 21.2 years with growth continuing in 10% of males until 23.5 years (Roche and Davila, 1972). Although, loss of stature seen with increasing age is not accompanied by diminution of body size and it is difficult to see how much variability could be incorporated into predictive calculation (Barker and Scheuer, 1998). A study by Friedlaender *et al*. (1977)suggests that a decline in stature does not commence until the fifthdecade of life.

The procedure to estimate stature is to use its components. The accuracy is usually more reliable when the parts are situated along its length such as the lengths of the femur and tibia more so than the humerus and radius in the skeleton (Fully, 1956). The present study takes this into consideration and used similar measurements from the living people. There is an obvious need for a study as such. It could have been applied, for example, the identification of a victim who died in the Oklahoma City Federal Building bombing. As one of the authors (MYI) studied one of the legs of a victim to be identified, stature could have been estimated relatively simple instead of stripping the soft tissue to expose the bone. Anthropometry has enjoyed popularity over the years as a reliably technique to measure human body and its components (Iscan, 2000). Almost all human growth studies use it. The technique requires considerable experience so the measurements obtained are comparable with those taken by others. In osteological remains errors are relatively less especially in length dimensions because a long bone is relatively simpler to measure. Yet, there are numerous difficulties in the anthropometry of the living arising from the determining of the correct landmark on the body. In the present study, male subjects were measured by male and female subjects by female investigators. When two regression formulae were developed from these dimensions and test on the randomly selected sample the difference between the actual stature and the estimated stature were not found to be statistically significant. One must consider differences between populations in order to apply functions as such to others.

The hand bones have been documented as good anthropometric parameters and had proven to exhibit great ethnic variations (Sancho-Bru *et al.*, 2011). Earlier studies have observed that various hand measurements tend to differ in various ethnic groups (Okunribido, 2000). This was also observed in the current study in whicha statistically significant differences in hand index occur between male and female in the four ethnic groups, Agoi, Ayiga, Ekoi and Lokaa. Generally, the mean hand indices for both male and female shows the males having higher mean values when compared with the females. This finding is consistent with the studies on sexual dimorphism in hand and foot length, indices, stature-ratio and relationship to height in Nigerians (Danborno *et al.,* 2007). This is also in line with a study that was carried out on students of university of Port-Harcourt in which the average hand indices for both males and females were 44.68 ± 0.13 and 43.29 ± 0.14, respectively. In the present study, the population under study falls under the hyperbrachycheri (hbch) group of hand classification. In the mean hand indices of the four ethnic groups shows the Ekoi and Ayiga having higher mean values when compared to the Agoi and Lokaa. No significant difference was observed when comparing same sex. This is also in conformity with the report of Danborno *et al.*(2007). Although, the hand indices were shown to be different between the sexes compared to other hand dimensions. This is also at the level of comparison between Agoi, Ayiga, Ekoi and Lokaa. This may further lead to a suggestion that a difference in anthropometric variable such as hand index may be absent within the same population but present when compared with other age group of other populations. This may also potentiate the application of hand index among other variables in forensic science as well as ethnic differentiation.In adults, sexual differences are evident in hand length measurements and in hand width to length ratios (McFadden and Shubel, 2002). Our study showed that the male hand length, breadth and indices were higher than the female. The difference in hand dimension between male and female could be explained as part of genetic expression of male being larger than female. However, this is in agreement with (Davies *et al*., 1980; Kanchan and Rastogi, 2009) which shows that there are ethnic differences in the anatomical dimensions and its relation to sex. It has also been emphasized that differences in body dimension among population and ethnic origins are as a result of differences in nutrition and levels of physical activity (Malina, 1994). The mean value of male hand length, breadth and indices is higher than that from a study done on Mauritaus population by Agnihotri *et al*. (2008), which revealed an average length of an adult male hand of 189mm, while the average length of an adult female hand is 172mm. The average hand breadth for adult males and females is 84 and 74 mm, respectively. Our study revealed an average length and breadth of an adult male hand and the average length and breadth of adult female hand. The results of our mean hand length is in agreement with that reported by Isurani *et al*., 2009) with a male mean hand length higher than the female. The hand index which is a percentage expression of the breadth over the length suggested that adult Nigerians falls to mesocheir and dolichocheir groups according to Wechsler hand classification (Ethel *et al*., 1995).

The hand anthropometry of the present study showed that males and females had almost similar values and this showed no statistically significant values. The mean values of right digit ratio, R2D:4D in this study were higher in females than males. while left digit ratio, L2D:4D were also higher in females than males. This result also shows that females had significantly higher values compared with the males in left 2D:4D ratio. It was observed from the present study that second digit length in males was shorter than fourth digit length which was not different when compared among the sexes. This finding agrees with the reports of Manning *et al.* (2000), McFadden and Shubel, (2002), Holm *et* *al*. (2005), Danborno *et al*. (2007), Oladipo *et al*. (2009) and Ibegbu *et al*. (2014) who reported that second digits in the males tend to be shorter than fourth digits. These digits' lengths are influenced by testosterone and oestrogen *in-utero* (Manning *et al*., 2000). This sexual dimorphism in 2D:4D ratios are influenced by prenatal testosterone concentrations. This hormone is thought to modify developmental rate such as epidermal ridges of the digits during fourth week of fetal development (McFadden and Shubel, 2002; Neave *et al*., 2003; Wallien *et al*., 2008). High concentrations of fetal testosterone indicate a low 2D:4D ratios, which therefore indicate a high prenatal testicular activity which also influences higher long bone development and determines the height of the individual. On the other hand, 2D:4D ratio is positively correlated with oestrogen in men and women (Williams *et al*., 2000; Malas *et al*., 2006; Paul *et al*., 2006). Similarly, the morphometric parameters of the hand show considerable sexual dimorphism in the Indian population while the hand and palm index were poor sex indicator (Kanchan and Rastogi, 2009). The ratio between the length of the 2^{nd} or index finger and the 4^{th} or ring finger (2D:4D) shows sex differences, a sex difference in adult 2D:4D was found in children as young as 2 years, it is robust across ethnic groups, but there are also ethnic differences in 2D:4D which are independent of sex and may result from between-population variation in foetal sex hormones. A cross-sectional study of 2D:4D in Caucasian English children and adults found that finger ratio showed sex differences as early as age 2 years and there was no evidence of a change of ratio at puberty (Manning *et al.*, 2000, 2002, 2003). A sex difference in 2D:4D with lower values in males compared to females, was also found in a sample of Scottish children aged 2 to 5 years (Williams *et al.*, 2003). This was also observed in the current study in which an intra sexual dimorphic significant difference in hand digit ratio occurred.

The result of the study showed that sitting height had the highest correlation with height than the other parameters in the four ethnic groups in Yakurr which were significant.

This result is contrary to the report of Chittanatarat *et al.* (2012), which reported that knee height or leg length had the highest correlation in the single parameters indicating a highest prediction than other parameters. This is followed by thigh length, leg length, demispan length, hand length, weight, foot breath, hand breath, foot length, neck length, neck circumference, calf circumference, biaxillary length, body mass index, thigh circumference, chest circumference and foot index respectively. This is contrary with the study of Fatmah, (2009), which reported that arm span had the strongest correlation with actual height compared to knee height and sitting height, this finding is in disagreement with the study performed in elderly female in South India (Mohanty *et al.,* 2001) that had proven the strongest correlation between the arm span and actual body compared to the sitting height and leg length.

Sexual dimorphism in human body size and composition is well established, and apparent in diverse populations. In the four ethnic groups' males tends to have higher mean values of neck circumference when compared to their female counterparts. This is in line with a work done on the neck circumference as a useful marker of obesity which shows the males having higher mean values than the females (Mozaffer *et al.,* 2012). In this study, the mean values of Ayiga tends to be higher when compared to the Agoi, Ekoi and Lokaa.

For body mass index, significant gender differences were observed within the four ethnic groups, with females showing higher mean values than their male counterparts. This is consistent with the study carried-out in Chinese subjects which shows the females having slightly higher mean values than their male counterparts (Liu *et al.,* 2011). In the previous literature it has been documented that from obesity surveys, body mass index (BMI) is easy to perform on a large scale. However, it does not depict the true body composition (Chan *et al.,* 2003). It is nevertheless a crude index that does not take into account the distribution of body fat, resulting in variability in different individuals and populations. Asian Indians, in common, were reported to have mean and median values of BMI lower than that observed in non-Asians, and also have higher percentage body fat (PBF), waist-to-hip ratio (WHR) and abdominal fat at a lower level of BMI (Deurenberg *et al.*, 2003). This may support the present findings in which intra ethnic variation was noticed. In the four ethnic groups studied, Agoi shows higher mean values when compared to the Ayiga, Ekoi and Lokaa.

Similarly, the waist and hip circumferences show the same trend as seen in the BMI. In addition, in the four ethnic groups, waist and hip circumferences females tends to have higher mean values compared to their male counterparts. Considering the waist circumferences, in the four ethnic groups' females tends to have higher mean values compared to their male counterparts, this is inconsistent with the work done which shows the males having higher mean values than their female counterparts (Liu *et al.,* 2011). The mean values in Ayiga female tends to be higher when compared to the Ekoi female, while there was no significant difference between the Agoi and Lokaa. In the case of the hip circumferences, in the four ethnic groups' Agoi females tends to have higher mean values compared to Lokaa females, while there was no significant difference between the Ayiga females and Ekoi females. This is consistent with the work done which shows the females having higher mean values than their male counterparts (Mozaffer *et al.,* 2012). Ayiga males have higher mean values than their Ekoi counterparts while there was no significant difference between the Agoi males and Lokaa males. Sex-differences in size and body composition in early adulthood thus illustrate profoundly different patterns of energy allocation; however, this dimorphism appears to decrease through adult life, such that by old age dimorphism in body shape is substantially reduced. This has been attributed to an age-associated shift in the target of energy allocation, especially in females, from reproduction to survival (Wells, 2007; Wells *et al.*,2011). Again, changes in body composition across the life course may derive from both genetic and plastic mechanisms. With respect to the waist-to-hip ratio (WHR) no statistically significant differences were observed within and between the ethnic groups.In the four ethnic groups' Ayiga and Lokaa females tend to show higher mean values compared to their male counterparts. This is in line with the work done which shows the females having higher mean values than the males (Liu *et al.,* 2011). But in the case of Agoi and Ekoi, the males tend to show higher mean values compared to their female counterparts. This is inconsistent with the work done which shows the males having higher mean values than the females (Liu *et al.,* 2011). The Ekoi males have higher mean values than the Agoi, Ayiga and Lokaa males while the Ayiga females have higher mean values than the Agoi, Ekoi and Lokaa females.

The moderate to high degree of correlation obtained in this study is in agreement with the usefulness of different body length in the estimation of stature in Nigeria of West Africans descent. Practitioners of forensic anthropology in Nigeria and West Africa will therefore find the regression equations presented in this study useful when intact long bones are not present for analysis.

The accuracy of each regression equation derived in this study was assessed using the obtained standard error of estimate (SEE). Regression equations for height estimation in females presented with slightly higher SEE compared to those obtained in males, this is contrary with the report of Danborno and Elukpo (2008), in their study of Nigeria population which reported that; when hand and foot were correlated the relationship between hand and foot length was higher in the females than the males, but when hand and foot lengths were compared to height the relationship was stronger in the males than in the females.

Multivariate analysis was conducted with parameters that showed the strongest correlation with height to see if the height of subjects could be predicted from the lengths of body in circumstances where two or three dismembered body length fragments were found. This proved to be effective and provided valuable predictive equations that enable the prediction of height for both males and females. Higher predictive ability was observed in females than males in the combined study population because it showed lower standard error of estimates in females than males. This finding is in agreement with reports of Danborno and Elukpo (2008) in Nigerian population and from Turkish sample (Ozden *et al*.,2005; Sanli *et al*., 2005) and Indian sample (Krishan and Sharma, 2007; Patel *et al*., 2007). In conclusion, estimation of stature from its segments or dismember parts has important considerations for identifications of human remains recovered from mass disaster.

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Regression equations were derived for estimation of stature from measurements of body lengths. Males showed higher correlation between measured variables and stature compared to females. This allowed for formulation of more accurate regression equations for males compared to females. The accuracy of the equations in this study is lower than that obtained for intact combine long bones but higher than that for other skeletal elements like metacarpals, metatarsals, intact calcaneus and fragments of femur, humerus, tibia etc. Therefore, combined intact bones should be used in the estimation of stature when they are available for forensic analysis. However, in the absence of intact long bones, equations presented in this study can offer a reasonable estimate of stature.

Differences of stature estimation between the four ethnic groups of Yakurr, Cross River state of Nigerian population has been established in this study, indicating population specificity in height estimations.

In conclusion, sitting height, thigh length, leg length, hand breadth, demispan length, waist/height ratio etc, and combination could be applied for height estimation in Yakurr adult's population. Although sitting height had the highest precision as single prediction parameter, other parameters were also proposed with acceptable error margin. Combination of double and triple parameters might decrease actual deviation in all subjects. However, over-estimation might be of concern in shorter people and vice versa in taller people. Therefore, formula prediction should be used only in cases when direct measurement of stature is not possible.

6.2 RECOMMENDATIONS

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

i. The present study was conducted on direct measurement of only 28 variables. Further research with a larger study design and more number of measurable variables should be done to establish the relationship between stature and anthropometric variables of the body in the Agoi, Ayiga, Ekoi and Lokaa ethnic groups in Nigeria.

ii. Differences of stature estimation between four ethnic groups of Cross River state of Nigerian population has been established in this study, indicating population specificity in stature estimations. Therefore, further studies should be conducted on different other ethnic groups of the state in other to establish a more reference data base for stature estimation in Nigerian populations, because morphological variations related to race and population can be worked out using population-based studies.

iii. Model or formula creations were performed based on healthy individuals. However, external validation into diseased patients should be performed in future studies.

iv. The present approach is new especially for the four ethnic groups, as no report of stature estimation has been given for that population, we therefore recommend further studies in the four ethnic groups in order to validate the current study.

6.3 CONTRIBUTIONS TO KNOWLEDGE

a. Baseline data were obtained (mean height for Agoi = 162.61 ± 4.87 cm; Ayiga = 166.00 ± 7.29 cm; Ekoi = 167.15 ± 6.03 cm and Lokaa = 167.04 ± 5.53 cm).

b. Regression equation for stature estimation from sitting height, thigh length, leg length and demispan length was generated in the total study population as follows:

i. Agoi, HT = 2.33 + (0.908*TL) + (0.040*Age) + (0.981*LL) + (I.007*SHt) + (0.074*HB), r = 0.99, S.E.E. = 0.64, p = <0.001.

ii. Ayiga, HT = 19.73 + (1.190*TL) + (0.108*DSL) + (1.018*SHt) + (2.523*WHtR), r = 0.96, S.E.E. = 2.09, p = <0.001.

iii. Ekoi, HT = -5.08 + (1.097*SHt) + (0.767*TL) + (0.967*LL) + (0.101*DSL), r = 0.98, S.E.E. = 1.08, p = <0.001.

iv. Lokaa, HT = 30.85 + (1.043*SHt) + (1.238*LL), r = 0.92, S.E.E. = 2.15, p = <0.001.

c. Also alternative means of predicting stature from sitting height, thigh length, leg length, hand breadth and demispan length was achieved among the ethnic groups in Yakurr Local Government Area of Cross River State.

REFERENCES

Abdel-Malek, A. K., Ahmed, A. M., Sharkawi, S. A. and Hamid, N. M. (1990). Prediction of stature from hand measurements. *Forensic Science International*, 46: 181-187.

Aggrawal, A. N., Gupta, D., Ezekiel, L. M. and Jindal, S. K. (2000). Statistical estimation of height from arm span in north Indian Subjects. *Indian Journal of Physiological Pharmacology*, 44 (3): 329-334.

Agnihotri, A. K., Agnihotri, S., Jeebun, N. and Googoolybe, k. (2008). Prediction of stature using hand dimensions. *Journal of Forensic and Medicine,* 15 (8): 479-482.

Agnihotri, A. K., Purwar, B., Googoolybe, K., Agnihotri, S. and Jeebun, N. (2007). Estimation of stature by foot length. *Journal of Forensic and Legal Medicine*, 14 (5): 279-283.

Amirsheybani, H. R., Crecelius, G. M., Timothy, N. H., Pfeiffer, M., Saggers, G. C. and Manders, E. K. (2000). The natural history of growth of hand. Part I: Hand area as a percentage of body surface area. *Plastic and Reconstructive Surgery*, 107 (3): 726 -733.

Amirsheybani, H. R., Crecelius, G. M., Timothy, N. H., Pfeiffer, M., Saggers, G. C. and Manders, E. K. (2001). The natural history of growth of hand. Part II: Hand length as a treatment guide in paediatric trauma patients. *Journal of Trauma*, 49: 457 – 460.

Anderson, M. M., and Blais, M. M. and Green, W. T. (1956). Green, growth of the normal foot during childhood and adolescence length of the foot and interrelations of foot, stature and lower extremity as seen in serial records of children between 1–18 years of age. *American Journal of Physical. Anthropology*, 14: 287-308.

Anite, H. (2007). Worldwide variation in human growth. *Cambridge University Press*. 4: 67-68.

Anyanwu, G. E., Anibeze, C.I.P. and Akpuaka, F. C. (2007).Cardiothoracic ratio and body habitus in a Nigerian population. *Biomedical Research*, 18 (2): 119-122.

Ashizawa, K., Kumakura, C., Kusumato, A. and Narasaki, S. (1997). Relative foot size and shape to general body size in Japanese, Filipians and Japanese with special reference to habitual foot war types. *Annals of Human Biology,* 24: 117-129.

Ashley-Montagu, F. M. (1931). On the primate thumb. *American Journal Physical Anthropology*, 16 (2): 291.

Auerbach, B. M. and Ruff, C. B. (2004). Human body mass estimation: a comparison of morphometric and mechanical methods. *American Journal of Physical Anthropology*, 125: 331 – 342.

Baba, K. (1975). Foot measurement for shoe construction with reference to the relationship between foot length, foot breadth, and ball girth. *Journal of Human Ergonomics,* 3: 149-156.

Barker, S. L. and Scheuer, J. L., (1998). Predictive value of human footprints in a forensic context. *Forensic Science International*38: 341–346.

Bassey, E. J. (1986). Demi-span as a measure of skeletal size. *Annals of Human Biology,* 13: 499-502.

Ben-Noun, L. and Laor, A. (2003).Relationship of neck circumference to cardiovascular risk factors. *Obesity Research,* 11: 226-231.

Bhatnagar, D. P., Thapar, S. P. and Batish, M. K. (1984). Identification of personal height from the somatometry of hand in Punjabi males. *Forensic Science International,* 24: 137-141.

Bhavana, A. and Nath, S. (2009). Use of lower limb measurement in reconstructing stature among Shia Muslims. *Internet Journal of Biological Anthropology,* 2 (2).

Bidmos, M. A. (2006). Adult stature reconstruction from the calcaneus of South Africans of European descent. *Journal of Clinical and Forensic Medicine,* 13 (5): 247 – 252.

Bidmos, M. A. (2009). Evaluation of accuracy of direct and indirect methods in stature reconstruction. *Journal of Clinical and Forensic Medicine,* 18: 202 - 209.

Bidmos, M. and Asala, S. (2005). Calcaneal measurement in estimation of stature of South African blacks. *American Journal of Physical Anthropology,* 126 (3): 335-342.

Bjelica, D., Popovic, S., Kezunovic, M., Petkovic, J., Jurak, G. and Grasgruber, P. (2012). Body height and its estimation utilizing arm span measurements in Montenegrin adults. *Anthropological Notebooks,* 18 (2): 69-83.

Blais, M. M., Green, W. T. and Anderson, M. M. (1956). Lengths of the growing foot. *Journal of Bone Joint Surgery*, 38A: 998-1000.

Blant, J. M. and Altman, D. G. (1986). Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet,* 1: 307-310.

Bogin, B. and Keep, J. (1999). Patterns of human growth. *Cambridge University Press.*

Boldsen, J. (1984). A statistical evaluation of the basis for predicting stature from lengths of long bones in European populations. *American Journal of Physical Anthropology*, 65: 305 – 311.

Brenda, M. A. and Rohren, A. (2011). Estimation of stature from foot and shoe length: applications in forensic science. *Journal of Anatomical Society of India*, 5: 68-27.

Brown, J. K., Whittemore, K. T. and Knapp, T. R. (2000). Is arm span an accurate measure of height in young and middle-aged adults? *Journals of Clinical Nursing Research,* 9 (1): 84-94.

Byers, S., Akoshima, K. and Curran, B. (1989). Determination of adult stature from metatarsal length. *American Journal of Physical Anthropology,* 79: 275-279.

Cavelaars, A. E., Kunst, A. E. and Geurts, J. J. (2000). Persistent variations in average height between countries and between socioeconomic groups: an overview of 10 European countries. *Annals of Human Biology,* 27: 407-421.

Chan, D. C., Watts, G. F., Barrett, P. H. and Burke, V. (2003). Waist circumference, waist-to-hip ratio and body mass index as predictors of adipose tissue compartments in men. *Qatar Journal of Medicine,* 96: 4417.

Chandler, P. J. and Bock, R. D. (1991). Age changes in adults stature: trend estimation from mixed longitudinal data. *Annals of Human Biology*, 18: 433-440.

Chittanatarat, K., Sakda, P., Vibul, T., Winai, U. and Jayanton, P. (2012). Height prediction from anthropometric length parameters in Thai people. *Asia Pacific Journal of Clinical Nutrition*, 21 (3): 347-354.

Chitterjee, S., Das, N. and Chittergee, P. (1999). The estimation of the heritability of anthropometric measurements. *Journal of Applied Human Science,* 8: 1-7.

Chumlea, W. C., Roche, A. F. and Steinbearagh, M. L. (1985). Estimating stature from knee height for persons 60 and 90 years of age. *Journal of American Geriatric Society,* 33: 116-120.

Cline, M. G., Meredith, K E., Boyer, J. T. and Burrows, B. (1989). Decline of height with age in adults in a general population sample: estimating maximum height and distinguishing birth cohort effects from actual loss of stature with aging. *Annals of Human Biology,* 61: 415-425.

Cockram, D. B. and Baumgartner, R. N. (1990). Evaluation of the accuracy and reliability of callipers for measuring recumbent knee-height in elderly people. *American Journal of Clinical Nutrition*, 52: 397-400.

Cole, T. J. (2000). Secular trends in growth. *Proceedings for Nutritional Society,* 59: 317-324.

Courtney, A. J. (1984). Hand anthropometry of Hong Kong Chinese females compared to other ethnic groups. *Ergonomics*, 27: 1169-1180.

Cox, B. D. and Whichelow, M. J. (1996).Ratio of waist circumference to height is a better predictor of death than body mass index. *Biomedical Journal of Medicine,* 313: 1487.

Danborno, B. and Elukpo, A. (2008). Sexual dimorphism in hand and foot length, indices, stature-ratio and relationship to height in Nigerians. *The Internet Journal of Forensic Science,* 3(1).

Danborno, B., Adebisi, S. S., Adelaiye, A. B. and Ojo, S. (2009). Estimation of height and weight from the lengths of second and fourth digits in Nigerians. *TheInternet Journal of Forensic Science,* 3- 2.

Datta, B. S. (2011). Arm span as a proxy measure for height and estimation of nutritional status: A study among Dhimals of Darjeeling in West Bengal India. *Annals of Human Biology,* 38 (6): 728-735.

Dangour, A. D. (2001). Growth of upper and lower body segments in Patamona and Wapishana Amerindian children (cross-sectional data), *Annals Human Biology,* 28: 649-663.

Davis, K. T. (1984). The foot length and hand length to stature ratio. A study of racial variance. MA thesis. Department of anthropology, *Texas Tech University, Lubbock, TX.*

De Lucia, E., Lemma, F., Tesfaye, F., Demisse, T. and Ismail, S. (2002). The use of armspan measurement to assess the nutritional status of adults in four Ethiopian ethnic groups. *European Journal of Clinical Nutrition,* 56: 91-95.

De Mendonca, M. C. (2000). Estimation of height from lengths of long bones in a Portuguese adult population. *American Journal of Physical Anthropology*, 112: 39 -48.

Dean, R. S. (2006). Sexual dimorphism in upper Palaeolithic hand stencils. *Antiquity*, 80: 390-404.

Del Prado-Lu, J. L. (2007). Anthropometric measurement of Filipino manufacturing workers. *International Journal of Industrial Ergonomics* 37: 497-503.

Despres, J. P., Lemieux, I. and Prud'homme, D. (2001). Treatment of obesity. Need to focus on high risk abdominally obese patients. *Biomedical Journal of Medicine,* 322: 716-720.

Deurenberg, P., Deurenberg-Yap, M. and Guricci, S. (2003). Asians are different from Caucasians and from each other in their body mass index / body fat percent relationship. *Obesity Revolution,* 3: 141-146.

Dewangan, K. N., Prasanna Kumar, G. V., Suja, P. L. and Choudhury, M. D. (2005). Anthropometric dimensions of farm youth of the north eastern region of India. *International Journal of Industrial Ergonomics* 35: 979-989.

Didia, B. C., Omu, F. T. and Obuoforibo, A. A. (1987). The use of foot print contact index II for classification of flat feet in a Nigerian population. *Foot and Ankle Society,* 8(4): 0192-0211.

Ducharme, R. F., (1977). Women workers rate male tools inadequate. Hum. Factors Soc. *Bull.,* 20: 1-2.

Dupertius, A., Dupertius, C. W. and Casey, A. E. (1972). Physical anthropology of young adult females in Slieve Loughter, South West Island. *American Medical journal of Physical Anthropology,* 37: 435.

Duyar, I. and Pelin, C. (2003). Body height estimation based on tibia length in different stature groups. *American Journal of Physical Anthropology*, 122: 23 – 27.

Duyar, I., Pelin, C. and Zagyapan, R. (2006). A new method of stature estimation for forensic anthropological application. *Anthropological Science International,* 114: 23-27.

Ebimobo, K. T., Mukoro, D. G., Ezeuko, V. and Dorothea, B. (2014). Sexual dimorphism of correlations of feet anthropometric parameters and height (stature) among undergraduate students of a university, western Nigeria. *Journal of Dental and Medical Sciences,* 13 (14): 46-53.

Ebite, L. E., Ozoko, T. C., Eweka, A. O., Otuaga, P. O. and Oni, A. O. (2009). Height: Ulna Ratio: a method of stature estimation in a rural community in Edo state, Nigeria. *The Internet Journal of Forensic Science,* 3 (1).

Enang, S. B. (2009). The history of Yako people in Cross River State, Nigeria: Makurdi: *Oracle Business limited.*

Ebite, M. N., Guachi, S. T. and Frisher, K. R. (2000). Predicting stature through hand length. J*ournal of Crime and Criminalistics,* 52: 23-27.

Ekezie, J., Anibeze, C., Uloneme, G. C., Anyanwu, G. E, Danborno, S. B. and Iwuoha, G. (2015). Somatometric Evaluation of Long Bones of the Upper Extremity: A Forensic Tool. *Forensic Res Criminology International Joournal,* 1 (5):29.

Eksioglu, M., Fernandez, J. E. and Twomey, J. M. (1996). Predicting peak pinch strength: artificial neural networks vs. regression. *International Journal of Industrial Ergonomics,* 18: 431-441.

Enang, S. B. (1980). Mkpani pre-colonial history. *University of Calabar B.A History Project.*

Ethel, J. A. (1995). The anthropology and social significance of the human hand. *Virual Library Project*, 2 (2): 4-21.

Eveleth, P. and Tanner, J. M. (1990). Worldwide variation in human growth. *Cambridge University Press, Cambridge,* 157.

Fatmah, M. S. (2009). Predictive equations for estimation of stature from knee height, arm span, and sitting height in Indonesian Javanese elderly people. *International Journal of Medicine and Medical Sciences,* 1 (10): 456-461.

Fatmah, M. S. (2010). Validation of predicted height model based on arm span, knee height and sitting height in Indonesian elderly people. *Journal of Clinical Medicine and Research,* 2 (5): 67-73.

Fessler, D. M. T., Haley, K. J. and Lai, R. D. (2005). Sexual dimorphism in hand length proportionate to stature. *Annals of Human Biology,* 32 (1): 44-59.

Fraser, T. M. (1980). Ergonomic principles in the design of hand tools. Occup Safety and Health Series No. 44. *Geneva: International Labour Office*, pp, 93.

Freivalds, A. (1987). The ergonomics of tools. Inter. Rev. Ergonom., 1: 43-75.

Friedlaender, J. S., Costa, P. T., Bosse, R., Ellis, E., Rhoads, J. G. and Stoudt, H. W. (1977). Longitudinal physique changes among healthy white veterans at Boston. *Human Biology,* 49: 451-558.

Fully, G. (1956). Une nouvelle methode de determination de la taille.Ann. Me´d Le´gale, 36: 266-273.

Galloway, A. (1988). Estimating actual height in older individual. *Journal of Forensic Science*, 33: 126-136.

Gasser, T., Kneip, A., Binding, A., Prader, A. and Molinari, L. (1991). The dynamics of linear growth in distance, velocity and acceleration. *Annals of Human Biology*, 18-205.

Gauld, R. F. and Rakhir, S. M. (1996). The prediction of stature from hand length. *Journal of Crime and Criminalistics,* 8: 79-81.

Gauld, R. F. and Rakhir, S. M. (2004). The nutritional status of disabled children: a cross-sectional survey. *European Journal of Clinical Nutrition,* 53 (12): 915-919.

Giles, E. and Hutchinson, V. P. (1991). Height estimation from foot and shoeprint length. *Journal of Forensic Science,* 36: 1134-1151.

Gite, L. T.and Yadav, B. G. (1989). Anthropometric survey for agricultural machinery design: *An Indian case study, Applied Ergonomics,* 20: 191-196.

Golshan, M., Amra, B. and Hoghogi, M. A. (2003). Is arm span an accurate measure of height to predict pulmonary function parameters? *Monaldi Archives for Chest Disease,* 59 (3): 189-192.

Golshan, M., Crapo, R. O., Amra, B., Jenson, R. I. and Golshan, R. (2007). Arm span as an independent predictor of pulmonary function parameters: validation and reference values. *Respirology,* 12 (2): 361-366.

Gordon, C. C. and Buikstra, J. E. (1992). Linear models for the prediction of stature from foot and boot dimensions. *Journal of Forensic Science,* 37 (3): 771-782.

Gorman, R. E., Noble, A. and Andrews, C. M. (1997). The relationship between shoe size and mode of delivery. Midwifery Today Childbirth Education,41: 70-71.

Goswami, M. (2013). Prevalence of under-nutrition among the juangs: a study on a particularly vulnerable tribal group of Odisha, India. *Anthrocom Online Journal of Anthropology,* 9 (1): 1973-2880.

Grivas, T. B., Mihas, C., Arapaki, A. and Vasiliadis, E. (2008). Correlation of foot length with height and weight in school age children. *Journal of Forensic Science and Legal Medicine,* 15 (2): 89-95.

Gulsah, Z., Ipek, E. and Zehra, D. (2008). Stature and gender estimation using foot measurements. *Forensic Science International,* 181: 54.

Gustafsson, A. and Lindenfors, P. (2009). Latitudinal patterns in human stature and sexual stature dimorphism.*Annals of Human Biology* 36: 74-87.

Gunnel, D. J., Davey, S. G., Holly, J. M. P. and Frankel, S. (1998). Hand length and risk of cancer in the Boyd Orr. *British Medical Journal,* 317: 1350-1352.

Gupta, P. K., Gupta, M. L. and Sharma, A. (1983). Anthropometric survey of Indian farm workers. Agricultural *Mechanization in Asia, Africa and Latin America,* 14: 27-30.

Hairunnisa, M. (2014). Stature estimation from the anthropometric measurements of footprint in Iban ethnics of east Malaysia by regression analysis. *Journal of Forensic Science and Criminology,* 1 (5): 1.

Hansford, K., Bendor-Samuel, J. and Stanford, R. (1976). Studies in Nigerian language. *Summer Institute of LinguisticAccra*.

Hauspie, R. C., Vercauteren, M. and Sussane, C. (1996). Secular changes in growth. *Hormonal Research,* 45: 8-17.

Hasegawa, I., Uenishi, K., Fukunaga, T., Kimura, R. and Osawa, M. (2009). Stature estimation formulae from radiographically determined limb bone length in a modern Japanese population. *Legal Medicine*, Tokyo. 11: 260- 266.

Hauser, R., Smolinski, J. and Gos, T. (2005). The estimation of stature on the basis of measurements of femur. *Forensic Science International,* 147: 181-184.

Heitmann, B. L., Frederiksen, P. and Lissner, L. (2004).Hip circumference and cardiovascular morbidity and mortality in men and women. *Obesity Research,* 12: 482-487.

Heitmann, B. L. and Frederiksen, P. (2009).Thigh circumference and risk of heart disease and premature death: prospective cohort study. *Biomedical Journal of Medicine,* 339: 3292.

Hickson, M. and Frost, G. A. (2003). Comparison of three methods for estimating height in the acutely ill elderly population. *Journal of Human Nutrition and Dietetics,* 16 (1): 13-20.

Himes, J. H. and Roche, A. F. (1982). Reported versus measured adult statures. *American Journal of Physical anthropology,* 58: 335-341.

Hirani, V. and Mindell, J. (2008). A comparison of measured height and demi-span equivalent height in the assessment of body mass index among people aged 65 years and over in England. *Age and Ageing,* 37: 311-317.

Hirani, V., Tabassum, F., Aresu, M. and Mindell, J. (2010). Development of new demi-span equations from a nationally representative sample of adults to estimate maximal adult height. *Journal of Clinical Nutrition,* 140 (8): 1475-1480.

Holm, M., Peterson, J. H., Shakkebaek, N. E. and Jorgensen, N. (2005). A study of finger lengths, semen quality and sex hormones in 360 young men from the general Danish population. *Human Reproduction*, 20: 3109-3113.

Hossain, S., Begum, J. A. and Banu, L. A. (2010). Prediction of stature from hand length and breadth – an anthropometric study on Christian Garo tribal Bangladeshi females. *Bangladesh Journal of Anatomy,* 8: 21-27.

Ibeachu, P. C., Abu, E. C. and Didia, B. C. (2011). Anthropometric sexual dimorphism of length of the hand, breadth and hand indices of university of Port‐ Harcourt students. *Asian Journal Medical Science,* 3: 146‐ 150.

Ibegbu, A. O., Danjuma, Z. C., Hamman, W. O., Umana, U. E., Ikyembe, D. and Musa, S. A. (2014). Association of the index (2^{nd}) and ring (4^{th}) digit ratios with some physical attributesin Ebira ethnic group of Nigeria. *Applied Technologies and Innovations,* 7: 46-54.

IIayperuma, I., Nanayakkara, B. G. and Palahepitiya, K. N. (2008). A model for reconstruction of personal stature based on the measurements of foot length. *Galle Medical Journal,* 13: 6-9.

Ilayperuma, I., Nanayakkara, G. and Palahepitiya, N. (2009). Prediction of personal stature based on the length of the hand. *Galle Medicine Journal*, 214: 1.

Ilayperuma, I., Nanayakkara, G. and Palahepititya, N. (2010). A model for the estimation of personal stature from the length of forearm. *International Journal of Morphology,* 28 (4): 1081-1086.

Imrhan, S. N. and Contreras, M. G. (2005). Hand anthropometry in a sample of Mexicans in the US Mexico border region. In: Proceedings of the XIX Annual Occupational Ergonomics and Safety Conference, Las Vegas, NE, PP. 589-593.

Imrhan, S. N. and Nguyen, N. (1993). Hand anthropometry of Americans of Vietnamese Origin. *International Journal of industrial Ergonomics,* 12: 281-287.

Imrhan, S. N., Sarder, M. D. and Mandahawi, N. (2005). Hand anthropometry in a sample of Bangladesh females. In: Proceedings of the 10th Annual International Conference on Industrial Engineering-Theory, Applications and Practice, Clearwater, FL, PP. 566-569.

Imrhan, S. N., Sarder, M. D. and Mandahawi, N. (2006). Hand anthropometry in a sample of Bangladesh males. In: proceedings of the 8th Annual Industrial Engineering Research, Conference, Clearwater, FL, PP. 15-18. *Internet Journal of Forensic Science*, 1: 2.

Imrhan, S. N., Sarder, M. D. and Mandahawi, N. (2008). Hand anthropometry in survey of Jordanian. *International Journal of Industrial Ergonomics*, 38 (11-12): 966-976.

Iscan, M. Y. (1988). Rise of forensic anthropology. *Year Book of PhysicalAnthropology*, 31: 203-230.

Iscan, M. Y. (2000). Anthropometry, in: J. Siegel, P. Saukko, G. Knupfer (Eds.), *Encyclopedia of Forensic Sciences, Academic.*

Iscan, M. Y. (2001). Editorial: Global forensic anthropology in the 21st century. *Forensic Science International*, 117: 1-6.

ISO 7250 (2004). Basic human body measurements for technological design. *International Standard Organization.*

Iseri, A. and Arslan, N.(2009). Estimated anthropometric measurements of Turkish adults and effects of age and geographical regions.*International Journal of Industrial Ergonomics,*39: 860-865.

Isurani, I., Ganananda, N. and Nadeeka, P. (2009). Prediction of personal stature based on the hand length. *Galle Medical Journal,* 14 (1): 15-18.

Jain, P., Kaur, S. and Nath, S. (1996). Reconstruction of stature from hand and foot dimensions among male Brahmins of Kumaon (India). *Journal of Indian Academy and Forensic Sciences,* 35 (1-2): 22-29.

Jain, P., Roy, S. and Nath, S. (1999). Estimation of stature through measurements of hand and foot among Jats of Delhi. *Indian Journal of Anthropology,* 1 (3): 171-173.

Jalzem, P. F. and Gledhill, R. B. (1993). Predicting height from limb measurement. *Journal of Paediatrics and Orthopaedics,* 13 (6): 761-765.

Jasuja, O. P. (1987). Calculation of stature from foot and shoe impressions, *PhD dissertation, Punjabi University, Patiala,* India.

Jasuja, O. P., Jasvir, S. and Manjari, J. (1991). Estimation of stature from foot and shoe measurement by multiplication factors: A revised attempt. *Journal ofForensic Science*, 50: 203-215.

Jasuja, O. P. (2004). Estimation of stature from hand and phalange length. *Journal of Indian Academy and Forensic Medicine,* 26: 100- 106.

Jaydip, S. and Shila, G. (2008). Estimation of stature from foot length and foot breadth among the Rajbanshi: An indigenous population of north Bengal. *Forensic Science International,* 181 (1-3): 551-555.

Jakhar, J. K., Pal, V. and Paliwal, P. K. (2008). Estimation of height from measurements of foot length in Haryana region.*Journal of Indian Academy of Forensic Medicine,* 32(3):237-241.

Kanchan, T., Menzes, R. G., Mougil, R., Kotian, M. S. and Garg, R. K. (2008). Stature estimation from foot dimensions. *Forensic Science International,* 179 (23): 241-245.

Kanchan, T. and Rastogi, P. (2009). Sex determination from hand dimensions of North and South Indians. *Journal of Forensic Science,* 54: 546- 550.

Kar, S. K., Ghosh, S., Manna, I., Banerjee, S. and Dhara, P. (2003). An investigation of hand anthropometry of agricultural workers. *Journal of Human Ecology* 41: 57-62.

Karaday, B., Ozturk, A. O., Sener, N. and Altuntas, Y. (2012). Use of knee height for estimation of stature in elderly Turkish people and their relationship with cardiometabolic risk factors. *Archives of Gerontology and Geriatric,* 54 (1): 82-89.

Karunanithi, R., Tajuddin, A. and Kathirvel, K. (2001). Study on anthropometric dimensions of agricultural workers. *Journal of the Institution of Engineers (India), Agricultural Engineering Division,* 82: 13-19.

Kaur, D., Shukla, L., Jain, S., Pandey, S. M. and Choudhary, S. (2013). Hand: a scientific tool of measurement. *Journal of Morphological Sciences,* 30 (3): 167-169.

Kaya, M. D., Hasiloglu, A. S., Bayramoglu, M., Yesilyurt. H. and Ozok, A. F. (2003). A new approach to estimate anthropometric measurements by adaptive neuro-fuzzy inference System. *International Journal of Industrial Ergonomics,* 32: 105-114.

Kissebach, A. H. and Vydelingum, N. (1982). Relation of body fat distribution to metabolic complications of obesity. *Journal of Clinical Endocrinology,* 54: 254-260.

Krishan, K. (2008a). Determination of stature from foot and its segments in a north Indian Population. *Journal of Forensic Medicine and Pathology,* 29 (4): 297-303.

Krishan, K. (2008b). Estimation of stature from foot prints and foot outline dimensions in Gujjarrs of North India. *Forensic Science International,* 75: 93-101.

Krishan, K. and Sharma, A. (2007). Estimation of stature from dimension of hands and feet in north Indian Population. *Journal of Forensic and Legal Medicine,* 14: 327-332.

Krishan, K. and Sharma, A. (2007). Estimation of stature from foot print and foot dimensions of hands and feet in North Indian population. *Journal of Forensic and Legal Medicine,* 14: 327-332.

Krishan, K. and Vij, K. (2007). Diurnal variation of stature in three adults and one child. Vol. 9. Delhi: Kamla Raj Enterprise, *Anthropology,* 113- 117.

Krogman, W. M. and Iscan, M. Y. (1986). Determination of sex and parturition. *The Human Skeleton in Forensic Medicine. Charles C Thomas Publishers, Springfield,* 208-259.

Kwok, T., Lau, E. and Woo, J. (2002). The prediction of height by armspan in older Chinese people. *Annal Journal of Human Biology,* 29: 649-656.

Lahti-koski, M. and Pietenin, P. (2000). Trends in waist-to-hip ratio and its determinants in adults in Finland from 1987 to 1997. *American Journal of Clinical Nutrition,* 72: 1436-1444.

Laila, S. (2008). Anthropometric measurements of the upper limb and their relationships with the stature and hand shape, frame size and somato type of Bangali adult Muslim females. Thesis (M. Phil). *BSMMU, Bangladesh.*

Li, L., Hardy, R., Kuh, D., Lo, C. R. and Power, C. (2008). Child-to-adult body mass index and height trajectories: a comparison of 2 British birth cohorts. *American Journal of Epidemiology.* 168: 1008-1015.

Liu, Y., Tong, G., Tong, W., Lu, L. and Qin, X. (2011). Can body mass index, waist circumference, waist-to-hip ratio and waist-to-height ratio predict the presence of multiple metabolic risk factors in Chinese subjects? *Biomedical Central Public Health,* 11: 35.

Lohman, T. G., Roche, A. F. and Martorell, R. (1988). Anthropometric standardization reference manual. 1ed. Illinois: Abridged edition. *Human Kinetics Books,* 184p.

Macdonnel, W. R. (1901). On criminal anthropometry and identification of criminals. *Biometrika,* 1: 177-227.

Malas, M., Dogan, S., Evcil, E. and Desdicioglu, K. (2006). Fetal development of the hand, digits and digit ratio (2D:4D). *Early Human Development,* 82: 469-475.

Malina, R. M. (1994). Physical activity and training: Effects on stature and adolescent growth spurt. *Medical Science and Sport Exercise*, 26 (6): 759-766.

Manning, J. T., Barley, L., Walton, J., Lewis-Jones, D. I., Trivers, R. l., Singh, D. and Szwed, A. (2000). The 2^{nd}:4^{th} digit ratio, sexual dimorphism, population differences, and reproductive success: Evidence for sexually antagonistic genes. *Evolution and Human Behaviour*, 21: 163-183.

Manning, J. T., Bundred, P. E. and Flanagan, B. F. (2002). The ratio of 2^{nd} to 4^{th} digit length: a proxy for transactivation activity of the androgen receptor gene. *Medical Hypotheses,* 59: 334-336.

Manning, J. T., Henzi, P., Venkatramana, P., Martin, S. and Singh, D. (2003). 2^{nd} to 4^{th} digit ratio: ethnic differences and family size in English, Indian and South African populations. *Annals of Human Biology,* 30: 579-588.

Mauthausen, K. and Gusen, Y. R. (1959). Estimation of actual individual height during the exhumation of the remains of the former concentration camps. *Journal of Forensic Science,* 3: 533-537.

McFadden, D. and Shubel, E. (2002). Relative lengths of fingers and toes in human males and females. *Hormones and Behaviour*, 42: 492-500.

Meadows, L. and Jantz, R. L. (1995). Allometric secular change in the long bones from the 1800s to the present. *Journal of Forensic Science,* 40: 762-767.

Melton, J. l. and Cooper, C. (2001). Magnitude and impact of osteoporosis and fractures. In: Marcus, R., Feldman, D., Kelsey, J. editors. Osteoporosis SanDiego: *Academic Press*, 557-567.

Menezes, B. and Khany, M. (1998). Estimation of stature from length of sternum in South Indian males. *Forensic Science International*, 125: 141-148.

Mohanty, S. P., Babu, S. S. and Nair, N. S. (2001). The use of arm span as a predictor of height. A study of south Indian women. *Journal of Orthopaedics Surgery,* 9 (1): 19-23.

Mozaffer, R. H., Masood, A. Q. and Asghar, M. (2012). Neck circumference as a useful marker of obesity: a comparison with body mass index and waist circumference, *Journal Pak Medical Association,* 62: 36.

Munoz, J. I., Iglesias, M. I. and Penaranda, J. M. (2001). Stature estimation from radiographically determined long bone length in a Spanish population sample. *Forensic Science International,* 46 (2): 363-366.

Nabeel, M., Salman, S. I. and Al-Shobaki, B. S. (2008). Hand anthropometry survey for the Jordanian population. *International Journal of Industrial Ergonomics,* 38: 966-976.

Nag, A., Nag, P. K. and Desia, H. (2003). Hand anthropometry of Indian women. *Indian Journal of Medical Research,* 117: 260-269.

Nagesh, K. R. and Pradeep, K. G. (2006). Estimation of stature from vertebral column length in south Indians. *Legal Medicine,* 8 (5):269-272.

Naing, L., Winn, T. and Rusli, B. N. (2006). Practical issues in calculating the sample size for prevalence studies, *Archives of Orofacial Sciences*, 1: 9-14.

Nath, S. and Chug, D. (2002). Determination of Stature using hand and foot lengths among male and female Brahims of Sundernagar, Himachal Pradesh. In: Bhasin M. K, Surinder Nath. Preceding volume of the seminar on role of forensic science in the new millennium. *India: KRE Publishers*, 174-181.

Nath, S., Dayal, N. and Chandara, N. S. (1998). Reconstruction of stature using percutaneous lengths of forearm bones among Mundas of Midnapore district. *Journal of West Bengal Human Biology*, 37: 170-175.

Nath, S., Kaur, S., Jain, P. and Joshi, P. C. (1999). Reconstruction of stature among Rajputs and Brahmins of Srinagar Garhwal (U.P.). *South Asian Journal of Anthropology*. 20 (2): 63-66.

Neave, N., Laing, S., Fink, B. and Manning, J. (2003). Second to fourth digit ratio, testosterone and perceived male dominance, Proceedings. *Biological Sciences*, 270 (1529): 2167-2172.

Ngoh, H. J., Harith, S. and Harsa, A. M. (2012). Development of demi-span equations for predicting height among the Malaysian elderly. *Malaysian Journal of Nutrition*, 18 (2): 149-159.

Nicolay, C. W. and Walker, A. L. (2005). Grip strength and endurance: influences of anthropometric variation, hand dominance, and gender. *International Journal of Industrial Ergonomics*, 35: 605-618.

Numan, A. I., Idris, M. O., Zirahei, J. V., Amaza, D. S. and Dalori, M. B. (2013). Prediction of stature from hand anthropometry: a comparative study in the three major ethnic groups in Nigeria. *British Journal of Medicine and Medical Research*, 3: 1062- 1073.

Obikili, E. N. and Didia, B. C. (2009). Foot dimensions of a young adult Nigerian population. *Port Harcourt Medical Journal*, 1 (1): 22-24.

Okoi, I. O. (2011). Boundaries and resources conflicts in Cross River State, Nigeria: a case study of Ugep-Idomi boundary conflict between 1920 and 1992. *A Master Thesis submitted to the Graduate School University of Calabar*, Calabar.

Okoi-Uyouyo, M. (2002). Yakurr systems of kinship, family and marriage. Bookman, Calabar.

Okunribido, O. O. (2000). A survey of hand anthropometry of female rural farm workers in Ibadan, *Western Nigeria. Ergonomics*, 43: 282-292.

Oladipo, S., Fawehinmi, B., Ezon-Ebidor, E., Osunwoke, A. and Ordu, K. (2009). Second to fourth digit ratio in Nigerian Igbos and Yorubas. *Scientific Research and Essay*, 4: 1146-1148.

Oommen, A., Mainker, A. and Oommen, T. (2006). A study of the correlation between hand length and foot length in humans. *Journal of Anatomical Society of India,* 54 (2): 55-57.

Oria, R. S., Igiri, A. O., Egwu, O. A. and Nandi, M. E. (2016). Prediction of stature from hand length and breadth: anthropometric study on an adult Cross River State population. *Annals of Biological Anthropology,* 4:12-16.

Ozaslan, A., Iscan, M. Y., Ozaslan, I. and Tugcuh, K.O.C. (2003). Estimation of stature from body parts. *Forensic Science International*, 132: 40-45.

Ozaslan, A., Koç, S., Ozaslan, I. and Tuğcu, H. (2006). Estimation of stature from upper body extremity. *Forensic Science International*, 171: 288- 291.

Ozaslan, A., Karadayi, B., Kolusayin, M. O., Kaya, A. and Afsin, H. (2012). Predictive role of hand and foot dimensions in stature estimation. *Romans Journal of Legal Medicine*, 20: 41- 46.

Ozden, H., Balci, Y., Demirustu, C., Turgut, A. and Ertugrul, M. (2005). Stature and sex estimate using foot and shoe dimensions. *Forensic Science International,* 147: 181-184.

Padez, C. (2002). Stature and stature distribution in Portuguese male adults 1904-1998: the role of environmental factors. *American Journal of Human Biology,* 14: 39-49.

Palomino, H., Mueller, W. H and Schull, W. J. (1978). Altitude heredity and body proportions in Northern Chile. *American Journal of Physical Anthropology,* 50: 39-50.

Patel, S. M., Shah, G. V. and Patel, S. V. (2007). Estimation of height from measurement of foot length in Gujarat region. *Journal of the Anatomical Society of India,* 56 (1): 25-27.

Patel, P. N., Tanna, J. A. and Kalele, S. D. (2012). Correlation between hand length and various anthropometric parameters. *International Journal of Medical Toxicology and Forensic Medicine,* 2 (2): 61-63.

Paul, S., Kato, B., Hunkin, J., Vivekanandan, S. and Spector, T. (2006). The big finger: the second to fourth digit ratio is a predictor of sporting ability in women. *British Journal of Sports Medicine,* 40 (12): 981-983.

Pearson, K. (1899). Mathematical contributions to the theory of evolution. On the reconstruction of the stature of prehistoric races. *Philosophical Transactions of the Royal Society*, London. 192: 169-244.

Popovic, S., Bjelica, D., Molnar, S., Jaksic, D. and Akpinar, S. (2013). Body height and its estimation utilizing arm span measurements in Serbianadults. *International Journal of Morphology,* 31 (1): 271-279.

Qamra, S. R., Jit, I. and Deodhar, S. D. (1980). A model for reconstruction of height from foot measurements in an adult population of North West India. *Indian Journal of Medicine and Residency,* 71: 77-83.

Qamra, S. R., Deodhar, S. D. and Jit, I. (1986). A metric study of feet of north-west Indians and relationships to body height and weight. *Indian Journal of Physical Anthropology and Human Genetics,* 12 (2): 131-138.

Rastogi, P., Nagesh, K. R. and Yoganarasimha, K. (2008). Estimation of stature from hand dimensions of north and south Indians. *Legal Medicine,* 10 (4): 185-189.

Raxter, M. H., Auerbach, B. M. and Ruff, C. B. (2005). Revision of the fully technique for estimating statures. *American Journal of Physical Anthropology,* 130 (3): 374-384.

Reeves, S. L., Varakamin, C. and Henry, C. J. (1996). The relationship between limb measurement and height with special reference to gender and ethnicity. *European Journal of Clinical Nutrition,* 50(6): 398-400.

Roche, A. F. (1986). Bone growth and maturation, In: F. Falkner, J. M. Tanner (Eds.), 2nd ed., Human growth- A comprehensive treatise, vol. 2, Plenum Press, *New York and London*, 25-60.

Roche, A. F. and Davila, G. H. (1972). Late adolescent growth in stature. *Paediatrics,* 50: 874-880.

Rodier, P. M., Ingram, J. L., Tisdale, B. and Croog, V. J. (1997). Linking etiologies in humans and animal models: studies of autism. *Journal of Reproductive Toxicology,* 11: 417-422.

Rogol, A. D., Roemmich, J. N. and Clark, P. A. (2002). Growth at puberty. *Journal of Adolescent Health*, 31: 192-200.

Rolland, Y., Lauwers-Cances, V. and Cournot, M. (2003). Sarcopenia, calf circumference, and physical function of elderly women: A Cross-Sectional Study. *Journal of the American Geriatrics Society,* 51:1120-1124.

Sancho-Bru, J. L., Perez-Gonzalez, A., Mora, M. C., Leon, B. E., Vergara, M., Iserte, J. L., Rotriguez-Cervantes, P. J. and Morales, A. (2011). Towards a realistic and self-contained biomechanical model of the hand. *Theoretical Biomechanics,* 211-240.

Sandeep, S., Shema, N. K., Vaibhav, A., Vishal, B., Stapathy, D. K. and Yogender, M. (2013). Regression equation for estimation of femur length in central Indians from inter-trochanteric crest. *Journal of Indian Academy of Forensic Medicine,* 35 (3): 223-226.

Sanli, S. G., Kizilkanat, E. D., Boyan, N., Ozsahio, E. T, Bozir, M. G, Soames, R., Erol, H. and Oguz, O. (2005). Stature estimation based on hand length and foot length proportionate to stature. *Clinical Anatomy,* 18: 589- 600.

Santos, J. L. (2004). Anthropometric measurements in elderly population of Santiago, Chile. *Journal of Clinical Nutrition*, 20: 452-457.

Saxena, S. K. (1984). A study of correlations and estimation of stature from hand length, hand breadth and sole length. *Anthropologischer Anzeiger,* 42: 271-276.

Scherider, E. (1975). Ecology rules and body heat regulation in man. *Nature,* 1, 79, 915-916.

Schultz, R., Glaze, D., Motil, K., Hebert, D. and Percy, A. (1998). Hand and foot growth failure in Rett Syndrome'. *Journal of Child Neurology,* 13 (2): 71-74.

Seilers, S. (2008). The relationship between physical fitness and playing ability in rugby league players. *Research Journal of NSCA.*

Sen, J. and Ghosh, S. (2008). Estimation of stature through hand and foot breadth among the Rajbanshi: an indigenous population of north Bengal. *Forensic Science International,* 181 (1-3): 55-56.

Sen, R. N., Nag, P. K. and Ray, G. G. (1977). Some anthropometry of people of Eastern India. *Journal of the India Anthropological Society,* 12: 201-208.

Sheta, A., Hassan, M. and Elserafy, M. (2009). Stature estimation from radiological determination of humerus and femur lengths among a sample of Egyptian adults. *Bulletin of Allexendria Faculty of Medicine, 45. No.2. Academy Press.*

Singh, T. S. and Phookan, M. N. (1993). Stature and foot size in four Thai communities of Assam. *Indian Journal of Anthropology,* 51 (4): 349-355.

Sjostrom, C. D. and Hakangard, A. C. (1995). Body compartment and subcutaneous adipose tissue distribution-risk factor patterns in obese subjects. *Obesity Research,* 3: 9-22.

Sjostrom, C. D. and Lissner, L. (1997). Relationship between changes in body composition and changes in cardiovascular risk factors: the SOS intervention study: Swedish obese subjects. *Obesity Research,* 5: 519-530.

Smith, W. D., Cunningham, D. A., Paterson, D. H. and Koval, J. J. (1995). Body mass indices and skeletal size in 394 Canadians aged 55-86 years. *Annals of Human Biology,* 22: 305-314.

Smith, S. L. (2007). Stature estimation of 3-10-year-old children from long bone lengths. *Journal of Forensic Sciences,* 52:538-46.

Smolej, N. N., Jasna, M., Eljka, T., Matea, Z. P., Tatjana, K. J. and Spomenka, T. R. (2013). Anthropometric indices of nutritional status in Croatian oldest old: new equations to predict height and weight. *Periodicum Biologorum,* 115 (4): 483-489.

Steyn, M. and Iscan, M. Y. (1997). Sex determination from the femur and tibia in south African whites. *Forensic science International,* 90: 111-119.

Stock, Y. K. (2006). Correlation of human height as polygenic. *Forensic Science International,* 212: 523-535.

Stranisev, D., Pavlons, K. G., Kerrmikov, L. and Petrov, I. (1970). Somatometrische. *Tabellen Folia Medical,* 12 (1-4): 148-157.

Swati, R. P., Anjali, D. P. and Meshram, M. M. (2012). Estimation of height (stature) from inferior extremity length and foot length in Children. *International Journal of Recent Trends in Science and Technology,* 3 (2): 33-37.

Tanner, J. M., Hayashi, T., Preece, M. A. and Cameron, N. (1982). Increase in length of limb relative to trunk in Japanese children and adults from 1975 to 1977: comparison with British and Japanese Americans. *Annals of Human Biology,* 9: 411-423.

Teixeira, P. J. and Sardinha, L. B. (2001). Total and regional fat and serum cardiovascular disease risk factors in lean and obese children and adolescents. *Obesity Research,* 9: 432-442.

Ter Goon, D., Toriola, A. T., Musa, D. I. and Akusu, S. (2011). The relationship between arm span and stature in Nigerian adults. *Kinesiology,* 43 (1): 38-43.

Thakur, S. D. and Rai, K. S. (1987). Determination of stature from hand measurement. *Medicine Science and Law,* 78: 25-28.

Trotter, M. and Glesser, G. C. (1951). Are evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. *American Journal of Physical Anthropology,* 16(1): 79-123.

Ubi, O. A. (1978). The Yakurr: A reconstruction of pre-colonial history. PhD. History Thesis submitted to the University of Lagos.

Ubi, O. A. (1986). Analysis of two bronzes from a Nigerian Asunaju shrine: *A Rejoinder Africana Marburgensia* xix, pp. 7-8.

Ukpenetu, E. (1987).The impact of urbanization on the traditional government of Ugep 1900 – 1960. *A Project submitted to the Department of History, Unviersity of Calabar,* Calabar.

Vague, J. (1956). The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. *American Journal of Clinical Nutrition,* 4: 20-34.

Vasavada, J. D., Anita, N. and Gunter, S. P. (2007). Female necks are not uniformly scaled versions of male necks. *American Journal of Epidemiology,* 34: 56-67.

Wallien, M., Zucker, K., Steensma, T. and Cohen-Kettenis, P. (2008). 2D:4D finger length ratios in children and adults with gender identity disorder. *Hormones and Behaviour*, 54 (3): 450-450.

Weinbrenner, T., Vioque, J., Barber, X. and Asensio, L. (2006). Estimation of height and body mass index from demi-span in elderly individuals. *Archive of Gerontology and Geriatrics*, 52 (5): 275-281.

Wells, J. C. (2007). Sexual dimorphism of body composition. *Best Practical Research in Clinical Endocrinology and Metabolism*, 21: 415-430.

Wells, J. C., Charoensiriwath, S. and Treleaven, P. (2011). Reproduction, aging and body shape by three-dimensional photonic scanning in Thai men and women. *American Journal of Human Biology,* 23: 291-298.

WHO. (1995). Physical status: the use and interpretation of anthropometrics. *Report of a WHO Expert Committee Technical Report, Series No 854, Geneva*.

Wilder, H. H. (1920). A laboratory manual of anthropometry, *Blakiston, Philadelphia*, 84-109.

Williams, T., Pepitone, M. and Christensen, S. (2000). Finger length ratios and sexual orientation. *Nature*, 404 (6777): 455-456.

Wolanski, N. (1970). Kinetics and dynamics of growth and differentiation in body proportions in children and young people from Warsaw (aged 3 to 20 years). *Pantroswong Zaklad Wydwnectw Lekarskich, Warsaw.*

Wunderlich, R. E. and Cavanagh, P. R. (2001). Gender differences in adult foot shape: implication for shoe design. *Medical Sciences and Sports Exercise*, 33: 605-611.

Yyagi, A. K. and Kohli, A. (1999). Correlation between stature and finger length. *International Journal of Medical Toxicology and Legal Medicine*, 1: 20-22.

Zeybek, G., Ergur, I. and Demiroglu, Z. (2008). Stature and gender estimation using foot measurements. *Forensic Science International,* 181 (54): 1-545.

APPENDIX I

AHMADU BELLO UNIVERSITY, ZARIA
DIRECTORATE OF ACADEMIC PLANNING & MONITORING

Vice Chancellor: *Prof. Ibrahim Garba, B.Sc. (Hons) Geology, M.Sc. (Mineral Exploration) A.B.U., Ph.D Geology (London), D.I.C., FNMGS*
Director: Prof. M.F. Ishiyaku, B.Sc. (Hons) Botany (ABU), M.Sc. Plant Breeding (UniJos), Ph.D Agriculture (University of Reading, U.K.), MASN, MBSN

Tel. Zaria + 234-069-551912 Fax. 234 (069) 550022 Telegram: UNIBELLO Zaria e-mail: dapm@abu.edu.ng

Appl No.: ABUCUHSR/2017/Human Anatomy/011 13th April, 2018

Approval No: ABUCUHSR/2017/011

Dr. B. Danborno
Department of Human Anatomy,
College of Health Sciences,
Ahmadu Bello University,
Zaria.

Sir,

PROVISIONAL APPROVAL OF RESEARCH TITLED "ANTHROPOMETRIC STUDY AND STATURE ESTIMATION IN LOKAA, AYIGA AND EKOI ETHNIC GROUPS OF YAKURR LOCAL GOVERNMENT AREA OF CROSS RIVER STATE, NIGERIA"

This is to convey the provisional approval of the ABUCUHSR to you for the aforestated study domiciled in Department of Human Anatomy of the Ahmadu Bello University. The approval is predicated on the assumption that you shall maintain and cater for the study subjects as indicated in your application.

Monitoring of the Research by spot checks, invitations, interactions with the subjects any other means the Committee deems fit shall be undertaken at the convenience of the Committee.

This approval can and shall be revoked should a significant breach in the terms and condition of the approval occur. It is hence your responsibility to ensure that the agreed terms are maintained to the end of the Study.

The said approval shall be posted on the ABUCUHSR Page on the University's website.

Note upon completion of the research, ethical clearance certificate will be issued.

Prof. I.H. Nock
ABUCUHSR Chairman

Cc. Director, DAPM
Director, IC &ICT
Provost, College of Health Sciences
HOD, Human Anatomy.
Prof. J.A. Randawa

APPENDIX II

DEPARTMENT OF HUMAN ANATOMY

FACULTY OF BASIC MEDICAL SCIENCES

COLLEGE OF HEALTH SCIENCES

AHMADU BELLO UNIVERSITY, ZARIA

Dear Respondent,

I, Koko Ottoh Arikpo, an M.Sc. student in the Department of Human Anatomy of the above named institution, I am carrying out a research on Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi Ethnic Groups of Yakurr Local Government Area of Cross River State, Nigeria. Participation is voluntary. It involves collection of certain information about your personal and family characteristics and measurements of some anthropometric parameter: weight, height, demi span length, biaxillary length, hand length, foot length, thigh length, leg length, neck length, sitting height, thigh circumference, calf circumference, chest circumference, neck circumference, waist circumference and hip circumference.

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

Thank you for your cooperation.

Yours sincerely,

Koko Ottoh Arikpo

APPENDIX III

CONSENT TO PARTICIPATE IN RESEARCH

Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi Ethnic Groups of Yakurr Local Government Area of Cross River State, Nigeria

INTRODUCTION

You are kindly being asked to participate in a research study conducted by Koko Ottoh Arikpo for a Master of Science degree under the supervision of Dr. B. Danborno, and Dr. J. A. Timbuak, from the Department of Human Anatomy, Faculty of Basic Medical Sciences, Ahmadu Bello University, Zaria. If you have any questions or concerns about the research, please feel free to contact: Koko Ottoh Arikpo, Faculty of Basic Medical Sciences, Tel: 08062679628, Dr. B. Danborno, Faculty of Basic Medical Sciences, Tel: 08139429300, or Dr. J. A. Timbuak, Faculty of Basic Medical Sciences, Tel: 08036986537.

PURPOSE OF THE STUDY

The present study is primarily aimed to compare the anthropometric parameters of Yakurr using four different ethnicities including Lokaa, Ayiga, Agoi and Ekoi, and to estimate stature from anthropometric parameters of the ethnic groups. However, it is also expected that the results might implicate certain anthropometric indexes, ethnicity, demography, nutrition, physical activities and socioeconomic factors of the ethnicities in the local government area.

If you volunteer to participate in this study, I would ask you to do the following things:

To fill in proforma and I shall take some of your anthropometric measurements.

POTENTIAL RISKS AND DISCOMFORT

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

POTENTIAL BENEFITS TO PARTICIPANTS

The result of this study, when published will help to provide anthropometric data on the various ethnic groups of Yakurr, contribute to understanding of the relative status of Yakurr population in the context of anthropometric variations round the world, used by law enforcement agents and forensic scientists to identify fragmentary and dismemberedhuman remains in Nigerian adults of Yakurr descent of Cross River State, and to create specific regression equation which could help in prediction of stature of Nigerian adults of Yakurr descent of Cross River State, and the influence of these body parameters on anthropometric indexes, ethnicity, demography, nutrition, physical activities and socioeconomic factors. The conclusions that will be drawn will suggest whether there is a strong correlation between stature and the parameters measured, and will indicate if stature could be predicted using these parameters, age, weight and BMI among Lokaa, Ayiga, Agoi and Ekoi adults of Cross River State – Nigeria.

PAYMENT FOR PARTICIPATION

Participation will not attract any financial benefit.

CONFIDENTIALITY

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS

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

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

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I have read the information provided for the study "Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi ethnic groups of Yakurr Local Government Area of Cross River State, Nigeria" as described herein. I have been given a copy of this form.

____

Name of Participant

___________________________________ _______________

Signature of Participant Date

SIGNATURE OF WITNESS

____

Name of Witness

___________________________________ ______________

Signature of Witness Date

Anthropometric Study and Stature Estimation in Lokaa, Ayiga, Agoi and Ekoi Ethnic Groups of Yakurr Local Government Area of Cross River State, Nigeria

Name: Koko Ottoh Arikpo

Position:MSc Student

Contact Address: Department of Human Anatomy, Faculty of Basic Medical Sciences, Ahmadu Bello University, Zaria

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

-- ------------------------

Name of Participant Date Signature

---------------------------- ----------------------- ------------------------

Name of Researcher Date Signature

APPENDIX IV

Proforma for Estimation of Height from Anthropometric Length Parameters of Lokaa, Ayiga Agoi and Ekoi Ethnic Groups of Cross River State, Nigeria

BIODATA

1. Research ID ______________
2. Age _______________
3. When were you born ________/ __________/ ______ (DD/MM/YYYY)
4. Sex Male [ ] Female [ ]
5. Tribe: Lokaa [ ] Ayiga [ ] Agoi [ ] Ekoi [ ]
6. Father's Tribe ______________________
7. Grand Father's Tribe ________________________
8. Mother's Tribe _____________________________
9. Grand Mother's Tribe ________________________

SOCIO-DEMOGRAPHIC DATA

1. Fathers Occupation _________________________
2. Father's level of education: A None [ ] B. Primary [ ] C. Secondary [ ] D. Tertiary [ ]
3. Mother's level of education: A . None [ ] B. Primary [ ] C. Secondary [ ] D. Tertiary [ ]
4. Birth order: A. First birth [ ] B. Second birth [ ] C. Third birth [ ] D. Later born [ ]
5. Number of brother (s) ____________________
6. Number of sister (s) ________________________

ANTHROPOMETRIC DATA

GENERAL MEASUREMENTS

1. Height_____________ (cm)
2. Weight _____________ (kg)
3. BMI _______________ (kg/m^2)

UPPER LIMB ANTHROPOMETRY

1. Demispan length __________ (cm)
2. Biaxillary length ____________(cm)
3. Hand length_______________ (cm)

LOWER LIMB ANTHROPOMETRY

1. Foot length ______________ (cm)
2. Thigh length _____________ (cm)
3. Thigh circumference _____________ (cm)
4. Calf circumference ________________ (cm)
5. Leg length __________________ (cm)

TRUNK ANTHROPOMETRY

1. Neck length _________________ (cm)
2. Chest circumference ____________ (cm)
3. Neck circumference _____________ (cm)
4. Waist circumference _____________ (cm)
5. Hip circumference _______________ (cm)
6. Sitting height ___________________ (cm)

You have finished the proforma ------- Thank you