Original article

Predictive Role of Hand Dimensions in Stature Estimation Among Medical Students

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Abstract

Background:
Stature or body height is one of the important and useful anthropometric parameters that determine the physical identity of an individual. The present study was undertaken to set up a standard formula to estimate stature from different hand dimensions.

Objective:
To find out the variations of different hand anthropometric dimensions and their relationship with stature among the students of both sexes of Rangpur Medical College.

Methods:
This cross-sectional, analytical study was conducted in the Department of Anatomy, Rangpur Medical College, Rangpur, from January 2018 to December 2018. 700 medical students (350 male and 350 females) were included in this study.

Results:
Stature had significant correlation with all hand dimensions in both male and female students. In male, highest correlation (0.995) was found for right palm length, right thumb length, left thumb length, left ring finger and lowest correlation (0.983) was found for right wrist circumference. On the other hand, in female, highest correlation was found for arm span (0.989) and lowest correlation was found for right palm length (0.968), the correlation was more prominent in male student.

Conclusion:
Hand dimensions can be successfully used for estimating stature. Multiplication factors are applicable to the population from which it is calculated. So, there is need to calculate multiplication factors for each parameter in every ethnic region and race.

Keywords: Stature estimation, Hand dimensions, Multiplication factor

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Introduction:

There exists an established relationship between stature and hand anthropometry. The correlation between stature and various hand dimensions such as hand length,[1-6] hand breadth,[1-5] maximum hand breadth,[4,5] palm length,[3-5] thumb length,[4,5] index finger length,[3-7] middle finger length,[4,5] ring finger length,[4-7] little finger length,[5] arm span[8] has been reported in previous studies. The relationship between body segments has been the focus of anatomists, anthropologists and scientists for many years. These relationships have been utilized to compare and highlight the differences between different ethnic groups and to narrate them to locomotor patterns, energy expenditure and lifestyle.[5] Again these dimensional relationships between body segments allow the reconstruction of its original stature and are widely used in forensic practice.[9] Analysis of the recently conducted studies shows that stature can be effectively estimated from length of separated long bones of the upper and lower limbs.[10] Various studies have been undertaken to establish the relationship of hand dimensions with the height of individual and implicated its use for personal identification; sexual and racial dimorphism.[11] In this study, it was aimed to evaluate the predictive role of hand dimensions in stature estimation.

Methods:

The cross-sectional, analytical study was conducted on 700 Bangladeshi medical students

(350 males and 350 females) of Rangpur Medical College in the Department of Anatomy from January 2018 to December 2018 through convenient sampling. Any deformity of hand was excluded. The objectives and methods of the study were explained to the study population and informed consent was obtained. The anthropometric measurements such as stature, hand length, palm length, hand breadth, five fingers length, hand span, wrist circumference, arm span were measured. The hand measurements of both left and right side were measured separately for everyone usingstadiometer, digital slide caliper, measuring tape and ruler. Measurement technique for measuring stature, hand length, palm length, hand breadth, hand span, wrist circumference, arm span and five fingers length was taken following the methods recommended by Weiner and Louri.[12]

Measurements were taken from the participants following the standard technique and appropriate landmarks[5] which are shown in figure-1.

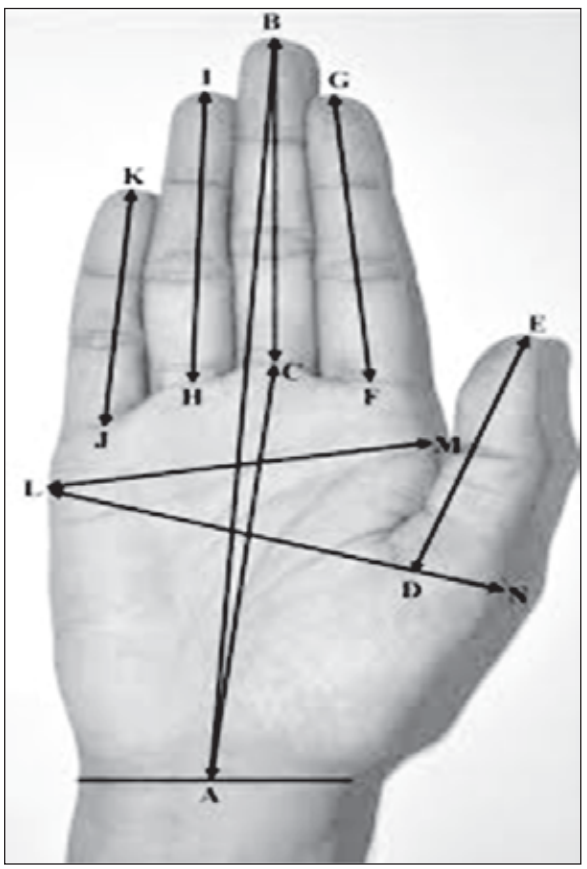

Figure-1: Human hand illustrating the landmarks of different hand dimensions

A to B: Hand length; A to C: Palm length; D to E: 1st digit length; F to G: 2nd digit length;C to B: 3rddigit length; H to I: 4th digit length; J to K: 5th digit length; L to M: Hand breadth (Pal et al 2016)[5]

Statistical analysis was carried out using the statistical package for social sciences (SPSS) version 16.0. Pearson correlation coefficient (r) was calculated to assess the correlation of stature with independent variables of hand. The value of reliability correlation coefficient ranged from 0 to 1. A correlation coefficient of below 0 indicates "no reliability'', >0 to <0.2 is slight reliability, 0.2 to <0.4 is fair reliability, 0.4 to <0.6 is moderate, 0.6 to<0.8 is substantial and 0.8-1.0 is almost perfect reliability.[5] p-value <0.05 was considered significant to assess accuracy of the prediction of stature by multiplication factors.

Multiplication factors:

Multiplication factor is the ratio of stature to the respective physical measurements.

Multiplication factor was calculated from the following formula:

$$\text{Multiplication factor} = \frac{\text{Stature}}{\text{Length of each upper limb segment}}$$

The equation was formulated according to Devi et al shows that when stature is constant, the multiplication factor is inversely proportional to limb segment lengths.[8]

In the present study, multiplication factors were calculated for each segment of hand. A mean multiplication factor was then calculated for each measurement. Then mean multiplication factor were used for estimating the stature from each hand measurement.

Estimated stature:

Estimated stature was the value that found by multiplication of each hand measurement with the mean of its multiplication factor. It was estimated by following formula

Estimated stature = Multiplication factor × each hand measurement

The equation was formulated from the equation of multiplication factor.[8]

Results:

Table-I and II show the multiplication factors and estimated statures from different variables in male and female medical students. In both groups, no significant difference was found between measured stature and estimated stature (paired t test) for any of the hand variables.

It was observed from Table-I, in male, highest correlation 0.995, was found for right palm length, right thumb length, left thumb length, left ring finger and lowest correlation 0.983, and was found for right wrist circumference.

Again, in male, lowest difference between estimated stature and measured stature (+0.07) were found for left hand length, left palm length, left thumb length, right ring finger, left little finger, right hand breadth, left hand breadth, right hand span, left hand span, arm span, right wrist circumference and left wrist circumference and highest difference was found for right thumb length (+0.38).

On the other hand, it was observed from Table 2, in female, highest correlation 0.989, was found for Arm span and lowest correlation 0.968 were found for right palm length and left palm length. Again, lowest difference between estimated stature and measured stature (+0.25) were found for right palm length, left palm length, right thumb length, left thumb length, right index finger, left index finger, right middle finger, left middle finger, right ring finger, left ring finger, right little finger, left little finger, right hand breadth, left hand breadth, right hand span, left hand span, right wrist circumference and left wrist circumference and highest difference (-0.75) was found for arm span.

Table-I: Measurement of estimated stature of male medical students

Variables	Multiplication factors	Estimated stature (ES)	Measured stature (MS)	Difference Between ES-MS	R-value
Hand length Right	9.11	169.01	168.93	+0.08	0.985
Hand length Left	9.03	169		+0.07	0.99
Palm length Right	16.03	169.03		+0.10	0.995
Palm length Left	15.99	169		+0.07	0.993
Thumb length Right	26.28	169.31		+0.38	0.995
Thumb length Left	26.3	169		+0.07	0.995
Index finger Right	23.56	169.1		+0.17	0.993
Index finger Left	23.51	169.11		+0.18	0.994
Middle finger Right	21.43	169.016		+0.086	0.992
Middle finger Left	21.36	169.08		+0.15	0.993
Ring finger Right	23.26	169		+0.07	0.992
Ring finger Left	23.21	169.08		+0.15	0.995
Little finger Right	28.4	169.25		+0.32	0.993
Little finger Left	28.36	169		+0.07	0.994
Hand breadth Right	20.26	169		+0.07	0.987
Hand breadth Left	20.29	169		+0.07	0.985
Hand span Right	7.85	169		+0.07	0.992
Hand span Left	7.78	169		+0.07	0.993
Arm span	0.99	169		+0.07	0.993
Wrist circum.Right	10.11	169		+0.07	0.983
Wrist circum.Left	10.09	169		+0.07	0.987
Little finger Right	28.4	169.25		+0.32	0.993

ES-MS; calculated by subtracting measured stature from estimated stature
R value obtained from correlation co-efficient test

Table-II: Measurement of estimated stature of female medical students

Variables	Multiplication factors	Estimated stature (ES)	Measured stature (MS)	Difference Between ES-MS	R-value
Hand length Right	9.15	155.47	155.75	-0.28	0.979
Hand length Left	9.1	155.48		-0.27	0.981
Palm length Right	16.62	156		+0.25	0.968
Palm length Left	16.57	156		+0.25	0.968
Thumb length Right	26.98	156		+0.25	0.978
Thumb length Left	27.01	156		+0.25	0.978
Index finger Right	23.87	156		+0.25	0.981
Index finger Left	23.77	156		+0.25	0.981
Middle finger Right	21.77	156		+0.25	0.984
Middle finger Left	21.74	156		+0.25	0.986
Ring finger Right	23.67	156		+0.25	0.986
Ring finger Left	23.67	156		+0.25	0.987
Little finger Right	28.96	156		+0.25	0.984
Little finger Left	29.02	156		+0.25	0.984
Hand breadth Right	21.55	156		+0.25	0.982
Hand breadth Left	21.6	156		+0.25	0.984
Hand span Right	8.19	156		+0.25	0.981
Hand span Left	8.12	156		+0.25	0.982
Arm span	1.00	155		-0.75	0.989
Wrist circum.Right	10.51	156		+0.25	0.986
Wrist circum.Left	10.53	156		+0.25	0.988

R value obtained from correlation co-efficient test. ES-MS, calculated by subtracting measured stature from estimated stature

Discussion:

Stature is anatomically complex that includes the dimensions of legs, pelvis, vertebral column and skull. There may be inter-racial and inter-geographical differences in body dimensions and thus differ in their relation to their stature. Some workers reported that ethnic differences in body dimensions were affected by several factors such as heredity, economic development, socio-demographic status, environment, labor structure, and type of work.[13-15] Body dimensions/proportions may change due to age, nutrition, environment, physical activity and living condition.[14,16] Several workers derived their own formula for calculating stature from long bones. However, hand measurements have not frequently been used for this. There are various methods to estimate stature, but easiest and reliable method is by multiplication factor. Multiplication factor is the ratio of stature and respective limb segment length[8]. In the present study, multiplication factor was calculated for each segment of hand. A mean multiplication factor was then calculated for each measurement. Then mean multiplication factor were used for estimating the stature from each hand measurements. So, using respective multiplication factors to estimate the stature from different hand variables and arm span and to assess the effectiveness of the above estimation, comparison was done between the estimated and measured values of stature in the present study. Multiplication factor values give an easy way to understand the relative estimate of linear body dimensions for height in men and women,[17] but some tried regression analysis method for estimation of stature.

Table-III showed a summary of multiplication factor of hand length and hand breadth found in the present and previous studies.[7, 17-27]

In this table it is evident that mean of stature, hand length, lowest multiplication factor was found for 8.84, Jodhpur India[20] and highest value of multiplication factor was found for 9.36, Amritsar India.[21]

Table-III: Mean of multiplication factors of hand segments

Population group	References	Multiplication factor	
		Hand length	Hand breadth
Jodhpur, India (M)	Agrawal et al (2013)[20]	8.84	
Naxalbari region of Darjelling, India (M)	Banik et al (2016)17	9.06	20.34
Rajput, Dehradun, India (M)	Nath, Garg & Krishan (1991)[22]	9.16	
Rajput, Himachal, India (M)	Krishan et al (2012)[7]	9.27	20.82
Rajput, Himachal, India (F)		9.28	21.42
Bundelkhand, India	Srivastava & Yadav (2014)[23]	9.29	20.93
		9.36	21.53
Rajkot, India (M)	Varu et al(2015)[19]	9.32	20.54
Gujrat, India (M)	Patel et al (2014)[24]	9.32 (R) 9.33 (L)	
Gujrat, India (F)		9.40 (R) 9.42 (L)	
Amritsar, India (M)	Kaur et al(2013)[11]	9.36	
Kori population, North India (M)	Kamal et al(2016)[18]		15.7
Bengali, Muslim (F)	Laila et al (2009)[25]	9.28	
Panjabi, India (F)	Nath, Rajni & Chhibber et al (1990)[26]	9.12	
Hindu, Baniya, India (F)	Nath, Krishan et al (1990)[27]	9.11	
Male students of Rangpur Medical College	Present study	9.11(right)	20.26(right)
		9.03(left)	20.29(left)
Female students of Rangpur Medical college	Present study	9.15(right)	21.55(right)
		9.1(left)	21.6(left)

Regarding hand breadth, lowest multiplication factor for hand breadth 15.7 was found in Kori population, North India.[18] Whereas highest multiplication factor for hand breadth 21.6 was found in left hand breadth of female students in present study. But multiplication factor for palm length was higher in right of female students in present study. So, it could also be stated that multiplication factor varies according to the build or body dimension for each population. So, it could be calculated separately for each population.

Correlation of Estimated stature with measured stature

Estimated stature was found from the multiplication factors of hand lengths measurement. Their correlation was done to see whether the hand measurements could be used for accurate understanding of the stature of the subjects. It was found that stature was significantly and positively correlated with all hand dimensions. Again, there was no significant difference between estimated stature and measured stature in both male and female by paired t test.Among the hand dimensions, in male, left hand length, both hand breadth, both hand span, arm span, left palm length, left thumb length, left little finger length and right ring finger length showed most accurate estimation of stature in the present study (Table-I). But in females, though, estimated stature from all hand dimensions showed significant positive correlation with measured stature but difference was a bit higher than males. So, it could be stated that among the hand dimensions of both sexes, males have higher correlation with stature than females. Also, values of left sides are more effective than right in estimation of stature from hand dimensions.The mean value of male stature is comparatively higher than that of female stature in this study. Pal et al also stated that hand length and palm length showed a better correlation with stature.[5]

Conclusion:

The study suggested that estimation of stature could be made possible by using various dimensions of hand segments which have positive correlations with each other. So, estimation of stature could be done using the hand segment length. The prediction function was derived

through calculation of multiplication factors for each measurement with stature, for overall population. These multiplication factors can be routinely used for estimation of stature from fragmentary

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