Research Paper: Stature Estimation Based on Fingers Anthropometry in Iranian Population

Sina Mojaverrostami[1], Tahmineh Mokhtari[2,3], Mehrnoush Malekzadeh[1], Leila Noori[1], Shokoofeh Kazemzadeh[1], Sahar Ijaz[1], Ibrahim Mohammed[1], Gholamreza Hassanzadeh[1*]

1. Department of Anatomy, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran.
2. Research Center of Stem Cells in the Nervous System, Semnan University of Medical Sciences, Semnan, Iran.
3. Department of Anatomy, School of Medicine, Semnan University of Medical Sciences, Semnan, Iran.

Citation Mojaverrostami S, Mokhtari T, Malekzadeh M, Noori L, Kazemzadeh Sh, Ijaz S, et al. Stature Estimation Based on Fingers Anthropometry in Iranian Population. Anatomical Sciences. 2017; 14(4):163-168.

Sina Mojaverrostami is a PhD. Candidate in anatomical sciences in the anatomy department of Tehran University of Medical Sciences. He is a graduate of Veterinary Medicine (DVM) from Urmia University. His research interests are neuroanatomy, neurodegenerative disease and anthropological anatomy.

Article info:
Received: 25 Jun 2017
Accepted: 19 Sep 2017
Available Online: 01 Nov 2017

Keywords:
Anthropology, Stature, Finger Length, Iranian population

ABSTRACT

Introduction: The stature is one of the determinant factors to identify a person. We investigated the possibility of predicting stature based on Fingers Length in Iranians.

Methods: We studied 195 healthy Iranian students (97 females and 98 males) of Tehran University of Medical Sciences. The correlation between stature and fingers anthropometric measurements was investigated and equations for stature prediction were demonstrated by linear regression analysis.

Results: According to the obtained results, males had higher mean values in each anthropometric measurement, compared to females. Third Finger Length (3rd FL) indicated higher correlation coefficients with stature in both genders. Regression analysis suggested a lower Standard Error of Estimate (SEE) in females (±4.91-5.60 cm), than males (±5.87-6.74 cm).

Conclusion: 3rd FL provides a better prediction of stature among the lengths of fingers in both genders.

1. Introduction

Anatomical parameters like stature are important for personal identification. In forensic anthropology, the identification of unknown individuals and determination of why they have died are important [1]. Determination of gender, age, and stature from living or dead persons leads to a correct identification [2-4]. After mass disasters, explosions, wars or in definite murder situations where deceased bodies have been dismembered or mutilated, only a small part of a human body exists.

*** Corresponding Author:**
Gholamreza Hassanzadeh, PhD.
Address: *Department of Anatomy, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran.*
Tel: *+98 (21) 88953008*
E-mail: *hassanzadeh@tums.ac.ir*

Thus, the identification of individuals is necessary in such situations [5-8].

Estimation of stature with the help of gender, age, and ethnicity is a determinative parameter in the identification of decomposed or mutilated bodies [9]. Several methods are available for the estimation of stature from different body parts; most of them measure upper and lower limbs bones, such as metatarsal [10], foot [11], tibia [12], femur [13], ulna [14], upper arm [15], hand [16], fingers and phalanges lengths [17]. Although some studies have used the bony parts, others used soft tissue measurements and radiological techniques [18, 19].

Human height grows from intrauterine life to 20-25 years of age, and declines about 2.5 cm every 25 years, after the age of 30 [20]. Population-specific studies emphasize on stature estimations, because of the ancestral and ethnic differences that exist in the different regions of the world. Numerous studies developed regression models for predicting stature. The current study evaluated the anthropometric relationship between Fingers Length and stature, and provided stature estimation equations for Iranian students.

2. Materials and Methods

A total of 195 healthy Iranian students (97 females and 98 males) of Tehran University of Medical Sciences, in the age range of 17-36 years were evaluated. All the individuals were right-handed and non-athletic. To prevent any technical and inter-observer mistakes, measurements were performed by the same observers and the same instruments. According to standard ethics by the Ethics Committee for Human Experimentations of Tehran University of Medical Sciences, the subjects were examined in terms of stature, Fingers Length, wrist breadth and hand breadth in the left side. Individuals with any deformity or disease in the vertebral column, hands, and fingers were excluded from this research.

All the subjects were requested to stand barefoot on the flat surface of floor with the head oriented in the Frankfurt Plane; stature was measured with anthropometer in centimeters. Upright height was considered from the vertex to the floor. As per Figure 1, Fingers Length was measured by a sliding caliper on the left hand from the most proximal flexion crease of the fingers to the tip of each finger.

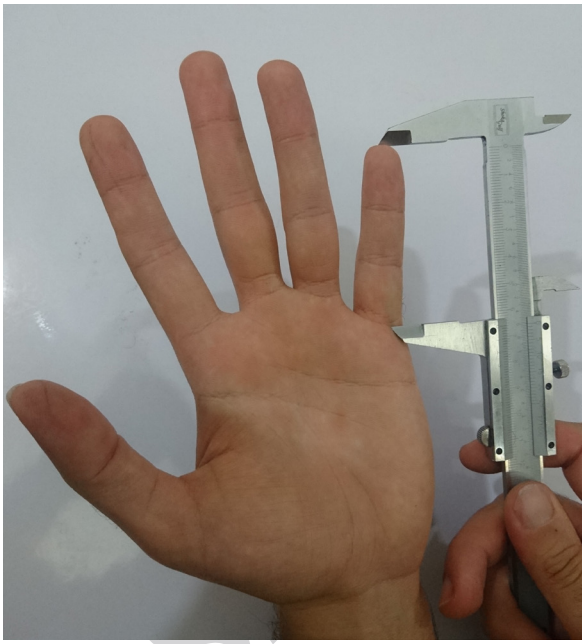

Figure 1. Measuring Fingers Length by a sliding caliper on the left hand

Statistical analysis was performed by SPSS. The gender differences were tested using Independent Samples t-test. The association between stature and Fingers Length was determined by Pearson's correlation coefficient. Linear regression analysis was used to determine equations for stature estimation from these measurements.

3. Results

In this study, the stature ranged from 148 to 194 cm in the students of Tehran University of Medical Sciences. The mean stature values of male and female were 177.84 and 162.96 cm, respectively. The mean weight of male students was 75.74 kg and mean weight of female students was 62.52 kg. The mean measurements of first Finger Length (1st FL), second Finger Length (2nd FL), third Finger Length (3rd FL), fourth Finger Length (4th FL) and fifth Finger Length (5th FL) in male students were 5.27, 7.70, 8.72, 7.92, and 6.07 cm, respectively. The mean measurements of 1st FL, 2nd FL, 3rd FL, 4th FL and 5th FL in female students were 4.77, 7.35, 8.22, 7.35, and 5.56 cm, respectively.

The mean, minimum, maximum and standard deviations of fingers measurements for Iranian males and females in addition to age, stature and weight measurements are presented in Table 1. According to the t-test results, the male population had significantly higher values in all dimensions, than the female population. There were significant differences between all measurements

Table 1. Comparison of measurements between males and females

Variables	Gender						P
	Male			Female			
	Mean±SD*	Min.	Max.	Mean±SD*	Min.	Max.	
Age (y)	18.76±1.29	17	26	19.03±2.62	17	36	0.352
S (cm)	177.84±6.76	160	194	162.96±5.80	148	183	0.0001
Weight (Kg)	75.74±14.39	47.80	122.5	62.52±9.89	45.90	89.2	0.0001
1st FL (cm)	5.27±0.57	4.00	8.00	4.77±0.53	3.10	7.30	0.0001
2nd FL (cm)	7.70±0.73	4.60	9.40	7.35±0.66	4	9	0.001
3rd FL (cm)	8.72±0.70	6.80	10.30	8.22±0.64	6.60	10.1	0.0001
4th FL (cm)	7.92±0.82	5.90	10.20	7.35±0.67	5.80	8.8	0.0001
5th FL (cm)	6.07±0.75	4.40	8.40	5.56±0.58	4.50	7.2	0.0001

SD: Standard Deviation; Min: Minimum; Max: Maximum; S: Stature; FL: Finger Length

ANATOMICAL SCIENCES

Table 2. Correlation between stature and measured variables in both genders (Total group), males and females

Variables	1st FL (cm)		2nd FL (cm)		3rd FL (cm)		4th FL (cm)		5th FL (cm)	
	r	P	r	P	r	P	r	P	r	P
ST (cm)	0.430	0.0001	0.398	0.0001	0.582	0.0001	0.534	0.0001	0.455	0.0001
SM (cm)	0.276	0.006	0.326	0. 01	0.539	0.0001	0.490	0.0001	0.300	0.003
SF (cm)	0.122	0.230	0.353	0. 0001	0.503	0.0001	0.396	0.0001	0.312	0.002

S: Stature; FL: Finger Length; T: Total; M: Males; F: Females.

ANATOMICAL SCIENCES

in both genders (P<0.001). The correlation coefficients and regression model need to be separately developed for the males and the females, because of the size differences between the two genders.

The relationship between the stature and measured variables for both genders were analyzed using the Pearson's correlation coefficient (Table 2). In the analysis of all subjects (total group), all measurements revealed significant correlation coefficients with stature (P<0.05). The 3rd FL had the highest correlation with stature

Table 3. The linear regression equation for stature estimation in terms of the total, male and female groups

Groups	Regression Equation (cm)	R^2	SEE	P
Total	S=135.37+6.98×1st	0.185	8.83	0.0001
	S=129.67+5.41×2nd FL	0.158	8.97	0.0001
	S=103.44+7.90×3rd	0.338	7.95	0.0001
	S=120.60+6.52×4th FL	0.285	8.27	0.0001
	S=134.48+6.18×5th FL	0.207	8.70	0.0001
Male	S=170.13+1.46×1st FL	0.015	6.74	0.230
	S=152.85+3.24×2nd FL	0.124	6.35	0.0001
	S=135.57+4.84×3rd FL	0.253	5.87	0.0001
	S=151.85+3.28×4th FL	0.157	6.24	0.0001
	S=160.89+2.79×5th FL	0.097	6.45	0.002
Female	S=148.49+3.03×1st FL	0.076	5.60	0.006
	S=141.81+2.87×2nd FL	0.106	5.51	0.001
	S=123.06+4.85×3rd FL	0.290	4.91	0.0001
	S=131.86+4.22×4th FL	0.240	5.08	0.0001
	S=146.27+2.99×5th FL	0.090	5.56	0.003

SEE: Standard Error of the Estimate; S: Stature; FL: Finger Length

ANATOMICAL SCIENCES

Table 4. Summary data of Fingers Length, wrist breadth and hand breadth (Mean±SD) of Iranian males and females and other populations (cm)

Groups		Iranian	Korean	Turkish	American	Indian
Male	1st FL (cm)	5.27±0.57	6.12±0.39	6.56±0.45	6.97±0.48	
	2nd FL (cm)	7.70±0.73	7.05±0.43	7.46±0.48	7.53±0.49	6.86±0.40
	3rd FL (cm)	8.72±0.70	7.86±0.47	8.18±0.51	8.38±0.54	
	4th FL (cm)	7.92±0.82	7.43±0.47	7.55±0.52	7.92±0.52	6.86±0.44
	5th FL (cm)	6.07±0.75	5.90±0.44	6.24±0.46	6.47±0.49	
Female	1st FL (cm)	4.77±0.53	5.61±0.35	5.94±0.37	6.35±0.48	
	2nd FL (cm)	7.35±0.66	6.63±0.43	6.83±0.34	6.96±0.46	6.37±0.41
	3rd FL (cm)	8.22±0.64	7.35±0.43	7.44±0.39	7.72±0.51	
	4th FL (cm)	7.35±0.67	6.92±0.43	6.83±0.34	7.22±0.50	6.61±0.46
	5th FL (cm)	5.56±0.58	5.45±0.46	5.56±0.32	5.83±0.46	

FL: Finger Length

(r=0.582). In the female group, 3rd FL (r=0.539) and 4th FL (r=0.490) had the highest correlation with stature; however, the remaining length was less relevant. In the male group, 3rd FL (r=0.503) had the strongest correlation with stature; the remaining measured variables were less relevant with it. Additionally, 1st FL length was not statistically correlated with stature (Table 2).

Linear regression analysis was conducted to estimate stature by the measured variables. Regression equations have been separately computed for each gender, as well as each measurement (Table 3). Stature was considered as the dependent variable and 1st FL, 2nd FL, 3rd FL, 4th FL and 5th FL, as the independent variables. The regression equations derived for the estimation of stature from measured variables are listed in Table 3. In the total group, third Finger Length (R^2=0.338) was the highest determining factor in the regression equation (Table 3). The 3rd and 4th Finger Lengths (R^2=0.253 and R^2=0.157, respectively) demonstrated the highest accuracy among the female group (Table 3). Similarly, in the male group, the 3rd and 4th Finger Lengths (R^2=0.290 and R^2=0.240, respectively) suggested the highest accuracy (Table 3). The Standard Error of Estimate (SEE) predicted the deviations of estimated stature from the actual stature. It ranged between ±5.87 and ±6.74 for the males and between ±4.91 and ±5.60 for the females. A lower value of SEE indicates greater reliability in stature estimation.

4. Discussion

In the current study, the relationship between stature and Fingers Length were evaluated, and equations for stature prediction were calculated from these measurements. Population variations are very important and these formulae are applicable on the studied population. Several studies have reported a positive relationship between stature and different body measurements [21, 22]. Previous studies suggested a strong correlation between upper limb length (r=0.89) [23] and lower limb length (r=0.89) [24], and stature. Additionally, our former study conducted on ulnar length in Chabahar City, Iran, demonstrated a positive correlation (male: r=0.59, female: r=0.57) with stature [25].

The present study indicated that gender differences in Fingers Length were statistically significant. Males demonstrated higher mean values in each anthropometric measurement, than females; this finding is in line with other studies [26-28]. This dissimilarity may be due to the fusion of bones (epiphyses) which occurs earlier in girls; thus, boys have more time for physical growth [29]. The 3rd FL in both genders exhibited higher correlation coefficients with stature. Therefore, 3rd FL is an appropriate parameter for estimating stature. This result was also supported by higher R^2 and lower SEE in both genders. This result is compatible with Jee and Yun study who reported that 3rd Finger Length had the highest correlation with stature [1]. Akhlaghi et al. achieved the same result in Iranian population [30].

The obtained data suggested that Iranian females exhibit a lower SEE (±4.91-5.60 cm) in all measurements, than males (SEE: ±5.87-6.74). This finding indicates that the accuracy in predicted stature would be greater among females, than males. Similar results were informed by Krishan and Sharma [26]. According to anthropometric studies conducted on Fingers Length, the mean length of 2nd, 3rd, and 4th fingers in the studied subjects were longer than those of other studies (Table 4) [31]. Akhlaghi et al. have reported shorter Fingers Length in Iranian population, compared to the present study [30]. This might pos-

sibly relate to the distribution of various Iranian population around the country.

Fingers Length are reliable for the estimation of stature in personal identification. Third Finger Length provides a better prediction of stature. Stature prediction is more reliable in Iranian females, than males. The regression equations calculated from Fingers Length suggested that the stature can be estimated from them with SEE ranging from ±4.91 to ±6.78 cm for both genders. Further studies are required on stature estimation in respect of gender by Fingers Length in different age groups and various ethnicities of Iran.

Ethical Considerations

Compliance with ethical guidelines

According to the standard ethics drawn by the Tehran University of Medical Sciences ethical committee for human experimentation, subjects were examined for different parameters.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors contributions

Concept study design: Sina Mojaverrostami; Analysis, Interpretation of data, Critical revision of the manuscript: Tahmineh Mokhtari; Acquisition of data: Mehrnoush Malekzadeh, Leila Noori, Shokoofeh Kazemzadeh, Sahar Ijaz, Ibrahim Mohammed, Sina Mojaverrostami; Drafting the manuscript: Mehrnoush Malekzadeh, Leila Noori, Shokoofeh Kazemzadeh, Sina Mojaverrostami; and Study design, Administrative, technical and material support, and study supervision: Gholamreza Hassanzadeh.

Conflict of interest

The authors declared no conflict of interest.

References

[1] Jee SC, Yun MH. Estimation of stature from diversified hand anthropometric dimensions from Korean population. Journal of Forensic and Legal Medicine. 2015; 35:9-14. [DOI:10.1016/j.jflm.2015.06.014] [PMID]

[2] Kharoshah MAA, Zaki MK, Galeb SS, Moulana AAR, Elsebaay EA. Origin and development of forensic medicine in Egypt. Journal of Forensic and Legal Medicine. 2011; 18(1-3):10-3. [DOI:10.1016/j.jflm.2010.11.009] [PMID]

[3] Ishak NI, Hemy N, Franklin D. Estimation of stature from hand and handprint dimensions in a Western Australian population. Forensic Science International. 2012; 216(1):199. e1-e7. [DOI:10.1016/j.forsciint.2011.09.010] [PMID]

[4] Prasannakumar S, Selvaraj G, Rabi S, Holla JS. Estimation of length of the ulna from the bony markers of the proximal end in South Indian population. European Journal of Anatomy. 2014; 14(2):67-73.

[5] Ilayperuma I, Nanayakkara G, Palahepitiya N. A model for the estimation of personal stature from the length of forearm. International Journal of Morphology. 2010; 28(4):1081-6. [DOI:10.4067/S0717-95022010000400015]

[6] Krishan K. Anthropometry in forensic medicine and forensic science-'Forensic Anthropometry'. The Internet Journal of Forensic Science. 2007; 2(1):95-7.

[7] Menezes RG, Nagesh K, Monteiro FN, Kumar GP, Kanchan T, Uysal S, et al. Estimation of stature from the length of the sternum in South Indian females. Journal of Forensic and Legal Medicine. 2011; 18(6):242-5. [DOI:10.1016/j.jflm.2011.04.004] [PMID]

[8] Poorhassan M, Mokhtari T, Navid S, Rezaei M, Sheikhazadi A, Mojaverrostami S, et al. Stature estimation from forearm length: An anthropological study in Iranian medical students. Journal of Contemporary Medical Sciences. 2017; 3(11):270-2. [DOI:10.22317/jcms.09201705]

[9] Chandra A, Chandna P, Deswal S, Mishra RK, Kumar R. Stature prediction model based on hand anthropometry. International Journal of Medical, Health, Biomedical, Bioengineering. 2015; 9(2):201-7.

[10] Bidmos MA. Metatarsals in the estimation of stature in South Africans. Journal of Forensic and Legal Medicine. 2008; 15(8):505-9. [DOI:10.1016/j.jflm.2008.05.007] [PMID]

[11] Rani M, Tyagi A, Ranga VK, Rani Y, Murari A. Stature estimates from foot dimensions. Journal of Punjab Academy of Forensic Medicine & Toxicology. 2011; 11(1):26-30.

[12] Chibba K, Bidmos M. Using tibia fragments from South Africans of European descent to estimate maximum tibia length and stature. Forensic Science International. 2007; 169(2):145-51. [DOI:10.1016/j.forsciint.2006.08.011] [PMID]

[13] Brits DM, Bidmos MA, Manger PR. Stature estimation from the femur and tibia in black South African sub-adults. Forensic Science International. 2017; 270: 277.e1-e10. [DOI:10.1016/j.forsciint.2016.10.013] [PMID]

[14] Torimitsu S, Makino Y, Saitoh H, Sakuma A, Ishii N, Hayakawa M, et al. Stature estimation based on radial and ulnar lengths using three-dimensional images from multidetector computed tomography in a Japanese population. Legal Medicine. 2014; 16(4):181-6. [DOI:10.1016/j.legalmed.2014.03.001] [PMID]

[15] Chandran S, Manipady S, Shetty M, Tarvadi PV, Shetty SS. Estimation of stature by percutaneous measurement of

upper arm length among native adult population of Dakshina Kannada district. Indian Journal of Forensic Medicine & Toxicology. 2016; 10(2):279-83. [DOI:10.5958/0973-9130.2016.00071.2]

[16] Ibrahim MA, Khalifa AM, Hagras AM, Alwakid NI. Sex determination from hand dimensions and index/ring Finger Length ratio in North Saudi population: Medico-legal view. Egyptian Journal of Forensic Sciences. 2016; 6(4):435-44. [DOI:10.1016/j.ejfs.2016.11.002]

[17] Agrawal J, Raichandani L, Kataria SK, Raichandani S. Estimation of stature from hand length and length of phalanges. Journal of Evolution of Medical and Dental Sciences. 2013; 2(50):9651-6. [DOI:10.14260/jemds/1672]

[18] Rodríguez S, Miguéns X, Rodríguez-Calvo MS, Febrero-Bande M, Muñoz-Barús JI. Estimating adult stature from radiographically determined metatarsal length in a Spanish population. Forensic Science International. 2013; 226(1-3):297-e1. [DOI:10.1016/j.forsciint.2012.12.006] [PMID]

[19] Meadows L, Jantz RL. Estimation of stature from metacarpal lengths. Journal of Forensic Science. 1992; 37(1):147-54. [DOI:10.1520/JFS13222J]

[20] Krishan K, Kanchan T, Menezes R. Stature estimation in forensic examinations: A few technical considerations. Indian Journal of Dental Research. 2012; 23(5):692-93. [DOI:10.4103/0970-9290.107414] [PMID]

[21] De Mendonça M. Estimation of height from the length of long bones in a Portuguese adult population. American Journal of Physical Anthropology. 2000; 112(1):39-48. [DOI:10.1002/(SICI)1096-8644(200005)112:13.0.CO;2-#]

[22] Sanli SG, Kizilkanat ED, Boyan N, Ozsahin ET, Bozkir MG, Soames R, et al. Stature estimation based on hand length and foot length. Clinical Anatomy. 2005; 18(8):589-96. [DOI:10.1002/ca.20146] [PMID]

[23] Mahakizadeh S, Moghani-Ghoroghi F, Moshkdanian G, Mokhtari T, Hassanzadeh G. The determination of correlation between stature and upper limb and hand measurements in Iranian adults. Forensic Science International. 2016; 260:27-30. [DOI:10.1016/j.forsciint.2015.12.005] [PMID]

[24] Moshkdanian G, Mahaki Zadeh S, Moghani Ghoroghi F, Mokhtari T, Hassanzadeh G. Estimation of stature from the anthropometric measurement of lower limb in Iranian adults. Anatomical Sciences Journal. 2014; 11(3):149-54.

[25] Borhani-Haghighi M, Navid S, Hassanzadeh G. Height prediction from ulnar length in Chabahar: A city in South-East of Iran. Romanian Journal of Legal Medicine. 2016; 24(4):304-7. [DOI:10.4323/rjlm.2016.304]

[26] Krishan K, Sharma A. Estimation of stature from dimensions of hands and feet in a North Indian population. Journal of Forensic and Legal Medicine. 2007; 14(6):327-32. [DOI:10.1016/j.jcfm.2006.10.008] [PMID]

[27] Jasuja O, Singh G. Estimation of stature from hand and phalange length. 2004; 26(3):100-6.

[28] Sen J, Kanchan T, Ghosh A, Mondal N, Krishan K. Estimation of sex from index and ring Finger Lengths in an indigenous population of Eastern India. Journal of Clinical and Diagnostic Research. 2015; 9(11):HC01. [DOI:10.7860/JCDR/2015/14940.6846]

[29] Habib SR, Kamal NN. Stature estimation from hand and phalanges lengths of Egyptians. Journal of Forensic and Legal Medicine. 2010; 17(3):156-60. [DOI:10.1016/j.jflm.2009.12.004] [PMID]

[30] Akhlaghi M, Hajibeygi M, Zamani N, Moradi B. Estimation of stature from upper limb anthropometry in Iranian population. Journal of Forensic and Legal Medicine. 2012; 19(5):280-4. [DOI:10.1016/j.jflm.2011.12.034] [PMID]

[31] Jee SC, Yun MH. An anthropometric survey of Korean hand and hand shape types. International Journal of Industrial Ergonomics. 2016; 53:10-8. [DOI:10.1016/j.ergon.2015.10.004]