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Estimation of Stature from Finger Length Based On the Correlation

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ABSTRACT

Introduction: Estimation of stature is of paramount importance in verifying the identity of an individual from the bodily remains, often after any kind of mass disaster, explosion or intentional cuts and dismantling we encounter very few bodily parts. The objective of the present study was to estimate stature from the measurement of finger length based on the principle of correlation.

Methods: The present study consisted of 300 individuals (150 male and 150 female) of age group 18 to 26 years during the period of August 2017 to August 2018. Stature and finger length of individuals were measured by using stadiometer and digital caliper respectively. Data were analyzed by using statistical software SPSS-22.

Results: A positive and highly significant ($p<0.01$) correlation was observed in both genders. Linear regression equation for stature estimation was derived using finger length and checked for their accuracy by comparing the estimated stature to measured stature. The result shows no significant difference between estimated and measured stature.

Conclusions: The results indicate that the finger length provides reliable means of estimating the stature of an unknown individual based on the principle of correlation. Hence it can be of significant help in establishing the identity of an individual.

Keywords: Anthropometric Measurement; Stature; Finger Length.

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INTRODUCTION

Anthropometry constitutes the technique of expressing quantitatively the form of the human body. There is a long record of discussion on the issue of human variation in anthropometric research.[1] The biological profile of a person such as age, sex, ethnicity and stature can be determined with the help of anthropometry.[2] Among these 'big fours' of anthropology, estimation of stature is considered as an important anthropometric parameter to Anthropologist, Anatomist, and in Medico-legal practice.[3,4] Stature can be defined as natural height of a person in erect position and is measured from foot to the vertex in anatomical position of Frankfurt plane

The stature prediction occupies relatively a central position both in the anthropological research and in the identification necessitated by the medical jurisprudence or by the medico-legal experts.[5]Estimation of stature has a significant importance in the field of forensic anthropometry.[6]Establishing the identity of an individual from mutilated, decomposed, & amputated body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc.[6]

Studies on the estimation of stature from the skeletal remains or from the mutilated limbs, mostly of the long bones have been reported as indicated by the published work of the Pearson[7] Trotter and Glesser.[8] Very few studies are available to estimate the stature of an individual from finger length. The aim of the present study is to estimate stature from finger length by regression analysis.

METHODS

The present study is descriptive cross-sectional study which was carried out in Tribhuvan University Teaching Hospital (TUTH) under Department of Anatomy during the period of one year August 2016 to August 2017. The study comprised a total of 300 samples which includes 150 male and 150 female between the age group of 18-26 years. The study protocol was approved by the ethical committee of TUTH with the inclusion and exclusion criteria of the study. Young healthy individuals without any significant diseases or deformities of hand, finger, leg, foot or back were included. The measurement of stature, right hand fingers length (thumb, index, middle, ring and little) and left hand fingers length (thumb, index, middle, ring and little) were taken. The measurement was taken twice and the average was recorded to ensure accuracy. The measurement was taken by using standard anthropometric instruments like height board (stadiometer) and digital caliper.

The stature was measured as the vertical distance from vertex to the foot. The subject was asked to stand with their heels placed together, touching the base of the vertical board while the head, scapulae, back and buttocks were positioned in contact with the vertical backboard. Subject was advised to position the head in the Frankfurt Horizontal plane; a horizontal plane represented in profile by a line between the lowest points on the margin of auditory meatus. Arms were placed by the side of body with palm in a prone position. Then, the movable board was brought onto the most superior point on the head and stature was recorded. The subject was asked to sit comfortably in a chair and asked to place their hands supine on a flat hard horizontal surface with fingers extended and adducted but not hyper extended. Finger length of all fingers (thumb, index, middle, ring and little) of both right and left hand was measured with the help of digital caliper. The finger length was measured as a straight linear distance between midpoints of proximal finger crease to the tip of finger of respectively. A simple linear regression analysis was performed to derive regression equation for estimation of stature from finger length. Further mean difference between the measured stature and estimated stature was examined using dependent or paired t-test. The value of Pearson's correlation coefficient 'r' between stature and finger measurements was derived. Data analysis was done by using Statistical Package of Social Science (SPSS).

RESULTS

Data are presented as mean, standard deviation (SD) in years for age and in centimeters for all other measurements. The mean stature of male was found to be 170.15 ± 6.27 cm and the mean stature of female was found to be 156.83±4.73 cm. All the measured parameters are greater in male than in female as can be seen in Table 1.

The normality of the data was verified using the Shapiro-Wilk test based on its p-value. P-value <0.05 was considered statistically significant.

Table 1. Anthropometric data in males and females.

Parameters	Male (n= 150) Mean ± SD	Female (n'= 150) Mean ± SD
Age (years)	20.21 ± 1.25	19.71 ± 1**
Stature (cm)	170.15 ± 6.27	156.83 ± 4.73**
RTFL (cm)	6.44 ± 0.46	5.87 ± 0.40**
RIFL (cm)	7.16 ± 0.41	6.60 ± 0.32**
RMFL (cm)	7.89 ± 0.53	7.30 ± 0.36**
RRFL (cm)	7.37 ± 0.43	6.75 ± 0.35**
RLFL (cm)	5.98 ± 0.43	5.43 ± 0.36**
LTFL (cm)	6.33 ± 0.45	5.76 ± 0.37**
LIFL (cm)	7.18 ± 0.45	6.60 ± 0.35**
LMFL (cm)	7.95 ± 0.45	7.30 ± 0.36**
LRFL (cm)	7.39 ± 0.44	6.76 ± 0.37**
LLFL (cm)	5.97 ± 0.43	5.40 ± 0.37**

n: number of male, n'=number of female, , RTFL: right thumb finger length, RIFL: right index finger length, RMFL: right middle finger length, RRFL: right ring finger length, RLFL: right little finger length, , LTFL: left thumb finger length, LIFL: left index finger length, LMFL: left middle finger length, LRFL: left ring finger length, LLFL: left little finger length.**p-value < 0.01 was considered as highly significant while *p-value<0.05 was considered as statistically significant.

Pearson's Correlation Coefficient

The correlation data shows that there is highly significant positive correlation between stature and finger length, in both male and female. Among the five fingers length, right index and left middle finger length shows the higher degree of correlation with stature. The positive and significant correlation between the bilateral finger measurements in both genders is evident in Table 2. The correlation is higher in males except for Right thumb finger length and Right middle finger length.

Table 2. The Pearson's correlation coefficient for stature and finger measurements.

Parameters	Stature Male (n= 150) r	Stature Female (n'= 150) R
Right thumb finger length	0.454**	0.572**
Right index finger length	0.642**	0.576**
Right middle finger length	0.469**	0.547**
Right ring finger length	0.591**	0.468**
Right little finger length	0.513**	0.433**
Left thumb finger length	0.468**	0.459**
Left index finger length	0.580**	0.532**
Left middle finger length	0.647**	0.535**
Left ring finger length	0.603**	0.454**
Left little finger length	0.498**	0.435**

Data are presented as correlation coefficient (r) between stature and hand and finger measurement in male and female. n= number of male, n'= number of female. ** p- value < 0.01 was considered as highly significant and * p-value<0.05 was considered as statistically significant

The regression model was based on the equation: S= a+bx, where "S" was estimated stature (dependent variable), "a" was constant and "b" was regression coefficient of independent variable (hand length and finger length). "x" was the length of independent variable (hand length and finger length). S in the table is estimated stature obtained from regression equation. (Table 3)

Table 3. Linear regression equation for estimation of stature using finger length.

Gender	Parameters	Regression equation to estimate stature using hand and finger measurements	
		Right hand	Left hand
Male	HL	S= 82.749 + 4.709(RHL)	S= 84.820 + 4.581(LHL)
	TFL	S= 130.537 + 6.150(RTFL)	S= 129.156 + 6.480(LTFL)
	IFL	S= 100.621 + 9.717(RIFT)	S= 112.377 + 8.047(LIFL)
	MFL	S= 126.959 + 5.471(RMFL)	S= 99.719 + 8.860(LMFL)
	RFL	S= 107.815 + 8.460(RRFL)	S= 107.682 + 8.454(LRFL)
	LFL	S= 125.640 + 7.443(RLFL)	S= 127.186 + 7.196(LLFL)
Female	HL	S= 92.717 + 3.745(RHL)	S= 90.197 + 3.892(LHL)
	TFL	S= 117.204 + 6.748(RTFL)	S= 123.791 + 5.733(LTFL)
	IFL	S= 101.775 + 8.335(RIFT)	S= 109.992 + 7.092(LIFL)
	MFL	S= 104.289 + 7.194(RMFL)	S= 106.127 + 6.947(LMFL)
	RFL	S= 115.125 + 6.175(RRFL)	S= 117.779 + 5.777(LRFL)
	LFL	S= 126.010 + 5.670(RLFL)	S= 127.127 + 5.502(LLFL)

TFL: thumb finger length, IFL: index finger length, MFL: middle finger length, RFL: ring finger length, LFL: little finger length, RHL: hand length, RTFL: right thumb finger length, RIFL: right index finger length, RMFL: right middle finger length, RRFL: right ring finger length, RLFL: right little finger length, HL: hand length, LTFL: left thumb finger length, LIFL: left index finger length, LMFL: left middle finger length, LRFL: left ring finger length, LLFL: left little finger length

Table 4. The measured and estimated stature

Parameters	Male				Female			
	MS (cm)	ES (cm)	MD (cm)	p-value	MS (cm)	ES (cm)	MD (cm)	p-value
RTFL	170.12	170.15	0.03	NS	156.83	156.83	0	NS
RIFL	170.15	170.15	0	NS	156.83	156.83	0	NS
RMFL	170.15	170.15	0	NS	156.83	156.83	0	NS
RRFL	170.15	170.13	0.02	NS	156.83	156.83	0	NS
RLFL	170.15	170.15	0	NS	156.82	156.83	0.01	NS
LTFL	170.15	170.15	0	NS	156.83	156.81	0.02	NS
LIFL	170.15	170.13	0.02	NS	156.83	156.83	0	NS
LMFL	170.15	170.15	0	NS	156.83	156.83	0	NS
LRFL	170.15	170.15	0	NS	156.83	156.82	0.01	NS
LLFL	170.15	170.14	0.01	NS	156.83	156.83	0	NS

Data are presented as measured stature (MS), estimated stature (ES) and mean difference (MD) between actual and estimated stature of male and female subjects. P< 0.05 is considered as statistically significant; p> 0.05 is considered as statistically not significant (NS).

Table 4 reveals that there was no statistically significant difference between measured stature and estimated stature in both genders. Therefore, the regression formula derived from the finger length can effectively be applied to estimate stature in the studied group of students.

DISCUSSION

The present study was carried out to derive equation for stature estimation from fingers length and also to determine the relationship between stature and finger length in both genders. This equation can be used as alternative mean of stature calculation when direct calculation of stature is not possible due to various circumstances. Evaluation and comparison of present study findings with previous studies revealed several differences as well as similarities.

Most of the studies on estimation of stature from skeleton of human body were carried out in Nigerian population, [9] Indian population[10],[11] and Thai population.[12] In our study, the mean stature of male was found to be 170.15 ± 6.27 cm and the mean stature of female was found to be 156.83±4.73 cm. The mean stature of male of present study was similar to Sri Lankans adults as shown by the study of Ilayperuma et al.[13] and the study of Tang et al.[14]among people of china but the mean stature of female in their study was higher than the present study. The mean stature of female of present study was similar to Bengali adult Muslim.[15]The mean stature of both genders was comparatively higher than the present study in North Indian population [5 ,16] Guajarati population[10] South Indian population [16] and Thai population [12] .The mean stature of both genders was comparatively lesser than present study in Tribal district population of India.[1] Such difference in stature may be due to population variation which may be attributed to genetic and environmental factor. The mean value of finger length in both genders was greater than present study in Western Australian population.[17]

In the present study, there was highly significant (p <0.01) gender difference with male stature and finger length being larger than female. There was significant sex difference in stature, hand length and phalange length with male being larger than female.[18] Our study showed that finger length measurement was statistically significant (p<0.01) sexual dimorphism with male finger length being larger than female. Kanchan et al also evaluated the difference in index and ring finger length between male and female in South Indian population; they reported that the mean value of index and ring finger length for both hands were significantly larger in male (p≤0.001) than in female.[19] Danborno et al. demonstrated that male index and ring finger length was significantly higher than female in Nigerian Population.[9] Rastogi et al.[16] examined North Indian and South Indian population and demonstrated that middle finger length was significantly higher among male than female. These study support the finding of present study by demonstrating that even the smallest measurement (e.g. thumb length) are still quantifiably sexually dimorphic.

Assessing bilateral asymmetry in finger measurements was important because it determines whether hand-side specific standards for stature estimation are required or not. In the absence of bilateral difference, one single standard for both the right and left hand and finger measurements would be more directly practical for estimating stature.[17]

In the present study, it is evident from the Table 2 that all the finger length measurements have a positive and highly significant correlation with the stature in both genders. Highly significant and positive correlation between the stature and finger measurements allowed the present study to calculate the regression equation which was supported by many previous studies. Jasuja and Singh also observed statistically significant correlation between stature and hand length and phalanges length and concluded that stature could be estimated from their study parameters.[5]

Danborno et al,[9] Bardale et al[20] reported significant correlation between IFL and RFL and suggested that stature can be predicted from the IFL and RFL which was in agreement to present study. Although the present study finding was similar to those reported in earlier studies but the value of correlation coefficient differs from those reported in earlier studies.

In assessing the accuracy of simple linear regression

equation to estimate stature from hand length and finger length, the estimated stature was compared with the measured stature and no significant difference was found between the measurements i.e. the measurements obtained by actual measurement and the one obtained by the regression equation was negligible in all study parameters showing there by the stature can be predicted with high accuracy using the regression equation in both male and female students. Numan et al,[4] Patel et al. [10] also checked accuracy of their regression equation by comparing measured stature and estimated stature and reported that difference was found to be statistically insignificant therefore the regression equation derived can effectively be applied to estimate stature of their study population.

Similarly the equation derived for estimating stature from hand length and finger length differs from those presented by the previous studies who carried out their among different population.[5,9,10,13,14,15,20] This observation could be attributed to population and ethnic difference between the present study and other earlier study which could be influenced by genetic and environmental factor. Population difference in anthropological studies had been noted and it was realized that they need to be studied separately.

CONCLUSIONS

The present study concluded that finger length has a moderate and positive relationship with stature of an individual. Hence the stature of an individual can be successfully estimated from the finger length using different regression equation derived in the present study.

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