A Model for Individual Height Estimation from Forearm Length in Natives of Kerman, Iran

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ABSTRACT

Introduction: Height is an important biological human characteristic in anthropological studies and forensic medicine. In this way, forearm length (FAL) can be a useful factor for the height prediction in different population. The goal of this study was to find the relation between FAL and height in natives of Kerman.

Methods: In a cross-sectional study, 150 cases including 75 males and 75 females (aged 18 to 22 years) of Kermanian population were randomly selected. In all cases height and left forearm were measured in standard positions. For finding the relation between FAL and the height, linear regression analysis was used.

Results: The mean age of subjects was 20.21±2.21 years and there wasn't a significant difference in the age of sex groups (P=0.211). There was a significant difference in the height of cases between two sex groups (P=0.0001). In addition, there was a significant difference in the FAL of sex groups (P=0.0001). In addition, there was a correlation between height and FAL of cases (r=0.801, P=0.0001). There was a correlation between height and FAL of male cases (r=0.668, P=0.002) and female cases (r=0.6, P=0.0001).

Conclusion: According to the results, FAL was a suitable factor for height estimation. In addition, this factor is a moderate predictor of height in native males and females of Kerman.

1. Introduction

Biological characteristics including height, age, sex, and ancestry of individuals can be used for identification of skeleton remain of human even many years after death [1-3]. Height is an important element for individual identification in forensic science and some factors such as age, genetic, gender, nutrition, environment, physical activities can effect it [4, 5]. Recently, various long bones dimensions have been considered as a technique for height estimation with the high reliability and many formulae were obtained from these demotions [6-8]. However, these formulae are specific for each population and can't be accurate for other hu-

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man population [9]. Sometimes, body fragments with soft tissue remain were found in the disasters and criminal cases [5]. In this way, body fragments can be used for predicting the biological characteristics of individuals, especially height in forensic medicine [10-13]. Mathematical methods and linear regression equations can predict the relation between height and body segments [14-16]. In the previous studies,upper limb dimensions such as shoulder width, arm, forearm, hand, figures were considered for prediction of height [5, 17-22].

In this study, the relation between FAL and stature was evaluated by regression equation in Iranian medical students.

2. Materials & Methods

In a cross-sectional study, from June 2015 to May 2015, 150 healthy cases (including 75 males and 75 females aged from 18 to 22 years) were randomly selected from Kermanain natives with middle socio-economic status. Exclusion criteria were skeletal deformities or pathological changes. A fixed time from 2:00 pm to 4:00 pm was determined for study. All measurements were performed in standard position by standard anthropological instruments. All measurements were taken in the unit of 1 cm and repeated with 1 week interval. A single person took all the measurements to avoid the interpersonal errors.

Standing height: Stadiometer was used for height measurement in upright position with the subject standing barefoot on its platform with their back, buttock and heels pressed against the instrument. Their head was positioned in the Frankfort horizontal plane. Head platform was placed on the vertex. So, standing height was defined as maximum distance from vertex of subject to the platform.

Forearm length: FAL was measured in arm flex position by a standard measuring tape. FAL was measured from the tip of olecranon to the point between radius and ulnar tuberosity. Left limb was used for measurements.

Statistical analysis: All data were entered to the computer and SPSS 22 software was used for data analysis. Descriptive quantitative data were shown as mean±standard deviation (SD). T-test was carried out to compare the data. Correlations between quantitative data were reported and linear regression was used to predict the relation between height and forearm length.

3. Results

The mean age of subjects was 20.21±2.21 years. Mean age of male cases was 19.73±1.08 years and female cases was 20.12±2.07 years and there wasn't a significant difference in the age of sex groups (P=0.211).

Mean height of all cases was 170.13±20.21 cm. Mean height of males and female cases was 177.73±5.73 cm and 162.73±5.76 cm, respectively. There was a significant difference in the height of cases between two sex groups (P=0.0001, and Table 1). Mean FAL was 27.28±2.4 cm in all cases. Also, there was a significant difference in the FAL of sex groups (P=0.0001, Table 1). In addition, there was a correlation between height and FAL of cases (r=0.801, P=0.0001). There was a correlation between height and FAL of male cases (r=0.668, P=0.0001) and female cases (r=0.6, P=0.0001). According to the linear regression, there was a relation between height and FAL of cases. Also, this relation was found in the male and female cases (Table 2).

4. Discussion

Stature estimation is one of the important elements for individual identification in forensic, legal medicine, anthropological researches and prediction of height from body segments remain from crimes and mass disasters i.e. earthquake, fire, wars, etc. [23-25]. Several researches were performed to estimate the relation between stature and upper limb segments such as shoulder width, arm, forearm, hand, figures in Iran and other populations [5, 9, 20, 24, 26].

Table 1. Comparing the standing height and forearm length (FAL) in males and females in Iranian medical students.

	Gender							
	Male				Female			
	Mean	SD*	Max	Min	Mean	SD	Max	Min
Age	19.73	1.08	22	18	20.12	2.07	26	18
Height (cm)	177.73	5.73	196	171	162.37	5.76	176	150
FAL (cm)	28.98	1.92	33	26	25.90	1.79	29	22

* Standard Deviation/Max: Maximum, Min: Minimum

Table 2. Linear regression for estimation of stature from forearm length of medical students.

Formulae	±SEE	R^2	P-value
H=73.69+3.54×FAL (cm)	6.21	0.65	0.0001
H_M=118.916+2.108×FAL (cm)	4.08	0.501	0.0001
H_F=112.461+1.109268×FAL (cm)	4.64	0.36	0.0001

FAL: Forearm length, H: stature, M: male, F: female, SEE: Standard Error of Estimate, R^2: Coefficient of Determination.

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In this study, 150 cases were randomly selected from healthy population. Mean height in males was higher than females. This result was similar to results of Srivastava et al. (2010) [24] and Ilayperuma et al. [27] studies.

Linear regression is a reliable method for estimating the relation between stature and body fragments [9]. In this study, there was a correlation between height and FAL of cases and correlation confection (r) was determined as 0.801. In addition, the relation between height and FAL was found for all cases based on linear regression equation (Height=73.69+3.54×FAL (cm), with SEE=6.21 and R^2=0.65).

Akhlaghi et al. (2012) found the correlation between FAL and height (r=0.580). In their study, correlation confection value was lower than value obtained in this study. These results confirmed the differences between Iranian nations. In the present study, FAL was superior for predicting the height in comparison with other factors such as arm length (r=0.759), hand breadth (r=0.736) [5].

In other study, Akhlaghi et al. (2012) used 105 cadavers from Iranian population to determine the relation between radius bone length and height. They could find the formulae for each age and sex groups separately [8]. Their results were more reliable for height prediction compared with the results of present study. In addition, their results showed that isolated bones were more valuable predictors for height estimation. Singh et al. (2013) formulate the relation between height and FAL and height in north Indian population [28]. In other study, Ilayperuma et al. (2010) could find a relation between height and FAL in Sri Lankan population. Their model was Height=97.252+2.645 (ulna length) for all cases [27].

In addition, sexual dimorphism was recorded in this study. Accordingly, FAL was longer in males than females. Akhlaghi et al. (2012) results confirmed the results of this study for Iranian population [5]. Mean FAL obtained was longer in the present study. According to this dimorphism, the separated formula was recorded for each sex groups. There was a correlation between height and FAL of male (r=0.668) and female (r=0.6) cases. According to correlation confection values obtained, FLA is a moderate predictor for height estimation for sex groups.

According to Akhlaghi et al. (2012) study, the correlation was found between FAL and height in males (r=0.354) and females (r=0.299) in Iranian population [5]. The correlation confection values in their study were lower than values obtained from Kermanian natives. In addition, formula from male group was reliable than female group and this result was similar to the result of this study. Similarly, Singh et al. (2013) used FAL for finding the relation between height and FLA in male (r=0.601) and female (r=0.531) of north Indians [28]. Their results confirmed the results of present study. Covertly, according to the results of Ilayperuma et al. (2010) study, formula for prediction of height form FAL females (r=0.76) was reliable than male cases (r=0.66) in Sri Lankan population.

Based on the results, FAL was a valuable predictor for height estimation. Also, this factor is a moderate predictor of height in native males and females of Kerman.

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