

ESTIMATION OF LIVING STATURE FROM SELECTED UPPER LIMB ANTHROPOMETRIC MEASUREMENTS: A STUDY ON CENTRAL INDIAN POPULATION

Kandregula Jyothirmayi*¹, Dr. Naresh Thaduri²

¹Research Scholar, Department of Anatomy, L.N. Medical College and Research Center, L.N.C.T. University, Bhopal, Madhya Pradesh, India.

²Associate Professor, Department of Anatomy, L.N. Medical College and Research Center, L.N.C.T. University, Bhopal, Madhya Pradesh, India.

*Corresponding Author: Kandregula Jyothirmayi

Email: lakshmi.jyothi14@gmail.com

DOI: 10.47750/pnr.2023.14.02.239

Abstract

Introduction: Stature is considered as one of the important core components. To identify human, besides age, sex and racial affiliation & personal identification of forensic anthropology. The purpose of the study is useful to find out the missing Person's Identity from fragmented skeletal remains, Amputated Limb or decomposed and dispersed human body parts by Medico-legal experts, forensic examiners and anatomists.

Methods: The present study sample was comprised of 670 (302 Males, 368 Females) young and healthy students studying in L.N Medical college and Research center, Bhopal (MP) aged between 17 -25 Years in the period of 2 years. Measurements of stature and three selected parameters of upper limb were taken. Statistical analysis involved by using SPSS Software (version 22.0).

Results: Using independent t-test, there was a significant difference ($p < 0.001$) in the measurement between males and females with regard to Tip of middle finger to 1st crease line of hand, & Tip of middle finger to acromion process of Scapula in both right & left sides, were observed to have strong correlations with stature.

Conclusion. The findings of the study show that there was significant positive correlation between the stature and the selected upper limb dimensions and thereby indicating that stature could be predicted successfully to identify skeletal remains among central Indian population.

Keywords: Stature, Middle Finger Length (MFL), Hand length (HL), Acromion process (AP).

INTRODUCTION

The word 'Anthropometry' was first coined in the seventeenth century by German physician Johann Sigismund Elshiltz (1623) ^[1]. In Greek Anthropos means "man" and Metro means "measure" hence measurement of man provides scientific methods and techniques for taking various measurements and observation on the living beings and skeleton ^[2].

Stature estimation is one of the crucial parameters, that various body parts show correlation with stature. The task of any medico-legal study on personal identification, becomes challenging in the form of skeletal remains or dismembered and mutilated body parts. Such partially destroyed dead bodies and human remains are frequently encountered in air crashes, dismemberment, explosions and other mass disasters. Sex, age, race and stature are acts as primary indicator for identification ^[3&4].

In forensic anthropology, assessment of stature from hand measurements plays a substantial role in creating personal identity. Despite the bilateral symmetry among humans, there seems to have asymmetry in various dimensions like arms, foot, hands, fingers etc. irrespective of gender ^[5].

Previously number of works have been studied, the correlation between stature and upper limb measurements, the important things to remember that body dimensions vary from population to population and person to person, even genetically identical twins are also differed. The important body dimensions are morphology of limb bone. Limb bone morphology is significantly related with climatic, nutritional and some environmental factors ^[6].

Estimation of stature from human skeleton/percutaneous measurement of height and body parts with age and gender are quite variable due to genetic and environmental factors across population ^[10]. Identification of living or dead subjects is necessary in the case of fragmented remains ^[11]. The growing incidence of mass disasters, such as conflicts and natural disasters, has created problems for investigators in terms of establishing identification from isolated upper extremity long bones. Great efforts have been made to identify remains in such disasters as the Turkish earthquake of 1999 and the terror attack on the World Trade Center in 2001 ^[12].

MATERIALS AND METHODS

The present study was conducted on a sample of 670 medical students (302 males and 368 females) within the age group of 17-25 years from LN Medical College Research Center Bhopal over a period of 2 years.

Inclusion Criteria: Apparently healthy, asymptomatic males and female's subjects with age group of 17-25 years were included in the study.

Exclusion Criteria: Subjects with physical deformities affecting stature and hand measurements Students with poorly defined wrist creases, pregnant ladies were excluded from the study. Age groups below 17 years and above 25 years also were excluded from the study.

Methods of Collection of Data: The study was conducted in a separate room. The objectives and methods of the study were explained to the sample population and informed consent was obtained, by taking their signatures on the consent form. All measurements were taken at a fixed time of day to eliminate diurnal variation. The anthropometric measurements i.e., Hand Length, Tip of the MFL to Acromion process and stature were measured. The parameters were measurements for both left and right side were measured separately, for each individual.

Instruments Used: Following instruments were used:

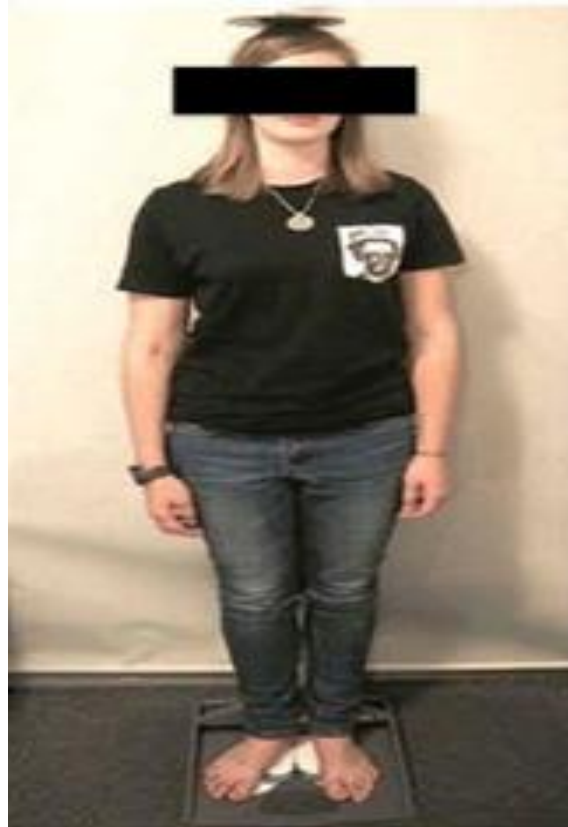
Stadiometer - It was used to measure vertical height of the subjects. It consists of platform on which the subject stands a long vertical bar which was scaled in millimeters and an adjustable horizontal bar for measuring the highest point of the subject.

Retractable tape: It is a flexible ruler used to measure length or distance. It consists of a metal strip with linear measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.

Landmarks and Techniques involved in taking anthropometric measurements:

Stature: It is the vertical distance between the highest point on the vertex and platform of stadiometer. The subject was made to stand erect, bare foot on a level platform against the stadiometer bar with his/her back and hips touching the bar, the feet were close to each other and the heels touching the bar, arms hanging by the side. The head of the subject was resting without any strain in the Orbito-meatal plane or Frankfurt's plane i.e., trigone and the infraorbital margin of both the sides lie in the same plane [7].

Fig. 1. Stature measurement



Hand Length (HL): It is the length taken between the mid-points of the 1st crease line of the wrist to the tip of the middle finger [8].

Fig. 2. Hand Length measurement



TIP OF THE MFL TO ACROMION PROCESS: It is length taken between the tips of the middle finger to Acromion process (A.P) of scapula ^[9].

Fig.3. Tip of MFL to Acromion process



Statistical analysis:

The data collected from the subjects were entered into Microsoft Excel Sheet. Measurements obtained were analyzed using statistical package for social sciences (SPSS) Software version. Descriptive data were presented as mean± standard deviation. P value of <0.001 was considered statically significant.

Pearson’s correlation coefficient (r) was analyzed to examine relationship between stature with hand length and upper extremity length. Regression analysis was done to formulate regression equations for estimation of stature from hand length and upper extremity length of both sides for total study population as well as for both males and females separately.

Coefficient of determination (R²) was used to calculate the proportion of variance in stature with hand length and upper extremity length. Standard error (SE) were also calculated.

Results:

Among all the 670 students enrolled, a descriptive statistic was calculated as shows in the table-1, all the parameters i.e., stature, Rt & Lt hand length and Rt & Lt upper extremity length shows mean± SD with minimum and maximum values.

Table no.1: Descriptive statistics of stature, Rt & Lt Hand length, Rt & Lt UEL of total study population (n=670)

Parameters	Mean ± SD	Minimum	Maximum
Stature	162.32 ± 9.22	134.5	196.5

Rt Hand Length	17.77 ± 1.33	11.9	22.3
Lt Hand Length	17.84 ± 1.31	14.0	21.5
Rt UEL	72.40 ± 4.78	61.8	91.1
Lt UEL	72.12 ± 4.98	63.0	91.4

All the measured parameters i.e. stature, Rt & Lt hand length (HL) and Rt & Lt upper extremity length(UEL) were higher in male subjects compared to females which was statically highly significant ($p < 0.001$) as shown in table-2.

Table no.2: Comparison of Stature, Rt & Lt Hand length, Rt & Lt UEL of both sides in Male & Female subjects

Parameters	Male (n=302) mean ± SD	Female (n=368) mean ±SD	P value
Stature	169.43 ± 6.88	156.49 ± 6.35	<0.001
Rt Hand Length	18.70 ± 1.10	17.00 ± 0.96	<0.001
Lt Hand Length	18.80 ± 0.99	17.05 ± 0.97	<0.001
Rt UEL	76.05 ± 3.74	69.42 ± 3.22	<0.001
Lt UEL	75.82 ± 4.13	69.10 ± 3.28	<0.001

Pearson's correlation coefficient (r) was calculated and strong positive linear correlation was found between stature with hand length and upper extremity length in both males and females and it was statically highly significant (< 0.001) as shown in table-3, 4.

Table no.3: Correlation between Stature and Hand Length of both sides in Male & Female subjects

Stature	Pearson's correlation Coefficient (r)	Male (n=302)		Female (n=368)		Total (n=670)	
		Rt HL	Lt HL	Rt HL	Lt HL	Rt HL	Lt HL
		.531**	.488**	.488**	.480**	.761**	.758**
P Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	

Table no.4: Correlation between Stature and upper Extremity Length (UEL) of both sides in Male & Female subjects

Stature	Pearson's correlation Coefficient (r)	Male (n=302)		Female (n=368)		Total (n=670)	
		Rt UEL	Lt UEL	Rt UEL	Lt UEL	Rt UEL	Lt UEL
		.697**	.722**	.651**	.637**	.845**	.842**
P Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	

Coefficient of determination (R^2) and standard error was calculated and shown in table -5, 6.

Table no.5: Coefficient of determination (R^2) and Standard error of estimation

Stature	R^2	Male (n=302)		Female (n=368)		Total (n=670)	
		Rt HL	Lt HL	Rt HL	Lt HL	Rt HL	Lt HL
		0.2221	0.222	0.459	0.459	0.558	0.558
	SE	0.06	0.06	0.05	0.05	0.05	0.05

Table no.6: Coefficient of determination (R^2) and Standard error of estimation

Stature	R^2	Male (n=302)		Female (n=368)		Total (n=670)	
		Rt UEL	Lt UEL	Rt UEL	Lt UEL	Rt UEL	Lt UEL
		0.2221	0.4176	0.459	0.459	0.5031	0.6649
	SE	0.22	0.24	0.17	0.17	0.18	0.19

Regression analysis was done and regression equation formulated for reconstruction of stature with hand length and upper extremity length of both sides for total study population as well as for both males and females separately as shown in table-7, 8.

Using regression formula $X =$ dependent variable (stature in cms), $A =$ constant, $B =$ Regression coefficient of variable and $Y =$ independent variable (Hand length in cms).

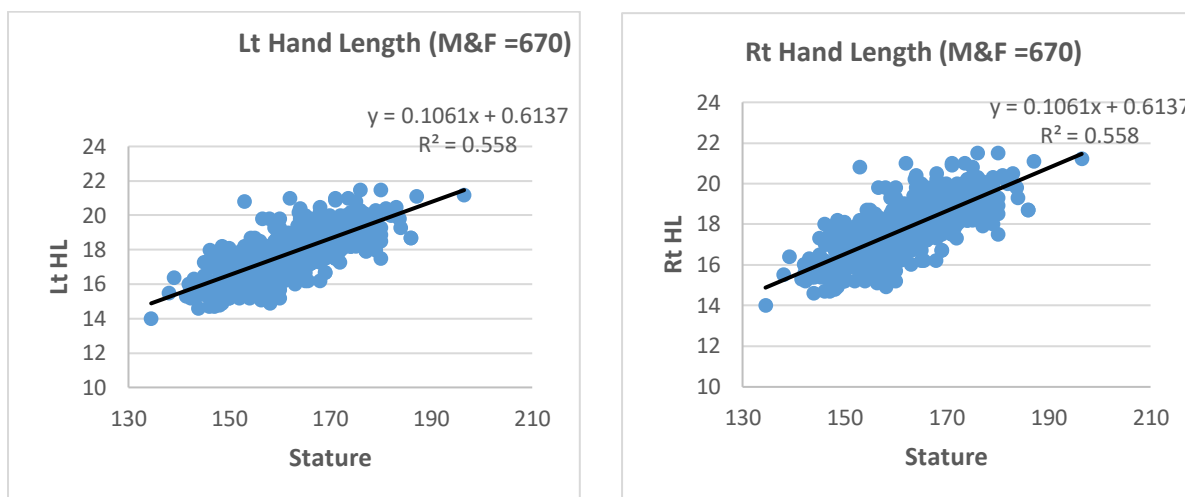
Table no.7: Regression equation for estimating stature from hand length in both males and females subjects.

	Participants	Rt Hand Length	Lt Hand Length
Stature	Males	$0.411x+5.9313$	$0.411x+5.9313$
	Females	$0.350x+14.305$	$0.350x+14.305$
	Total	$0.1061x+0.6137$	$0.1061x+0.6137$

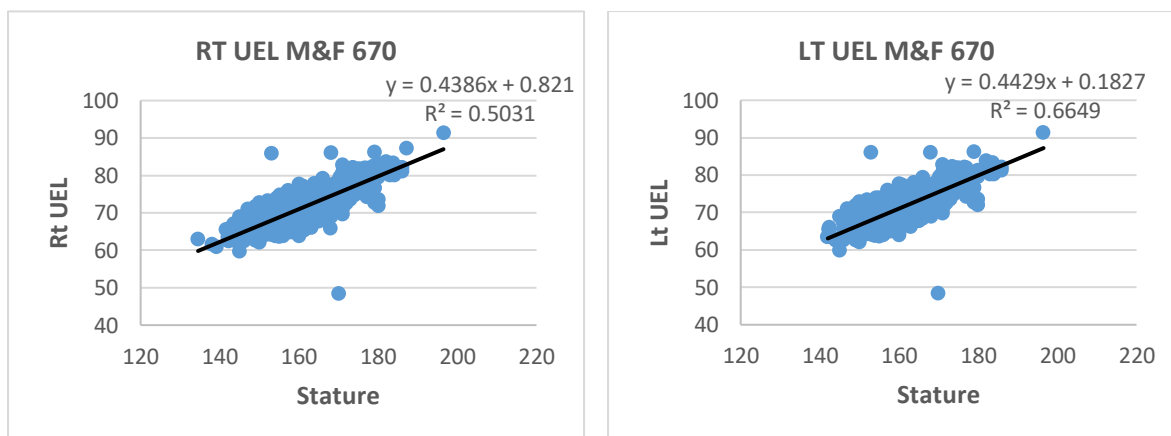
Table no.8: Regression equation for estimating stature from upper extremity length in both males and females subjects.

	Participants	Rt UEL	Lt UEL
Stature	Males	$0.411x+5.9313$	$0.3871x+10.178$
	Females	$0.3502x+14.305$	$0.3502x+14.305$
	Total	$0.4386x+0.821$	$0.4429x+0.1827$

Graph 1 & 2. Correlation between stature and hand length in both sides.



Graph 3 & 4. Correlation between Stature and upper extremity length in both sides.



Discussion:

First study of its kind, Rollet assessed the correlation between stature and long bone length. He measured the length of the humerus, radius, ulna, femur, tibia and fibula of adult Frenches cadaver and published a report with the methods of measurement, the individual measurements, and tables of stature estimation [13, 14].

In the present study we have chosen medial students, because of easy availability of the study population and easy for obtaining highest cooperation. Human stature mean was 162.32 ± 9.22 where as in males in 169.43 ± 6.88 , and in females 156.49 ± 6.35 . In this study maximum height is 196.5ms, while minimum height was 134.5cms. The range in stature was 134.5 to 196.5cms. Stature was statically significantly higher among males as compare to females ($p < 0.001$). Similar findings have been seen in Arif et al., Nandi et al., Navid et al., [15, 16, and 17].

In the present study mean Rt hand length with SD was 17.77 ± 1.33 where as in male was 18.70 ± 1.10 , and in females 17.00 ± 0.96 . In this study maximum length is 22.3 and minimum length is 11.9cms. Whereas Lt Hand length with SD was 17.84 ± 1.31 where as in males was 18.0 ± 0.99 , and in females 17.05 ± 0.97 . In this study maximum length is 21.5 and minimum length is 14.0 cms. Left hand length is slightly more when compared with right hand. Hand length was statically significantly higher among males as compare to females ($p < 0.001$). These findings correspond closely with those of Oommen et al., [18], Shankar et al., [19], Chikhalkar et al., [20] and Kavyashree et al., [21].

In the present study mean Rt UEL with SD was 72.40 ± 4.98 , In this study Maximum length is 91.1 and minimum length is 61.8cms. Where as in males was 76.05 ± 3.74 and in females 69.42 ± 3.28 . Whereas Lt UEL with SD was 72.12 ± 4.98 , in this study Maximum length is 91.4 and minimum length is 63.0cms. Where as in males is 75.82 ± 4.13 and in females 69.10 ± 3.28 . UEL was statically significantly higher among males as compare to females ($p < 0.001$). These findings correspond closely with those of Ozlem Uzun et al.,^[22], Syed Hina Mumtaz et al.,^[23].

Conclusion

The findings of the present study show that there was significant positive correlation between statures with Hand length, upper extremity length. The models in this study can be used for forensic identification purpose. These considerable significances of anthropometric and archaeological investigator in reconstruction of stature of an individual which can be useful tool for forensic scientist in medico legal investigation when only in fragmented remains of the body. Thereby indicating that stature could be predicted successfully using to identify skeletal remains among central Indian population.

References

1. http://de.wikipedia.org/wiki/Johann_Sigismund_Elsholtz, September 2009.
2. <http://en.wikipedia.org/wiki/Anthropometry>, September 2009.
3. Krogman WM, Iscan YM. The human skeleton in forensic medicine. 2nd ed. Springfield, Illinois, U.S.A: Charles C. Thomas Pub Ltd.; 1986.
4. Pickering RR, Bachman DC. The use of forensic anthropology. New York: CRC press – Taylor and Francis Group; 2009.
5. Amirshaybani HR, Crecelius GM, Timothy NH, Pfeiffer M, Sagers GC, K ME. The natural history of growth of hand, part 2: Hand length as a treatment guide in paediatric trauma patients. J Trauma.2000; 49(3):457-460.
6. Kudaka,M, Fukase, H, Kimura, R, Hanihara, T,Matsumura, H,Saso, A, Fukumine, T & Ishida, H 2013, 'Metric characteristics of human limb bones in Asian and Japanese population', International Journal of Anthropological Science, vol.12, no. 1, pp. 49-62, doi: 10. 1537/ase. 121125
7. Laila SZH, Ferdousi R, Nurunnobi ABM, Islam ATMS, Holy SZH, Yesmin F. Anthropometric measurements of the hand length and their correlation with the stature of Bengali adult Muslim females. Bangla J Anatomy.2009; 7:10-3.
8. Kanchan T, Krishan K. Anthropometry of hand in sex determination of dismembered remains-A review of literature. J Forensic Legal Med.2011;18:14-7
9. ShendeMR, Bokariya P, Kothari R, Tirpude BH. Correlation of superior extremity length with stature in central Indian populace. J Ind Academy Forensic Medic.2013;35:216-8
10. Ibeachu PC, Abu EC, Didia BC. Antropometric Sexual Dimorphism of Hand Length, Breath and Hand Indices of University of Port-Harcourt Students. Asian journal of medical Sciences 2011; 3: 146-150.
11. Kanchan T, Krishan K. Anthropometry of hand in sex determination of dismembered remains-A review of literature. J Forensic Legal Med.2011; 18:14-7.
12. Ebeye OA. Stature estimation from upper extremity long bones in a Southern Nigerian population. Aus J Basic Applied Sci.2013; 7:400-3.
13. Suneel Qamra, Indrajeet, Deodhar SD. A model for reconstruction of height from foot measurements in adult population of north-west India. Indian J of Med Research, 1980; 71: 77-83.
14. Pillay VV. Text book of Forensic Medicine and Toxicology. 4 th ed. Hyderabad: Paras publications; 2007;49-81
15. Arif M, Rasool SH, Chaudhary MK, Shakeel Z. Estimation of stature; upper arm length – a reliable predictor of stature. Professional Med J 2018; 25(11):1696- 1700.
16. Nandi ME, Olabiyi OA, Ibeabuchi NM , Okubike EA, IheazaEC.Stature Reconstruction from Percutaneous Anthropometry of Long Bones of Upper Extremity of Nigerians in the University of Lagos. Arab Journal of Forensic Sciences & Forensic Medicine 2018; 1(7):869-80.
17. Navid S, Mokhtari T, Alizamir T, Arabkheradmand A, Hassanzadeh G. Determination of Stature from Upper Arm Length in Medical Students Anatomical Sciences. 2014; 11(3):135-40.
18. Oommen A, Mainker A, Oommen T. (2005) A., *J. Anat.Soc* 54(2), 55-57.
19. Shankar G S, Shankar Radhika K, Shetty S. (2017) Correlation of Human height with hand length in Indian individuals. , *Int. J Anat. Res*; 5(41), 4478-4481.
20. Chikhalkar BG, Mangaonkar AA, Nanandkar SD, Peddawad RG. Estimation of stature from measurements of long bones, hand and foot dimensions. J .Indian Acad Forensic Med. 2009; 32(4): 329-330
21. Kavyashree AN N, Bindurani M K, Asha K R. (2015) Determination of stature from hand dimensions in Indian population. *Journal of International Medicine and Dentistry* 2(3), 209-214.
22. Ozlem uzun, Gulay Yeginoglu, Canan Ertemoglu Oksuz, Sahi Nur kalkisim, Nihat Burak Zihni. Estimation of Stature from Upper Extremity Anthropometric Measurements. Journal of clinical and Diagnostic Research. 2019 Jan, Vol-13(1):AC09-A15.
23. Syed Hina Mumtaz, B.R. Sharma Estimation of Stature from Right Upper Limb Measurements. Santosh University Journal of Health Sciences 2015; 1(2):53-56.