Section: Anatomy

Research

ESTIMATION OF STATURE FROM THE MEASUREMENT OF HAND AND FOOT IN THE POPULATION OF NALANDA DISTRICT OF BIHAR

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Abstract

Background: Identification of a person is of prime and foremost importance in both civil and criminal cases. Anthropologists have devised a number of measurements for describing the morphology of man based on anatomical landmarks. The aim is to obtain population-specific equations for estimation of stature from the dimensions of hands and feet in the population of Nalanda district of Bihar. **Materials and Methods:** Observational and cross-sectional study conducted on 200 study participants including undergraduate students and patients of either gender of 18-30 years age group. The exclusion was any physical deformities or systemic illness affecting measurements. Height, weight, right-hand length (RtHL), right foot length (RtFL), and body mass index (BMI) were measured. Correlation and regression (linear and multiple) among different study parameters were observed with the help of GraphPad Instat software (Version 3.06). **Result:** Mean age, height, weight, RtHL, RtFL, and BMI of males (n=100) & females (n=100) was 21.91±2.22 & 21.46±2.33 years, 1.68±0.06 & 1.54±0.05 meters, 63.46±3.68 & 54.93±5.29 kgs, 194.38±10.29 & 177.96±11.93 cm, 252.59±13.37 & 235.62±11.67 cm and 22.42±1.46 & 22.99±1.37 respectively. The correlation matrix and linear regression equation for estimation of height with age, weight, RtHL, and RtFL had a positive correlation both in males and females but height with BMI has a positive correlation in females but negative in males. Multiple regression among different parameters was statistically significant. **Conclusion:** Dimension of hand length, foot length, age, weight, and body mass index were associated with height and had a significant correlation with height in both males and females. This data can be useful for the development of population-specific anthropometric indices by anatomists and anthropologists amongst the population of the Nalanda district. Also, local law enforcement agents and forensic scientists can refer to this data for the identification of persons in case of mass disasters, homicides, airplane crashes, and train and road accidents.

INTRODUCTION

Identification of a person is of prime and foremost importance in both civil and criminal cases. Anthropologists have devised a number of measurements for describing the morphology of man. The measurements are based on anatomical landmarks and have been used for hundreds of years.[1] Stature is the natural height of a person in an upright position. It is maximum between the age group of 20-25 years. There is a loss of stature as aging progresses. Studies also suggest a diurnal and positional variation of stature.[2] Estimation of stature from extremities and their parts plays an important role in identifying the dead in forensic examinations. The study examines the relationship between stature and dimensions of the hand and foot.[3] Growth the vital process is measured by measuring the height of a person. Based on stature racial as well as comparisons of men living in

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different geographical areas can be made. Morphological methods of anthropology also provide an understanding of the form and function of various parts of the human body. By looking at the stature of a person one can get an insight into his health, nutrition, and genetics.[4] Stature is considered one of the parameters for personal identification. It is an inherent characteristic, the estimation of which is considered to be an important assessment in the identification of unknown human remains.[5] With the increasing frequency of mass disasters, homicides, airplane crashes, and train and road accidents there is always a need for studies that help in identifying deceases from fragmentary and dismembered human remains.[6] To assess height different body parts are used by the anatomist, anthropologists as well as forensic experts. Stature is usually estimated by employing either anatomical or mathematical methods. Dwight (1894) introduced the anatomical method to estimate the total skeletal height. The mathematical method makes use of bone lengths, stature tables, and regression formulae to estimate the skeletal height of living stature.[7] Karl Pearson (1899) devised a formula that was used worldwide. It gives different calculating factors for the bones of males and females of European subjects.[8] Trotter and Glesser (1952) succeeded in developing a formula for the determination of stature for males and females of white and Negro origins. Consequently, the formulae designed to estimate stature from various anatomical dimensions in one population do not apply to the other.[9] Several studies have dealt with an estimation of stature from dimensions of hands and feet in the past and have documented that these parameters can be successfully used for stature estimation. The present study is undertaken on the population of Nalanda district of Bihar state of India. The aim of this study is to obtain population-specific equations for the estimation of stature from the dimensions of hands and feet in the population of the Nalanda district of Bihar.

Objectives

1. To obtain dimensions of hands and feet (i.e., hand length and foot length and stature of males and females.
2. To find out the correlations between the dimensions of hands and feet with the stature of the individual.
3. To devise linear and multiple regression formulae to estimate stature from these dimensions.

MATERIALS AND METHODS

Study Site: Department of Anatomy, BMIMS (Bhagwan Mahavir Institute of Medical Sciences), Pawapuri, Nalanda, Bihar.

Study Duration: Two years (During the period of October 2020 to November 2022).

Study Design

This was an observational and cross-sectional study on 200 persons of either gender from the age group of 18-30 years from Nalanda district of Bihar, India. The study participants were undergraduate students (MBBS and B.Sc. Nursing students) and patients from the outdoor department of Medicine, Surgery, and Orthopaedics of BMIMS, Pawapuri, Nalanda, Bihar.

Inclusion Criteria

1. Participants of either gender from the age group of 18-30 years.
2. Residents of the Nalanda district of Bihar.

Exclusion Criteria

1. Age group <18 years and >30 years.
2. Any chronic disease.
3. Any orthopedic disease affecting bone mass and stature.
4. Any previous orthopedic condition due to fracture affecting bone mass and stature of any limb.
5. Any hormonal condition affecting normal growth and stature.

Study methodology

The study participants were recruited from undergraduate (MBBS and BSc. Nursing) students and patients from the outdoor department of Medicine, Surgery, and Orthopaedics of BMIMS, Pawapuri, Nalanda, Bihar. Participation was voluntary. The objectives and the methods of the study were explained to the participants and informed consent was obtained by taking their signatures or thumb impression. The study was conducted in the postgraduate laboratory of the Anatomy department. All the measurements were taken in a reasonably well-lit room, at a fixed time between 3 PM and 5.30 PM to eliminate diurnal variation. It was measured and recorded by the principal investigator, to avoid inter-observer error in methodology.

a. Sample of the study was drawn from the students and populations of the Nalanda district of Bihar.
b. Two anthropometric measurements i.e., hand length and foot length were measured separately, on the right side of each individual. The stature of each individual was recorded.
c. All the measurements were recorded thrice and then their mean was calculated for accuracy.
d. Weight of each study participant was measured.
e. Age of each study participant was noted.

Landmarks and techniques involved in taking anthropometric measurements:

a. Stature (Height): It is the vertical distance between the highest point on the vertex and the platform of the Stadiometer. The subject should stand erect, barefoot on a level platform against the stadiometer bar with his back and hips touching the bar, the foot should touch each other and the heels touching the bar, arms hanging by the side. The head of the subject

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should rest without any strain in the eye-ear plane or Frankfurt plane i.e., the tragion and the infraorbital margin of both sides must lie in the same plane.

b. Right-Hand length: It is the projected distance between the midpoint of a line joining the styloid process of the radius and ulna bones of the forearm and the tip of the third finger.
c. Right Foot length: It is the distance from the most prominent part of the heel to the most distal part of the longest toe (great toe sometimes it may be second toe).

Instruments used

1. Stadiometer was used to measure the vertical height for stature estimation.
2. Sliding calipers were used for hand and foot measurements. It consists of a long straight bar, a long arm fixed to one end, and a sliding sleeve with a long arm parallel to the first one. The arms are projected to an equal distance on both sides of the scale. They end in sharp points on one side and blunted on the opposite side. The sharp ends are used for taking measurements on the skeleton and the blunt ends are used for measuring the living. Usually, the calipers are graduated up to mm.
3. Digital scale for the measurement of weight.

Statistical Analysis

Correlation gives the degree and direction of the relationship between two variables. Correlation between the stature of individuals and various study parameters was observed and correlation coefficients were calculated. Regression equations were calculated for various combinations to reach the best possible estimate of stature. GraphPad Instat software (Version 3.06) was used to analyze the data.

RESULTS

Table 1: Anthropometric measurements in males and females of Nalanda district

	Male (n=128) Mean±SD	Range (Min-Max)	Median (50th percentile)	Female (n=72) Mean±SD	Range (Min-Max)	Median (50th percentile)
Age (Yrs)	21.91±2.22	19-29	21	21.46±2.33	18-29	21
Height (m)	1.68±0.06	1.53-1.81	1.68	1.54±0.05	1.43-1.65	1.54
Weight (Kg)	63.46±3.68	54-72	64	54.93±5.29	44-67	55
Right-Hand Length (cm)	194.38±10.29	174.18-218.50	194.1	177.96±11.93	156.39-219.60	178.20
Right Foot Length (cm)	252.59±13.37	226.7-295	250.55	235.62±11.67	208.85-270.50	235.90
Body Mass Index	22.42±1.46	19.4-26.7	22.5	22.99±1.37	20.10-26.10	23.10

Table 2: Correlation Matrix of the anthropometric parameters used among study participants of Nalanda district

	Parameters	Age	Height	Weight	RtHL	RtFL	BMI
Male (n=128)	Age		0.045*	-0.030#	0.244*	-0.136#	-0.069#
	Height	0.045*		0.364**	0.480**	0.561***	-0.571#
	Weight	-0.030#	0.364**		0.177*	0.280*	0.442**
	RtHL	0.244*	0.480**	0.177*		0.637***	-0.260#
	RtFL	-0.136#	0.561***	0.280*	0.637***		-0.284#
	BMI	-0.069#	-0.571#	0.442	-0.260#	-0.284#	
		Age	Height	Weight	RtHL	RtFL	BMI
Female (n=72)	Age		0.010*	0.003*	-0.179#	0.168*	0.112*
	Height	0.010*		0.777***	0.347**	0.497***	0.145*
	Weight	0.003*	0.777***		0.457**	0.527***	0.564***
	RtHL	-0.179#	0.347**	0.457**		0.430**	0.267*
	RtFL	0.168*	0.497***	0.527***	0.430**		0.364**
	BMI	0.112*	0.145*	0.564***	0.267*	0.364**	

Ht= Height, Wt= Weight, RtHL- Right Hand Length, RtFL= Right Foot Length, BMI= Body Mass Index
#Shows a negative correlation between the parameters
***Strong degree Correlation- Coefficient value lies between ± 0.50 and ± 1
**Moderate degree Correlation: Coefficient value lies between ± 0.30 and ± 0.49
*Low degree Correlation: Coefficient value lies below ±0.29
The correlation matrix for estimation of height with age, weight, RtHL, and RtFL had a positive correlation both in males and females.
The correlation matrix for the estimation of height with BMI had a positive correlation in females but a negative correlation in males.

Table 3: Linear Regression of Height (m) with other parameters in Males (n=128) and Females (n=72)

		Intercept+ Slope	SEE	R	R2	p value
Male	Ht & Age	Ht=1.669+0.0005* Age	0.0506+0.0021	0.02	0.0004	0.825, NS
	Ht & Wt	Ht=1.242+0.0069* Wt	0.0790+0.0012	0.4428	0.1961	<0.0001, ES

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	Ht & Rt HL	Ht=1.358+0.0017* RtHL	0.9221+0.0005	0.2975	0.0885	0.0006, ES
	Ht & Rt FL	Ht=1.066+0.0024* RtFL	0.0796+0.0003	0.5666	0.3210	<0.0001, ES
	Ht & BMI	Ht=2.190 -0.0227* BMI	0.0639+0.0028	0.5799	0.3363	<0.0001, ES
Female	Ht & Age	Ht=1.536+0.0002* Age	0.0606+0.0028	0.01	0.0001	0.9316, NS
	Ht & Wt	Ht=1.099+0.0080* Wt	0.0430+0.0008	0.7768	0.6034	<0.0001, ES
	Ht & Rt HL	Ht=1.258+0.0016* RtHL	0.0917+0.0005	0.3473	0.1206	0.0028, VS
	Ht & Rt FL	Ht=0.991+0.0023* RtFL	0.1148+0.0005	0.4973	0.2473	<0.0001, ES
	Ht & BMI	Ht=1.408+0.0058* BMI	0.1085+0.0047	0.1449	0.0210	0.2243, NS

$P \leq 0.05$: Shows there was an increased statistically significant difference
NS- Not Significant, S- Significant, VS- Very Significant, ES- Extremely Significant
SEE- Standard error of estimate
The linear regression equation for the estimation of height from Age in both Males and Females was not correlated (p-value > 0.05 not significant). The linear regression equation for estimation of height from Weight, Rt hand length, and Rt foot length showed a positive correlation ($p \leq 0.001$, Significant) both in Males and Females. The linear regression equation for the estimation of height from BMI showed a negative correlation ($p \leq 0.001$, Significant) in Males but a positive correlation ($p \leq 0.001$, Significant) in Females.

Table 4: Multiple Regression among parameters in Males (n=128) and Females (n=72)

		Intercept+ Slope	SE	R	R2	p value
Male	Ht vs Wt & Age	Ht=1.216+0.0011* Age+0.0069* Wt	0.0934+0.0021+0.0012	0.4449	0.1979	<0.0001, ES
	Ht vs RtHL & RtFL	Ht=0.9578+0.0008* RtHL+0.0022*RtFL	0.0979+0.0004+0.0003	0.5827	0.3395	<0.0001, ES
	BMI vs Ht & Wt	BMI=42.50-23.423* Ht+0.3035* Wt	1.7090+1.1190+0.0174	0.8979	0.8063	<0.0001, ES
	BMI vs Ht, RtHL & RtFL	BMI=46.848-16.371* Ht+0.0005* RtHL+ 0.0118* RtFL	3.318+2.282+0.0109+ 0.0098	0.5868	0.3443	<0.0001, ES
Female	Ht vs Wt & Age	Ht=1.095+0.0002* Age+0.0080* Wt	0.0577+0.0018+0.0008	0.7768	0.6034	<0.0001, ES
	Ht vs RtHL & RtFL	Ht=0.9352+0.0008* RtHL+0.0020*RtFL	0.1204+0.0005+0.0005	0.5187	0.2691	<0.0001, ES
	BMI vs Ht & Wt	BMI=35.345-18.562* Ht+0.2959* Wt	3.7820+3.2700+0.0339	0.7317	0.5354	<0.0001, ES
	BMI vs Ht, RtHL & RtFL	BMI=13.461-1.864*Ht+0.0171* RtHL+ 0.0398* RtFL	4.4900+3.2790+0.0145+0.0159	0.3895	0.1517	0.0103, S

$P \leq 0.05$: Shows there was an increased statistically significant difference

DISCUSSION

The result of the present study showed that age, weight, hand length, foot length, and body mass index can be associated with height and can be used in the estimation of height. Since it has been established that long bones are the most appropriate specimen for height evaluation and estimation (Iscan, 1988; Jasuga et al., 2004),[9,10] hand length and foot length was chosen in this study as it is part of the long bones of the body. In the present study, males showed higher mean values in all parameters studied than females. Stature estimation studies by Jasuja et al 1991,[11] and Kewal Krishan et al 2007,[12] and have reported statistically significantly higher values for males. These statistically significant differences may be due to the early maturity of girls than boys and necessitate different equations for males and females. In this study, all the parameters (Age, Weight, RtHL, RtFL and BMI) in both the males and females showed a statistically significant positive correlation with stature (i.e. height).
The relatively low standard estimate of error (SEE) of linear regression for the foot length with respect to hand length in males (0.0796 RtFL vs 0.9221 RtHL) and for hand length with respect to the foot length in females (0.0917 RtHL vs 0.1148 RtFL) ensures better accuracy in stature estimation. Foot length in males and hand length in females depict a comparatively higher correlation with stature. Thus, in males foot length and in females hand length is the best parameter for the estimation of stature. The presence of positive linearity between the study variables and the stature facilitates the formulation of regression equations which can be successfully utilized for stature estimation in the study population. The difference in the value of correlation coefficients of males and females for estimation of stature from right-hand length was remarkable in the present study (0.297 in males and 0.347 in females). Female hand length showed a statistically significant highly positive correlation to stature. Similar Indian studies conducted on homogenous population groups revealed no appreciable gender difference. The reason for the difference in the present study is a topic of further investigation and analysis. In a study done by Umana et al in 2013, there was a significant correlation between height and hand length, and foot length with age, weight, and BMI in male and female Nigerian school children of the Gbagyi tribe of Abuja.[13] In 1902 MacDonnell studied the relationship between height and foot length in a sample of 3000 English prisoners. This was the first

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study of the century at a time when correlation and linear regression were quite new techniques.[14] In 1952 Trotter and Glesser studied and published his work on long bones of skeletal remains or from mutilated limbs, to measure the stature.[15] In 1968, Ruttihauser reported a highly significant degree of correlation between height and foot length in African children. She also developed regression equations for the estimation of stature in children up to 5 years of age and showed that estimation of stature from foot length has confidence limits of the same order as found in stature estimation from long bones.[16] In 1976, B. R. Kate and R. D. Majumdar estimated stature from the femur and humerus by regression and autometry. It was seen that Pearson's formulae did not give exact results. The regression formulae differed statistically in both sexes in the femur and humerus. A method by which a proportion of these bones individually bear the stature of the same person to which the bone belongs is worked out both as a multiplication factor and percentage proportion to the body stature. This method is called autometry, which is a more reliable method.[17] In 1984, Saxena SK found a correlation among hand length, hand breadth, and sole length, and derived a regression formula to estimate stature from them. The results showed a significant correlation. The study was conducted on Nigerian Medical students between the ages of 20 to 30 years.[18] Abdi Ozaslan et al (2003) estimated stature from the measurement of different body parts like trochanteric height, thigh length, leg length, and foot length. They suggested that the estimation of living height could be made possible using various dimensions of the lower extremity.[19] In 2004, O. P. Jasuja and Singh have done a study based on various measurements of stature, hand length, and individual phalange length was conducted on Jat Sikhs. It has been observed that stature can be estimated from the above measurements with a standard error estimate ranging from 4.033 to 5.127 cms. Sexual dimorphism exists in mean hand length and hand length was observed to be higher in males.[20] In 2007, Patel S M Shah, and Patel S V estimated height from measurements of foot length in the Gujrat region. Asymptomatic, healthy medical students belonging to various regions of Gujrat were selected. The left foot was selected for measurement as per the recommendation of the international agreement for paired measurements at Geneva (1912). The correlation coefficient between height and foot length is +0.65 in males and +0.80 in females which is most significant.[21] Manish R Dayal, and Martina Steyn (2008) derived regression formulae for the estimation of total skeletal height and thereafter to predict stature in south African whites using long bone lengths. The sample comprised 98 white male and 71 white female skeletons from the Raymond A Dart collection of human skeletons and the Pretoria bone collections. It was concluded that the correlation tends to be greater where a combination of bones rather than a single long bone length was used.[22] In 2009, Isurani IIayperuma et al predicted personal stature based on the hand length of 258 medical students, at the University of Ruhuna, Galle, Sri Lanka. Statistical analysis indicated that bilateral variation was insignificant for the measurements of hand length in both sexes. The correlation coefficient between stature and hand length was found to be statistically significant and positive.[23] The data and subsequently the results obtained in the present study, to the best of the knowledge of the author, is the first ever documented anthropological work on this population of Nalanda district.[24-30]

Limitation of the study

This study design was focused only on the population of Nalanda, District of Bihar. Hence, the data collected, its interpretation, and its implication should be applicable to the area of study participants. It may be due to inherent population variation because of genetic and environmental factors like climate, nutrition, etc.

CONCLUSION

Dimension of hand length, foot length, age, weight, and body mass index were associated with height and had a significant correlation with height in both males and females. This data can be useful for the development of population-specific anthropometric indices by anatomists and anthropologists amongst the population of the Nalanda district. Also, local law enforcement agents and forensic scientists can refer to this data for the identification of persons in case of mass disasters, homicides, airplane crashes, and train and road accidents. The data obtained in the present study can be further utilized to perform discriminant analysis for sex determination.

REFERENCES

1. Dayal Manisha R., Steyn Maryna, Kuykendall Kevin L. Stature estimation from bones of South African whites. S. Afr. J. Sci. 2008 Apr;104(3-4): 24-128.
2. Biologydictionary.net Editors. (2017, May 15). Anthropometry. Retrieved from https://biologydictionary.net/anthropometry/.
3. Tuttle, R. Howard (2018, February 22). physical anthropology. Encyclopedia Britannica. https://www.britannica.com/science/physical-anthropology.
4. Dinakaran J, Hariganesgh P, Shamala S, Dhivya K, Saranya V, Saranya M. Stature Estimation of an Individual Using Nasal, Facial, and Palatal Height among Tamil Nadu Population. J Pharm Bioallied Sci. 2021 Jun;13:S751-S756.
5. Krishan K, Kanchan T, Garg AK. Dental Evidence in Forensic Identification - An Overview, Methodology and Present Status. Open Dent J. 2015;9:250-6.
6. Dwight T.: Methods estimating the height from parts of the skeleton. Med Rec NY 1894;46:293-296.
7. Pearson K. Mathematical contributions to the theory of evolution. On the reconstruction of the stature of prehistoric races. Phil. Trans. R. Soc. Lond. A 1899;192:169-244.
8. M TROTTER, G C GLESER. Estimation of stature from long bones of American Whites and Negroes. Am J Phys Anthropol. 1952 Dec;10(4):463-514.
9. Iscan M. Y. Rise of forensic anthropology. Year Book of Physical Anthropology. 1988;31:203-230.

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10. Jasuga O. P, Singh J, & Jain M. Estimation of stature from hand, foot and shoe measurement by multiplication factors: A reviewed attempt. Forensic Science International. 2004;50:203-215.
11. O.P. Jasuja, Jasvir Singh and Manjari Jain. Estimation of stature from foot and shoe measurements by multiplication factors: A revised attempt. Forensic Science International. 1991;50(2):203-15.
12. Kewal Krishan, Abhilasha Sharma. Estimation of stature from dimensions of hands and feet in a North Indian population. Journal of Forensic and Legal Medicine. 2007; 14(6):327-332.
13. Umana, Uduak & Ibegbu, AUGUSTINE & David, Eniola & Hamman, Wilson & Musa, Sunday. Association of Hand Length with Height in Nigerian School Children. Journal of Biology and Life Science. 2013;4:83-94.
14. Macdonell, W. R. On Criminal Anthropometry and the Identification of Criminals. Biometrika. 1902;1(2):177-227.
15. M TROTTER, G C GLESER. Estimation of stature from long bones of American Whites and Negroes. Am J Phys Anthropol. 1952 Dec;10(4):463-514.
16. Rutishauser IH. Prediction of height from foot length: Use of measurement in field surveys. Arch Dis Child. 1968;43(229):310-2.
17. Kate BR, Majumdar RD. Stature estimation from femur and humerus by regression and autometry. Acta. Anta. 1976;94:311-320.
18. Saxena, S. K. A study of correlations and estimation of stature from hand length, hand breadth and sole length. Anthropologischer Anzeiger. 1984;42(4):271-276.
19. Ozaslan A., Iscan MY., Ozaslan I., Tugcu H., Koc S. Estimation of stature from body parts. Forensic Sci. Int. 2003;132:40-50.
20. Jasuja OP., Singh G. Estimation of Stature from Hand and Phalange Length. JIAFM 2004; 26:100-6.
21. Patel S. M., Shah G. V., Patel S. V. Estimation of height from measurement of foot length in Gujarat region. J Anat Soc India 2007;56(1):25-7.
22. Dayal Manisha R., Steyn Maryna, Kuykendall Kevin L.. Stature estimation from bones of South African whites. S. Afr. J. Sci. 2008;104(3-4):124-128.
23. Ilayperuma I, Nanayakkara G, Palahepitiya N. Prediction of personal stature based on the hand length. Galle Medical Journal. 2009;14(1):15-18.
24. Abraham Philip. Formulae for estimating stature from foot size by regression method. J Ind Acad For Med, 1990;12(2):57-62.
25. Giles, E., & Vallandigham, P.H. Height estimation from foot and shoeprint length. Journal of forensic sciences. 1991;36(4):1134-1151.
26. Radoinova D, Tenekedjiev K, Yordanov Y. Stature estimation from long bone lengths in Bulgarians. Homo. 2002;52(3):221-32.
27. M, Rani & AK, Tyagi & Verma, Satish & Kohli, Anil. Estimation of stature from percutaneous measurements of legs. Journal of Forensic Medicine and Toxicology. 2004;21:12-14.
28. Sanli SG, Kizilkanat ED, Boyan N, Ozsahin ET, Bozkir MG, Soames R, Erol H, Oguz O. Stature estimation based on hand length and foot length. Clin Anat. 2005 Nov;18(8):589-96.
29. Kewal Krishan, Abhilasha Sharma. Estimation of stature from dimensions of hands and feet in a North Indian population. Journal of Forensic and Legal Medicine. 2007;14(6):327-332.
30. Bhavna and Surinder Nath. Estimation of Stature on the Basis of Measurements of the Lower Limb. Anthropologist 2007;3:219-222.

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