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Original Article

Comparison of Regression Equation with Multiplication Factor in Determination of Stature from Hand Length in Adults

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Abstract
Stature can be determined using the measurements of different body parts. Forensic anthropology applies regression equation and multiplication factor for determining stature from bone or body part. The aim of the present study is to compare regression equation with multiplication factor from right hand length (RHL) for stature estimation of both sexes in Chennai region. In this cross sectional study, 619 subjects of both sexes with age ranging from 18 to 59 years were studied for determination of stature. Simple regression equation and multiplication factor were derived from RHL. They were applied for determination of stature of an individual for both sexes separately. Then they were compared for their accuracy and reliability. The present study found no significant difference between regression equation and multiplication factor in determining stature from RHL. Since it is relatively easy to derive multiplication factor, stature estimation can be predicted more easily with multiplication factor than regression equation among population in Chennai region.

Keywords: *Stature, Hand length, Regression equation, Multiplication factor, Forensic anthropometry.*

Introduction

Personal identification is very important in person living or dead. Among the big four - age, sex, stature and race, of forensic anthropology; stature is one of the most important elements in the identification of an individual [1]. Determination of stature occupies relatively a central position in the anthropological research and it has an immense medico-legal importance when there is a difficulty in identifying the deceased from few body parts[2-4]. For instance, dismembered body parts are often received for forensic analysis due to natural disasters like earthquake, landslide, and human activities like stampedes, building collapse, road traffic, air traffic and railway accidents, fire, explosions and mutilation of dead body by murderer to destroy the identity[5]. Therefore, the determination of stature from the incomplete

skeletal remains or from the mutilated or fragmented human remains has obvious importance in personal identification[6].

Anatomical and mathematical methods are generally employed for determining the stature[7]. The Anatomical method also known as Fully method determines stature by arranging the skeletal elements that contribute to stature and adding a correction factor for the soft tissues[5]. Forensic anthropologists cannot apply the anatomical method for stature reconstruction if complete skeleton is not available. In this case, they have to use a relatively less precise method of stature reconstruction, i.e. the mathematical method[8]. The mathematical method includes regression equation and multiplication factor for determining stature from bone or body part[9]. There are many regional and international studies involving either regression equation or multiplication factor especially using hand lengths for determination of stature [5,6,10-16]. However, a very few studies reported the extent of deviation in estimated stature from actual stature using both the methods. Therefore, the aim of the present study was to compare regression equation with multiplication factor for determination of stature using right hand length.

Materials and Methods

The present study was conducted in the Institute of Forensic Medicine, Madras Medical College and in the Institute of Internal Medicine, Government General Hospital, Chennai, in the year of 2007 over a period of 9 months from January to September. The study population consisted of 619 healthy individuals comprising 311 males and 308 females in the age group of 18 to 59 years. This age group was selected based on the fact that all the centers of ossification in the foot, hand and long bones get completely fused around 18 years. Subjects with age above 60 years were excluded since stature and hand length significantly decline due to osteoporotic changes. All the measurements were taken in well lit room. The measurements were taken using standard anthropometric instruments in centimeter (cm.) to the nearest millimeter (mm.) accuracy according to the technique given in the manual of biological anthropology[17].

The study was approved by the Institutional Human Ethics Committee (IHEC) and an informed written consent in the regional language was obtained from each subject. The standing height method was chosen for measuring stature of each subject. Stature is the vertical distance between the highest point on the vertex and platform of stadiometer where the subject stands erect with feet together. The total hand length method was applied for measuring hand length. It is the straight distance from dactylion III and mid-point of the most distal flexing crease of the wrist, while the hand is extended along the long axis of the forearm and measured using a specially designed instrument (Depth gauge 12 inch size). Out of 619 study subjects, 100 males and 100 females were randomly selected to formulate regression equations and derive multiplication factor for determination of stature from RHL. The regression equation for determining stature from male RHL was 55.27 + 6.04 (RHL) while for female RHL; it was 66.28 + 5.17 (RHL). The multiplication factor was derived by making average ratio of the stature to the RHL and it was 9.0 for both sexes. Using both these methods, stature was estimated for remaining male and female subjects. Then it was compared with the actual stature values. Further the differences were compared between the two estimations separately for the male and female subjects.

Statistical analysis

Values were expressed as mean ± standard deviation (SD) and percentage. Paired *t*-test was applied to determine statistical significance of differences in regression equation and multiplication factor for determining stature with RHL. *p* - values of less than 0.05 were considered significant. Statistical analysis was performed in Systat version-12.

Results

Table 1 shows the descriptive statistics of stature and RHL of the study subjects. The average stature for male adults was 167.5 cm. and ranged from 146.1 cm. to 190.0 cm. and for female adults it was 154.1 cm. and ranged from 139.6 cm. to 178.0 cm. The average RHL for males was found to be 18.7 cm. and ranged from 16.2 cm. to 21.4 cm. while for females it was 17.3 cm. and ranged from 15.1 cm. to 19.6 cm. Table 2 shows distribution of the male subjects based on the difference between the actual and estimated stature for regression equation and multiplication factor methods. By using regression equation, it was found that 44.5%was within ± 3.0 cm., 39.8% was less than -3.0 cm. while 16.1% was more than +3.0 cm. from the actual stature values in males. By using multiplication factor, it was found that 42.7% was within ± 3.0 cm., 37.0% was less than -3.0 cm. while 20.4% was more than +3.0 cm. from the actual stature values in males.

Table 3 shows distribution of the female subjects based on the difference between the actual and estimated stature for regression equation and multiplication factor methods. By using regression equation, it was found that 37.0% was within ± 3.0 cm., 47.6% was less than -3.0 cm. while 15.4% was more than +3.0 cm. from the actual stature values in females. By using multiplication factor, it was found that 38.9% was within ± 3.0 cm., 45.2% was less than -3.0 cm. while 15.9% was more than +3.0 cm. from the actual stature values in females. Table 4 shows the comparison of regression equation with multiplication factor in males. It was not statistically significant when regression equation was compared with multiplication factor for determining stature from RHL in males (p=0.659). Table 5 shows the comparison of regression equation with multiplication factor in females. It was not statistically significant when regression equation was compared with multiplication factor for determining stature from RHL in females (p=0.712).

Table 1: Mean and SD of the stature, RHL of the study subjects

Selected variables in cm.	Male				Female			
	Mean	SD	Range		Mean	SD	Range	
			Min.	Max.			Min.	Max.
Stature	167.455	7.213	146.1	190.0	154.106	6.389	139.6	178.0
RHL	18.748	0.922	16.2	21.4	17.253	0.792	15.1	19.6

Table 2: Distribution of the male subjects based on the difference between the actual and estimated stature for the regression equation and multiplication factor

Variables	Prediction range	Number	Percentage
Regression equation	Within ± 3 cm	94	44.5
	Less than -3 cm	83	39.3
	More than +3 cm	34	16.1
Multiplication factor	Within ± 3 cm	90	42.7
	Less than -3 cm	78	37.0
	More than +3 cm	43	20.4

(n=211)

Table 3: Distribution of the female subjects based on the difference between the actual and estimated stature for the regression equation and multiplication factor

Variables	Prediction range	Number	Percentage
Regression equation	Within ± 3 cm	77	37.0
	Less than -3 cm	99	47.6
	More than +3 cm	32	15.4
Multiplication factor	Within ± 3 cm	81	38.9
	Less than -3 cm	94	45.2
	More than +3 cm	33	15.9

(n=208)

Table 4: Comparison of regression equation with multiplication factors in males

Variables	Number	Mean	SD	t value	p Value
Regression equation	211	-1.56	5.07	0.442	0.659 (NS)
Multiplication factor		-1.65	5.95		

NS: Not significant

Table 5: Comparison of regression equation with multiplication factors in females

Variables	Number	Mean	SD	t value	p Value
Regression equation	208	-2.08	4.77	0.370	0.712 (NS)
Multiplication factor		-2.16	5.56		

NS: Not significant

Discussion

Stature is the natural height of a person in an upright position. The hand length can be used as a basis for estimating age- related loss in stature and as an alternative measure to stature when stature cannot be measured directly due to deformity like kyphosis, lordosis and scoliosis, contracture or missing legs[4]. The stature is directly proportional to different body parts and shows a definite biological and genetic association with each other. Mathematical method is more useful in medico-legal cases as it can be applied even when only part of the body is available[5]. For instance, linear regression equation can predict the relation between stature and body segments. Similarly, the stature can also be estimated by multiplying the dimension of body with respective multiplication factor.

The present study found no significant difference between regression equation and multiplication factor when applied for stature determination in males from RHL. Similar findings were found in the case of females also. There was no significant difference between regression equation and multiplication factor when applied for stature determination from RHL. Many earlier studies reported using regression equation [2,18-20] and multiplication factor[15,21,22] for stature determination from hand length. However, a very few studies compared these methods for stature determination especially with hand length[7,9]. They reported that prediction of stature with regression analysis was more accurate and reliable than multiplication factor in the respective population. This is in contrast to the present study which found no significant difference between regression equation and multiplication factor for the prediction of stature. This could be attributed to the fact that variations in body dimensions are common among races and ethnic groups due to genetic, nutritional and environmental factors[6,14-16]. The strength of this study is that both the regression equation and multiplication factor were derived from a smaller group and tested with a larger group of the subjects.

Conclusion

The present study compared simple regression equation with multiplication factor derived from RHL for determination of stature in both sexes. The result shows that both the methods predict within ± 3.0 cm. of the actual stature around 40% of the subjects in both sexes. Further, the present study gives no significant difference between regression equation and multiplication factor when applied for the determination of stature. Since it is relatively easy to derive multiplication factor, stature estimation can be predicted more easily with multiplication factor than regression equation among population in Chennai region using hand length.

Conflicts of interest: There are no conflicts of interest

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