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**Original Article**

# Estimation of Stature from Hand Dimensions: An Anthropometric Study

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## ABSTRACT

The study is carried out to predict stature from upper limb anthropological measurements. Forensic anthropology is the application of anthropological knowledge in criminal investigation. So far, there are studies conducted to estimate stature from hand measurements, but from this region of Uttarakhand, studies are lacking. Such a study can assist in the identification of deceased individuals whose remains are decomposed, burned, mutilated or otherwise unrecognisable. In this study, attempt will be made to find the correlation between stature and hand dimension. The identification of individual from skeletal remains and badly decomposed or otherwise unidentified human remains is important in both legal and humanitarian contexts and also to give closure.

**Keywords:** Forensic anthropology, Stature, Hand length, Hand breadth, Identification

## INTRODUCTION

Forensic anthropology is the application of anthropological science in legal process. The determination of stature, age, sex from skeletal remains and badly decomposed or otherwise unidentified human remains is important in both legal and humanitarian aspect. When natural disasters, plane crashes and explosions occur, there will often be a large number of unknown victims requiring identification. In some of the criminal cases, body fragments are recovered from ditches, waste bins, etc. [1]. In such cases, knowledge of forensic anthropology can be applied and fragment or body parts can be utilised for identification. Stature is considered to be one of the important parameter of personal identification. It also provides a vision for various characteristics of a human population like nutrition, health and genetics [2].

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Till now the traditional methods of estimating stature from whole limb bone have been the centre of attention and there are very few studies in Kumaon region of Uttarakhand to estimate the stature from fragmentary part of the body. Hence, we conducted this study to predict stature using hand length and hand breadth and to find out variability in males and females by using hand measurement for estimation of stature.

## MATERIAL AND METHODS

This study comprised 204 participants in the age group of 22–40 years from the Kumaon region of Uttarakhand. The study was commenced after getting written consent from all the participants. Careful examination was done to rule out the conditions which can affect the general or bony growth like congenital defects on the upper and lower limb, any spinal disorder, previous history of fractures in upper and lower limb, bony involvement due to rickets, osteomalacia, rheumatoid arthritis and pregnancy in case of women participants. The subjects were measured for height and hand length in same time period to avoid diurnal variation [3]. Stature was measured accurately using stadiometer where participants were made to stand in erect posture on the board of standard stadiometer platform by keeping the foot in close contact without any footwear and arms hanging by the side, the trunk braced along the vertical board and eyes looking straight ahead and face adjusted in Frankfurt plane. The measurement was taken as maximum distance from floor to vertex of the head by bringing the horizontal sliding bar to vertex [4]. To measure hand length, participants were made to stand straight with hand hanging downwards with fully stretched. One arm of caliper was applied to the inter stylion point and other sliding arm is placed on the dactylion point [2]. Hand breadth is the distance between head of the metacarpal mediale and head of the metacarpal laterale. The measurement was taken over the dorsum of the hand in full extension [2]. To minimise subjective errors, all the measurements were taken three times and then mean were taken [5]. Data were analysed using SPSS v 16 software.

## RESULTS

Figure 1 shows gender-wise distribution of the study participants. In our study, majority of the participants were male (63.7%).

Figure 2 shows age-wise distribution of study participants. Individuals belonging to the age group of 22–30 years were found to be 51% and almost equal participants were seen in age group of 31–40 years (49%).

Table 2 shows that all the variants were significantly correlated with stature.

But the hand length was a better predictor of stature.

Table 3 shows r-square value of the predictors.

By using Table 4 (regression analysis), formula derived for stature are

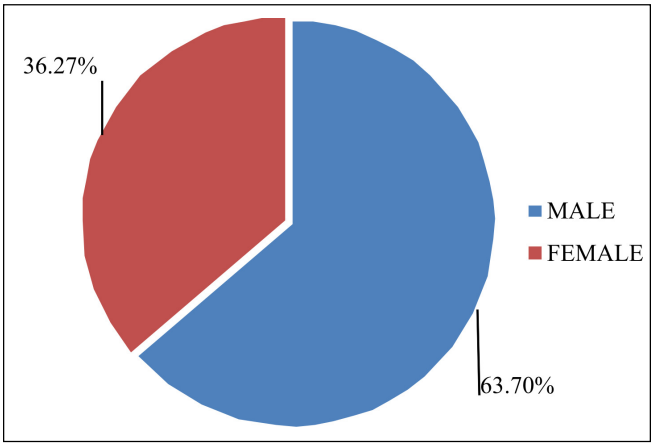


**Figure 1: Gender-wise distribution of the study participants**

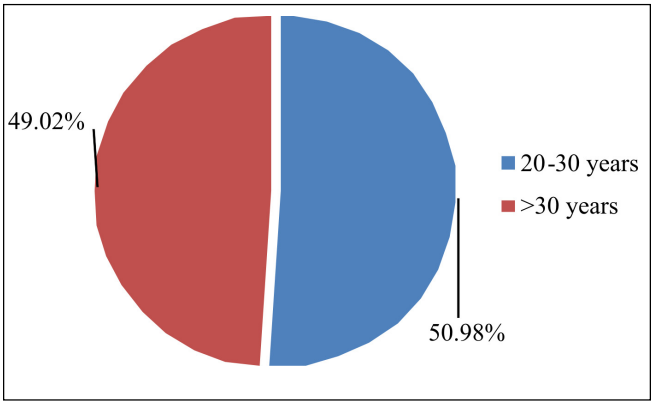


**Figure 2: Age-wise distribution of study participants**

**Table 1: Mean and standard deviation of stature and other dimensions of hands**

| Measurements | | N | Mean | SD | *p* |
|---|---|---|---|---|---|
| Right hand length | Male | 130 | 186.35 | 7.857 | <0.001 Sig |
| | Female | 74 | 173.23 | 11.360 | |
| | Total | 204 | 181.59 | 11.209 | |
| Left hand length | Male | 130 | 186.02 | 7.715 | <0.001 Sig |
| | Female | 74 | 173.18 | 9.987 | |
| | Total | 204 | 181.36 | 10.585 | |
| Right hand breadth | Male | 130 | 80.86 | 4.615 | <0.001 Sig |
| | Female | 74 | 72.85 | 5.484 | |
| | Total | 204 | 77.96 | 6.265 | |
| Left hand breadth | Male | 130 | 79.59 | 4.444 | <0.001 Sig |
| | Female | 74 | 71.99 | 5.521 | |
| | Total | 204 | 76.83 | 6.078 | |
| Stature | Male | 130 | 1654.35 | 66.944 | <0.001 Sig |
| | Female | 74 | 1563.09 | 67.616 | |
| | Total | 204 | 1621.25 | 80.164 | |

Average stature and other dimensions of hands were observed to be higher among male Participants as compare among female participants. It was found to be highly significant ($p<0.01$).

**Table 2: Correlation of stature with all other parameters**

| | Pearson correlation | *p* |
|---|---|---|
| Right hand length | 0.730 | <0.001* |
| Left hand length | 0.749 | <0.001* |
| Right hand breadth | 0.596 | <0.001* |
| Left hand breadth | 0.669 | <0.001* |

*Highly significant

**Table 3: R-square value of the predictors**

| Sex | Age group | *r* | r square | ANOVA *p*-value |
|---|---|---|---|---|
| Female | Model 1[a] | 0.655[a] | 0.429 | <0.001 |
| | Model 2[b] | 0.649[b] | 0.421 | 0.304 |
| Male | Model 1[a] | 0.644[a] | 0.415 | <0.001 |
| | Model 2[b] | 0.643[b] | 0.414 | 0.723 |

[a]Predictors: (constant), left hand breadth, right hand length, right hand breadth
[b]Predictors: (constant), left hand breadth, right hand length

**Stature in Males**

***Model 1***

616.803 + 4.037RHL – 0.563RHB + 4.155LHB

***Model 2***

606.171 + 4.050RHL + 3.686LHB

**Stature in Females**

***Model 1***

879.35 + 3.2 RHL – 2.124 RHB + 3.947 LHB

***Model 2***

865.903 + 3.006 RHL+ 2.451LHB

## DISCUSSION

This study was conducted among 204 study participants in order to predict stature using hand length and hand breadth and to find out variability in males and females by using hand measurement for estimation of stature. In our study, majority of the participants were male (63.7%).

**Table 4: Regression analysis for males and females**

| Sex | | | Unstandardised coefficients[a] | | Standardised coefficients | *T* | Sig. |
|---|---|---|---|---|---|---|---|
| | | | B | Std. error | Beta | | |
| Female | Model 1 | (Constant) | 879.353 | 98.202 | | 8.955 | 0.000 |
| | | Right hand length | 3.200 | 0.711 | 0.538 | 4.503 | 0.000 |
| | | Right hand breadth | -2.124 | 2.050 | -0.172 | -1.036 | 0.304 |
| | | Left hand breadth | 3.947 | 2.019 | 0.322 | 1.955 | 0.055 |
| | Model 2 | (Constant) | 865.903 | 97.390 | | 8.891 | 0.000 |
| | | Right hand length | 3.006 | 0.686 | 0.505 | 4.383 | 0.000 |
| | | Left hand breadth | 2.451 | 1.411 | 0.200 | 1.736 | 0.087 |
| Male | Model 1 | (Constant) | 616.803 | 115.469 | | 5.342 | 0.000 |
| | | Right hand length | 4.037 | 0.697 | 0.474 | 5.794 | 0.000 |
| | | Right hand breadth | -0.563 | 1.585 | -0.039 | -0.355 | 0.723 |
| | | Left hand breadth | 4.155 | 1.806 | 0.276 | 2.301 | 0.023 |
| | Model 2 | (Constant) | 606.171 | 111.134 | | 5.454 | 0.000 |
| | | Right hand length | 4.050 | 0.693 | 0.475 | 5.841 | 0.000 |
| | | Left hand breadth | 3.686 | 1.226 | 0.245 | 3.006 | 0.003 |

Dependent variable: STATURE

Study participants were belonging to two groups of 22–30 years and 31–40 years which comprised 51% and 49% of participants, respectively. Jaiswal [6] divided participants into three groups where majority of participants were in 20 year and above. In this study, males show higher mean values in each anthropometric dimension as compared with females (Table 1), these differences across the genders were statistically significant ($p$<0.01). Krishan *et al.* [2] and Jasuja *et al.* [7] observed the same in their study, which might be due to the early maturity of girls than boys [6] No significant asymmetry was observed in mean value across both the hand dimensions? Similar results were obtained by Krishna *et al.* [2] and Jaiswal *et al.* [6]. In our study, all the variants were significantly correlated with stature, but hand length dimensions were better predictor of stature. Krishnan *et al.*, Jaiswal *et al.* and Krishnan *et al.* also observed that correlation coefficients of the length measurements were higher than that of breadth measurements. A general linear regression was derived for both male and female. It is to be noted that, stature is being explained using Model 1 (left hand breadth, right hand length and right hand breadth) and Model 2 (left hand breadth and right hand length) with not much of a difference across the gender. Model 1 was the better predictors of stature with $p$<0.001. R-square values weren't showing any difference across the gender. In case of males, r square value is 41.5%. This means that 41.5% of the total variation in the stature can be explained by the left hand breadth, right hand length and right hand breadth. Among females, r square value was found to be 42.9%. This means that 42.9% of the total variation in the stature can be explained by the left hand breadth, right hand length and right hand breadth.

## CONCLUSION

It is concluded that the findings of the study show significant correlation between the stature of an individual and hand dimensions in both males and females. More significance correlation between stature and right hand

length, right hand breadth and left hand breadth was found. The equation we derived from this study may be helpful to estimate stature of an individual when fragmented or mutilated body parts are recovered.

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