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PREDICTION OF STATURE FROM PERCUTANEOUS MEASUREMENT OF HAND DIMENSIONS

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ABSTRACT

Background: Identification of an individual helps to establish a biological profile via estimation of age, race, sex and stature where anthropometry acts a measuring technique that expresses the dimensions of human body and skeleton quantitatively. Stature is an important parameter of identification that has certain degree of correlation with hand dimensions i. e. hand length and breadth showing a variation on basis of genetic, geographic and ethnic differences. This relationship between body segments i.e. hand dimensions and stature can be utilized to estimate the stature and identity of an individual when the entire body remains are not available. With this in mind, the present study was carried out to estimate the correlation between stature and the hand dimensions in the population and devise regression equations, multiplication factor in the region of Maharashtra. **Material and Method:** A cross sectional study comprising of 222 students who were born and brought up in Maharashtra and belonged to the age group 18-22 years, exhibiting an absence of any bony deformity and significant illness were chosen for percutaneous measurements of hand dimensions for stature estimation. **Result**: Hand length showed greater correlation than hand breadth for estimation of stature in both males and females. The regression equation for stature estimation from both hand length and breadth along with multiplication factor for the specific population was derived but it was found that hand length showed a better reliability. **Conclusion**: The hand dimensions showed a high degree of correlation for estimation of stature. Out of which maximum correlation is shown by hand length and is more reliable for estimation of stature with low error and high accuracy of regression equation.

KEYWORDS: Stature, Hand length, Hand breadth, Maharashtra, Regression, Multiplication Factor.

INTRODUCTION

Personal identification is one of the main tasks of forensic research which plays an important role in civil and criminal suits. For the identification of an individual, it is essential to establish a biological profile via estimation of age, race, sex and stature. Among these four parameters of biological profile, stature assumes a central position in the anthropometric studies.[1-6] Estimation of stature of an individual from skeletal material, mutilated or parts of limb is highly significant for identification process in Forensic science as it plays a crucial role in making opinions regarding medico-legal cases. Stature is a natural height of a person in erect position and anthropometry is a systematized measuring technique that expresses the dimensions of human body and skeleton quantitatively. Body physique is influenced to a greater extent by climatic, hereditary, nutritional and racial factors.[2-5]

Persons living under different environmental conditions, having different nutritional requirements and dietary habits, different levels of physical activity and members of different ethnic groups and the offspring of unions between them, present interesting differences in bodily form and proportions frequently.[6-10] The relationship between specific body dimensions or proportions can be used to help solve crimes in absence of complete evidence from hand prints and footprints left at scene of a crime as well as to compare and highlight the differences between different ethnic groups.[8-10,12-16] Stature is indeed a very important indicator of growth and development and a definite dimensional relationship exists between the height of the person and various parts of the body like head, trunk and lengths of upper and lower limbs.[1-10,15] Body proportions and the dimensions of different body segments, including the vertebral column, long bones of the limbs and the bones of the hand and foot can be used for stature estimation and attempts for doing the same have been recorded.[12-16] Therefore the relationship between the body segments e.g. hand dimensions and stature can be utilized to estimate the stature and identity of an individual when

the entire body remains are not available. While doing so it should be noted that a degree of variation is seen in the correlation between the hand dimensions and stature depending upon climate, ethnicity of a tribe or population and on the basis of effects of hereditary due to which no consistency can be established to calculate and estimate the relation between the hand dimensions and stature for all the regions at the same time.[1-16] Therefore each region needs its own regression formula for estimation of stature. The present study was undertaken to find out whether any correlation exists between the stature and hand dimensions i.e. hand length and breadth.

Aim and Objective

1. To derive regression formulae and multiplication factors for calculating the stature from percutaneous measurements of hand dimensions.

MATERIAL AND METHOD

The present study comprised of 222 (121 males and 101 females) young and healthy individuals who were born and brought up in Maharashtra of age group between 18-22 years studying in N.K.P. Salve Institute of Medical Sciences and Research Centre and Lata Mangeshkar Hospital, Nagpur. Since maximum height of an individual is attained in this period of time, only these individuals were selected for the study. Those having any congenital anomalies and pathology of bones and limbs like fractures, dislocations, poliomyelitis, rickets, scoliosis were excluded from study.

After obtaining approval from Institutional Ethics Committee, each subject was measured for stature and percutaneous hand length and hand breadth using stadiometer and caliper. Measurements on right and left sides in centimeters were taken separately as follows:

1. Stature

The subject was instructed to stand in a standard position with barefoot, both feet in close contact with each other, trunk braced along the vertical board on the stadiometer with head oriented in ear-eye plane and the lateral palpebral commisure and the tip of the auricle of the pinna in a horizontal plane parallel to that of the feet. The measurement was taken in centimeters as the distance between the standing surface and the highest point on the head (vertex).

2. Hand Length

Hand length is the projected distance between midpoint of a line joining the styloid process of radius and ulna bones of forearms and tip of the middle finger and it was measured from a palmer aspect as a straight distance between the midpoint of distal transverse crease of the wrist joint and the tip of the middle finger. It was measured in centimeters using caliper.

3. Hand breadth

Hand breadth is the distance between the most prominent point on the lateral aspect of the hand of the second metacarpal and the most prominent point on the medial aspect of the fifth metacarpal. The hand was kept straight in the prone position on flat table. All the fingers were extended and adducted whereas thumb was extended and abducted to measure the hand breadth in centimeters using the caliper.

Statistical Analysis

After collection of data, the data was tabulated and analyzed statistically for average, standard deviation, simple linear regression equation, and multiplication factor using Epi-Info Version 7.

RESULTS

A total of 222 (121 (54.5%) males and 101 (45.5%) females) healthy individuals between the age groups of 18 to 22 years were included in the present study and each subject was examined for the stature and percutaneous hand length and hand breadth of right and left sides. The observations were analyzed separately for both sides in both sexes and results are tabulated from which linear regression equations and multiplication factors were formulated.

Table 1: Demographic Distribution of Participants.

Age in years	Males	Females	Total
18	04(3.30%)	07(6.93%)	11(4.95%)
19	39(32.23%)	33(32.67%)	72(32.43%)
20	45(37.19%)	40(39.60%)	85(38.28%)
21	26(21.48%)	20 (19.80%)	46(20.72%)
22	07(5.78%)	01(0.99%)	08(3.60%)
Total	121(54.50%)	101 (45.50%)	222(100%)

Maximum participants were from 19-20 years age group as depicted in Table 1 out of which 195 (87.83%) were from urban population.

Table 2: Descriptive statistics of parameters among participants.

Gender		Height in cm	Right Hand Length in cm	Right Hand Breadth in cm	Left Hand Length in cm	Left Hand Breadth in cm
Females	Range	145-181	15.7-21.2	6.1-8.5	15.8-21.3	6.1-8.4
	Mean	159.64	18.00	7.00	17.95	6.94
	Std. Deviation	6.656	1.000	0.430	1.043	0.435
Male	Range	151-184	16.7-21.6	6.3-8.9	16.8-21.6	6.2-9.0
	Mean	170.94	19.34	7.80	19.32	7.766
	Std. Deviation	7.292	1.013	0.509	1.010	0.493

Stature

As depicted in Table 2, the stature in males ranged from 151.00 cm to 184.00 cm (Mean = 170.94 cm and SD = ±7.292) and in females ranged from 145.00 cm to 181.00 cm (Mean= 159.64 cm and SD= ± 6.656). It was observed that males have greater mean value of stature than that of females.

Hand Length

In males, length of right hand varied from 16.7 cm to 21.6 cm with a mean value of 19.34 cm standard deviation being ± 1.013 whereas the length of left side varied from 16.8 cm to 21.6 cm with a mean value of 19.32 cm and standard deviation ± 1.010. In females, the length of right hand ranged from 15.7 cm to 21.2 cm with mean of 18.00 cm, standard deviation being ± 1.000 cm and the length of left side ranged from 15.8 cm to 21.3 cm with mean of 17.95 cm and standard deviation of ± 1.043.

Hand Breadth

In males, the breadth of right hand ranged from 6.3 cm to 8.9 cm with a mean value of 7.80 cm, standard deviation being ±0.509 and the breadth of left hand ranged from 6.2 cm to 9.0 cm with mean value of 7.76 cm, standard deviation being ±0.493, however in females the breadth of right hand ranged from 6.1 cm to 8.5 cm with a mean value of 7.00 cm, standard deviation being ±0.430 and the breadth of left hand ranged from 6.1 cm to 8.4 cm with mean value of 6.94 cm, standard deviation being ±0.43.

Estimation of stature

Linear regression equations were derived for estimation of stature from the hand length and hand breadth of right and left side in both sexes, which are given as under:

Equations for females

S=117.25 ± 2.374 (Right Hand Length)
S=117.21 ± 2.377(Left Hand Length)
S=155.38 ± 0.594(Right Hand Breadth)
S=155.12 ± 0.637(Left Hand Breadth)

Equations for males

S=119.39 ± 2.676 (Right Hand Length)
S=128.11 ± 2.23(Left Hand Length)
S=156.32 ± 1.852 (Right Hand Breadth)
S=156.42 ± 1.851(Left Hand Breadth)

Multiplication factors

In the present study, multiplication factors were also derived for estimation of stature from percutaneous measurements of hand length and breadth. If these measurements are multiplied by the respective multiplication factor, the approximate height of an individual can be obtained (Table 3).

Table 3: Multiplication Factors for stature from hand length and hand breadth.

Multiplication Factor	Males	Females
Right Hand length	8.84	8.90
Left Hand Length	8.85	8.91
Right Hand breadth	21.90	22.80
Left Hand Breadth	22.07	23.06

Females exhibited greater mean multiplication factor for hand length and breadth indicating that males and females have variable proportion of limb dimensions with stature.

DISCUSSION

The estimation of stature is an important parameter in forensic examinations and anthropological studies. The main objective of present cross sectional study was to analyze the relation between hand dimensions i.e. hand length and breadth with stature and using this analysis as a basis for developing stature estimation standards for population in Maharashtra, as each individual shows a variation in the relation between hand dimensions and stature depending on upon the geographical, genetic factors.

In the present study males showed higher mean values in all the parameters studied as compared to females. The findings revealed a clear sexual dimorphism with females consistently having short stature, hand length and hand breadth compared to their male counterparts and this is in line with the findings of Ilaperuma I et al[2], Jethva N et al[7], Khan MA et al.[16] These differences may be due to early prepubertal growth spurt in girls that stops early, under the influence of estrogen, which causes early fusion of epiphysis. In males although the growth spurt occurs comparatively later, they continue to

grow for a longer period under the influence of testosterone. This necessitates different equations for males and females.

The mean stature value for males was greater than mean value of stature than that of females. This suggests that formula for one cannot be used for the stature estimation of other sex. These results were comparable with previous studies conducted by Ilaperuma I et al[2], Jethva N et al[7], Patel J et al[8], Varu PR et al[12], Oria RS et al[14] and Khan MA et al.[16] The mean stature found by different authors in different regions of India.[7,8,12,16] and outside India[2,14] exhibited that mean stature shows a slight difference depending upon region variation. It can be explained by the different genetic constitution, environmental factors and nutrition in different population groups. We observed that hand dimensions i. e. hand length and breadth were more in males than the dimensions in females. This finding is in agreement with the various studies conducted on hand dimensions in different adult population.[12,14,16]

The regression equations were derived and it was found that the maximum and minimum actual stature estimated from bilateral hand length and breadth among males and females varied, yet the mean value of stature for male (170.94 cm) and stature estimated from the bilateral hand length and hand breadth (170.94 cm) was almost similar. Similarly in females mean value of stature (159.64 cm) and that estimated from the bilateral hand length and breadth (159.61 cm) was almost similar. These findings are in accordance to the study conducted by Hossain S et al[3], Varu PR et al[12], Oria RS et al[14], Pal A et al[15], and Khan MA et al.[16]

It was found that regression equations had accuracy for calculating the stature. ± 2.676 and ± 2.23 for right and left hand length in males and ± 1.852 and ± 1.851 for right and left hand breadth in males ± 2.374 and ± 2.377 for right and left hand length for females and ± 0.594 and ± 0.637 for right and left hand breadth in females as compared to the findings noted by Varu PR et al[12] (±4.21 and ± 3.98 for right and left hand length in males and ± 3.52 and ± 2.82 for right and left hand breadth in males as opposed to ± 3.25 and ± 3.16 for right and left hand length in female and ± 2.69 and ± 2.41 for right and left hand breadth in females) and Kahn MA et al[16] (±4.98 and ± 5.06 for right and left hand length in males and ± 6.39 and ± 6.39 for right and left hand breadth in males as opposed to ± 4.43 and ± 4.38 for right and left hand length in female and ± 5.62 and ± 5.46 for right and left hand breadth in females). This accuracy may be attributed to the lack of diversity in their sample populations, specifically in terms of genetic variability.

We observed that females exhibited greater mean multiplication factor for hand length and breadth indicating that males and females have variable proportion of limb dimensions with stature.

CONCLUSION

The present study has found a positive and reliable and statistically significant correlation between hand dimensions and stature and its usefulness for the same. The maximum reliability was found in right hand length and breadth in case of males and females when mean length and breadth and standard deviation were considered. The regression equations showed lesser degree of error and provide maximum accuracy for estimating stature. The regression equations being population and region specific due to genetic, ethnic and geographic variation will help to identify stature of a person reliably of a particular region and in turn help in establishing a database and standard for this purpose on a larger population scale. So, similar studies will have to be conducted for specific populations to derive population specific formula and multiplication factor.

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