Original article

Role of Hand and Foot Print Dimensions in Stature Identification among Indian Population

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Abstract

Introduction: The four essential factors in Forensic Anthropology, representing in determining personal identification are age, sex, stature and ethnicity. Among this 'big fours' of the biological profile, determination of stature is considered as one of the main parameter of personal identification in forensic examinations. Thus, this study will aim to correlate relation between hand and foot measurements with stature of individual.

Aim of the study: The study aimed to estimate the relationship between statures of an individual on the basis of hand and foot prints, in Indian populations.

Materials and Method: The study group comprised of 100 subjects (age group above 18 years) with normal growth and development.

Measurement of height: The measurements of height was made using standard anthropometer by making the subject stand erect on the horizontal plane. The distance of the subject from the ground to the highest point of the vertex in the median sagittal plane was recorded.

***a) Hand length and Hand breadth*:** Hand length (HL) was measured from mid-point below radial and ulnar tuberosity to tip of middle finger. Hand breadth (HB) was measured from base of 5th to 2nd metacarpus by drawing the outline of hand on paper.

***b) Foot length and breadth*:** The foot length was measured as a direct distance from the most posterior point of back to tip of the Hallux or to tip of the second toe .The foot breadth was measured as the direct distance between the most prominent point on medial side and the most prominent on lateral side.

d) Heel Ball Index Measurement

The breadth of the foot at ball and at heel (BBAL, BHEL) were measured. The HB Index of the foot was calculated as (BHEL+ BBAL) x 100.

Results: Correlation of the various hand and foot parameters showed a regression coefficient range of 0.331-0.377. Among all variables measured, hand length exhibited the highest correlation with stature (r value of 0.377 p-value < 0.003). Further forward stepwise linear regression analysis [Height = 115.426+2.615* Hand length (Left)] established hand length to be the single best predictor of height (r value of 0.377 and standard error of 7.35cms).

Conclusion: Thus, the foot length provides highest reliability and accuracy in estimating stature of unknown males and females. Also this study will help to generate population-specific equations using a simple linear regression statistical method.

Key words: *Anthropology, Stature, Regression formulae, hand and foot length and breadth*

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Introduction

Forensic Anthropology is described as the analysis of human remains for the medico legal purposes to establish identity, investigate suspicious deaths and identify victims of mass disasters. Identification of human remains is one of the prime factors addressing the victims in case of mass disasters such as fire accidents,

explosions and aircrafts and railway accidents.

The four essential factors usually represented in determining personal identification are age, sex, stature and ethnicity. Among this 'big fours'[1] of the biological profile, determination of stature is considered as one of the main parameter of personal identification in forensic examinations. Stature is the height of a person in the upright posture and has a definite and proportional biological relationship with each and every part of the human body which helps the forensic experts to identify along with other evidences like dentition, foot prints and hand dimensions.[1]

Thus, this study aim to correlate relation between hand and foot measurements with stature of individual.

Aim of the Study

The proposed study aim to estimate the stature of an individual (male and female) on the basis of hand and foot prints, in Indian populations.

Objectives of the study

· To determine the relationship between stature and hand dimensions (length and breadth) among males and females of Indian populations.

· To determine the relationship between stature and foot dimensions (length and breadth) and also to derive heel ball (HB) index among males and females of Indian population.

Materials and Method

The study group comprised about 100 subjects of age group above 18 years after their informed consent and after Institutional ethical committee approval.

Inclusion criteria:

· Subjects with normal growth and development.

Exclusion criteria:

· Physically and mentally challenged individual

· Malocclusion

Measurement protocol

Measurement of Height[2]:

The measurements of height was made using standard anthropometer by making the subject stand erect in the anatomical position that is on the horizontal plane, barefooted according to the Frankfort plane, aligning the posterior surface of heels, pelvic girdle, scapular girdle, and occipital region to the vertical plane. The distance of the subject from the ground to the highest point of the vertex in the median sagittal plane was recorded. [2]

Hand and Foot Measurements

a) ***Hand length and Hand breadth*** [3]:

Hand of the subject (right and left hand) was kept straight and flat on table. Outline of hand was drawn on an A4 sheet of paper and the measurement were made respectively. Hand length (HL) was measured from mid-point below radial and ulnar tuberosity to tip of middle finger. Hand breadth (HB) was measured from base of 5th to 2nd metacarpus.[3] [fig.1]

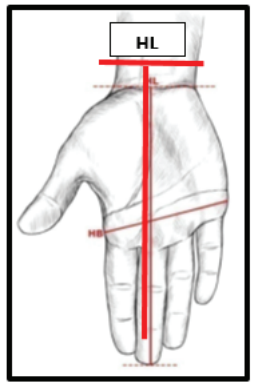

Fig: 1 Hand measurements

b) Foot length and breadth [4]**:**

Right and Left foot were taken for the measurement by placing on an A4 sheet of paper and drawing the outline of foot. The foot length was measured as a direct distance from the most posterior point of back [pternion] to tip of the Hallux or to tip of the second toe (acropodion) [fig:2]. The foot breadth was measured as the direct distance between the most prominent point on medial side (Metatarsal tibalae) and the most prominent on lateral side (Metatarsal fibulae).[4]

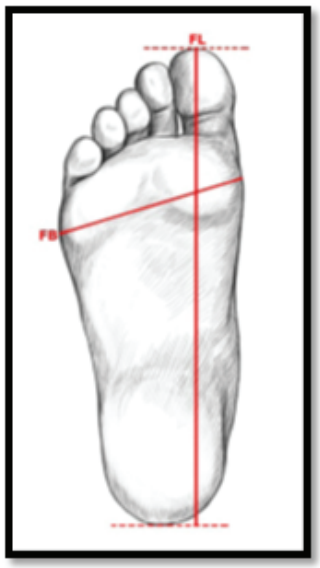

Fig: 2 Foot measurements

Heel Ball Index Measurement [3]

Foot breadth at the ball (BBAL) was measured as the widest part of the foot at the ball while the foot breadth at heel (BHEL) was measured as the widest part of the heel. [Fig: 3]. The HB Index of the foot were calculated as (BHEL+ BBAL) x 100.

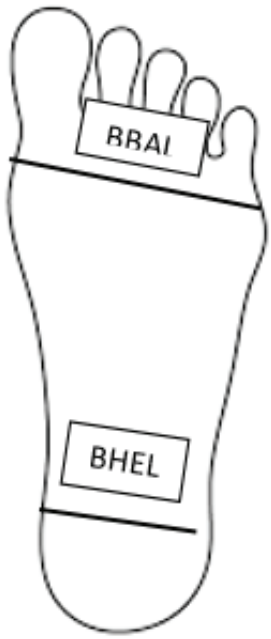

Fig3: Measuring the breadth of foot at ball (BBAL) and the breadth of foot at heel (BHEL).

Method to make the outline of hand and feet

The subject were asked to place his/her hand on an A4 sheet of paper. Outline of hand and foot were drawn using a pencil. Before lifting it from the paper, anatomical landmarks of the hand and feet were marked on the papers close to the hand and footprints which are mid-rear heel point and most anterior point of all toes in case of feet and mid-point below radial and ulnar tuberosity to tip of middle finger in case of hand.

Statistical Analysis

The data were then analyzed using linear Regression Analysis using the SPSS software to estimate the height of the individual based on and hand /foot indices. The regression equation with the R and R^2 values with standard errors of estimate were calculated to identify the most suitable predictor of stature of the individual.

Results

Correlation of the height of the individual with various hand and foot indices was done using Pearsons correlation coefficient (Table 1). The best parameters which correlated were the hand and foot lengths, with r value ranging from 0.331-0.377 (Figure 1). Among all variables measured, hand length exhibited the highest correlation with stature (r value of 0.377, p-value < 0.003). Forward stepwise linear regression analysis [Height = 115.426+2.615* Hand length (Left)] further established hand length (left side) to be the single best predictor of height (r value of 0.377 and standard error of 7.35cms) [Table 2].

TABLE 1: PEARSONS CORREATION OF HEIGHT OF THE INDIVIDUAL WITH VARIOUS HAND AND FOOT MEASUREMENTS

	Parameter	R	R Square	P value	equation	Std. Error of the Estimate
1	Hand L(R)	.346	0.12	0.007	HEIGHT = 122.033+2.238(Hand L(R))	7.1246
2	Hand L (L)	.377	0.142	0.003	HEIGHT = 115.426+2.615(Hand L (L))	7.0346
3	Hand B(R)	.177	0.031	0.175	HEIGHT = 141.104+2.863(Hand B(R))	7.4735
4	Hand B(L)	.197	0.039	0.131	HEIGHT = 136.062+3.539(Hand B(L))	7.4443
5	FL R	.331	0.11	0.01	HEIGHT = 110.904+2.13(FL R)	7.1653
6	FL (L)	.362	0.131	0.004	HEIGHT = 104.697+2.378(FL (L))	7.0775
7	FB R	.181	0.033	0.167	HEIGHT = 144.602+2.049(FB R)	7.4687
8	FB(L)	.131	0.017	0.318	HEIGHT = 148.164+1.649(FB(L))	7.5283
9	BBAL R	.163	0.026	0.214	HEIGHT = 146.693+1.82(BBAL R)	7.4927
10	BBAL(L)	.115	0.013	0.383	HEIGHT = 150.128+1.435(BBAL(L))	7.5436
11	BHEL R	.160	0.026	0.223	HEIGHT = 153.066+1.842(BHEL R)	7.4961
12	BHEL L	.289	0.084	0.025	HEIGHT = 145.162+3.294(BHEL L)	7.2694
13	HB R	.184	0.034	0.159	HEIGHT = 145.854+0.012(HB R)	7.4641
14	HB L	.240	0.058	0.065	HEIGHT = 138.911+0.017(HB L)	7.3715
					AVERHEIGHT STANDARD ERROR	7.353871
					SD OF ERROR	0.18137

Table 2: Forward stepwise linear regression for Hand length measurements

Parameter	R	R Square	P value	equation	Std. Error of the Estimate
Hand L (L)	.377	0.142	0.003	HEIGHT = 115.426+2.615(Hand L (L))	7.0346

Figure 1: Scatter plot showing the correlation of height and hand and foot measurements

Discussion

Stature is considered as one of the important characteristic for identification of an unknown person and is usually evaluated based on the lengths of the limb bones based predominantly on the femur. Stature depends on gender, genetic make-up, racial and geographical origin, social stratum as well as physical activity. The primary objective of the present research was to study the ethnic peculiarities of the relationship between the stature and hand and foot measurements in Indian population and to estimate stature using the measurements of handprints in this population.[6]

The results of the present study show that the dimensions of the hands and feet were statistically significant with positive correlation with stature of an individual. It also facilitates formulation of regression equations which can be successfully utilized for

stature estimation among Indian population. In this study among hand dimensions, HL had the best correlation with stature were r value = 0.377 and p value =0.003 and a weak correlation was stated between HB and stature.

Present study has found that both Hand length as well as Foot length are showing positive and statistically significant correlation with stature, but Hand length is showing more correlation with stature as compared to Hand breadth. Such finding were also observed in Australian and Thai population in the study done by Ishak NI *et al* and Laulathapho P *et al* .[7]

In the present study, the age of the subjects were between 18-30 years to avoid the process of bone loss after this age. In this regards, Firooznia et al. (1984) pointed out that bone loss with age is a natural phenomenon and bone mass peaks around ages 25–30 years and declines gradually thereafter in both men and women. The FL and FB were found to be increasing significantly on weight bearing between 3 and 19 years of age and in both genders (Hasegawa et al. 2009).[8]

In the present study, values of mean hand length were found to be higher on the left side compared to right side which is in agreement with the studies of Kulaksiz and Gozil. Results of the discriminant analysis by ***Troy case etal*** clearly indicate that the left hand should be preferred over the right, and that the hands should be preferred over the feet, for determining sex based upon length measures. It is also clear in both the hands and feet, that the phalanges are better at discriminating sex than the metacarpals or metatarsals.[9]

The human hand that is considered the most used and versatile part of the body and is of great importance to investigators in the field of anthropometry according to Rastogi *et al*'s study were HL was used for estimation of stature. In both, males and females, HL showed high positive value of correlation coefficient, which suggests a strong positive correlation between stature, HL, In the present study Regression equations for estimation of stature was derived as Height = 115.426+2.61 *(Hand Length of left side).

Length measurements of hand and feet differ substantively from the other measurements could be explained by the fact that they are less influenced by lifetime activity. The main impact on length measures will be genetic and nutritional. Evidence from stature and growth studies of living humans suggest that bone length is influenced .

Conclusion

The stature can be accurately and satisfactorily estimated for medico-legal and forensic purposes since bilateral and bisexual differences have been taken into account while devising the linear regression equation. However, if the age of the person is known, then better result can be obtained using the different linear regression equation as per age.

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Conflict of Interest : Nil

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