Prediction of Stature based on Measurement of Hand Length in Maharashtra Region

Wakode N S[1,*], Wakode S L[2], Ksheersagar D D[3], Tajane V D[4], Jachak A N[5]

[1]Assistant professor, [3]Professor & Head, [5]Undergraduate Student, Department of Anatomy,
NKP Salve Institute of Medical Sciences & RC, Hingna Nagpur.
[2]Associate professor, [4]Professor, Department of Physiology, Government Medical College & Hospital, Gondia

*Corresponding Author:
Email: nainawakode@gmail.com

ABSTRACT

Background & Objective: *Stature or body height is one of the most important and useful anthropometric parameter that determine the physical identity of an individual. Purpose of present study was to evaluate utility of hand length in estimation of stature & to predict the accuracy of regression equation & multiplication factor.*
Study Design: *Descriptive cross sectional study.*
Method: *The study was carried on 94 males and 106females with the age of 17 to 25yrs of NKP Salve Institute of Medical Science & Research Centre Nagpur. Measurement of stature done by using standiometer and hand length of right hand & left hand with a slide caliper.*
Result: *Mean and standard deviation of stature, hand length and correlation coefficient between hand length and stature was obtained. By using standard formulae regression equation & multiplication factor was derived for the estimation of stature from hand length.*
Conclusion & Interpretation: *The present study showed significant correlation between the stature and hand lengths from the region of Maharashtra. The present study also provides regression equation & multiplication factors which can be useful for nearly accurate estimation of stature. This data is useful for the identifying of war casualties & for medico legal purpose.*

Key Words: Anthropometric measurement, Hand length, Regression equation & multiplication factor.

INTRODUCTION

Stature or body height is of the most important and useful anthropometric parameter that determines the physical identity of an individual. The stature prediction occupies a relatively central position in the anthropological research and also used for identification of necessitated by the medical jurisprudence or by medico-legal experts.[1] The identification of isolated extremities is an issue of great significance in the investigation of the identity of victim of mass disaster & fatal assaults. The dimensions of hand and foot have been used for determination of sex, age, and stature of an individual in forensic investigation.[2]

Among the various parameters of identification, individual's stature is an inherent characteristic, the estimate of which is considered in those cases where only fragmentary or mutilated remains of an unknown person are recovered.[3] It is alsouseful when stature cannot be measured directly due to deformities like kyphosis, scoliosis, missing legs etc. Many studies have been carried out to estimate stature by taking measurements of long bones, hand length, foot length. A number of multiplication factors and regression equations have been developed to reconstruct stature from long bones throughout the world.[4-11]

Recently forensic experts, anthropologists are trying to develop appropriate formulae and regression equations for stature from different parts of upper and lower limbs.[12,13] The present study was undertaken to predictthe stature of individuals from Maharashtra state. The objective of the study was to measure the hand length, to estimate stature from the hand length and to derive any regression equation and multiplication factor for it.

MATERIALS AND METHOD

The current descriptive cross sectional study was conducted using 200 (94 males and 106 females) medical students of NKP Salve Institute of Medical Science and Research Centre, Nagpur, Maharashtra. Their age ranged from 17-25 years. The students were selected for the study irrespective of their caste, religion, dietary habits and socio-economic status. The students having any significant growth disorders, deformities, bony anomalies and fractures of forearm and hand are excluded from study group.

Standard anthropometer was used to measure stature, study subjects were standing erect without shoes and stature was measured as a distance

between standing surface to the highest point on the head in mid-sagital plane. The length of each hand was measured using a sliding calliper. The distance between the midpoint of the inter styloid line and the tip of the middle finger in extension was measured as the length of the hand.[14] The measurements were recorded in centimetres to the nearest 0.1cm.

     Data was complied on excel sheet, descriptive statistics was used to analyze and determine the parameter studied in both males and females. The strength of the relationships between the length of hand and stature was established by using Pearson's correlation.[15] The mean and standard deviation of standing height, hand length was derived and from which their correlation coefficient with standing height were calculated. The regression equation and multiplication factors were derived for stature estimation.

1. Regression equation for stature for male & female are derived from right and left hand by using the formula:

$$y - y' = \pi \frac{dy}{dx}(x - x') - y'$$

Where,

y = Standing height (stature)
y'= Average(mean) of standing heights
x = Length of hand
x'= Average(mean) of length of hands
Л= Co-relation coefficient between standing height and length of hand
∂y = Standard deviation of standing height
∂x = Standard deviation of hand length

2. Calculation of multiplication factor:

     Each multiplication factor is a ratio of the stature to the respective physical measurements. A mean multiplication factor was then calculated for each measurement. These mean multiplication factor were used for estimating the stature from those variables. According to the Lal and Lala[16], Multiplication factor is equal to stature divided by hand length.

DISCUSSION

     The relationship that exists between different part of body and height has been of great interest to anthropologists, for many years. So various parameters of long bones have been studied by many workers & their use in measurement of stature has been attempted. However a practical difference arises in a situation where only dismembered body part is available for medical examination like in mass disasters. Therefore we made an effort to find out correlation between hand length & stature.

     In the present study, a high degree of correlation is seen between heights of individual with

hand length for both the sexes. The correlation coefficient was found to be statistically significant indicating a strong relationship between hand length and stature for Males (r=0.6994right, r=o.6571left) and for females (r=0.6935right, r=o.6538left).(Table II) Further, linear regression equations for estimation of stature were derived for both left hand and right hand in males & females. (Table III & Table IV) The measurements of stature obtained using regression equations were compared with the actual measurements and there is a negligible difference between actual height and height obtained by using regression equation. So stature can be predicted with high accuracy using the regression equations.

     We found that the regression equations of one sex cannot be applied to the other even when predicting stature in same ethnic group.[17,18] In previous studies have found that the regression equations using various anatomical dimensions of one population do not apply to another.[19,20] The same was found in our study, where our data differs from data of previous studies of other ethnic groups.[21,22] There are reports of stature estimation using hand lengths and phalange length & calculation of multiplication factors for stature.[23] While in our study we calculated & compared the regression equation with multiplication factor. By applying the regression equations, the stature can be estimated within error of ±4 in most of the cases. Variation calculated for multiplication factor ranged from ±12 to ±9 for right hand and from ±13 to ±11 for left hand in males. The variation calculated for multiplication factor ranged from ±5 to ±6 for right hand and ±4 to ±5 for left hand in females. These values are more than the real stature in 95% males and 75% of females. Thus, multiplication factors are statistically inferior and less reliable than regression equations; this is in agreement with previous studies.[24] Linear regression equations were derived in the study can be used accurately and reliably for estimation of stature in a diverse population group.

RESULTS

     The data thus obtained was subjected to statistical calculations using SPSS computer programmer to derive linear regression equations.

Stature: Mean and standard deviation of stature for males & females was 171.4638 ± 5.7901 & 157.6613 ±5.3747 respectively. (Table I)

Hand length:

a. **Males:** The length of right side hand varied from 16.2cm to 20.7cm in males with mean 18.3106cm, standard deviation 0.8656 cm and co-relation coefficient with stature 0.6994. The length of left side hand varied from 16.3cm to 20.5cm in males with mean 18.3723cm, standard deviation 0.9389 cm and co-relation coefficient with stature 0.6571. (Table II)

b. **Females:** In female the length of right side hand varied from 14.9 cm to 18.8 cm with mean 16.7216 cm, standard deviation 0.7701 cm and co-relation coefficient with stature 0.6935. The length of left side hand varied from 15.2 cm to 18.8 cm with mean 16.6820 cm, standard deviation 0.7748 cm and co-relation coefficient with stature 0.6538. (Table II)

Regression equations for estimation of stature were derived from length of hand of right and left separately in males and females with formula:

$$y - y' = \pi \frac{dy}{dx}(x - x') - y'$$

as discussed above.

These were calculated as:

1. **For male**

a. Right hand length: $0.6994 \times 5.7901/0.8656$ (x – 18.3106) – 171.4638 = 4.6783x + 85.6635

b. Left hand length: $0.6571 \times 5.7901/0.9389$ (x – 18.3723) – 171.4638 = 4.0522x + 97.0141

2. **For female**

a. Right hand length: $0.6935 \times 5.3747/0.7701$ (x – 16.7216) - 157.6613 = 4.8400x + 76.7272

b. Left hand length: $0.6538 \times 5.3747/0.7748$ (x – 16.6820) – 157.6613 = 4.5353x + 81.0015

Here x is the length of hand. By putting the value of x in different situations the stature were calculated and compared with the corresponding real standing height and these were close (+/-4) in most of the cases. (Table III & Table IV)

Multiplication Factor: To establish the multiplication factor, ratio of standing height and hand length was calculated separately for males and females. In males, it ranged from 8.5024 to 10.0308 of right hand and from 8.5853 to 9.7546 of left hand. The average of multiplication factor in males is 9.2666 of right hand and 9.1699 of left hand. In females, it ranged from 9.2021 to 9.9328 of right hand and 9.2021 to 9.7368 of left hand. The average of multiplication factor for females is 9.5674 for right hand and 9.4694 for left hand. (Table V)

Table I: Stature of study group

	Total Males(94)	Total Females(106)
Minimum(cm)	159	141.9
Maximum(cm)	188	173
Mean(cm)	171.4638	157.6613
Standard Deviation(cm)	5.7901	5.3747

Table II: Showing Hand length, Standard Deviation (cm), Correlation coefficient with stature(r)

	Male			Female		
Measurement	**R H L**	**L H L**	**Mean hand lengths**	**R H L**	**L H L**	**Mean hand lengths**
Minimum(cm)	16.2	16.3	16.25	14.9	15.2	15.05
Maximum(cm)	20.7	20.5	20.6	18.8	18.8	18.8
Mean(cm)	18.3106	18.3723	18.34145	16.7216	16.6820	16.7018
Standard Deviation(cm)	0.8656	0.9389	0.90225	0.7701	0.7748	0.77245
Correlation coefficient with stature(r)	0.6994	0.6571	0.67825	14.9	15.2	15.05

Table III: Regression equation and variations in calculated stature for males.

Side	Regression equation	Hand length	Standing Height	Calculated stature	Variation in cms
Right	4.6783x + 85.6635	Min 16.2	162.5	161.45196	+1.04804
		Max 20.7	176	182.50431	-6.50431
Left	4.0522x + 97.0141	Min 16.3	162.5	163.06496	-0.56496
		Max 20.5	176	180.08420	-4.08420
Average	4.3522x + 91.63369	Min 16.25	162.5	162.35694	+0.14306
		Max 20.6	176	181.28901	-5.28901

Table IV: Regression equation and variations in calculated stature for Females.

Side	Regression equation	Hand Length	Standing Height	Calculated stature	Variation in cms
Right	4.8400x + 76.7272	Min 14.9	148	148.84320	-0.84320
		Max 18.8	173	167.71920	+5.28080
Left	4.5353x + 81.0015	Min 15.2	148	149.93806	-1.93806
		Max 18.8	173	166.26514	+6.73486
Average	4.6872x + 79.37663	Min 15.05	148	149.91899	-1.91899
		Max 18.8	173	167.49599	+5.50401

Table V: Multiplication factor

Ratio of standing height and average hand length	Males	Females
Maximum RHL	8.5024	9.2021
Minimum RHL	10.0308	9.9328
Maximum LHL	8.5853	9.2021
Minimum LHL	9.7546	9.7368

CONCLUSION

Stature of an individual constitutes an importance element to anthropologists, forensic experts and human biologists. There is a positive significant correlation between stature and hand length in a particular population. (P value 0.001for male and P value 0.001for female). Linear regression equations were derived for estimation of stature reliably and accurately that would be of immense value in the field of crime detection. This information will be useful in many ways like in identifying the war casualties and for medico legal purpose when only hand of the deceased is available.

INTERPRETATION

The present study shows that hand measurement yielded important predictive information about individual stature and provides the regression equations and multiplication factor for estimation of stature in a particular population.

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