

Research Article

Estimation of stature from anthropometry of hand: an interesting autopsy based study in Madhya Pradesh, India

Rajesh Ban Goswami*, P. S. Thakur, S. K. Dadu, A. K. Rastogi

Department of Forensic Medicine & Toxicology, MGM Medical College, Indore, Madhya Pradesh, India

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*Correspondence:

Dr. Rajesh Ban Goswami,

E-mail: grajeshban@gmail.com

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ABSTRACT

Background: Height of a person is an important parameter for the identification. Height or stature estimation is central dogma in anthropo-forensic examination. The human hand, which is the most used and versatile part of the body is of great scientific importance to investigators in the field of anthropometry, forensic pathology, orthopedic surgery and ergonomics. The hand length was found to be the most reliable alternative that can be used as a basis for estimating age-related loss in height. The hand length could also be used to predict body weight status and body surface area independent of the sex of the individual.

Methods: The present cross sectional prospective study was carried out in mortuary of department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (M.P.), India during study period from September 2014 to September 2015. The study was conducted on 250 deceased male and 250 deceased female individuals. The measurements were taken using standard anthropometric measuring instruments in centimeters to the nearest millimeters. All the measurements were recorded on a predesigned pretested proforma. Anthropometric measurements were taken as per the standard protocol.

Results: The mean age of the male and female study subjects was 38.472 ± 13.28 years and 34.728 ± 10.33 years respectively. Male to female ratio was 1:1. Mean stature in male subjects was 163.5 ± 5.21 cm. Mean stature in female subjects was 155.69 ± 10.12 cm. In male study subjects, mean hand length on right side was more than mean hand length on left side. In female study subjects, mean hand length on right side was more than on left side. In male study subjects, hand breadth (HB) on right side was more than on left side. Average HB in male subjects was 8.39 ± 0.203 cm. In female study subjects, hand breadth on right side was more than on left side.

Conclusions: The findings of the present study can be used as baseline information for other population based studies in the study area.

Keywords: Hand length, Hand breadth, Stature

INTRODUCTION

Height of a person is an important parameter for the identification. Height or stature estimation is central dogma in anthropo-forensic examination. It aids in personal identification of an individual.^{1,2} Stature is one of the most important and primary element in formulating

biological profile during the process of personal identification of an individual. The length of the body i.e. stature is one of the key parameters have been established in the course of identification of unknown skeletal remains.³ Stature measurements also play an inevitable part in drug dose adjustment, nutrition assessment and requirements, as well as for risk stratification. As all

individuals differ in their measurable traits, therefore stature estimation by anthropometry is of paramount importance for giving quantitative expression to variations of such traits.

Many human features have been used to estimate stature owing to their established relationships with stature. It is well known fact that there exists a definite proportionate relationship of different varying degree between the height of the person and various dimensions/measurements of the parts of the body like head, trunk and lengths of the upper and lower limbs.⁴ So stature can be estimated from different parts of human body. Like other parts of the body, the hand and its segments also display an explicit biological correlation with stature and on the basis of this relationship it is possible to predict the stature from hand dimensions.

The human hand is the most used and versatile part of the body is of great scientific importance to investigators in the field of anthropometry, forensic pathology, orthopedic surgery and ergonomics. The hand length was found to be the most reliable alternative that can be used as a basis for estimating age-related loss in height. The hand length could also be used to predict body weight status and body surface area independent of the sex of the individual.⁵ Thus, a reliable and precise means in predicting the height of an individual is by knowing the hand length of the individual.^{6,7}

Several studies have been conducted in different parts of the world on different population groups to estimate stature from certain bones and appendages of the body. In recent years many sets of regression formula have been devised by various researchers for estimation of stature from cadaveric bones and skeletal remains.^{8,9}

Although different researchers have ventured living population of India to formulate regression equations or multiplication factors for reconstruction of stature and also there is scarcity of availability of research work pertaining to population specific standard method for prediction of stature, therefore present study has been undertaken with purpose of finding out association between stature & various hand parameters (length and breadth) and establishing standard formulae for reconstruction of stature.

METHODS

The present cross sectional prospective study was carried out on a sample of 500 deceased individuals in mortuary of department of Forensic Medicine, Mahatma Gandhi Memorial Medical College and M.Y. Hospital, Indore (M.P.), India. Ethical considerations were met through institutional ethical committee. The study was conducted on 250 deceased male and 250 deceased female individuals. In the present study individuals of age more than 21 years were included. Bertillon system is based on the principle that after the age of 21 years the dimensions

of the skeleton remains unchanged and also that the ratio in size of different parts to one another varies considerably in different individuals. The study was carried out from September 2014 to September 2015 for a period of one year. In the study population, the subjects included were irrespective of caste, religion, dietary habits and socioeconomic status. The measurement taking includes height in centimeters, hand length in centimeters and hand breadth in centimeters to the nearest millimeters.

Method of collection of data

Firstly detailed history was taken both regarding the incident and complete clinical history including operative procedures, if any. Detailed individual demographic data including the height, sex, age etc. were also recorded on the predesigned pretested proforma. Written informed consent was taken prior to the research after giving detailed information to the relatives of the subjects regarding the study. Anthropometric measurements of the hand viz. hand length and hand breadth were taken independently on the left and right side of each individual. Stature of each subject was also recorded. Both right handed and left handed subjects were included in the present study. All the measurements were taken in a well-lighted room. Diurnal variations in the stature of an individual have been reported in several studies worldwide, therefore all measurements were taken during afternoon hours to avoid diurnal variations, if any.^{10,11} The measurements were taken twice for accuracy. The measurements were taken using standard anthropometric measuring instruments in centimeters to the nearest millimeters. Proper care has been taken to avoid any excessive compression of underlying tissues and to record the measurements precisely. All the measurements were recorded on a predesigned pretested proforma.

Anthropometric measurements (landmarks and techniques) were taken as per standard protocol.¹²⁻¹⁶

Inclusion criteria

All cases of post-mortem examination, where age of an individual is more than 21 years.

Exclusion criteria

- All subjects with skeletal abnormalities and deformities.
- All subjects with amputated upper limbs.
- All subjects below age 21 years.
- Mutilated and decomposed bodies.

Data collection instruments (standard vernier caliper, standard measuring tape and standard measuring scale) were used for the study. Firstly screen was designed for data entry and all the information available in the proforma was codified with appropriate value. The data of all proforma were collected, entered and subjected to

statistical analysis using Statistical Package for Social Sciences (SPSS) and Microsoft Excel.

RESULTS

The mean age of the male and female study subjects was 38.472±13.28763395 years and 34.728±10.33315131 years respectively. In the present study maximum age for the male subject was 86 years whereas minimum age for the male subjects was 22 years. The range of the age in male subject was 22 to 86 years. While in this study maximum age for female subject was 70 years, whereas minimum age for female subject was 22 years. The range of the age in female subject was 22 to 70 years. Male:Female ratio was 1:1 (Table 1, Figure 1)

Table 1: Distribution of anthropometric parameters for age in male and female study subjects.

Variables	Age in years	
	Male	Female
Mean	38.472	34.728
SD	13.28763395	10.33315131
Max	86	70
Min	22	22
Range	22-86	22-70

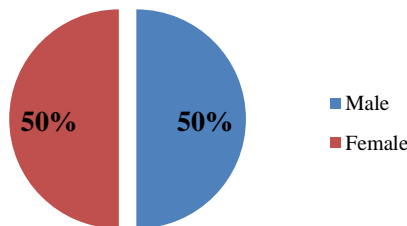


Figure 1: Gender wise distribution of study subjects.

Mean stature in male subjects was 163.5408±5.21728 cm. In this study maximum height reported was 179.5 cm, while minimum height was 153.6 cm. The range in stature of male was from 153.6 to 179.5 cm.

Table 2: Distribution of height among study subjects.

Variables	Mean	S.D.	Max	Min	Range
Ht in males (cm)	163.5408	5.21728	179.5	153.6	153.6-179.5
Ht in females (cm)	155.6904	10.12663754	171.1	145.0	145.0-171.1

Mean stature in female subjects was 155.6904±10.12663754 cm. In this study maximum height recorded was 171.1 cm, while minimum height was 145.0 cm. The range in height of female subjects was from 145.0 to 171.1 cm (Table 2).

Table 3: Distribution of anthropometric parameters for hand length in study subjects.

Variables	RHL in cm	LHL in cm	Avg. HL in cm
Males			
Mean	18.6792	18.537751	18.6038
SD	0.694238691	0.682094304	0.681084106
Max	20.5	20.7	20.6
Min	16.5	16.3	16.4
Range	16.5-20.5	16.3-20.7	16.4-20.6
Females			
Mean	16.4748	16.2744	16.389
SD	0.66870394	0.685204086	0.695750674
Max	18.4	18.2	18.9
Min	15.2	15.0	15.1
Range	15.2-18.4	15.0-18.2	15.1-18.9

RHL=Right hand length; LHL=Left hand length; HL=Hand length.

In male study subjects, mean hand length on right side was more than mean hand length on left side. This can be attributed to effect of hand dominance on hand measurements. In this study maximum hand length was 20.5 cm, while minimum hand length was 16.5 cm on right side and the range was from 16.5 to 20.5 cm, whereas maximum hand length was 20.7 cm and minimum hand length was 16.3 cm on left side and the range was from 16.3 to 20.7 cm in male subjects. In this study average hand length was found to be 18.6038±0.681084106 cm in male subjects. Maximum average HL was 20.6 cm while minimum HL was 16.4 cm. The range of average HL was 16.4 to 20.6 cm in male subjects.

In female study subjects, hand length on right side 16.4748±0.66870394 cm was more than on left side 16.2744±0.685204086 cm. In the current study maximum and minimum hand length on right side were 18.4 cm and 15.2 cm respectively, while maximum and minimum hand length on left side was 18.2 cm and 15.0 cm respectively in female subjects. The range in length of right hand was from 15.2 to 18.4 cm while in left hand was from 15.0 to 18.2 cm. Average hand length in females was found to be 16.389±0.695750674 cm. Maximum average HL in females was 18.9 cm, while minimum HL was 15.1 cm. The range of average HL was 15.1 to 18.9 cm in female study subjects (Table 3).

In male study subjects, hand breadth on right side 8.4608±0.191372307 cm was more than on left side 8.304±0.219235034 cm. In the present study maximum hand breadth on right side was 9.2 cm and minimum hand breadth on right side was 7.9 cm respectively, while maximum hand breadth on left side was 9.0 cm and minimum hand breadth on left side was 7.6 cm in male subjects. The range in breadth of right hand was 7.9 to 9.2 cm and in left hand was 7.6 to 9.0 cm. Average HB in male subjects was 8.3902008±0.20342322 cm. Maximum

HB was 9.1 cm and minimum HB was 7.75 cm whereas the range of HB was 7.75 to 9.1 cm in male subjects.

Table 4: Distribution of anthropometric parameters for hand breadth in study subjects.

Variables	RHB (cm)	LHB (cm)	Avg. HB (cm)
Males			
Mean	8.4608	8.304	8.3902008
SD	0.191372307	0.219235034	0.20342322
Max	9.2	9.0	9.1
Min	7.9	7.6	7.75
Range	7.9-9.2	7.6-9	7.75-9.1
Females			
Mean	7.7768	7.5616	7.6764
SD	0.332297698	0.277786681	0.306925137
Max	8.5	8.2	8.6
Min	7.0	7.0	7.0
Range	7.0-8.5	7.0-8.2	7.0-8.6

Table 5: Regression equations for estimation of stature from various hand parameters in study subjects.

Parameter	Stature
Males	
HT with RHL	$HT = (5.6746) * RHL + 57.5436$
HT with LHL	$HT = (5.6919) * LHL + 58.0370$
Avg. HL with HT	$HT = (5.7957) * Avg. HL + 55.7187$
HT with RHB	$HT = (15.1422) * RHB + 35.4254$
HT with LHB	$HT = (13.9713) * LHB + 47.5231$
HT with Avg. HB	$HT = (13.7460) * Avg. HB + 48.2061$
Females	
HT with RHL	$HT = (5.8259) * RHL + 59.7106$
HT with LHL	$HT = (5.5647) * LHL + 65.1289$
Avg. HL with HT	$HT = (5.3917) * Avg. HL + 76.3252$
HT with RHB	$HT = (9.4353) * RHB + 82.3143$
HT with LHB	$HT = (11.6512) * LHB + 67.5886$
HT with Avg. HB	$HT = (10.3399) * Avg. HB + 76.3169$
HT with Avg. HB	$HT = (10.3399) * Avg. HB + 76.3169$

*Indicates multiplication

In female study subjects, hand breadth on right side (7.7768 ± 0.332297698 cm) was more than on left side (7.5616 ± 0.2777866 cm). In this study maximum and minimum hand breadth on right side were 8.5 cm and 7.0 cm respectively, while maximum and minimum hand breadth on left side were 8.2 cm and 7.0 cm respectively. The range in breadth of right hand was 7.0 to 8.5 cm while the range of LHB was 7.0 to 8.2 cm. Average hand breadth in female subjects was 7.6764 ± 0.306925137 cm. Maximum average HB was found to be 8.6 cm while

minimum average HB was 7.0 cm. The range in average HB was 7.0 to 8.6 cm in female study subjects (Table 4).

(Regression Equation $(y) = b_0 + b_1x$, where x and y are variables, b_0 = Estimate of regression intercept, b_1 = the slope of regression line). Table shows linear regression equations for estimation of stature for both right hand and left hand measurements for male and female study subjects respectively (Table 5).

DISCUSSION

Previous several studies have established definitive relationship between hand and stature by anthropometry.¹⁰⁻¹⁴ Many recent studies have also shown a significant relationship between hand measurements with stature.¹⁶⁻²⁰

In the present study male to female ratio was 1:1, which was found to be similar to other studies by Dr. Sunil et al and Geetha et al.^{17,18}

In the present study the mean stature of male subjects was found to be 163.54 ± 5.217 cm, which was slightly lower than the findings of the other studies except Geetha et al (157.95 ± 6.42 cm).¹⁸ The mean stature was found to be on higher side by Ozaslan A et al (172.437 ± 6.86 cm) and Patel J et al (175.95 ± 5.917 cm) as compared to present study.^{19,20}

In the present study the mean stature of female subjects was found to be 155.69 ± 10.12 cm, which was slightly lower than the findings of the other studies, Sunil et al, Pal A et al and Patel J et al.^{17,13,20} The mean stature of female subjects was found to be on lower side by Geetha et al when compared to present study.¹⁸

In the present study mean hand length was found to be greater in right hand as compared to mean left hand in male subjects. When the mean hand length in the current study was compared with other studies, our findings were nearly similar to results of Patel J et al, Sunil et al and Pandey N et al have found higher hand length in their respective studies as compared to present study, while the findings of Geetha et al were found to be on lower side as compared to present study.^{20,17,14,18}

In the present study mean RHL was found to be more than mean LHL in female subjects. In this study mean hand length in females was found to be lower than other studies, Pal A et al, Pandey N et al, Geetha et al.^{13,14,18} The findings in this study were found similar to studies of Sunil et al and Patel J et al.^{17,20}

In the present study mean hand breadth (HB) was found to be more in male study subjects than females. The findings of the present study were found similar to study of Ozaslan A et al. The mean HB in the present study for males (8.3902 ± 0.2042 cm) was found to be similar to Chandra A et al (8.429 ± 4.04).^{19,15}

The multiplication factor is a handy tool and proves vital in situation where the forensic investigator is not well versed with complex mathematical equations or where the investigator is dealing with number of cases like mass disaster or people affected in terrorist attacks etc. Agrawal J et al & Pal A et al have found nearly similar multiplication factor 8.835 and 9.05 respectively for hand length in males while Patel J et al found higher MF (9.32) for hand length in males in contrast to present study.^{12,13,20}

The regression equations derived to estimate stature from hand breadth in the present study for males was found to be $HT=48.2061+(13.7460)*Avg. HB$, while in females was $HT=76.3169+(10.3399)*Avg. HB$.

Previous studies have established that the regression equations using various anatomical dimensions of one population do not apply to another population.²⁵ The result was found to be similar in our study, where our data differs from data of previous studies of other ethnic groups.

CONCLUSION

The findings of the present study can be used as baseline information for other population based studies in the study area, so that anthropologists, forensic and other medico-legal experts can estimate the stature of the individual by the use of length and width of hand within the standard error of estimate. One must consider differences between populations to apply such formula to other populations.

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