Original Article

Estimating Stature Using Handprint Dimensions: A Medico-Legal Investigative Approach

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ABSTRACT

Objective: To evaluate the relation of handprint dimensions using various parameters in the stature estimation of the study population in Hyderabad, Pakistan.

Study Design: Cross-sectional study

Place and Duration of Study: This study was conducted at the Isra University, Hyderabad from August 2021 to July 2022.

Materials and Methods: Participants of either gender, aged between 20 and 65 years, appeared to be in good health, without any deformity of hands, feet or vertebral columns were picked randomly. Handprints were scanned to measure the length and breadth of the hand, length of the palm and digits while the height of all participants was also measured.

Results: A total of 177 participants were picked of which 51.4% were females. The mean age of the male participants was 25.6±4.8 years and the female was 25.3 ± 4.2 years (age range 21-59). The mean of measured stature for males was 170.1±6.32cm (range: 157-195 cm) was significantly higher than that for females 158.04±6.14 cm (range: 146-174) with the ($p < 0.05$). Measurements of both handprint lengths had a statistically significant largest difference between both sexes ($p<0.05$).

Conclusion: A strong positive relationship between participant's handprint parameters and stature. While the most dependable single measure for estimating height was the 2nd digit length of the right handprint in men and the handprint length in females for estimating stature in forensic applications.

Key Words: Forensic anthropometry, Hand anthropometry, Stature

Citation of article: Abdul Waheed, Talpur MGA, Qadri NA, Abdul Qayyum S, Ram H, Khan IA. Estimating Stature Using Handprint Dimensions: A Medico-Legal Investigative Approach.Med Forum 2023;34(3):35-39.

INTRODUCTION

Forensic medicine is the cornerstone in the medico-legal investigations of crimes, enormous catastrophes and frequently in cases of death with badly preserved remains.(1) The prime goals of forensic medicine are the effective identification of unidentified bodies in such conditions. In contrast, forensic anthropology has developed to embrace a wide range of forensic applications such as the investigation of living persons as well as human remains following natural disasters or terrorism. (2) Four key parameters are vital for recognizing an individual when other shreds of evidence are confirmative includes; age, gender, ethnic background, and stature. Among these parameters, stature is the main parameter. (3, 4) Sex refers to a human biological genotype. When attempting to identify an unidentified individual, sex clarification is required in order to estimate age and size accurately. Sex identification plays a significant influence, eventually contributing to a hypothetical differentiating profile of an unidentified skeleton in developing a biological profile. (5, 6)

Forensic anthropologists greatly benefit from the use of human bones in the investigation of crimes. Several anthropometric methods have been published to evaluate height from various body components, such as head measurements and measurements of the bones in the arms and legs. (7) Furthermore, for a number of reasons, the human hand is the most adaptable

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Received: October, 2022
Accepted: January, 2023
Printed: March, 2023

component of the body. Forensic experts used measurements taken from hands, either real hands or hand bones, to determine the height. As a result, feet and handprints are used to measure height, with footprints being more important than handprints. Only a few works on the handprint were completed. As handprints are regularly captured at crime scenes, using many anthropometric characteristics on crime scene evidence as handprints for indicating height and sex can play an essential role in reducing the number of accused persons than can be validated by conventional means such as DNA.[8, 9]

To estimate stature from specific bones and body parts, numerous studies have been carried out on various population groups in various parts of the world. Researchers have developed numerous sets of regression formulas in recent years to estimate stature from cadaveric bones and skeletal remains. The purpose of the present study is to evaluate the relation of handprint dimensions using various parameters in the stature estimation of the study population in Hyderabad, Pakistan.

MATERIALS AND METHODS

This cross-sectional study was conducted at the department of forensic medicine from August 2021 to July 2022. Discrete adult volunteers were picked randomly from the Isra university campus and outpatient department of Isra university hospital, Hyderabad, Pakistan. Before collecting measurements, participants were given an information sheet outlining the study's objectives. A questionnaire was also used to gather basic demographic information (i.e. gender, age, ethnicity, etc.). Participants of either gender, aged between 20 and 65 years, appeared to be in good health, without any deformity of hands, feet or vertebral column deformity, and those who gave consent to participate were included in the study.

Stadiometer was used for the stature of every individual using the landmark definitions mentioned in earlier studies.[2, 10,11] To prevent inter-observer variability, the measurements were repeated and the mean values were reported (by one observer). All dimensions were taken in cm and rounded up to the closest millimeter. The scans of participants' hand prints were obtained using the flatbed scanner. All the participants were asked to put both hands and gently press against the scanning surface of the scanner so that their thumbs were at the ideal angle with the four fingers completely stretched and medially adducted. Hand and its corresponding print dimensions were taken as, Handprint length (HPL), Handprint breath (HPB), Palmer print length (PPL) and Thumb (1DP); Index (2DP); Middle (3DP); Ring (4DP), little (5DP) finger length. HPL is represented as the distance measured from the end of the small wrist bone at the base of the thumb to the tip of the hand's middle finger. The distal phalangeal length was determined by measuring the distance from the tip of a finger's most forward-projecting projecting point to the centre of the first distal phalange crease. This width was quantified as HPB. Moreover, the distance from the mid-point of the distal transverse crease of the wrist and the point of contact between the proximal flexion crease of the middle and fourth fingers was measured as PPL.

SPSS ver. 22 was used to enter and analyze the gathered data. The quantitative data were reported as mean SD, whilst the qualitative data was represented as frequencies and percentages. The student's t-test was employed for statistical analysis to discover the presence of significant sexual dimorphism in the hand between males and females. For each measurement, regression equations for stature estimates were developed for both sexes (using basic linear regression analysis). To forecast, SEE (standard error of estimation) was determined as the deviation of the estimated stature from the real one, where the lower its value, the higher reliability & accuracy of the estimated stature. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 177 participants were included in this study, of which the majority 91 (51.4%) were females compared with their counterparts 86 (48.6%). The mean age of the male participants was 25.6±4.8 years (age range 20-54 years) while the mean age of females was 25.3 ± 4.2 years (age range 21-59). The mean of measured stature for males was 170.1±6.32cm (range: 157-195 cm) was significantly higher than that for females 158.04±6.14 cm (range: 146-174) with the p-value < 0.05.

The estimation of intra-observer errors in the measurement (absolute TEM and relative technical error measurement rTEM) variables utilized in this investigation are presented in Table I.

Table No.1: Intra-observer errors in the measurement

Hand	Measurement	Absolute Tem	R Tem%	R
RIGHT	Hand Print Breadth	0.64	0.59	0.974
	R1DP length	0.66	0.54	0.991
	R2DP length	0.65	0.64	0.994
	R3DP length	0.62	0.33	0.991
	R4DP length	0.61	0.34	0.992
	R5DP length	0.62	0.41	0.996
LEFT	Hand Print Breadth	0.63	0.57	0.973
	L1DP length	0.62	0.51	0.992
	L2DP length	0.60	0.34	0.994
	L3DP length	0.55	0.30	0.993
	L4DP length	0.60	0.35	0.993
	L5DP length	0.68	0.45	0.997

Table II demonstrates the gender-wise descriptive findings of hand measurements of study participants. It is evident that the mean values of all the measurements were larger in males compared to their counterparts. Measurements of both handprint lengths had a statistically significant largest difference between both sexes ($p<0.05$). (Table 2).

Table No.2: Gender-wise distribution of right and left handprints measurements (n=177)

HAND	Variables	Studied group	
		Male mean± SD	Female mean± SD
RIGHT	Hand Print Length	19.7±1.4	17.6±0.9
	Hand Print Breadth	8.5±0.7	7.8±0.4
	Palm Print Length	11.6±0.7	10.2±0.6
	R1DP	6.8 ± 0.6	6.5±0.6
	R2DP	7.5 ± 0.5	6.6±0.5
	R3DP	8.6 ± 0.3	7.7±0.4
	R4DP	7.8 ± 0.4	7.4±0.5
	R5DP	6.2 ± 0.6	5.8±0.3
LEFT	Hand Print Length	19.4±0.7	17.3±0.4
	Hand Print Breath	9.0±0.4	3.1±0.2
	Palm Print Length	11.1±0.5	9.8±0.3
	L1DP	6.7±0.5	6.5±0.3
	L2DP	7.6±0.4	6.7±0.3
	L3DP	8.5±0.5	7.7±0.3
	L4DP	7.7±0.5	7.3±0.4
	L5DP	6.1±0.7	5.6±0.4

Table 3 displays the linear regression equations with the R^2, SSE and p-value to calculate the stature from the dimensions of the left and right hands. Neither the investigator nor the police is aware of who left the handprint—a man or a woman. R values in men varied from + 0.47 to + 0.71, while those in females ranged from + 0.34 to + 0.55. The relationship between size and the length of the second finger on the right handprint in men had the highest R-value (R = + 0.71). On the other side, among females, the right handprint and height had the highest value of R. Right handprint measurement (R = + 0.56). However, when all of the data were merged, the right handprint length (R = + 0.78) proved to be the most accurate measure of height.

Table No.3: Linear regression equations for stature estimation using right and left-hand measurements

Gender	Measurement	Equation	R^2	SEE	P-value
Male	Rt. Hand Breadth	S=117.26+4.72 RHB	0.24	5.45	0.000
	Lt. Hand Breadth	S=118.71+4.61 LHB	0.23	5.48	0.000
	Rt. Hand Length	S = 81.3+4.71 RHL	0.49	5.63	0.000
	Lt. Hand Length	S = 81.3+4.69 LHL	0.48	5.63	0.000
	R1D length	S= 119.54+4.06 R1D	0.23	5.48	0.000
	L1D length	S=121.60+3.97 L1D	0.22	5.51	0.000
	R2D length	S = 84.98+4.81 R2D	0.51	4.47	0.000
	L2D length	S = 85.42+4.79 L2D	0.50	4.45	0.000
	R3D length	S = 88.11+ 4.37 R3D	0.42	4.76	0.000
	L3D length	S = 87.67+4.41 L3D	0.43	4.72	0.000
	R4D length	S = 96.41+ 4.15R4D	0.36	5.02	0.000
	L4D length	S = 99.10+4.01 L4D	0.35	5.07	0.000
	R5D length	S = 107.02+ 4.11R5D	0.31	5.23	0.000
	L5D length	S = 108.34+4.04 L5D	0.30	5.22	0.000
Female	Rt. Hand Breadth	S=109.31+4.82 RHB	0.11	5.54	0.001
	Lt. Hand Breadth	S=110.13+4.74 LHB	0.11	5.52	0.001
	Rt. Hand Length	S = 81.3+4.69RHL	0.21	5.62	0.000
	Lt. Hand Length	S = 81.2+4.71 LHL	0.23	5.63	0.000
	R1D length	S = 127.56+2.70 R1D	0.11	5.53	0.000
	L1D length	S=125.62+2.72 L1D	0.11	5.52	0.000
	R2D length	S = 92.58+3.89 R2D	0.21	5.27	0.000
	L2D length	S = 95.66+3.79 L2D	0.20	5.29	0.000
	R3D length	S = 81.03+4.37 R3D	0.30	4.91	0.000
	L3D length	S = 82.36+4.33 L3D	0.31	4.92	0.000
	R4D length	S= 91.06+4.15R4D	0.29	4.96	0.000
	L4D length	S = 99.10+4.04 L4D	0.29	4.95	0.000
	R5D length	S= 93.83+4.51R5D	0.29	4.95	0.000
	L5D length	S = 95.62+4.37 L5D	0.27	5.04	0.000

Note: (R2) Coefficient of determination, (SEE) standard error of estimation

Table No.4: Multiple regression equation for the estimation of stature from Hand measurements

Gender	Equation	R^2	SEE	P-value
Male	S=85.74+1.69 HB-1.35 TDL+6.47 IDL+0.40 MDL-2.39 RDL + 0.17 LDL	0.53	±4.40	0.000
	S=85.33+1.27HB-1.32TDL+5.69 IDL+2.50 MDL-4.38 RDL + 0.88 LDL	0.53	±4.41	0.000
Female	S=75.17+1.76 HB-1.30 TDL-3.61 IDL+7.05 MDL-0.49 RDL + 1.76 LDL	0.38	±4.76	0.000
	S=76.55+1.86 HB-1.05 TDL-3.69 IDL+6.40 MDL+1.09 RDL + 0.67 LDL	0.37	±4.83	0.000
Both (Combined)	S=46.04+3.80 HB-1.56 TDL+3.43 IDL+4.20 MDL-2.59 RDL + 0.71 LDL	0.67	±5.12	0.000

	S=45.74+3.81 HB-1.70 TDL+3.20 IDL+4.82 MDL-2.70 RDL + 0.21 LDL	0.66	±5.20	0.000

Table 4 is presenting the multiple regression equations. For formulating the equations that provided a more accurate assessment of stature than the straightforward linear regression calculations, all the handprint parameters were combined.

DISCUSSION

There are many different ways to find handprints, such as on a flat surface or in dirt or soil. Law enforcement officials have frequently compared handprints to identify suspects and learn more about them when the accused individual is not present. **(11)** In the present study, the majority (51.4%) were females compared with their counterparts (48.6%). These findings are consistent with Moizuddin K et al, Nanayakkara D et al. and Aidy S et al **(6, 8, 12)** Studies have indicated that by the age of 18, the ossification centres in the wrist and elbow joints have fused and that by the age of 20, the distal end of the radius has completely fused.**(6, 9)** The age range we have chosen for our study cohort is supported by this as the mean age of the male participants was 25.6±4.8 years while the mean age of females was 25.3 ± 4.2 years.

Our study found that the overall mean stature was 170.4 cm ranging from 152.2 to 179.7cm. Consistent findings are also reported by Madadin M. et al and Kim W. et al. that reported mean stature of their study participants was 170-171 cm.**(1, 3)** The male participants had a significantly higher stature (mean height 170.1±6.32cm) compared to their counterparts (female) with a mean height of 158.04±6.14 cm. These findings are consistent with Aidy S. et. Al[12] and Kornieieva M et al.[4] These differences may be due to the variability in mean height indicates that individuals from different groups reach varying heights, which may be ascribed to heredity and environmental influences.

In the present study, male participants have bigger handprint measurements than females, and this holds true for all handprint dimensions. Studies carried out previously in different parts of the world revealed that males had longer height, hand length, hand breadth, palm length, thumb figure length, index figure length, middle figure length, ring figure length, and little figure length.**(1, 7, 11, 13)**

There was no bilateral imbalance in our investigation. According to the linear regression study, the right handprint 2nd digit length was the most exact single component to estimate height from handprint measurements in males, with the lowest SSE (4.41 cm) and the greatest R (+ 0.71) and R^2 (0.51). Females, on the other hand, had the highest values of R (+ 0.56) and R^2 (0.30) and the lowest value of SSE (4.91 cm) for their right handprint 3rd digit length.

A comparison of the values of the R and R^2 between stature and other handprint metrics reported in different populations. All prior investigations by Paulis et al[14], Aiday et al[12] and Asadujjaman, et al[13] indicated a favorable connection between handprint measures and height. The only shared handprint measurement between this research and prior investigations were handprint length (i.e., the third digit length in this study). As a result, the comparison was provided in terms of hand length. Right hand length measurements for men and women were more accurate in Paulis, et al study of the Egyptian population.**(14)** Handprint measures can be used to estimate height, according to several researches on a variety of people. To the best of our knowledge, this anthropometric investigation is the first one of its kind to be carried out in Sindh province, Pakistan.

CONCLUSION

The study concludes that a strong positive relationship between participant's handprint parameters and stature. While the most dependable single measure for estimating height was the 2nd digit length of the right handprint in men and the handprint length in females for estimating stature in forensic applications.

Author's Contribution:

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Conflict of Interest: The study has no conflict of interest to declare by any author.

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