Stature estimation from hand length in north Karnataka population, India

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Abstract
Stature is an important parameter of personal identification of an individual there are many studies conducted along with others parameters such as age, sex, race, etc. The present study is an attempt to examine the relationship between the stature and right hand length of 100 males and 100 females of north Karnataka, Population in age ranging from 21 to 35 years. Linear and multiple regression equations formula for stature estimation were calculated. The co-relation co-efficient between stature and right hand length were found to be positive and statistically highly significant (P<0.01). The highest co-relation co-efficient is +0.35. The regression formula was checked for their accuracy, applicability and reliability.

Keywords: Human Anatomy, Anthropology, Stature, North Karnataka.

Introduction

Anthropometry is a series of systemized measuring techniques that express quantitatively the dimensions of human body and skeleton. Anthropometry is often viewed as a traditional and perhaps the basic tool of biological anthropology, but it has a long tradition of use in forensic sciences. The significance and importance of craniometry, somatometry, cephalometry and osteometry in the identification of human remain have been described and a new term "Forensic Anthropometry" is coined.[1] Forensic Anthropology, an applied discipline, is a branch of physical anthropology which interacts with other disciplines pertaining to the understanding of crime and its investigations. Forensic anthropology becomes important nowadays as the scientific techniques for foul play have been sophisticated.

Examination of skeletal remains and mutilated body parts recovered from crime scene has often been used by the forensic anthropologists to extract relevant personal information about the victim. There is increase in the number of catastrophic events causing mass death from natural and manmade errors. Such disasters like flooding, tsunamis, earthquakes, plain crashes, train crashes, terrorist attacks usually requires the identification of victims from fragmentary and dismembered human remains.

In such situations, the stature prediction occupies relatively a central position in the identification of an individual necessitated by the medical jurisprudence or by the medico-legal experts. The foundation from which forensic anthropology has developed includes the 'Big Fours' - Age, Sex, Race and Stature which helps in personal identification.[2]

Identification is an individual's birth right.[3] Stature is one of the basic indicator of the biological profile that can aid in the identification of an individual. It helps distinguish between multiple individuals who have the same ancestry, sex and age, and thus provides a circumstantial or presumptive identification of an individual. Based on the correlation, attempts have been made to establish the stature from the dimensions of almost all the body parts bones.[4]

There are two major methods used to estimate stature; Mathematical method and the Anatomical method. The Mathematical method takes advantage of the higher linear correlation between long bones and stature. With a long bone as the dependent or independent variable, one can utilize regression equation that reflects the relationship between an individual's stature and the chosen long bone. The Anatomical method, more commonly referred as "Fully's Method", reconstructs stature by summing the measurements of the skeletal elements that contribute to the height and adding a correction factor for the soft tissue.[5]

In the present scenario, personal identification of a living person has become a common problem and such problem has risen in the court of law in relation to various crimes such as rape, murder, child trafficking etc.

Thus when the complete skeleton is not available for identification of an individual, the forensic experts must use mathematical method of stature estimation instead of anatomical method. Mathematical method has the obvious advantage that it is workable even if a single long bone or its fragments are available for stature estimation.

Estimation of stature especially from bones is a tedious and time consuming process which involves cleaning and preparation of bones.[6] Due to this reason forensic anthropologist are using percutaneous measurements instead of direct measurements of the bone. For stature estimation researches different nutrition types and physical activities may cause variations in populations. Many studies are successfully performed on this topic despite a wide range of ethnics and races through the populations.

There have been many researches on stature estimation from various body segments. But there are only a handful of studies in this region of north Karnataka. Again very few studies have concentrated on estimation of stature from hand length. Thus the present study aims at estimating stature right hand length that will help in forensic medico-legal work.

Objectives

1. To derive linear regression formulae to estimate stature from these dimensions obtained.
2. To evolve linear regression equation for male separately.

Material and Methods

Source of data: 200 healthy adult population, 100 males and 100 females residing in Bijapur district are selected from among those volunteering for the study, only after obtaining informed consent.

Method of collection of data: Stature is measured using anthropometry. Right hand length is measured using first segment of anthropometric rod. All the measurements are taken before noon to avoid diurnal variation as the stature is maximum in morning and decreases by 1.5-2.0 cm by the end of the day.

Inclusion criteria: Male and female age range between 21 to 35 years and all being healthy are considered in the present study.

Exclusion criteria:

1. Subjects with skeletal abnormalities, deformities and endocranial disorders.
2. Persons with amputated fingers will be excluded from the study.

Measurements

1. **Stature:** It is measured as vertical distance from the vertex to the floor as in Fig. 1. Measurement is taken by making the subject stand erect in anatomical position on a horizontal resisting plane with bare footed. Shoulder blades and buttocks are touching the wall. Anthropometer is placed in straight vertical position in front of the subject with head oriented in eye-ear-eye Plane (Frankfurt Plane). The movable rod of the Anthropometry is brought in contact with vertex in the mid saggital plane.

Fig. 1

2. **Right Hand length:** The subjects are asked to place their right hand prone on a flat hard horizontal surface with fingers extended and adducted. Radial styloid process and ulnar styloid process are marked. Right Hand Length is measured as distance from midpoint joining radial and ulnar styloid process to the distal end of most projecting point of the middle finger as in Fig. 2.

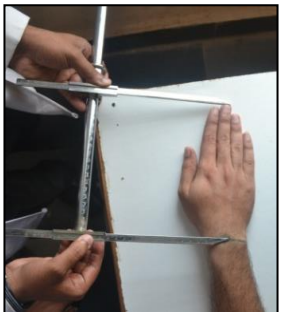

Fig. 2

Statistical method adopted: All the measurements were analyzed by using SPSS software. The results were presented separately for males and females. Initially the data was summarized into Minimum value, Maximum value, Mean, Standard Deviation and Range for all the parameters. To study the relationship of right hand length with the stature, the Pearson Correlation Coefficient was estimated and the significance was tested through Z- test. Linear Regression Equations were derived to estimate stature of unknown from right hand length.

Correlation coefficient: The relationship or association between two variables is called correlation. The extent or degree of relationship between two set of figures is measured in terms of a parameter called Correlation Coefficient. It is mathematically estimated by a formula and is denoted as Pearson's Correlation 'r'.

1. If r = 0 : there is no correlation * If r = -1 : there is perfect negative correlation
2. If r = +1 : there is perfect positive correlation * If r = 0-0.1 : trivial correlation
3. If r = 0.1-0.3 : small correlation * If r = 0.3-0.5 : moderate correlation
4. If r = 0.5-0.7 : large correlation * If r = 0.7-0.9 : very large correlation
5. If r = 0.9-1 : near perfect correlation

Regression: The word regression means prediction. It is a method to estimate or predict the value of unknown variable from the value of known variable. This is possible only when the two variables are linearly correlated. The variable to be estimated is called dependent variable and the variable which is known is called independent variable. The mathematical equation from which dependent variable can be calculated is called regression equation.

Results

Table 1: Minimum, Maximum, Mean, Standard Deviation (SD) and range of Height measurements included in present study

	Min. (in cm)	Max. (in cm)	Mean (in cm)	SD	Range (in cm)
Females	145	169	154.34	5.49	24
Males	160	184	171.73	5.01	24

Among female subjects, the mean height is 154.34±5.49 cm. minimum height is 145 cm and maximum is 169 cm with range being 24 cm.

Among male subjects, the mean height is 171.73±5.01 cm minimum height is 160 cm and maximum is 184 cm with range being 24 cm.

Table 2: Minimum, Maximum, Mean, Standard Deviation (SD) and range of Right Hand Length measurements included in present study

	Min.	Max.	Mean	SD	Range	r value	P value
Females	14.6	18.6	16.78	0.78	4	0.4746	0.001
Males	17.5	20.8	19.03	0.80	3.3	0.7324	0.001

In female study group, mean right hand length is 16.78±0.78 cm, minimum is 14.6 cm and maximum is 18.6 cm with range being 4 cm. Correlation coefficient (r) of right hand length with stature of female subjects is 0.4746. Thus stature is moderately correlated with right hand length of females included in present study group.

Multiplication factor to calculate stature from right hand length is 4.744 and constant is 74.72. The regression equation is formulated as;

Stature of females in cm = 4.744 x RHL + 74.72.

In male study group, mean right hand length is 19.03±0.80 cm, minimum is 17.5 cm and maximum is 20.8 cm with range being 3.3 cm. Correlation coefficient (r) of right hand length with stature of male subject is 0.7324. Thus stature is very strongly correlated with right hand length of among males in our study group.

Multiplication factor to calculate stature from right hand length is 4.946 and constant being 77.57. The regression equation was formulated as;

Stature of males in cm = 4.946 x RHL + 77.57.

Discussion

In the first study of its kind, Rollet assessed the correlation between stature and long bone length. He measured the lengths of the radius, ulna, humerus, fibula, tibia and femur of adult French cadavers and published a report with the methods of measurement, the individual measurements, and tables of stature estimations.[7]

Pearson (1899) used Rollet's data to create regression formulae for estimating stature. He used only long bone lengths of the right side. He found through analysis of Rollet's data that age shrinkage was not a significant factor for stature estimation. Mildred Trotter and Goldine Gleser, however, later provided evidence that age shrinkage is a significant consideration when estimating stature. Pearson contributed greatly to the advancement of stature estimation.

O.P. Jasuja and G. Singh (2004) performed the study on 60 adult male and female for stature, hand length and phalangeal length age ranging from 18 to 60 years. He concluded that statistically significant correlation is present among the stature and these measurements. Regression equations for stature estimation from hand length were formulated, Right hand: Y= 069.513 + 5.223 (hand length) ± 4.033, Left hand: Y= 084.742 + 4.491 (hand length) ± 4.406. He also correlated actual measurements with hand print measurements and concluded that stature can be estimated from both values with a standard error of estimate ranging from 4.033 to 5.127.[8]

Sayeda Zamila H L et al. (2009) did a study on 150 females, 25-30 years approximate by age. The study showed positive correlation (p value <0.001) between the stature and hand lengths. The mean stature and mean hand length of the right and left were 156.02 (+6.13) cm, 16.39(+0.79) cm and 16.34 (+0.80) cm respectively. All the measurements in this study were positive as well as had statistically significant correlation with the stature.[9]

Isurani Ilayperuma et al. (2009) carried out a study to investigate the relationship between personal stature and hand length among a group of male and female adults and to derive a linear regression formula between the hand length and height of an individual. A total of 258 individuals with an age range of 20-23 years (140 male and 118 female) were included in the study. Regression equation for stature estimation was derived, male: Y = 103.732 + 3.493 (hand length), females: Y = 93.689 + 3.625 (hand length). Both male and female (combined): Y = 60.807 + 5.637 (hand length).[10]

The findings of present study are consistent with above studies. Mean right hand length is found to be 19.03±0.80cms in males and 16.78±0.78 cm in females.

Correlation coefficient r= 0.732 and r= 0.474 in males and females respectfully. Regression equations are Stature = 4.946 x RHL + 77.57 and Stature = 4.744 x RHL + 74.72 in males and females respectfully.

Conclusion

Forensic anthropometry expresses quantitative relationship between stature and various body dimensions. The relationship that exists between stature and different body parts of an individual has been of great interest to the forensic and medico legal experts.

The present study has established definite correlation between stature, parameter individually in both males and females included in the study: - Right Hand Length

Regression equations for each of parameter were derived as:

For Females: Stature = 4.744 x Right Hand Length + 74.72

For Males: Stature = 4.946 x Right Hand Length + 77.57

The above equations can be used to know the height of an individual and thus helps to determine the identity of an unknown. The anthropometric measurements differ in different sex and ethnic groups which are determined by genetic and environmental factors suggesting the need for different normograms for various populations.

These types of studies are of anthropological importance as it helps to know the difference between different population groups. If the study is repeated on the same population group after several years, it will help to identify the micro evolutionary changes. It also helps in forensic analysis in establishing the identity of the person in question, where stature is one of the primary characteristics of identification.

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