"ESTIMATION OF STATURE BY ANTHROPOMETRIC MEASUREMENTS OF INTER-ACROMIAL LENGTH AMONG NORTH KARNATAKA STUDENTS - A CROSS SECTIONAL STUDY"

By

DR. VISHAL V. KOULAPUR

Dissertation

Submitted to the KLE UNIVERSITY, BELGAUM, Karnataka,
In partial fulfillment of the requirements
for the degree of

M.D. (DOCTOR OF MEDICINE)

IN

FORENSIC MEDICINE & TOXICOLOGY

Under the guidance of
DR. S. S. AGARWAL MD, DNB

DEPARTMENT OF FORENSIC MEDICINE & TOXICOLOGY
JAWAHARLAL NEHRU MEDICAL COLLEGE,
BELGAUM - 590010.

MAY – 2009

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BELGAUM.

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **"ESTIMATION OF STATURE BY ANTHROPOMETRIC MEASUREMENTS OF INTER ACROMIAL LENGTH AMONG NORTH KARNATAKA STUDENTS – A CROSS SECTIONAL STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. S. S. AGARWAL** MD, DNB Associate Professor, Department of Forensic Medicine and Toxicology, J. N. Medical College, Nehru Nagar, Belgaum-590010.

Date:
Place: **Belgaum**

Signature of the Candidate
(Dr. Vishal Koulapur)

KLE UNIVERSITY
BELGAUM

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Date:
Place: **Belgaum**

Signature of the Guide
Dr. S. S. AGARWAL
MD, DNB
Associate Professor,
Department of Forensic Medicine & Toxicology,
KLE University's
J. N. Medical College,
Nehru Nagar, Belgaum -10.

KLE UNIVERSITY
BELGAUM.

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This is to certify that the dissertation entitled **"ESTIMATION OF STATURE BY ANTHROPOMETRIC MEASUREMENTS OF INTER ACROMIAL LENGTH AMONG NORTH KARNATAKA STUDENTS – A CROSS SECTIONAL STUDY"** is a bonafide research work done by **Dr. Vishal V. Koulapur** under the guidance of **Dr. S. S. Agarwal** MD, DNB Associate Professor, Department of Forensic Medicine & Toxicology, J. N. Medial College, Nehru Nagar, Belgaum-590010.

Seal & Signature of the

Head of Department

Dr. Swapnil Agarwal MD, DNB
Assoc. Professor and I/C Head of Department,
Department of Forensic Medicine & Toxicology,
KLE University's
J. N. Medical College, Nehru Nagar,
Belgaum -10

Date:
Place: **Belgaum**.

Seal & Signature of the

Principal

Dr.V. D. Patil MD, DCH
Principal,
KLE University's
J. N. Medical College,
Nehru Nagar,
Belgaum – 10

.

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ABSTRACT

Background and objectives:

Personal identification is an integral part of the investigation in cases of mass disasters where disintegrated and amputated body organs are found very frequently. Estimating stature from various parameters based on the above mentioned evidences becomes one of the most important and essential exercise for personal identification. The objective of this study is to derive a regression equation to estimate stature from the inter-acromial length suitable for North Karnataka region population.

Methods:

The present study is a cross-sectional study of one year duration from 1st November 2006 to 31st October 2007. A total of 150 subjects (75 females and 75 males) aged 21 years and above, studying in KLE's health institutions, born and brought up in North Karnataka region are studied. Stature and inter-acromial length of each subject was measured using a standard anthropometer rod set and the data was statistically analyzed to derive regression equations.

Results:

Three sets of regression equations were derived after statistical analysis of the data. They are:

1. Females and males combined
2. Females only
3. Males only

Interpretation and conclusion:

The present study revealed that there exists a positive and significant correlation between stature and inter-acromial length in both the sexes and that stature can be estimated with the inter-acromial length when mutilated upper parts of the trunks are available.

Results of the present study indicate that the stature can be estimated with inter-acromial length by using the regression equation:

Males and females combined: $y = 103.82 + 2.1\ x$ with a standard error of ±5 cm.

Females only: $y = 103.62 + 1.6\ x$ with a standard error of ±4 cm.

Males only: $y = 167.50 + 0.20\ x$ with a standard error of ±6 cm.

Where y is stature and x is inter-acromial length in cm.

The above equations are suitable for North Karnataka region population.

Keywords: Stature, inter-acromial length, regression equation.

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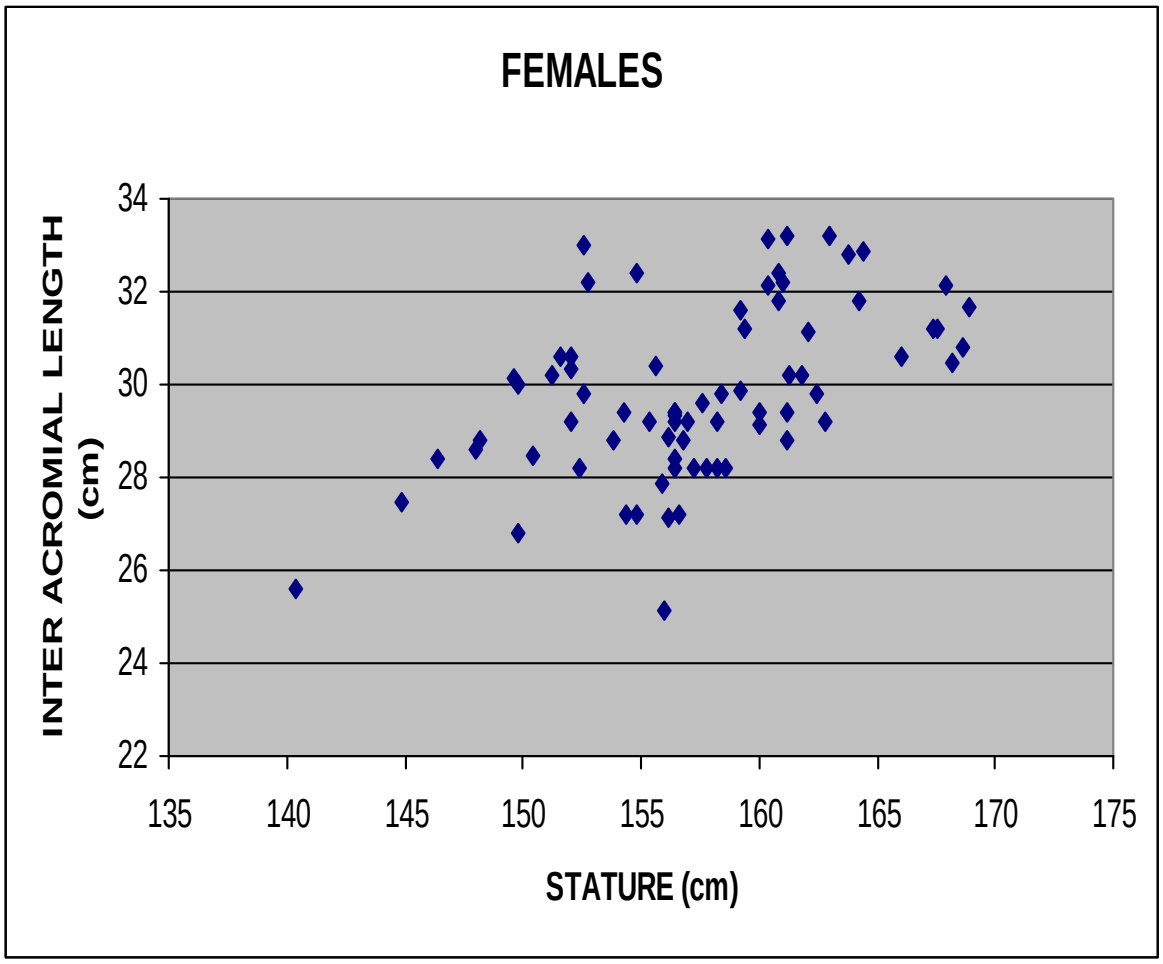

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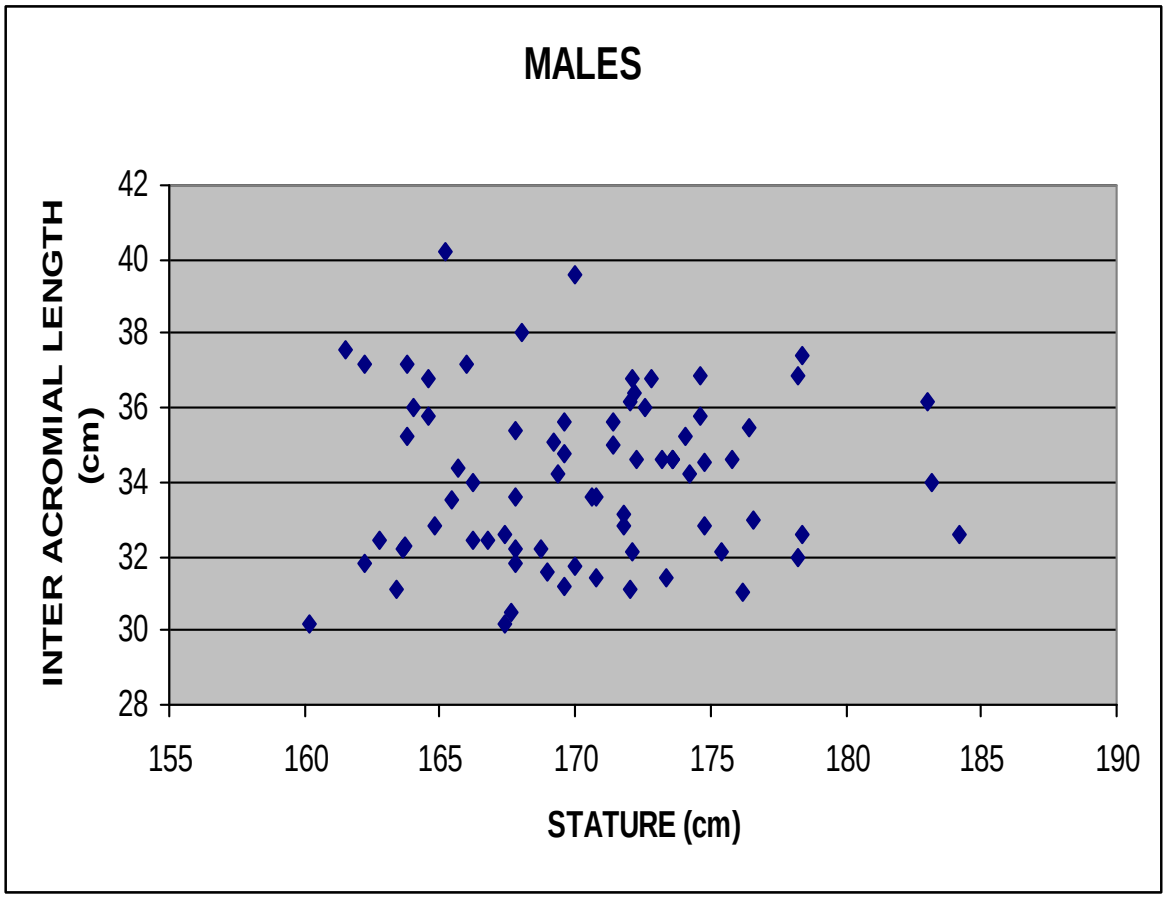

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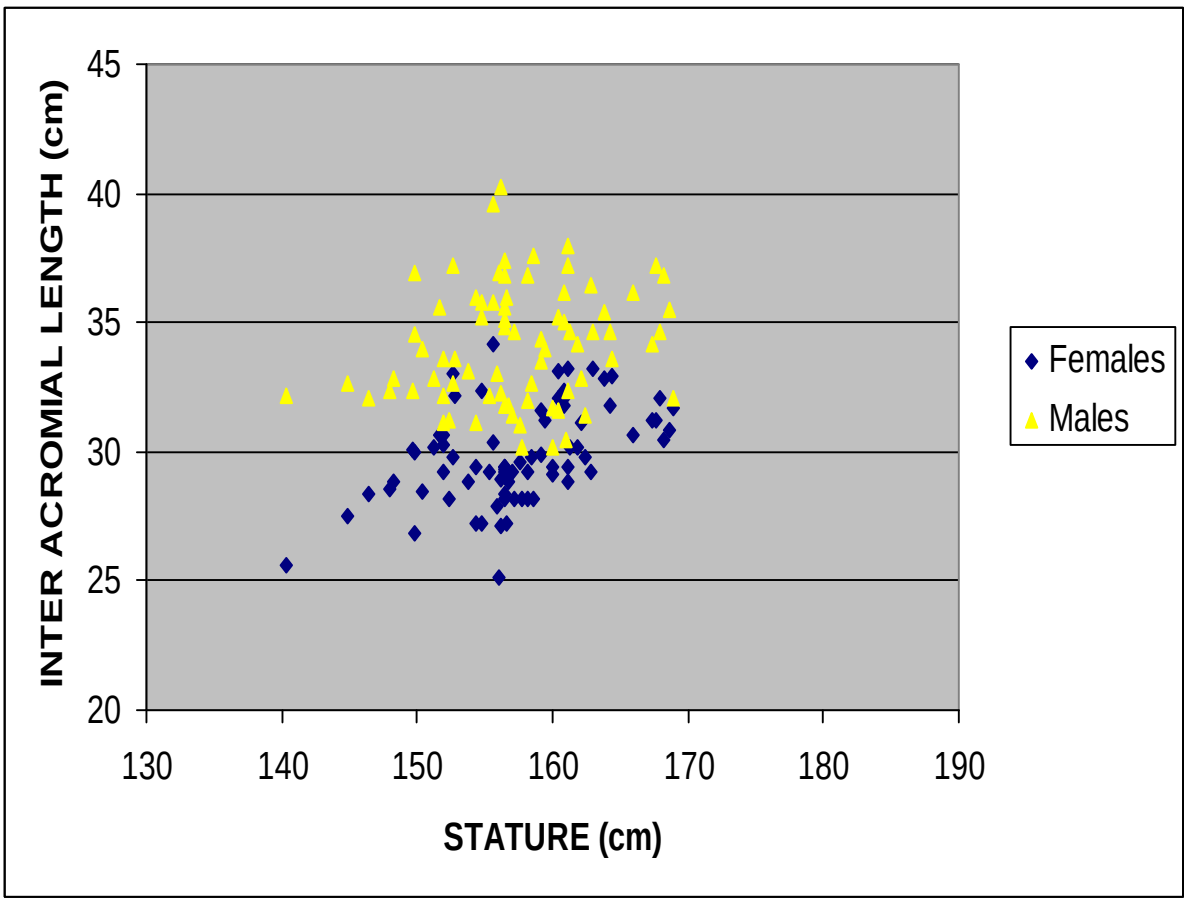

INTRODUCTION

United Nations Declaration on Human Rights dated December 10, 1948 says that "Identification is an individual's birth right". [1]

Identification in the medico-legal sense refers to the determination of individuality of a person. It can be complete or partial. Complete identification is a proven fact by itself, wherein all the data of the individual is available. Partial identification is one, where in, the data available is in bits / pieces, from which the complete individuality of the person has to be framed. The various parameters of partial identification are age, sex, race, stature etc. [2]

Out of these various parameters of partial or incomplete identification, this study focuses upon **"stature"**, which is one of the important parameters.

Stature provides one aspect of an individual's physiognomy and one piece of information that may prone to be an important aid in individual's partial identification.

Estimation of stature of an individual by any means is a part of science called Anthropology. Anthropology is a Greek word where anthropos means human being and logos means knowledge. It is a field of science that deals with the study of humans from their earliest beginnings on earth up to the present time. [3]

Forensic anthropology is the application of this anthropological knowledge and techniques in a legal context. This involves detailed knowledge of osteology to aid in the identification, to establish cause of death and time since death etc from skeletal remains.[4] Estimation of living stature from skeletal remains is an important feature of forensic anthropology. The identification of skeletal, badly decomposed or otherwise unidentified human remains is significant for both legal claims (property,

insurance) and humanitarian reasons. Forensic anthropologists apply standard explicit techniques of physical anthropology to identify human remains to assist the process of identification. They assist the investigating team in locating and recovering evidence and work to suggest the sex, age, race, stature, and other unique features of a decedent from the skeletal remains. They often work in juxtaposition with forensic pathologists, odontologists and homicide investigators to identify a decedent. [5]

The method for estimating stature from skeletal remains is by various anthropometric measurements.Literal meaning of anthropometry is "measurement of humans". It refers to the measurement of living human individuals for the purposes of understanding human physical variation. [6]

The estimation of height of an individual is of more compelling concern to forensic and anthropology experts. The orthodox method for stature estimation is correlation between living stature and lengths of long bones. Consequently, many sets of regression equations have been developed for this purpose. The better known are Karl-Pearson, Dupertius and Hadden and Trotter and Glesser. However, these methods are limited to long bones only and applicable to western populations.[7] Several Indian researchers have also developed regression equations for the same, some of them are Siddiqui and Shah, Singh and Soha and Mehta and Thomas. [8]

Some authors have attempted to find suitable alternatives when human remains are discovered. Methods have also been developed for use in case of fragmentary remains with identifiable bony land marks. [9]

Earlier, studies have been done on stature estimation by using different body parts and their measurements such as estimation of stature using foot and shoe dimensions, from dimensions of hands and feet, from the long bones of the forearm,

from long bones of the lower limb, from per-cutaneous tibial length, stature estimation from somatometry of skull, etc.

Although a number of studies have been done on stature estimation by using different body parts, very few of them are by using inter- acromial length. Inter– acromial length is the distance between two bony landmarks, i.e. acromial processes of scapula on each side. Acromion is the most lateral point on the lateral margin of the acromial process when the subject stands in normal position with his arms hanging by the sides. [10] The present study is taken up to fill the above lacuna. In addition, inter – acromial length being a macro measurement, is easy to measure. Ethical issues involved in the study are minimal and no invasive methods are involved.

Till now no study has been done on stature estimation by anthropometric measurements of inter - acromial length in North Karnataka Region. In view of this, the present study is undertaken on the subjects of the North Karnataka Region. (Districts included are Belgaum, Dharwad, Bijapur, Bagalkot, Gulburga, Haveri and Gadag).

AIMS AND OBJECTIVES

- To evolve regression equation for both the sexes for stature estimation from inter-acromial length suitable for the people from North Karnataka region.
- The regression equation to be prepared using statistical methods from the relationship between stature and inter-acromial length.
- To know the accuracy of developed regression equation.

REVIEW OF LITERATURE

Historical Background

Aristotle (384-322 BC) is considered as the first authority to use the word "Anthropology". He observed the comparative characters of man and other animals. According to him, man is the most complete animal in all its parts. His work provide us with much useful and interesting anthropological information on heredity, growth, body proportions, biped nature of man and so forth. He marked the peculiar characteristics of man and on the basis of those; he gave man a special place among animals.

Anthropology is the science which deals with the comparative study of man, as a physical and cultural being. It has two main branches – Cultural or Social Anthropology and Physical Anthropology. Cultural Anthropology is the study of man as a cultural being, his work, behaviors and social patterns, etc., while physical anthropology is concerned with man as a physical organism in time and space. Here, "time" means the stages of development of man in the process of evolution during different periods of time, while "space" refers to the differentiation of physical types in modern man living in different parts of globe. Thus, physical anthropology has two principal focuses and these are human evolution and variation. The study of human evolution and human variation are the two principal aspects of physical anthropology.

The development of physical anthropology as an organized and systemic discipline started in the second half of 19^{th} century. Hippocrates (460-377 BC) laid more emphasis on environment to explain differences in physical features among different populations. He demonstrated the differences in physical features between the inhabitants of the hills and the plains.

Galen (131-200 AD) observed that the apes were the closest kins of man. He found that apes resembled man most closely in viscera, muscles, bones etc.

Vesalins (1514-1564) was a renowned anatomist of the 16th century. His observations on anatomical characters and descriptions of the structure of human body contributed considerably towards the growth and development of physical anthropology at a later stage.

Of the scientists of the 17th century who made notable contributions towards physical anthropology were Tyson (1650-1708), Garengeot (1688-1708) and John Ray (1628-1705). Tyson made a comparative study of the anatomical characters of apes and man.

Carl Linnaeus (1707-1778), Count de Buffon (1707-1788) & J.F. Blumenbach (1753-1840) were three renowned scholars of 18th century, who made notable contributions to physician anthropology.

Buffoon may be regarded as the founder of anthropology. According to him with an anthropological approach man may be studied:

i. In general, as a natural history subject throughout the ages
ii. In groups, i.e. races-their origin, description and admixture
iii. To compare physical characteristics of man and other animals

Blumenbach is considered to be the father of physical anthropology. He looked at the variation in physical features observed in different population groups. [11]

As defined, anthropology is the study of human kind, culturally and physically, in all times and places. Forensic Anthropology is the application of this anthropologic knowledge and techniques in a legal context. [4]

The forensic anthropologist uses the skills and techniques learned in the study of prehistoric skeletal population and apply this knowledge for establishing the age,

sex, race, stature etc. and often the manner of death from skeletal remains found in medico-legal context. In situations, where the corpse is severely mutilated, decomposed or represented by skeletal remains only, the stature of the individual may be estimated by means of skeletal measurements. Such estimation is based on the relations between skeletal parts and stature. As a rule of thumb, the larger the skeletal parts, the taller the individual. [12]

With regard to the method of stature reconstruction, Thomas Dwight proposed two methods for estimation of stature from skeletal remains.

1. Anatomical
2. Mathematical.

The Anatomical method involves simply putting the bones together, in reproducing the curves of the spine, in making due allowance for the soft parts and measuring the length. This method is workable when almost complete skeleton is available for examination. The Mathematical method, on the other hand, is based on the proportion of long bone to the height of an individual. This method is workable even if a single limb bone is available for examination.

The Mathematical method may be used in following ways:

1. By formulating prediction equation.
2. By computing multiplication factors.

Out of these two methods, the prediction equations provide a more reliable estimate of stature as compared to the one obtained using multiplication factor. [5]

Alphonse Bertillion was a French Law enforcement officer and biometrics researcher who created anthropometry, an identification system based on physical measurements. Anthropometry was the first scientific system used by police to identify criminals. [13]

Anthropometry – the measurements of man – provides scientific methods and techniques for taking various measurements and observations on the living man and skeleton. Anthropometry represents the typical and traditional tool of physical anthropology. The number and type of measurements have varied with the nature of the problems.

Anthropometry may be sub – divided into the following sections:

i) Somatometry: Measurements of the body i.e. the outermost measurements of the living or dead body.

ii) Osteometry: Measurements of skeletal long and short bones.

iii) Craniometry: Measurements of the skull. [14]

Literature review:

In a study conducted in the Department of Forensic Medicine and Toxicology, Regional Institute of Medical Sciences, Imphal, determination of stature was done from the inter-acromial length. A total number of 500 individuals i.e. 275 males and 225 females of mongoloid type from the Northeast India in the age group of 21 – 86 years were studied. The stature and inter-acromial length of each individual was measured in centimeters with the subject standing in erect position using a standard anthropometer rod set. The data was statistically analyzed and regression equations were evolved. Three regression equations were evolved. They are

$Y = X + 115$ (males and females together)

$Y = 2X + 69$ (males only)

$Y = 1.7X + 84$ (females only)

(X is inter-acromial length in cm; Y is stature in cm) [15]

The Department of Anatomy, Government Medical College, Patiala, Punjab, conducted a study where stature estimation was done from the somatometry of hand in Punjabi males. A total number of 100 normal Punjabi males of age group 19 – 25 years were studied. Subjects were examined for height, hand length and hand breadth. An anthropometer rod set was used to measure stature and sliding calipers for hand length and breadth. The data was statistically analyzed and regression equations were evolved to estimate stature from the somatometry of hand. The regression equations regardless of the side were:

S = 127.97 + 2.06 HL

S = 141.67 + 3.13 HB

(HL is hand length & HB is hand breadth in cm) [16]

In a study conducted in the Department of Forensic Medicine and Toxicology, Assuit College of Medicine, Egypt, estimation of stature was done from hand measurements. A total number of 166 normal Egyptian individuals (79 Males and 87 Females) of the age group 18 – 23 years were studied. The subjects were examined for stature, hand length & breadth (in both sides). Stature was measured using an anthropometer rod set & sliding calipers were used for hand measurements. The data was statistically analyzed in order to assess the relationship between stature and hand measurements. A generalized multiple regression equation was evolved to estimate stature from hand measurements. The generalized regression equation regardless of side for both sexes:

S = 34.5 + 5.77 HL + 2.7 HB ± 5.1

(HL is hand length & HB is hand breadth in cm) [17]

Several studies have been conducted in the Department of Forensic Science, Punjab University, Patiala, Punjab, India. In one study, the estimation of stature was done from foot and shoe measurements by multiplication factors. A total number of 256 adult male Jat Sikhs were studied. Subjects were examined for stature, foot length and breadth, shoe length and breadth. Stature was measured with an anthropometer rod set and all other measurements with a rod compass. The foot prints and the shoe prints were also studied. The data was statistically analyzed and multiplication factors for each measurement were evolved. The stature of the individual was calculated with these multiplication factors, more effectively with smaller error. [18]

SL. No	Measurement	Multiplication factors	
		Right	Left
1	Foot length	6.68	6.64
2	Foot breadth	17.65	17.57
3	Foot print length	6.49	6.47
4	Shoe length	6.06	6.07
5	Shoe breadth	17.28	17.36
6	Shoe print length	6.03	6.04

In the second study conducted, the estimation of stature was done from the stride length while walking fast. A total number of 198 adult male Jat Sikhs in the age group of 18 – 58 years were studied with no abnormality in their walking. Subjects were studied for stature using an anthropometer rod set and stride length in normal and time fast paced bare foot walking on smooth plastered floor. The data was statistically analyzed. There existed a positive and a significant linear correlation between stature and step length at both paces. The multiplication factors were derived by dividing the stature of the individual by stride length. The following are the multiplication factors: [19]

Step length	Normal walking	Fast walking
First	2.40 ± 0.27	2.0 ± 0.16
Second	2.36 ± 0.25	1.96 ± 0.15
Third	2.35 ± 0.24	1.94 ± 0.15
Fourth	2.35 ± 0.24	1.94 ± 0.15
Fifth	2.36 ± 0.23	1.94 ± 0.13
Mean	2.36 ± 0.23	1.95 ± 0.13

In the third study, a total number of 60 Jat Sikh individuals (30 Males & 30 Females) were studied. Their age group ranged from 18 - 60 years. In this study, stature estimation was done from hand & phalange length. Measurement of stature was done by a standard anthropometer rod set & hand and phalange length of all the fingers of both hands were taken by a sliding calipers. The data was statistically analyzed and regression equations were derived to estimate stature from hand and phalange length and concluded that stature can be estimated from these measurements. The regression equations were:

Right Hand: S = 69.513 + 5.223 * X ± 4.033 (boys)

S = 130.594 + 1.612 * X ± 5.061 (girls)

Left Hand: S = 84.742 + 4.491 * X ± 4.406 (boys)

S = 130.035 + 1.660 * X ± 5.064 (girls)

(X is hand length; S is stature in cm) [20]

In another study conducted in the Department of Forensic Medicine and Toxicology, Maulana Azad Medical College, New Delhi, stature estimation was done from hand length. A total number of 150 individuals (75 Males & 75 Females) of the age group 18 – 22 years were studied. The stature was measured in a standard standing

position with an anthropometer set and the hand length with a sliding caliper. The data thus obtained was subjected to statistical calculations and regression equations were derived to estimate stature from these measurements. The regression equations were:

Males: S = 86.93 + 4.25 (R) HL x 0.7 ± 4.35 (Rt side)

S = 85.84 + 4.32 (R) HL x 0.6 ± 4.26 (Lt side)

Females: S = 77.42 + 4.56 (R) HL x 0.7 ± 4.57 (Rt side)

S = 80.94 + 4.4 (L) HL x 0.7 ± 4.63 (Lt side)

(HL is hand length; S is stature in cm) [21]

The Department of Anatomy and Department of Forensic Medicine, Osmangazi University, Eskisehir, Turkey, conducted a study where the estimation of stature was done using foot and shoe dimensions. A total number of 569 healthy individuals (294 males & 275 females) over 19 years of age were studied. Subjects were measured for stature, length and width of right and left foot – shoe, using anthropometry sets. A notable difference between males and females existed with regard to both right and left foot and shoe length and width. Among the group, a significant correlation was found in regard to stature and right shoe length, stature and right foot length both in males and females. Using statistical methods, regression equations were evolved in order to estimate the stature when the measurements of foot and shoe were known. The regression equations were:

S = 47.93 + 1.083 (maximum FL) + 0.788 (shoe length) × 1.813 (shoe No) → Rt. Side

S = 47.33 + 1.319 (maximum FL) + 0.593 (shoe length) × 1.924 (shoe No) → Lt. Side

(S is stature; FL is foot length in cm) [22]

The Department of Dentistry, Indira Gandhi Government Medical College, Nagpur, has conducted a lateral cephalometric study on, "Determination of sex by discriminate function analysis and stature by regression analysis". The study sample consisted of 150 normal healthy adults (75 males & 75 females) in the age group 25—54 years were studied. Height of each subject was measured using an anthropometer rod. Lateral Cephalometric radiograph was taken. The magnification factor of the X ray was calculated. This magnification factor was subtracted from each linear measurement to get correct value for estimation of stature. The regression formulae obtained using the maximum length of skull showed high degree of reliability for stature estimation. The regression equations derived were:

Males: S = 9.323724 X maximum length of skull

Females: S = 9.19782 X maximum length of skull

(S is stature in cm) [23]

In a study conducted in the Department of Forensic Medicine, Inonu University, School of Medicine, Kampus, Malatya, Turkey, the estimation of stature was done from radial and ulnar bone lengths. A total number of 80 male and 47 female corpses of age group 18—63 years without any deformity were studied. Following measurements were taken body height, radial and ulnar lengths. Body length was measured with a steel tape and vernier calipers were used to measure radial and ulnar lengths. The study showed high correlation between stature and bone lengths. The data was statistically analyzed and regression equations were evolved to estimate stature from these bones. The regression equations regardless of side were:

Males: S = (3.367 X radius length) + 872.286

S = (3.054 X ulnar length) + 890.603

Females: S = (4.731 X radius length) + 539.893

S = (4.217 X ulnar length) + 573.174

(S is stature in cm) [24]

Similar studies have been conducted at the Department of Anthropology, Punjab University, Chandigarh. In the first one, estimation of stature was done from foot print and foot outline dimensions in Gujjars of North India. A total number of 1040 adult male Gujjars of North India in the age group 18 – 30 years and their 2080 bilateral foot prints and foot outlines were studied. Stature was measured using an anthropometer rod and a total number of ten measurements were taken on right and left foot prints and eight measurements on right and left foot outlines. Significant and positive correlation existed between stature and various measurements of footprint and foot outline. The data was statistically analyzed and regression equations were evolved to estimate stature. The following table gives the details: [25]

Measurement	R. Equation (Lt foot)	Mean error	R. Equation (Rt foot)
T-1 length	3.25 X T1 length+88.5	2.18	3.29 X T1 length+ 87.39
T-2 length	3.57 X T2 length+79.9	2.22	3.45 X T2 length + 83.58
T-3 length	3.62 X T3 length+90.5	2.23	3.59 X T3 length + 80.97
T-4 length	3.71 X T4 length+85.3	2.30	3.67 X T4 length + 84.78
T-5 length	3.94 X T5 length+ 83.9	2.28	3.92 X T5 length + 85.58

The Department of Forensic Medicine, SSR Medical College, Mauritius conducted a study on estimation of stature from foot length. A total number of 250 medical students (125 males & 125 females) of age group 18 –30 years were studied. The stature of the subject was measured with an anthropometer rod and the foot length with vernier calipers. The data was statistically analyzed and multiple linear regression

equations were derived to estimate stature from foot length which was highly significant. The regression equations regardless of the side were:

In males: S = 68.586 + 4.036 FL

In females: S = 77.059 + 3.536 FL

(FL is foot length and S is stature in cm) [26]

The second study was estimation of stature from the dimensions of hands and feet in North Indian population. The study was a cross sectional study of sample from 246 Rajputs, (123 males & 123 females) in the age group 17—20 years. The following measurements were taken on the sample, the stature, the hand length & breadth, the foot length and breadth. Stature was measured using an anthropometer rod and other measurements were taken using a sliding calipers or an anthropometer rod compass. The data was statistically analyzed and regression equations for stature estimation were evolved. The correlation coefficients between stature and all measurements of hands and feet were positive and statistically significant. The regression equations regardless of the side were:

Males	Females
S = 88.243 + 4.39 HL	S = 81.314 + 4042 HL
S = 68.085 + 4.054 FL	S = 71.941 + 3.703 FL
S = 135.24 + 3.47 FB	S = 135.419 + 2.37 FB

(HL is hand length; FL is foot length; FB is foot breadth and S is stature in cm)[27]

Several studies were also conducted at the School of Anatomical Sciences, Faculty of Health Sciences, University of Witwatersrand, Johannesburg, South Africa. In first study, the estimation of stature was done from measurements of the skull in indigenous South Africans. A total number of 99 complete skeletons (50 males and 49

females) of indigenous South Africans whose age ranged between 25 – 70 years were studied. Total skeletal height was calculated for each skeleton and further more, six variables were measured on each skull. Total skeletal height was regressed onto these cranial measurements to obtain regression formulae, with which stature can be estimated when only the skull is available. The regression equations were:

Males: TSH = (0.303 x BBH) + (0.282 x MBB) + 76.17

Females: TSH = (0.283 x MBB) + (0.285 x MFB) + 39.55

(TSH is total skeletal height; BBH is Basibregmatic height; MBB is Maximum bizygomatic breadth; MFB is Maximum frontal breadth) [28]

The second study was using tibia from South Africans of European descent to estimate maximum tibia length and stature. Analysis was based on a sample of 50 males and 50 females complete Skeltons of adult South African's of European descent. The age group ranged from 46—75 years. The total skeletal height for the individual skeletons was measured using an anthropometer. Six variables were measured on the tibia using the vernier calipers. The data was statistically analyzed and regression equations were formulated for estimation of total skeletal height and subsequent estimation of living stature from the measurements of the tibia. The regression equations derived were:

Males: TSH = (0.42 x LTCL) – (0.3 x DSBT) + (1.03 x PXBT) + 78.48

Females: TSH = (1.22 x DSBT) + (0.48 x PXBT) + 59.17 ± 5.4

(TSH is Total skeletal height; LTCL is Length of superior lateral articular facet of tibia; DSBT is distal breadth of tibia; PXBT is proximal breadth of tibia) [29]

The International Commission on missing persons, Alipasina, Sarajevo, Bosnia, has conducted a study, "Stature estimation for Bosnian male population" to develop appropriate stature estimation formulae from the length of the femur, tibia and fibula for use in Bosnia to help in identifications of individuals of victims. Research was undertaken on male cadavers of the age group 23 –54 years. The cadaver length was measured and the length of long bones was obtained from X-rays. This study established that using Trotter and Glesser formulae underestimate stature of tall people in the current population of Bosnia. Smallest standard error of estimate is observed in the formula that uses the sum of the length of femur and fibula. Therefore, formulae developed from the average length of bone pairs are recommended for use. [30]

Several studies have been conducted at The School of Anatomical sciences, Faculty of Health Sciences, University of the Witwatersrand, Parkton, Johannesburg, South Africa. First study has been conducted on "Calcaneal measurement in estimation of stature of South African blacks". The aim of this study was to derive regression equations that will allow the calcaneal to be used for stature estimation in S. African blacks. In total, complete skeletons (60 males and 56 females) were selected. The skeletal heights of these sets of skeletons were calculated using the Anatomical Fully's method. Nine parameters of the calcaneus were measured and matched against skeletal heights, using univariate and multivariate regression methods. Regression equations were obtained for estimation of the stature of the S. African black population from the calcaneus. [31]

Second study has been done on "Adult stature reconstruction from the calcaneus of South Africans of European descent". In this study, Fully's anatomical method was

utilized in the estimation of stature of 85 complete skeletons of South Africans of European descent with known sex and age. Univariate and multivariate regression equations were derived from nine measurements of the calcaneus. Most measurements presented with significantly positive correlation with stature. [32]

The third study has been done on, "Estimation of stature using fragmentary femora in indigenous South Africans". The aim of this study was to derive equations based on measurements of fragments of femur for the indigenous S. African population group. A total of 100 complete skeletons, equally distributed by sex were studied. Stature was estimated for each Skelton. Regression equation for the estimation of stature and maximum length of the femur were derived from six measurements of the femur. This study confirms the usefulness of fragments of the femur in estimation of stature. [33]

The Department of Forensic Medicine, Medical University of Gdansk, Poland, has conducted a study, "The estimation of stature on the basis of measurements of the femur". It aims to establish the relationship between body height and the greatest length of the femur. Examinations were conducted on 91 human bodies of both sexes from the polish population aged above 21 years. This study points to a very close relationship between the length of a dead body and the measured greatest length of the femur. This relationship was expressed in nine coefficients of correlation calculated for both sexes.[34]

MATERIAL & METHODS

Source of the data and materials:

a) Source:

The students of KLE's Health Science Institutions in Jawaharlal Nehru Medical College campus, Belgaum belonging to North Karnataka region (Districts included are Belgaum, Dharwad, Bijapur, Gulbarga, Bagalkot, Gadag & Haveri) aged 21 years and above, have been chosen for this study. Age above 21 years is chosen for the reason that by this age, there is completion of skeletal growth by ossification of long bones. The KLE's Health Science Institutions in Jawaharlal Nehru Medical College campus are Jawaharlal Nehru Medical College, KLE's Vishwanath Katti Institute of Dental Sciences, KLE's Institute of Physiotherapy and KLE's College of Pharmacy.

b) Study design:

It's a cross-sectional study done over a period of one year from 1st November 2006 to 31st October 2007.

c) Sample size:

150 subjects (75 males and 75 females) of above mentioned seven districts of North Karnataka region studying in KLE's Health Science Institutions are studied.

Inclusion Criteria:

- The students of KLE's Health Science Institutions in Jawaharlal Nehru Medical College campus Belgaum, born and brought up in North Karnataka with ancestral origin from this region are the target population.
- Districts covered are Belgaum, Dharwad, Bijapur, Gulburga, Bagalkot, Gadag and Haveri are considered.

- The students aged 21 years and above are considered.

Exclusion Criteria:

- The students of KLE's Health Science Institutions in Jawaharlal Nehru Medical College campus Belgaum, residing in the North Karnataka region, but not born and brought up here. (Natives of other parts of India and other Districts of Karnataka) are not considered.
- Cases of Dwarfism, where the skeletal growth is abnormally stunted.
- Cases of Gigantism, where the skeletal growth is abnormally enhanced.
- Subjects with skeletal anomaly especially of spine and long bones.

Method of collection of data:

The subjects chosen for this study are as mentioned above. After taking their written informed consent and recording their full particulars like name, age, sex and place to which they belong, the stature of each individual is measured in centimeters with the subject standing against a vertical background surface in normal erect position, the shoulders, buttocks and heels lightly touching the background / wall. An anthropomater rod set is used for taking the above measurements.

Anthropometer rod: It is the most commonly used instrument for many of the anthropometric measurements on the living. It is used to take height measurements as well as transverse breadths of the body. It consists of four segments which when joined together form a rigid rod of 200cms. There is a fixed sleeve on top of the rod. An adjustable graduated cross-bar passes through it. There is also a movable sleeve with an adjustable graduated cross-bar which registers the height measurements in centimeters. [35] Photos enclosed in annexure I.

The measurement from the vertex of head to the ground is taken after bringing down the adjustable cross-bar to the head and the measurement is read from the vertical scale. The inter-acromial length is measured in centimeters with the person in the same erect position. Photos enclosed in annexure I. All these measurements are taken by the candidate himself to avoid inter observer bias and recorded in the pretested and predesigned proforma given at the end in the annexure II. A master chart is then prepared with all the readings given in the annexure III.

After taking the measurements, statistical analysis is done using statistical equations as given below:

1) $\sum y = Na + b\sum x$
2) $\sum xy = a \sum x + b \sum x^2$

Where $\sum$= Sum value

y= Value of stature

N= Number of cases studied

x= Value of inter-acromial length

a= Unit greater than x value by y value

b= Regression coefficient

From the above equations, regression formulae, standard errors and co-efficient of correlations are developed to fulfill the aims and objectives of the study.

RESULTS

The maximum, minimum and average statures of different sexes along with their maximum, minimum and average inter-acromial lengths have been calculated and tabulated as shown in Table 1.

TABLE 1

Shows sex wise distribution of maximum, minimum and average statures and inter-acromial lengths in cm

Characters	Males	Females
Maximum stature	184.2	167.9
Minimum stature	160.2	140.4
Average stature	170.3	157.3
Maximum inter-acromial length	40.2	33
Minimum inter-acromial length	30.2	25.6
Average inter-acromial length	34.2	29.9

The Regression formulae, Standard errors, Standard deviations and Coefficient of co-relations of the above data have been computed using statistical methods by presuming X as an independent variable and Y as dependent variable.

After statistical analysis of the results, three regression equation formulae have been obtained from the relationship between statures and inter-acromial lengths of:

1) Females only
2) Males only
3) Males and females combined

The formulae have been obtained by using the statistical equations:

1) $\sum y = Na + b\sum x$
2) $\sum xy = a \sum x + b \sum x^2$

Where $\sum$= Sum value

y= Value of stature

N= Number of cases studied

x= Value of inter-acromial length

a= Unit greater than x value by y value

b= Regression coefficient

Then regression formulae, standard errors, coefficient of correlations of the three studies were calculated using the statistical formulae.

All the above results are tabulated in the table 2 given below:

TABLE 2

Showing Regression formulae, Standard errors, and Coefficient correlations

Characters	**Regression formulae**	**Standard error**	**Coefficient of correlation**
Males & Females together	y =103.82+2.1x	± 5 cm	0.7
Males only	y =167.50+0.20x	± 6 cm	0.5
Females only	y =103.62+1.6x	± 4 cm	0.6

Where y is stature and x is inter-acromial length in cm

DISCUSSION

Population variations in anthropometric dimensions do exist and are attributed to genetic, dietary habits and environmental factors. This indicates that specific formulae or regression equations used in prediction of stature are only applicable to the population from which the data were collected.

Various researchers with variable degree of success have attempted the estimation of stature from various long bones, by using different statistical methods such as regression equations and multiplication factors for a very long time. The difficulty in availability of adequate quantities of bones, in the choice of bones, then cleaning and the need of trained personnel are encountered while correlating bone dimensions with stature. But very little work has been reported on the use of these statistical methods to calculate the stature from the inter-acromial length in living.

In agreement with the view of Trotter that the most accurate estimates of stature can be obtained when the equation applied to the unknown has been derived from a representative sample of the population of the same sex, race, age and geographical area to which the unknown is believed to belong, the present study has been done on the Aryans of Caucasoid type of people from the North Karnataka region of India.

The maximum stature in males in this study is 184.2 cm and in females is 167.9 cm whereas in a study conducted by Momonchand. A., Meera Devi T, it is 176.5cm and 166.5 cm respectively. The minimum stature in males and females in this study is 160.2 cm and 140.4 cm whereas the same in the study mentioned above is 152.0 cm and 141.0 cm respectively. The average stature in this study in males and females is 170.3 cm and 157.3 cm whereas it is 162.8cm and 152.5 cm respectively in the study mentioned above.

On comparing the inter-acromial lengths of this study with the study mentioned above, the maximum inter-acromial length in this study in males and females is 40.2 cm and 33.0 cm whereas it is 51.0 cm and 48.0 cm respectively in the study mentioned above. The minimum inter-acromial lengths in this study are 30.2 cm and 25.6 cm for males and females whereas it is 35.0 cm and 32.0 cm respectively in the above mentioned study. The average inter-acromial lengths in this study are 34.14 cm and 29.9 cm for males and females whereas it is 44.5 cm and 40.3 cm respectively in the above mentioned study.

The standard errors came out to be ± 8 cm (males) and ± 5 cm (females) in the study by Momonchand A and Meera Devi T. These standard errors were ± 6 (males) and ± 4 (females) in this study. The difference is of ± 2 cm in males and ± 1 cm in females which is better than earlier study.

In both the studies, the error is more in males as compared to females. This can be attributed to the reason that females, being thin and lean; bony projections are easily palpable and more accurately taken for measurement as compared to muscular males where it is not so easy to mark out the bony projections.

Both the studies have been done in India but one can clearly find a notable difference in the regression equations in both the studies. In first study done by Momonchand A and Meera Devi T, the regression equations were $y = 1.7x + 84$ in females and $y = 2x + 69$ in males, while that in this study, it has come out to be $y = 103.62+1.6x$ in females and $y = 167.50+0.20x$. When inter-acromial lengths taken from the population study were used to find out stature from regression formulae developed by Momonchand A and Meera Devi T, there was a significant error in stature calculated. This implies that these formulae can be used for estimating the stature in the given population from which they have been developed. This also arises

the need to have similar studies on different populations so that similar equations can be evolved for different population groups and the differences can be studied further.

Similar studies should be done on dead bodies in mortuary, where it is easier to mark bony projections accurately on account of absence of clothes. May be in these studies the standard of error can be minimized and these regression equations can be made more useful.

Though various researchers with variable degree of success have attempted estimation of stature from various long bones, they have their own limitations. More studies need to be conducted to estimate the stature from inter-acromial length among other racial groups and of different geographical areas, as it can be extremely useful to estimate the stature when mutilated upper part of trunks are available.

CONCLUSION

The following conclusions are drawn from the present study of stature estimation from inter-acromial length:

1. Stature forms an important aspect of individual's physiognomy and can be used as a tool for partial identification of an individual.
2. There exists a significant correlation of height with the inter-acromial length of an individual in both the sexes and that stature can be estimated with the inter-acromial length when mutilated upper parts of the trunks are available.
3. The correlation matrix of the present study shows that the use of a single regression equation to predict stature from the measurements of inter-acromial length does not make a great difference from individual measurement equations based on sex.
4. In the present study, the regression equation developed for stature estimation from the inter-acromial length by regression equation formulae y = 167.50+0.20x in males and y = 103.62+1.6x in females can be useful in estimating stature of the population of North Karnataka.
5. Whether these equations are useful with other population needs to be researched.

SUMMARY

The present study is a cross-sectional study conducted in the Department of Forensic Medicine and Toxicology, J. N. Medical College, Belgaum during one year period from 1st November 2006 to 31st October 2007. During this period, a total number of 150 subjects (75 females & 75 males) aged above 21 years, studying in KLE's health science institutions in J N Medical college campus, Belgaum, born and brought up in North Karnataka region comprising of districts Belgaum, Dharwad, Bijapur, Gadag, Haveri, Gulbarga and Bagalkot. The subjects were studied for stature and inter-acromial length using a standard anthropometer rod set. The purpose of the study was to derive a regression equation to estimate stature from inter-acromial length, suitable for north Karnataka region population, by statistical analysis of the data.

A predesigned and a pretested proforma is used to collect the required data and the following were the findings.

1. The maximum stature in males is 184.2 cm.
2. The minimum stature in males is 160.2 cm.
3. The maximum inter-acromial length in males is 40.2 cm.
4. The minimum inter-acromial length in males is 30.2 cm.
5. The average stature in males is 170.3 cm.
6. The average inter-acromial length in males is 34.2 cm.
7. The maximum stature in females is 167.9 cm.
8. The minimum stature in females is 140.4 cm.
9. The maximum inter-acromial length in females is 33 cm.
10. The minimum inter-acromial length in females is 25.6 cm.
11. The average stature in females is 157.3 cm.

12. The average inter-acromial length in females is 29.9 cm.
13. Three sets of regression equations are derived. One for the female population, one for the male population and the third one for the combined females and males population.
14. The regression equation for the female population is y = 103.62+1.60 x with a standard error of ± 4 cm where y is stature in cm and x is inter-acromial in cm.
15. The regression equation for the male population is y = 167.50+0.20 x with a standard error of ± 6 cm where y is stature in cm and x is inter-acromial in cm.
16. The regression equation for the combined female and male population is y=103.82+2.1 x with a standard error of ± 5 cm where y is stature in cm and x is inter-acromial in cm.

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PROFORMA FOR DOCUMENTATION OF DETAILS OF SUBJECTS

I. General particulars

1. Name :
2. Age :
3. Sex :
4. Address :

Nativity:

II. Informed consent:

Proforma Enclosed

III. Anthropometric measurements:

1. Height of the individual (cm):
   (From vertex to heel)
2. Inter-acromial length (cm):

IV. Any other information

MODEL

INFORMED CONSENT

Date:

Time:

I, Mr/Ms.……. aged ……. years willingly consent to participate in the dissertation work undertaken by Dr. Vishal V. Koulapur and permit him to take anthropometric measurements (height and inter-acromial length) and use them for statistical purpose.

The procedure has been clearly explained to me and I have understood the same.

I have gone through the contents of this form before signing it.

Signature of the consenting person

Witness: (Name and signature)

1.

2.

VARIOUS PARAMETERS INCLUDING STATURE AND INTER-ACROMIAL LENGTH IN FEMALES

S.No	Name	Age	Sex	Stature	IA length	Place	Nativity						
		(Yrs)		(cms)	(cms)		BGM	BJR	GLB	BGK	GDG	HVR	DWR
1	AC	21	F	162.4	29.8	SDM			+				
2	LVH	22	F	158.4	29.8	HBL							+
3	VK	23	F	166	30.6	BGM	+						
4	AGS	21	F	153.8	28.8	HBL							+
5	SRK	21	F	159.2	31.6	HBL							+
6	VLS	21	F	148	28.6	SRPR			+				
7	TVB	21	F	157.2	28.2	GDG					+		
8	SP	21	F	152	29.2	BGM	+						
9	SB	21	F	156.2	28.9	BGM	+						
10	PAH	21	F	150.4	28.5	BGM	+						
11	SR	22	F	157.8	28.2	BGK				+			
12	AK	22	F	155.9	27.9	DWR							+
13	PR	22	F	156.8	28.8	BJR		+					
14	DSV	22	F	161.2	29.4	BGM	+						
15	KN	22	F	162.1	31.1	BGM	+						
16	AS	22	F	161	32.2	GLB			+				
17	PM	22	F	160.8	31.8	BGM	+						
18	SP	22	F	159.4	31.2	BGM	+						

19	CK	22	F	156.4	29.3	BGM	+						
20	PH	22	F	149.8	30	BJR		+					
21	ST	21	F	149.8	26.8	BGM	+						
22	VP	22	F	155.4	29.2	BGM	+						
23	CP	22	F	152.6	29.8	BGK				+			
24	KR	22	F	156.4	28.4	BGM	+				+		
25	SS	22	F	159.2	29.9	GDG					+		
26	VM	22	F	160	29.4	BGM	+						
27	FH	22	F	154.3	29.4	BGM	+						
28	IH	22	F	148.2	28.8	BGM	+						
29	VK	21	F	146.4	28.4	YDGR			+				
30	TR	21	F	152	30.6	BGM	+						
31	SMK	21	F	157	29.2	DNDL							+
32	SSS	21	F	160	29.1	BGM	+						
33	UB	21	F	163	33.2	BGM	+						
34	PLM	21	F	157.6	29.6	GKK	+						
35	SSN	21	F	158.2	28.2	ANKG	+						
36	SIP	21	F	161.8	30.2	ATHN	+						
37	LBP	21	F	156.4	29.4	GKK	+						
38	MG	21	F	164.4	32.9	HVR						+	
39	LSD	21	F	152.4	28.2	BGM	+						
40	ANP	21	F	152.8	32.2	BGM	+						
41	BNB	21	F	160.4	33.1	BGM	+						

42	AR	21	F	144.9	27.5	GLB			+				
43	AIK	21	F	140.4	25.6	GLB			+				
44	BNK	21	F	152	30.3	SNDT	+						
45	SMK	21	F	168.6	30.8	BGM	+						
46	SAK	21	F	156.6	27.2	BGM	+						
47	RCB	21	F	154.4	27.2	BGM	+						
48	SS	21	F	156	25.1	BGM	+						
49	RAS	21	F	168.2	30.5	BGM	+						
50	NN	21	F	151.2	30.2	DWR							+
51	SMH	21	F	155.6	30.4	GKK	+						
52	AHN	21	F	158.2	29.2	JKD		+					
53	CAN	21	F	151.6	30.6	HTNL		+					
54	MVH	21	F	155.6	34.2	BGM	+						
55	MB	21	F	152.6	33	BGM	+						
56	MDH	21	F	160.8	32.4	BGM	+						
57	PH	22	F	156.2	27.1	BGM	+						
58	MN	22	F	158.6	28.2	BJR		+					
59	SA	22	F	154.8	27.2	HBL							+
60	NK	22	F	162.8	29.2	BGM	+						
61	DS	21	F	161.2	28.8	DWR							+
62	SP	22	F	156.4	29.4	BGK				+			
63	SK	22	F	156.4	28.2	HBL							+
64	SA	22	F	161.2	33.2	BGM	+						

65	SB	22	F	163.8	32.8	ILK		+					
66	GV	22	F	154.8	32.4	ATHN	+						
67	AMS	27	F	156.4	29.2	BGM	+						
68	KK	22	F	167.6	31.2	HBL							+
69	NM	27	F	160.4	32.1	GKK	+						
70	SG	27	F	161.3	30.2	BGM	+						
71	STS	27	F	168.9	31.7	GDG					+		
72	CD	27	F	149.6	30.1	BLHL	+						
73	GS	27	F	167.4	31.2	BJR		+					
74	NK	26	F	164.2	31.8	BLHL	+						
75	SK	28	F	167.9	32.1	DWR							+

KEYS

SL No	Serial number
M	Male
F	Female
IA	Inter-acromial
BGM	Belgaum
BJR	Bijapur
GLB	Gulburga
BGK	Bagalkot
GDG	Gadag
HVR	Haveri
DWR	Dharwad

VARIOUS PARAMETERS INCLUDING STATURE AND INTER-ACROMIAL LENGTH IN MALES

S.No	Name	Age	Sex	Stature	IA Length	Place	Nativity						
		(Yrs)		(cms)	(cms)		BGM	BJR	GLB	BGK	GDG	HVR	DWR
1	KP	22	M	170.8	31.4	GKK	+						
2	MBT	22	M	178.4	32.6	GLB			+				
3	RP	23	M	183	36.2	BGM	+						
4	PSG	23	M	171.8	33.1	HBL							+
5	SG	22	M	165.4	33.5	GLB			+				
6	SSB	22	M	162.8	32.4	GLB			+				
7	GGB	23	M	173.6	34.6	GLB			+				
8	SP	23	M	167.8	32.2	GLB			+				
9	VG	23	M	163.7	32.3	GLB			+				
10	AN	21	M	166.2	34	BGM	+						
11	ASM	23	M	160.2	30.2	BGM	+						
12	ARA	21	M	176.6	33	BGM	+						
13	ASM	21	M	167.8	31.8	CKD	+						
14	NG	22	M	166.8	32.4	DNDL							+
15	NSH	23	M	174.8	32.8	BJR		+					
16	NKP	23	M	167.6	30.5	BGK				+			
17	MAK	21	M	171.4	35	SNR						+	
18	KN	21	M	183.2	34	DWR							+

19	KMW	21	M	178.4	37.4	DWR							+
20	KJG	21	M	174.8	34.5	BGM	+						
21	SSG	21	M	178.2	36.9	BGM	+						
22	RVN	21	M	168.7	32.2	BGK				+			
23	NOP	21	M	184.2	32.6	BJR		+					
24	ARM	21	M	169.6	34.8	NPN	+						
25	ASP	21	M	165.7	34.4	GKK	+						
26	SSM	21	M	167.4	30.2	ANK	+						
27	SPM	21	M	172	31.1	ATHN	+						
28	SHK	21	M	171.8	32.8	BGK				+			
29	SC	21	M	175.4	32.1	BGM	+						
30	PCK	21	M	163.4	31.1	RBG	+						
31	VBM	21	M	173.4	31.4	BGM	+						
32	SCG	21	M	170	31.7	BGM	+						
33	VD	21	M	173.2	34.6	BGK				+			
34	SBM	21	M	176.2	31	BGM	+						
35	VVN	21	M	178.2	32	BGM	+						
36	SSG	21	M	169.4	34.2	BGM	+						
37	VAA	28	M	162.2	31.8	GKK	+						
38	MSA	21	M	170.8	33.6	GLB			+				
39	STT	21	M	169.6	31.2	JKD				+			
40	SGA	21	M	170.6	33.6	GDG					+		
41	SP	21	M	169	31.6	SWR						+	
42	SG	21	M	167.4	32.6	MDHL				+			

43	SBP	21	M	163.6	32.2	BNHT				+			
44	SVS	21	M	167.8	33.6	GLB			+				
45	SKD	21	M	176.4	35.5	RBG	+						
46	SLN	21	M	164	36	BGM	+						
47	AP	21	M	172.6	36	BGM	+						
48	NKP	21	M	174.6	36.9	BJR		+					
49	SAP	21	M	172.8	36.8	BGM	+						
50	MBT	21	M	164.8	32.8	RMDG	+						
51	HAK	24	M	170	39.6	HGR	+						
52	VAG	21	M	164.6	36.8	CKD	+						
53	VMB	21	M	171.4	35.6	GLB			+				
54	VSK	21	M	174.6	35.8	BGM	+						
55	SSR	21	M	166	37.2	GLB		+					
56	VSL	21	M	172	36.2	BGM	+						
57	VLM	21	M	165.2	40.2	BGM	+						
58	MPR	21	M	161.5	37.6	GDG					+		
59	HDK	21	M	164.6	35.8	MDHL				+			
60	SHK	21	M	172.2	36.4	GKK	+						
61	KDS	21	M	162.2	37.2	BGM	+						
62	MSP	21	M	169.6	35.6	ILK				+			
63	GM	21	M	169.2	35.1	BGM	+						
64	PBP	21	M	168	38	HBL							+
65	KP	28	M	167.8	35.4	BGM	+						
66	SAP	30	M	163.8	35.2	HBL							+

67	RSH	30	M	172.1	36.8	RMDG	+						
68	SD	31	M	163.8	37.2	BGKY				+			
69	MS	32	M	174.1	35.2	NSRG	+						
70	SM	32	M	173.6	34.6	GLB		+					
71	BK	29	M	172.1	32.1	HKR	+						
72	SK	29	M	166.2	32.4	DWR							+
73	VRS	26	M	174.2	34.2	GDG					+		
74	VBR	28	M	172.3	34.6	ATHN	+						
75	PP	27	M	175.8	34.6	GKK	+						

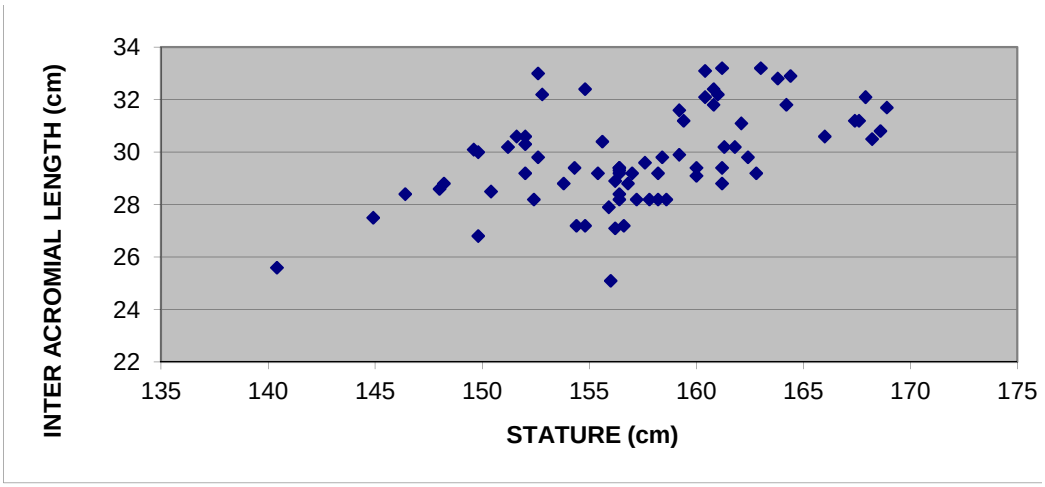
KEYS

SL No	Serial number
M	Male
F	Female
IA	Inter-acromial
BGM	Belgaum
BJR	Bijapur
GLB	Gulburga
BGK	Bagalkot
GDG	Gadag
HVR	Haveri
DWR	Dharwad

S.No	Name	Age	Sex	Stature	IA length	Place	Nativity						
		(Yrs)		(cms)	(cms)		BGM	BJR	GLB	BGK	GDG	HVR	DWR
1	AC	21	F	162.4	29.8	SDM			+				
2	LVH	22	F	158.4	29.8	HBL							+
3	VK	23	F	166	30.6	BGM	+						
4	AGS	21	F	153.8	28.8	HBL							+
5	SRK	21	F	159.2	31.6	HBL							+
6	VLS	21	F	148	28.6	SRPR			+				
7	TVB	21	F	157.2	28.2	GDG					+		
8	SP	21	F	152	29.2	BGM	+						
9	SB	21	F	156.2	28.9	BGM	+						
10	PAH	21	F	150.4	28.5	BGM	+						
11	SR	22	F	157.8	28.2	BGK				+			
12	AK	22	F	155.9	27.9	DWR							+
13	PR	22	F	156.8	28.8	BJR		+					
14	DSV	22	F	161.2	29.4	BGM	+						
15	KN	22	F	162.1	31.1	BGM	+						
16	AS	22	F	161	32.2	GLB			+				
17	PM	22	F	160.8	31.8	BGM	+						
18	SP	22	F	159.4	31.2	BGM	+						
19	CK	22	F	156.4	29.3	BGM	+						
20	PH	22	F	149.8	30	BJR		+					
21	ST	21	F	149.8	26.8	BGM	+						
22	VP	22	F	155.4	29.2	BGM	+						
23	CP	22	F	152.6	29.8	BGK				+			
24	KR	22	F	156.4	28.4	BGM	+				+		
25	SS	22	F	159.2	29.9	GDG					+		
26	VM	22	F	160	29.4	BGM	+						
27	FH	22	F	154.3	29.4	BGM	+						
28	IH	22	F	148.2	28.8	BGM	+						
29	VK	21	F	146.4	28.4	YDGR			+				
30	TR	21	F	152	30.6	BGM	+						
31	SMK	21	F	157	29.2	DNDL							+
32	SSS	21	F	160	29.1	BGM	+						
33	UB	21	F	163	33.2	BGM	+						
34	PLM	21	F	157.6	29.6	GKK	+						
35	SSN	21	F	158.2	28.2	ANKG	+						
36	SIP	21	F	161.8	30.2	ATHN	+						
37	LBP	21	F	156.4	29.4	GKK	+						
38	MG	21	F	164.4	32.9	HVR						+	
39	LSD	21	F	152.4	28.2	BGM	+						
40	ANP	21	F	152.8	32.2	BGM	+						
41	BNB	21	F	160.4	33.1	BGM	+						
42	AR	21	F	144.9	27.5	GLB			+				
43	AIK	21	F	140.4	25.6	GLB			+				
44	BNK	21	F	152	30.3	SNDT	+						
45	SMK	21	F	168.6	30.8	BGM	+						
46	SAK	21	F	156.6	27.2	BGM	+						
47	RCB	21	F	154.4	27.2	BGM	+						
48	SS	21	F	156	25.1	BGM	+						
49	RAS	21	F	168.2	30.5	BGM	+						
50	NN	21	F	151.2	30.2	DWR							+
51	SMH	21	F	155.6	30.4	GKK	+						
52	AHN	21	F	158.2	29.2	JKD		+					
53	CAN	21	F	151.6	30.6	HTNL		+					
54	MVH	21	F	155.6	34.2	BGM	+						

55	MB	21	F	152.6	33	BGM	+						
56	MDH	21	F	160.8	32.4	BGM	+						
57	PH	22	F	156.2	27.1	BGM	+						
58	MN	22	F	158.6	28.2	BJR		+					
59	SA	22	F	154.8	27.2	HBL							+
60	NK	22	F	162.8	29.2	BGM	+						
61	DS	21	F	161.2	28.8	DWR							+
62	SP	22	F	156.4	29.4	BGK				+			
63	SK	22	F	156.4	28.2	HBL							+
64	SA	22	F	161.2	33.2	BGM	+						
65	SB	22	F	163.8	32.8	ILK		+					
66	GV	22	F	154.8	32.4	ATHN	+						
67	AMS	27	F	156.4	29.2	BGM	+						
68	KK	22	F	167.6	31.2	HBL							+
69	NM	27	F	160.4	32.1	GKK	+						
70	SG	27	F	161.3	30.2	BGM	+						
71	STS	27	F	168.9	31.7	GDG					+		
72	CD	27	F	149.6	30.1	BLHL	+						
73	GS	27	F	167.4	31.2	BJR		+					
74	NK	26	F	164.2	31.8	BLHL	+						
75	SK	28	F	167.9	32.1	DWR							+

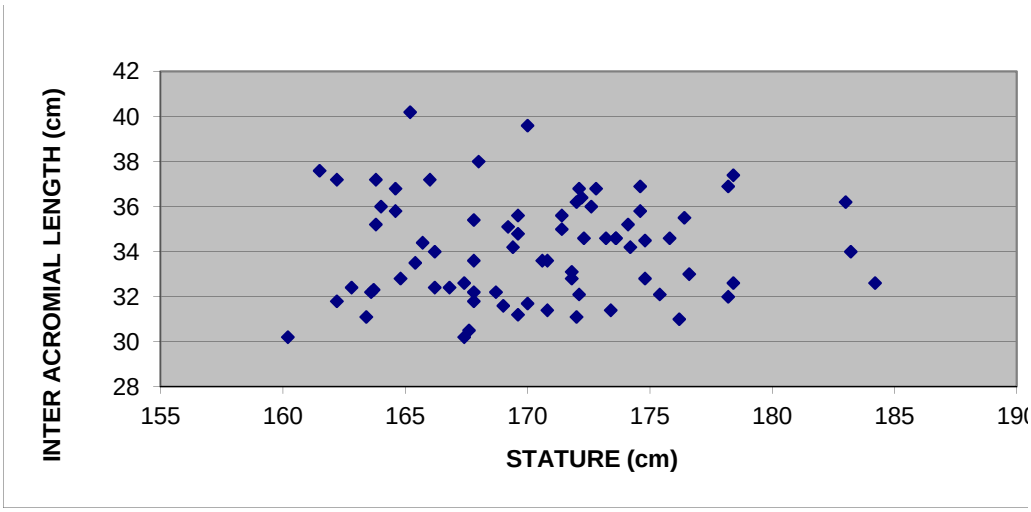
FEMALES


INTER ACROMIAL LENGTH (cm)
34
32
30
28
26
24
22
135
140
145
150
155
160
165
170
175
STATURE (cm)

S.No	Name	Age	Sex	Stature	IA Length	Place	Nativity						
		(Yrs)		(cms)	(cms)		BGM	BJR	GLB	BGK	GDG	HVR	DWR
1	KP	22	M	170.8	31.4	GKK	+						
2	MBT	22	M	178.4	32.6	GLB			+				
3	RP	23	M	183	36.2	BGM	+						
4	PSG	23	M	171.8	33.1	HBL							+
5	SG	22	M	165.4	33.5	GLB			+				
6	SSB	22	M	162.8	32.4	GLB			+				
7	GGB	23	M	173.6	34.6	GLB			+				
8	SP	23	M	167.8	32.2	GLB			+				
9	VG	23	M	163.7	32.3	GLB			+				
10	AN	21	M	166.2	34	BGM	+						
11	ASM	23	M	160.2	30.2	BGM	+						
12	ARA	21	M	176.6	33	BGM	+						
13	ASM	21	M	167.8	31.8	CKD	+						
14	NG	22	M	166.8	32.4	DNDL							+
15	NSH	23	M	174.8	32.8	BJR		+					
16	NKP	23	M	167.6	30.5	BGK				+			
17	MAK	21	M	171.4	35	SNR						+	
18	KN	21	M	183.2	34	DWR							+
19	KMW	21	M	178.4	37.4	DWR							+
20	KJG	21	M	174.8	34.5	BGM	+						
21	SSG	21	M	178.2	36.9	BGM	+						
22	RVN	21	M	168.7	32.2	BGK				+			
23	NOP	21	M	184.2	32.6	BJR		+					
24	ARM	21	M	169.6	34.8	NPN	+						
25	ASP	21	M	165.7	34.4	GKK	+						
26	SSM	21	M	167.4	30.2	ANK	+						
27	SPM	21	M	172	31.1	ATHN	+						
28	SHK	21	M	171.8	32.8	BGK				+			
29	SC	21	M	175.4	32.1	BGM	+						
30	PCK	21	M	163.4	31.1	RBG	+						
31	VBM	21	M	173.4	31.4	BGM	+						
32	SCG	21	M	170	31.7	BGM	+						
33	VD	21	M	173.2	34.6	BGK				+			
34	SBM	21	M	176.2	31	BGM	+						
35	VVN	21	M	178.2	32	BGM	+						
36	SSG	21	M	169.4	34.2	BGM	+						
37	VAA	28	M	162.2	31.8	GKK	+						
38	MSA	21	M	170.8	33.6	GLB			+				
39	STT	21	M	169.6	31.2	JKD				+			
40	SGA	21	M	170.6	33.6	GDG					+		
41	SP	21	M	169	31.6	SWR							
42	SG	21	M	167.4	32.6	MDHL				+			
43	SBP	21	M	163.6	32.2	BNHT				+			
44	SVS	21	M	167.8	33.6	GLB			+				
45	SKD	21	M	176.4	35.5	RBG	+						
46	SLN	21	M	164	36	BGM	+						
47	AP	21	M	172.6	36	BGM	+						
48	NKP	21	M	174.6	36.9	BJR		+					
49	SAP	21	M	172.8	36.8	BGM	+						
50	MBT	21	M	164.8	32.8	RMDG	+						
51	HAK	24	M	170	39.6	HGR	+						
52	VAG	21	M	164.6	36.8	CKD	+						
53	VMB	21	M	171.4	35.6	GLB			+				
54	VSK	21	M	174.6	35.8	BGM	+						

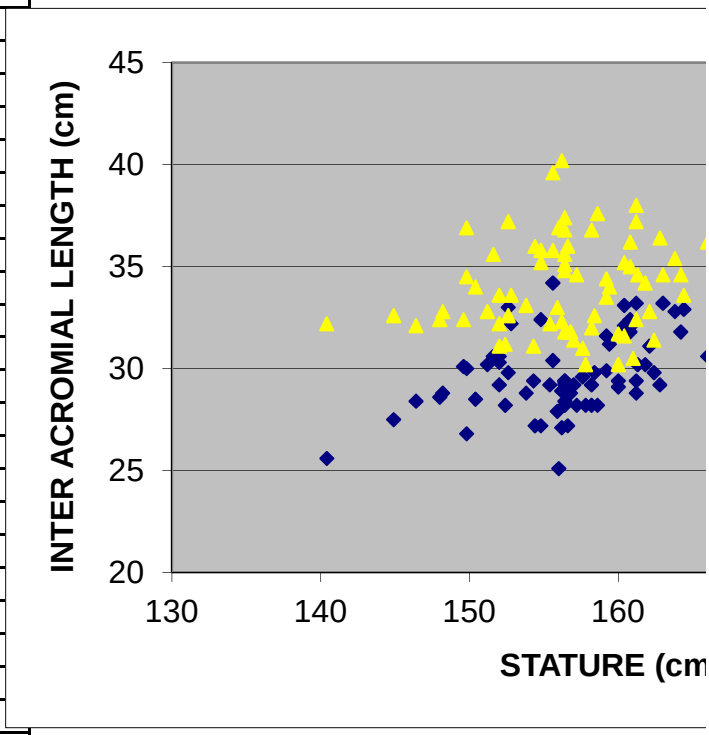
55	SSR	21	M	166	37.2	GLB		+					
56	VSL	21	M	172	36.2	BGM	+						
57	VLM	21	M	165.2	40.2	BGM	+						
58	MPR	21	M	161.5	37.6	GDG					+		
59	HDK	21	M	164.6	35.8	MDHL				+			
60	SHK	21	M	172.2	36.4	GKK	+						
61	KDS	21	M	162.2	37.2	BGM	+						
62	MSP	21	M	169.6	35.6	ILK				+			
63	GM	21	M	169.2	35.1	BGM	+						
64	PBP	21	M	168	38	HBL							+
65	KP	28	M	167.8	35.4	BGM	+						
66	SAP	30	M	163.8	35.2	HBL							+
67	RSH	30	M	172.1	36.8	RMDG	+						
68	SD	31	M	163.8	37.2	BGKY							
69	MS	32	M	174.1	35.2	NSRG	+						
70	SM	32	M	173.6	34.6	GLB		+					
71	BK	29	M	172.1	32.1	HKR	+						
72	SK	29	M	166.2	32.4	DWR							+
73	VRS	26	M	174.2	34.2	GDG					+		
74	VBR	28	M	172.3	34.6	ATHN	+						
75	PP	27	M	175.8	34.6	GKK	+						

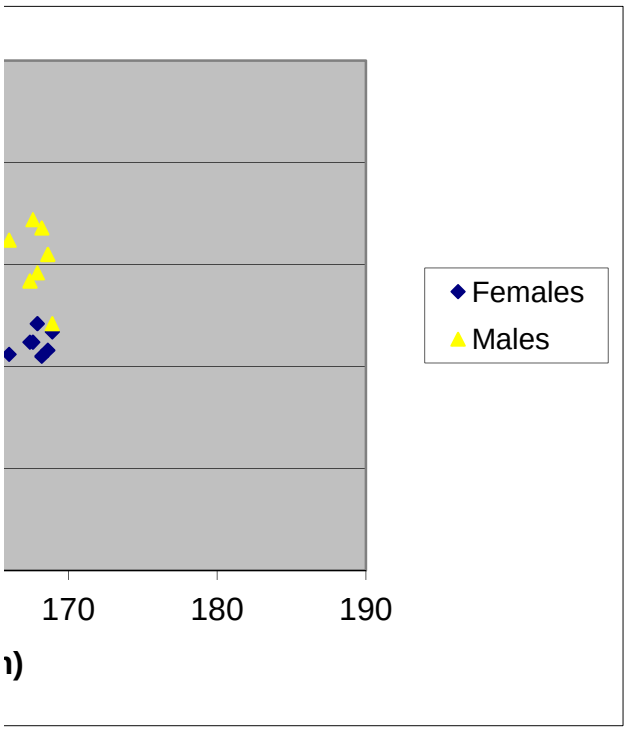
MALES


INTER ACROMIAL LENGTH (cm)
42
40
38
36
34
32
30
28
155
160
165
170
175
180
185
STATURE (cm)

F	Females	M	Males
162.4	29.8	170.8	31.4
158.4	29.8	178.4	32.6
166	30.6	183	36.2
153.8	28.8	171.8	33.1
159.2	31.6	165.4	33.5
148	28.6	162.8	32.4
157.2	28.2	173.6	34.6
152	29.2	167.8	32.2
156.2	28.9	163.7	32.3
150.4	28.5	166.2	34
157.8	28.2	160.2	30.2
155.9	27.9	176.6	33
156.8	28.8	167.8	31.8
161.2	29.4	166.8	32.4
162.1	31.1	174.8	32.8
161	32.2	167.6	30.5
160.8	31.8	171.4	35
159.4	31.2	183.2	34
156.4	29.3	178.4	37.4
149.8	30	174.8	34.5
149.8	26.8	178.2	36.9
155.4	29.2	168.7	32.2
152.6	29.8	184.2	32.6
156.4	28.4	169.6	34.8
159.2	29.9	165.7	34.4
160	29.4	167.4	30.2
154.3	29.4	172	31.1
148.2	28.8	171.8	32.8
146.4	28.4	175.4	32.1
152	30.6	163.4	31.1
157	29.2	173.4	31.4
160	29.1	170	31.7
163	33.2	173.2	34.6
157.6	29.6	176.2	31
158.2	28.2	178.2	32
161.8	30.2	169.4	34.2
156.4	29.4	162.2	31.8
164.4	32.9	170.8	33.6
152.4	28.2	169.6	31.2
152.8	32.2	170.6	33.6
160.4	33.1	169	31.6
144.9	27.5	167.4	32.6
140.4	25.6	163.6	32.2
152	30.3	167.8	33.6
168.6	30.8	176.4	35.5
156.6	27.2	164	36
154.4	27.2	172.6	36
156	25.1	174.6	36.9
168.2	30.5	172.8	36.8
151.2	30.2	164.8	32.8
155.6	30.4	170	39.6

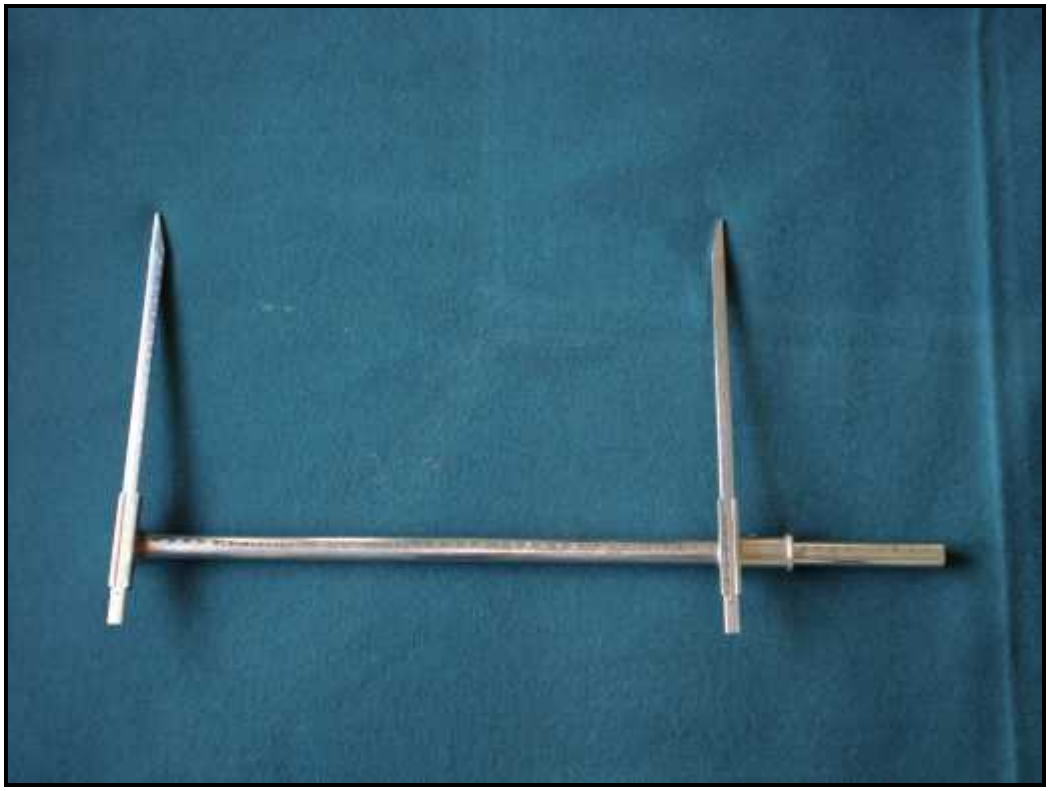
158.2	29.2	164.6	36.8
151.6	30.6	171.4	35.6
155.6	34.2	174.6	35.8
152.6	33	166	37.2
160.8	32.4	172	36.2
156.2	27.1	165.2	40.2
158.6	28.2	161.5	37.6
154.8	27.2	164.6	35.8
162.8	29.2	172.2	36.4
161.2	28.8	162.2	37.2
156.4	29.4	169.6	35.6
156.4	28.2	169.2	35.1
161.2	33.2	168	38
163.8	32.8	167.8	35.4
154.8	32.4	163.8	35.2
156.4	29.2	172.1	36.8
167.6	31.2	163.8	37.2
160.4	32.1	174.1	35.2
161.3	30.2	173.6	34.6
168.9	31.7	172.1	32.1
149.6	30.1	166.2	32.4
167.4	31.2	174.2	34.2
164.2	31.8	172.3	34.6
167.9	32.1	175.8	34.6




Females
Males
170
180
190

PHOTOGRAPHS

Photograph 1: Anthropometer rod set



Photograph 2: Part of Anthropometer rod set used to measure inter-acromial length

Photograph 3: Measurement of stature of a male subject using Anthropometer rod set

Photograph 4: Measurement of stature of a female subject using Anthropometer rod set

Photograph 5: Measurement of inter – acromial length of a male subject using Anthropometer rod set

Photograph 6: Measurement of inter – acromial length of a female subject using Anthropometer rod set

KEY TO MASTER CHART

Sl. No.	Serial number
M	Male
F	Female
IA	Inter-acromial
BGM	Belgaum
BJR	Bijapur
GLB	Gulburga
BGK	Bagalkot
GDG	Gadag
HVR	Haveri
DWR	Dharwad