Estimation of Stature from the Anthropometric Measurement of Lower Limb in Iranian Adults

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ABSTRACT

Introduction: Estimation of stature is one of the most important fields in forensic medicine. Also it is of particular interest to anthropologists and anatomist. Our aim was to investigate the relationship between stature and the length of lower limb and foot to derive a regression formula for estimating the stature.

Methods: Three anthropometric measurements; Stature, Lower Limb Length (LLL) and Foot Length (FL) were taken on the subjects, comprising 142 male students (18-25 years) using standard measuring instruments. The data were analyzed using SPSS 16. Then linear regression models were used to estimate stature.

Results: The results indicated a positive correlation between stature and lower limb and foot measurements. The correlation coefficient with lower limb length was r=0.89 & P=0.0001 and with foot length was r=0.78 & P=0.0001.

Conclusion: There was a significant correlation between stature and lower limb and foot length. As the regression analysis showed, the Lower Limb Length provides better prediction of stature rather than Foot length measurements.

1. Introduction

I dentification appears to be a critical consideration in the forensic medicine. The necessity of identification may arise in cases of suicide, bomb blast, war, accident, earthquakes and crimes [1]. Whenever case materials such as skeletal remains and body parts are discovered, a forensic examiner is asked to opine about recognition for deceased [2]. Stature along with age, race and gender, the big four parameters, are considered to develop the anthropometri-

cal databases. These data can confirm the process of identification [3].

According to different studies, bones are commonly used for stature estimation and long bones are strongly proposed. However, lower limb measurements have more directly correlation with stature than upper limbs [2]. Although several studies have been done for finding a relationship between stature and bone measurements, there is limited reports regarding Iranian population [3-7]. So, the present study was designed to create a regression equa-

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Table 1. Descriptive statistics of stature and lower limb length and foot length.

Variable	N=146		
	Range	Mean	SD
Stature	159 - 185	174.04	5.81
LLL	94-102	97.54	1.49
FL	23- 28	26.22	1.02

LLL: lower limb length (cm), FL: foot length (cm)

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tion for determination of relationship between stature and length of lower limb and foot in Iran.

2. Materials & Methods

A sample of 142 normal healthy Iranian male volunteers was selected from medical students studying at Tehran University of Medical Sciences. The participants ranged between 18–25 years old. All the subjects were non-athletic. According to standard ethics drawn by the Tehran University ethical committee for human experimentation, subjects were examined for stature, lower limb and foot lengths. Techniques for measuring anthropometric indexes were as below:

Stature: Stature was measured in centimeter. Each subject was asked to stand barefoot on a flat surface. Upright height was taken from the vertex to the floor according to the anatomical position and Frankfurt Plane [8, 2].

Lower extremity: Lower extremity length was measured in centimeter as the distance between iliac crest to the floor. Cases were in standing position whereas back of the shoulders, buttocks, and heels were close to the wall without any rotation.

Foot length: Foot length was measured from the maximum distance between tip of second finger to the most posterior part of heel.

Statistical Analysis: The data were analyzed using SPSS 16. Association of parameters was assessed by Pearson's correlation coefficient (r). Regression equations were computed to examine the relationship between stature to upper limb length and hand length.

3. Results

The stature ranged from 159 to 185 cm. Mean lower limb length and foot length were 97.54 and 26.22, respectively. Descriptive statistics of stature, lower limb length and foot length are shown in Table 1. Statistically significant correlation was observed between stature and lower limb length and foot length. Pearson correlation (r) for stature and lower limb length and foot length was 0.89 and 0.78, respectively (Table 2). The relationship between stature and lower limb length and foot length are shown in Scatter graphs (Figure 1).

Linear regression models were determined for estimation of stature.

Linear regression models derived for reconstruction of stature are shown in Table 3. Lower limb and foot length showed a significant correlation with the stature (P=0.0001). In addition, for determination of the predictive accuracy of linear regression models for stature estimation from lower limb and foot length, coefficient of determination (R^2) and Standard Error of Estimate (S.E.E) were estimated. Lower Limb length in comparison with foot length appear to be the better predictor of stature. Also, the multifactorial liner regression was used for formulation of two factors (Table 3).

4. Discussion

Estimating stature from human skeletal remains in anthropology and forensic medicine has an old history. Between two basic methods of estimating stature, mathematical method is more available than anatomical method. So,

Table 2. Pearson correlation(r) between stature and Lower Limb Length and foot Length.

Variable	r	P-value
LLL	0.89	0.0001
FL	0.78	0.0001

LLL: Lower limb length (cm), FL: Foot length (cm)

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Table 3. Linear regression for estimation of stature from Lower limb length and Foot length

Regression equation	±SEE	R²	p-Value
S=112.522+2.938×LLL (cm)	3.8	0.57	0.0001
S=80.693+3.56×FL (cm)	4.52	0.39	0.0001
S=-91.341+2.297× LLL (cm) + 1.576× FL (cm)	3.58	0.62	0.0001

S: stature, LLL: Lower Limb Length, FL: Foot length, SEE: Standard Error of Estimate, R²: Coefficient of Determination.

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regression equations can be useful for formulation of different parameters.

In our country, despite of the acceptable progression in different fields of forensic medicine, less attention has been paid to estimation of the body stature from the skeletal remains. Whereas several studies have been performed to estimate the stature from body remains such as extremities, shoulder girdle, vertebral column, and cephalofacial measurements in different countries [4, 9-12].

So in the present study, the linear regression was formulated for estimation of stature from lower limb and foot length in the male gender. It is worthy to note that there are some various factors such as genetic, nutrition, geographical location, physical activity and various races which affect the anthropometric data [13].

As it was mentioned, there are not enough anthropometric databases in Iran. To investigate anthropometric characteristic over the country, this study was done on 142 male students between 18 to 25 years. Samples were collected from national university of Iran in which different races of the country study .

In two previous studies in Iran, the mean length of lower limb was reported 104.5 cm [14] and 88 cm [15] whereas in our study it was 97.54 cm but in Indian subjects, it was reported that the mean length of lower limb was 96.09 cm [16] and it is similar to present study.

According to studies carried out on the relationship between stature and total lower limb length, the mean length of total lower limb in our study was not the same as those in other Iranian studies but similar to Indian study (see Table 4).

The correlation coefficient (r) between stature and lower limb length had equivalent relation in our study and in India (see Table 4). The reported foot length in our study was approximately similar to other studies which are mentioned in Table 4 except in Nepal population [17].

The correlation coefficient (r) between stature and length of foot was 0.78 in the current study. When compared with previous studies, it has the most similarity with Malaysian and Turkish people which are reported to be 0.789 and 0.70, respectively [18, 19].

Table 4. Comparison of the mean stature, lower limb length and foot length and their correlation coefficients (r) in the present study with similar studies.

Study	Country	Stature	LLL	LLL(r)	FL	FL(r)
The present study	Iran	174.04	97.54	0.89	26.22	0.78
Arazi et al. [14]	Iran	181.1	104.5	-	-	-
Sadeghi et al. [15]	Iran	173	88	-	25.7	-
Eftekhar et al. [21]	Iran	173	88	-	27	-
Krishan et al. [16]	India	172.54	96.09	0.87	-	-
Ahmed et al. [22]	Saudi Arabia	-	-	-	26.53	0.649
Mansur et al. [17]	Nepal	165.66	-	-	21.85	0.688
O¨ zaslan et al. [18]	Turkey	171.97	-	-	24.9	0.70
Kumar Jakhar et al. [23]	India	173.48	-	-	25.44	0.525
MAK et al. [19]	Malaysia	164.8	-	-	23.2	0.789

LLL: Lower limb Length, FL: Foot length, r: Correlation coefficient.

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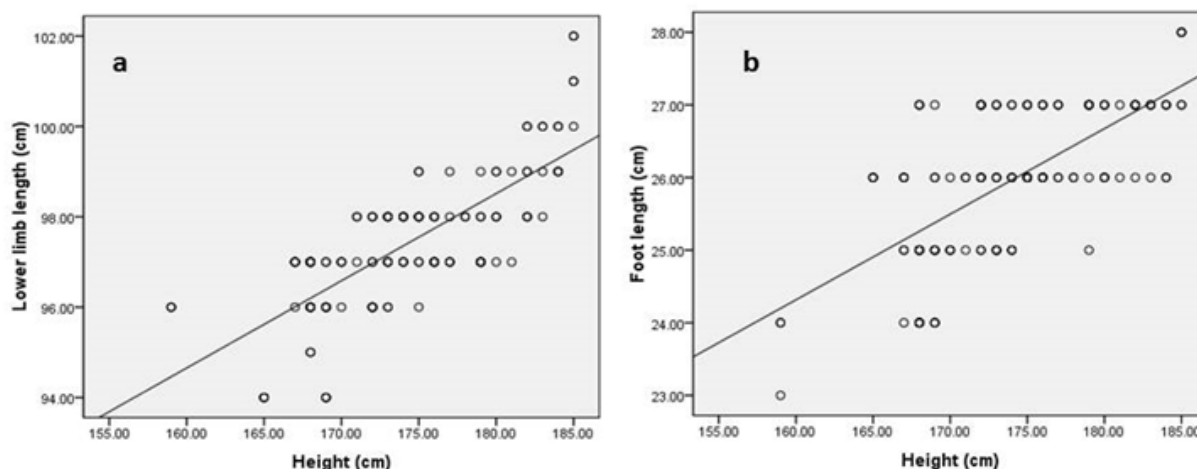**Figure 1.** Correlation between stature (cm) and a) Lower limb length (cm) and b) foot length (cm).

According to our results, lower limb length (R=0.89) can be a more logical predictor of stature for males in comparison with foot length (R=0.78) as reported by Krishan et al. for Indian population [16]. While Sanli et al. reported that hand length and foot length should be used together in stature estimation [20].

In view of the fact that various Iranian races distribute all over the country, it is expectable to have different anthropometric features from city to city. Consequently, the linear relationship of the stature with body parts of the individuals can be different. Hence, the regression models derived for defined geographical region should not be applied to another region.

This study has shown significant correlation between stature and dimensions. Also, the regression equation is developed. So the lower limb length and foot length provided the reliability and accuracy in estimating stature with the use of regression equation. In spite of that further researches, especially on different races distributed in various regions of Iran must be carried out to prepare extensive information for forensic experts for stature estimation.

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