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Research Article

Correlations of stature with foot length in Andhra region

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Abstract

Objectives- Stature is the height of the person in the upright posture. It is an important measure of physical identity. Interrelationships among different body measurements may be used to estimate one from another in case of missing body parts. There are numerous means to establish stature and their significance lies in the simplicity of measurement, applicability and accuracy in prediction. The current study aimed at developing a regression equation for stature estimation from foot length and to find out the correlation between body height and foot length of Andhra population if any.

Method- It was conducted on 300 students of age group 17 to 22 years studying in Kamineni Institute of Medical Sciences, Narketpally, AP, India. Body height and foot length were measured in centimeter.

Result- There was significant correlation between height and foot length. The regression equation for height and foot length was found to be Y = 3.179 X + 87.65, where X is the foot length and Y the height.

Conclusion- The present study will be of immense significant for the anthropologists, medico legal workers and scientists for accurate measurement of either of the parameter when one is available particularly for Andhra Population.

Keywords: Body Height, Foot length, Correlation Coefficient, Regression Equation and its coefficient

1. Introduction

Stature is defined as the height of the person in the upright posture. There are many important parameters to establish the personal identity such as height, length of long bones, finger prints etc. Out of these foot length forms an important parameter as it can be used in cases of mutilated, decomposed and amputed body fragments which are very frequent in the events of natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. It is important both for legal and humanitarian reasons.[1] Dimensional relationships between the body segments and the whole body have been of interest to artists, scientists, anatomists, anthropologists and medicolegal professionals for long time.[2] Examination of skeletal remains recovered from a scene of crime, have often been used by the forensic anthropologists to extract relevant information about the victim. One such aspect pertains to reconstruction of living stature from such skeletal remains.[3] In medico-legal autopsies, establishing personal identity of the victims is often required. Estimation of stature from extremities and their parts plays an important role in identifying the dead body in forensic examinations.[4] Ossification and maturation in the foot occurs earlier than the long bones and therefore, during adolescence age, height could be more accurately predicted from foot measurement as compared to that from long bones.

The aim of the present study was to find out the correlation between foot length and height of an individual and to derive regression formulae to estimate the height from the foot length in the Andhra population.

2. Material and Method

The present study was carried out in the Department of Anatomy, Kamineni Institute of Medical Sciences, Narketpally, AP; India. The study consisted of 300 healthy medical students of the age group ranging between 17 -22 years belonging to Andhra region only. The two parameters were selected for the study, **Foot Length** and **Height**. They were measured as follows

Foot length- Left foot was selected for measurement as per recommendation of the international agreement for paired measurement Geneva (1912). Foot length was measured from most prominent point from the back of heel to the tip of great toe by using spreading caliper while the foot was on the ground.

Height - Height was measured in standing erect in anatomical position by using height measuring instrument 'Stadiometer' with least count of 1mm. Height was measured by single person, using the same instrument and at the fixed time of day to minimize the personal bias, instrumental bias and diurnal variation.

3. Observation And Result

Foot length and stature was measured in 300 subjects (150 Male & 150 Female). Following observations were made.

1. Age wise distribution of the mean foot length and mean height shown in the Table No.1

Table No.1- showing mean foot length and mean height in centimeters

Age in years, n= Number of subjects	Mean Height Male (cm)	Mean Height Female (cm)	Mean foot length Male (cm)	Mean foot length Female (cm)
17 (n=16)	167.3+8.14	155.8+ 7.19	26.0+ 1.15	23.4+ 1.05
18 (n=60)	168.8 +9.18	158.0 + 5.82	26.3 + 1.51	23.8 + 1.05
19 (n=90)	169.4 +5.59	156.4 + 6.15	26.1 + 1.29	23.6 + 1.13
20 (n=58)	170.5 +5.78	157.5 + 4.75	26.1 + 1.24	23.8 + 0.91
21 (n=47)	171.3 +5.93	159.2 + 6.8	26.0 + 1.32	24.1 + 1.09
22 (n=29)	169.0 +6.38	154.5 + 4.3	25.7 + 1.03	23.1 + 1.01

2. Correlation coefficient between height and foot length as shown in Table No. 2

Table No. 2- showing Correlation coefficient between height and foot length

Parameter	Male	Female
Total number	150	150
Height range (cm)	150.0- 183.0	147.0- 173.0
Mean height (cm)	169.9	157.1
S.D of Height	6.28	5.98
Foot length range (cm)	23.2- 30.0	21.4 – 26.1
Mean foot length (cm)	26.0	23.7
S.D of foot length	1.24	1.03
Correlation coefficient (r)	+0.73	+0.68
Regression coefficient (b)	3.67	3.98
Value of constant (a)	74.46	62.88

In the present study the subjects were divided according to their age in the age groups of 17, 18, 19, 20, 21 and 22. Table No1 shows the mean parameters of height and foot length in males and females of individual groups. Table No.2 shows that the height in male subjects ranges from 150.0cms to 183.0 cms and in female subjects from 147.0 cms to 173.0 cms. The regression equation was derived for males as Y=74.5+(3.67x X) and for Females as Y=62.9+(3.98 x X) where X is foot length and Y is height in centimeters. Correlation coefficient between height and foot length observed was +0.73 in males and +0.68 in females which is statistically highly significant.

4. Discussion

Vast amount of research has been conducted in the area of anthropometry dealing with the correlation of the various parameters of the human body mainly for the purpose of identification. The result of the individual study is dependent on the population races on which it is carried out. There is a paucity of such kind of literature in ANDHRA population.

Height estimation by measurement of various long bones has been attempted by several workers with variable degree of success. Each researcher has derived his own formula for calculating the stature from long bones. However, foot measurement has not frequently been used for this. It was Rutishauser who for the first time showed that reliability of prediction of height from foot length was as high as that from long bones.[5]

Natarajamoorthy T et.al studied on 107 randomly selected subjects in Malaysia and developed a regression equation for stature estimation from foot length obtained from foot impression.[6] Groote ID et.al studied on the skeletal sample compromised 87 individuals (Andamanese, Australians, Africans, Native Americans and British) and found a regression equation using first metatarsal bone to estimate stature.[7] Shushil Kumar et.al measured length of forearm and hand of 200 male medical students age ranging 18-25 years in India and developed a formula.[2] Akhter Z et.al studied head circumference and length of 100 Garo female subjects were included from Dhaka city and Mymensingh district, Bangladesh and advised head circumference showed significant positive correlation with stature but head length did not reach statistically significant level with stature.[8] Bhavna et.al have been studied on 503 male Shiah Muslim of Delhi, India and reported a body dimension which correlates highly with stature.[3] Ebite LE, et.al in their study on 109 healthy adults (45 male and 66 female) at Urome, Edo state, Nigeria and derived a formula based on Ulna length.[9] Dayal *et al* studied on 169 people (98 white male and 71 white female) and derived a regression formula for the estimation of total skeletal height and thereafter to predict stature in South African whites using long bone length.[10]

Patel *et al* in their study on 502 medical students (278 male and 224 female) between 17 to 22 years of age belonging to various region of Gujarat, India and reported a regression formula between foot length and height of an individual which was reported as Y=75.45+3.64X for Males and Y=75.41+ 3.43X for Females.[5] In present study the regression formula derived is Y=74.5+(3.67X) for males and Y=62.9+(3.98X) for Females where X is foot length and Y is height in centimeters. Thus the present study nearly correlates with the study of Patel *et al*.

Krishna *et al* studied 252 Koli male adolescents from North India and suggested that all the cephalo-facial measurements are significantly correlated with stature.[11] They also reported a regression equation for stature estimation from dimension of hand and feet in a North Indian Population. They found the correlation coefficient to be +0.767 for males and females taken together.[4] In the present study correlation coefficient between foot length and height in males is +0.73 and in females is +0.68. Thus the present study correlates with this study.

Jadav *et al* took length of head of 727 (468 male and 259 female) medical students belongs to various region of Gujarat, India and established a regression equation.[12] Mall G, *et al* in their study on 143 individuals (64 male and 79 female) reported correlation between the bone lengths of forearm and the stature led to unsatisfactory results with large 95% confidence intervals for the coefficients and high standard errors of estimate.[13] Saxena SK, et.al who derived a regression equation between head-length and height in Agra population. Their correlation coefficient between head-length and height was +0.2048.[14]

Qamra *et al* made a study on height and foot length as well as breadth and derived a correlation coefficient for foot breadth (Male 0.42 and Female .0.47) and foot length (Male 0.69 and Female 0.70).[15] In the present study correlation coefficient between foot length and height in males is +0.73 and in females is +0.68. Thus the present study correlates with this study.

Shroff *et al* have also derived the height from the length of superior extremity and its segments.[16] Patel *et al* have derived regression equation between tibia and total height in Gujarati population.[17] Athawale MC derived a regression equation between total height and forearm bones.[18]

Charnalia showed the significant correlation between height and foot-length, where correlation coefficient was +0.46.[19] Same significant correlation between height and foot length is observed in the present study.

According to John G, nasion-inion length (head-length) is 1/8 of the total height of an individual.[20] Singh *et al* and Jit *et al*. have shown a significant correlation between height and length of clavicle.[21,22]

No such type of study was carried out in Andhra region of India. In present study the correlation coefficient between height and foot length is + 0.73 in male and + 0.68 in female which is highly significant. From the above facts, it is clear that if either of the measurement (foot length or total height) is known the other can be calculated and this fact may be of practical use in Medico-legal investigations and in Anthropometry.

5. Conclusion

The present study has established definite correlation between stature and foot-length and also regression equations have been established. It will help in medico-legal cases in establishing identity of an individual when only some remains of the body are found as in mass disasters, bomb explosions, accidents etc. If either of the measurement (foot length or total height) is known, the other can be calculated and this would be useful for Anthropologists and Forensic Medicine experts. It will also help in establishing identity in certain civil cases.

There are lot of variations in estimating stature from limb measurements among people of different region & race. Hence there is a need to conduct more studies among people of different regions & ethnicity so that stature estimation becomes more reliable & identity of an individual is easily established.

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