HUMAN STATURE AND DIMENSIONS OF HAND AND FOOT- A SYSTEMATIC REVIEW

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ABSTRACT

BACKGROUND

Estimation of human stature is one of the important aspects of any forensic investigation. Anatomists, forensic experts and anthropologists all over the world have studied dimensions of various parts of body and correlated them with stature. India is studded with many places of pilgrimage, and other religious places where people tend to walk bare footed for religious reasons. Various studies have been conducted in Indian population on the same subject in past. The principal goal of these studies was to create a database and to derive coefficient and linear regression coefficient for stature and hand and foot dimensions. The present study aims to systematically review all the observations achieved from previous studies done in India.

METHODS

A detailed online search of articles was made on various databases like MedLine, PubMed, Wiley Online Library, Science Direct, Google Scholar, Cochrane Library, Embase etc. from 2000 to present and 23 studies were found. Amongst these 23 studies, 15 studies were shortlisted based on their similarity as per study design, sample size, variables studied taking authors own study as reference study.

RESULTS

All the 23 shortlisted studies were reviewed, and observations were tabulated, statistically analysed and graphically represented.

CONCLUSIONS

Significant positive correlation was observed between human stature and hand and foot dimensions. Foot length was stated as a better predictor of stature compared to other dimensions. Human stature of north Indian population is higher than south Indian population. Hand and foot dimensions are higher in north Indian males than south Indian males.

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BACKGROUND

Estimation of human stature is one of the important aspects of any forensic investigation. Anatomists, forensic experts and anthropologists all over the world have studied dimensions of various parts of body and correlated them with human stature and vice versa. India is studded with many pilgrimages and religious places and walking bare footed is a very common practice. Hence information about hand and foot dimensions and its correlation with human stature is of forensic importance. Various studies have been conducted in Indian population on the same subject in past. Unfortunately, most of those studies have yielded statistically insignificant conclusions. Also, a lot of diversity has been observed in the conclusions of similar studies done in same population of same region.

The principal goal of these studies was to study the correlation of dimensions of body parts with human stature and thereby to create a database of this population. They also derived a correlation coefficient and linear regression coefficient between stature and dimensions of different body parts.

The present review aims to systematically analyse the observations achieved from all previous similar studies done in Indian population. Focus was on studies on correlation of stature with hand and foot dimensions. It is believed that this systematic analysis will be useful for forensic investigations and anthropological studies conducted in Indian population.

METHODS

A detailed online search of articles was made on various databases like MedLine, PubMed, Wiley online library, science direct, google scholar, Cochrane library, Embase etc. from 2000 till present. Studies conducted by various authors on Indian population were searched (Either full pdf copy or abstract) and 22 such studies were found on correlation of human stature and hand and foot dimensions (Table 1). These studies varied in study design, age groups, variables studied and also in methodology used for taking measurements of hand and foot. 14 studies were shortlisted based on inclusion criteria (Table 2, Table 3). Observations were tabulated and analysed.

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Sl. No.	Name of Author	Year of Study	Study Age Group (Yrs.)	Variables Studied	Place of Study
1	Oommen et al ¹	2005	19-25	HL, FL	Mangalore
2	Danborno and Elukpo ²	2007	M - 24.5, 22.2	H, HL, HB, FL, FB	Nigeria
3	Patel et al ³	2007	17-22	H, FL	Gujarat
4	Krishnan K et al ⁴	2007	17-20	H, HL, HB, FL, FB	Himachal Pradesh
5	Rastogi et al ⁵	2008	20-30	HL, HB, H	Manipal
6	Sen J et al ⁶	2008	18-50	H, FL, FB	North Bengal
7	Kanchan et al ⁷	2008	NM	H, FL, FB	North India
8	Chikhalkar et al ⁸	2009	19-23	H, W, FAL, HL, HB, FL, FB	Mumbai
9	Krishan, et al ⁹	2011	17-20	HL, HB, FL, FB	Chandigarh
10	Patel, et al ¹⁰	2012	17-23	H, FL, FB, HL, HB, AS	Gujarat
11	Ibegbu, et al ¹¹	2013	5-10	H, HL	Nigeria
12	Mohite, et al ¹²	2015	17-25	H, HL, HB, FL	Wardha
13	Bodorikova and Nescakova ¹³	2015	18-24	H, HL, HB, FL, FB	Slovakia
14	Kavyashree et al ¹⁴	2015	20-22	H, HL, HB	Karnataka
15	Dey and Kapoor ¹⁵	2015	Above 18	HL, HB	New Delhi
16	Pal, et al ¹⁶	2016	20-40	HL, HB, W, H, DL	West Bengal
17	Tandon et al ¹⁷	2016	18-30	H, HL, HB, FL, FB, DL	Uttar Pradesh
18	Dhaneria et al ¹⁸	2016	17-25	H, FL, FB	Rajasthan
19	Shankar et al ¹⁹	2017	18-25	H, HL	Bangalore
20	Kim, et al ²⁰	2018	20-59	H, HL, HB, FL, FB	Korea
21	Samoon et al ²¹	2018	20-45	HL, H	Kashmir
22	Ibrahim et al ²²	2018	20-30	S, HL, PL, HB, FL	Saudi Arabia

Table 1. List of Previous Studies

H- Height, HL – Hand length, HB – Hand breadth, FL – Foot length, FB – Foot breadth,
 PL – Palm length, DL – Digit/ finger length, AS-Arm span, FAL – Forearm length,
 NM – Not measured NC - Not comparable, NA – Data not available

Sl. No.	Name of Author	Year of Study	Study Age Group (Yrs.)	Variables Studied	Place of Study
1	Patel et al ³	2007	17-22	H, FL	Gujarat
2	Krishnan K et al ⁴	2007	17-20	H, HL, HB, FL, FB	Himachal Pradesh
3	Rastogi et al ⁵	2008	20-30	HL, HB, H	Manipal
4	Sen J et al ⁶	2008	18-50	H, FL, FB	North Bengal
5	Kanchan et al ⁷	2008	NM	H, FL, FB	North India
6	Chikhalkar et al ⁸	2009	19-23	H, W, FAL, HL, HB, FL, FB	West Maharashtra
7	Patel, et al ¹⁰	2012	17-23	H, FL, FB, HL, HB, AS	Gujarat
8	Mohite, et al ¹²	2015	17-25	H, HL, HB, FL	East Maharashtra
9	Kavyashree et al ¹⁴	2015	20-22	H, HL, HB	Karnataka
10	Pal, et al ¹⁶	2016	20-40	HL, HB, W, H, DL	West Bengal
11	Tandon et al ¹⁷	2016	18-30	H, HL, HB, FL, FB, DL	Uttar Pradesh
12	Dhaneria et al ¹⁸	2016	17-25	H, FL, FB	Rajasthan
13	Shankar et al ¹⁹	2017	18-25	H, HL	Bangalore
14	Samoon et al ²¹	2018	20-45	HL, H	Kashmir

Table 2. Shortlisted Studies for Review

Sl. No.	Criteria for Shortlisting	No. of Studies
1.	Studies done on Indian population	18 studies
2	Age group of study population	17 years and above
3	Studies correlating stature with hand or foot dimensions	15 studies
4	Measurement of human stature	The height was measured from the sole of the feet to the vertex of the head ¹¹
5	Measurement of hand length	Hand length (HL) was measured as the distance between the distal crease of wrist to tip of middle finger ¹²
6	Measurement of hand breadth	Hand Breadth (HB) was measured from 1 st metacarpophalangeal joint to base of 5 th metacarpal ¹²
7	Measurement of foot length	Foot length (FL) was measured as the distance between the posterior most point of the heel and the anterior most point of the foot ¹ .
8	Measurement of foot breadth	Foot breadth (FB) was measured as distance between Metatarsal tibiale (point projecting most medially on the head of the 1 st metatarsal bone) and Metatarsal Fibulare (point projecting most laterally on the head of the 5 th metatarsal bone) ¹⁷

Table 3. Inclusion Criteria for Shortlisting Studies

Sl. No.	Name of Study	Place of Study	Subject of Study	Methods of Measurement			
				HL	HB	FL	FB
1.	Oommen et al ¹	Indian	Correlates HL and FL	Midpoint of inter-styloid line to tip of middle finger	NM	Distance between the posterior most point of the heel and anterior most point of the foot	NM
2	Danborno and Elukpo ²	Foreign study	Correlates stature with hand and foot dimensions	As done by Krishnan K et al ⁴	As done by Krishnan K et al ⁴	As done by Krishnan K et al ⁴	As done by Krishnan K et al ⁴
3	Patel et al ³	Indian	Correlates stature with hand and foot dimensions	NM	NM	Distance between the posterior most point of the heel and anterior most point of the foot	NM
4	Krishnan K et al ⁴	Indian	Correlates stature with hand and foot dimensions	NA	NA	NA	NA
5	Rastogi et al ⁵	Indian	Correlates stature with hand and foot dimensions	HL -1: Distal wrist crease to tip of middle finger HL-2: Midpoint of inter-styloid line to tip of middle finger	Measured between radial side of the second metacarpophalangeal joint and ulnar side of the fifth metacarpophalangeal joint	NM	NM
6	Sen J et al ⁶	Indian	Correlates stature with hand and foot dimensions	NA	NA	NA	NA
7	Kanchan et al ⁷	Indian	Correlates stature with hand and foot dimensions	NA	NA	NA	NA
8	Chikhalkar et al ⁸	Indian	Correlates stature with hand and foot dimensions	From mid-point below radial & ulnar tuberosity to tip of middle finger	From base of fifth to second metacarpal (position – prone)	From tip of toe to heel on the medial side	From base of first to fifth metatarsal
9	Krishan et al ⁹	Indian	Correlates Sex with HL, HB, FL and FB	NA	NA	NA	NA
10	Patel, et al ¹⁰	Indian	Correlates stature with hand and foot dimensions	Midpoint of inter-styloid line to tip of middle finger	Measured at level of metacarpophalangeal joint.	Distance between anterior & posterior point of foot	Measured at level of metatarsophalangeal joint.
11	Ibegbu, et al ¹¹	Indian	5-10 years	Findings not applicable	Findings not applicable	Findings not applicable	Findings not applicable
12	Mohite, et al ¹²	Indian	Correlates stature with hand and foot dimensions	Midpoint of inter-styloid line to tip of middle finger	From first metacarpophalangeal joint to base of fifth metacarpal	Distance between anterior & posterior point of foot	NM
13	Bodorikova and Nescakova ¹³	Foreign	Correlates stature with hand and foot dimensions	NA	NA	NA	NA
14	Kavyashree et al ¹⁴	Indian	Correlates stature with hand and foot dimensions	Straight distance between the midpoint of a line joining the two styloid process of radius and ulna and the lowest point on the anterior margin of the middle finger.	Straight distance between the most medially placed point on the head of second metacarpal on the stretched hand and the most laterally placed point on the head of fifth metacarpal on the stretched hand.	NM	NM
15	Dey and Kapoor et al ¹⁵	Indian	Correlates HL and HB	Mid-point of a line joining the two styloid process and tip of the middle finger.	Distance between metacarpal radialis and metacarpal ulnare.	NM	NM

16	Pal et al ¹⁶	Indian	Correlates stature with hand and foot dimensions	Distal wrist crease to tip of middle finger	Distance between metacarpal radialis and metacarpal ulnare.	NM	NM
17	Tandon et al ¹⁷	Indian	Correlates stature with hand and foot dimensions	Tip of the styloid process of the radius to the tip of the middle finger	Distance between the most prominent point outside of the lower epiphysis of second metacarpal to the most prominent inside of the lower epiphysis of fifth metacarpal.	Distance between anterior & posterior point of foot	Distance between the most medially projecting point on the head of the first metatarsal bone and most laterally projecting point on the head of the fifth metatarsal bone
18	Dhaneria et al ¹⁸	Indian	Correlates stature with hand and foot dimensions	NM	NM	Distance between anterior & posterior point of foot	Distance between the most prominent point on the medial aspect of head of first metatarsal and most prominent point on lateral aspect of the head of fifth metatarsal
19	Shankar et al ¹⁹	Indian	Correlates stature with hand and foot dimensions	Not specified	NM	NM	NM
20	Kim, et al ²⁰	Foreign	Correlates stature with hand and foot dimensions	NA	NA	NA	NA
21	Samoon et al ²¹	Indian	Correlates stature with hand and foot dimensions	The proximal crease of the wrist to the tip of middle finger.	NM	NM	NM
22	Ibrahim et al ²²	Foreign	Correlates stature with hand and foot dimensions	Distal crease of the wrist and the tip of the middle finger	Distance between the most remote points on the heads of the first and fifth metacarpal bones	NM	NM

Table 4. List of Studies with Methods of Measurement

H- Height, HL – Hand length, HB – Hand breadth, FL – Foot length, FB – Foot breadth, PL – Palm length, DL – Digit/ finger length, AS-Arm span, FAL – Forearm length, NM – Not measured NC - Not comparable, NA – Data not available

RESULTS

Sl. No.	Name of Study	Sample Size (n)	Parameters Studied	Observations				
				Mean Height (cm) M/F	Mean Hand Length (cm)		Mean Hand Breadth (cm)	
					Right M/F	Left M/F	Right M/F	Left M/F
1	Oommen et al ¹	100	HL, FL	NA	19.06/ 17.32	19.06/ 17.24	NM	NM
2	Danborn and Elukpo ²	400	H, HL, HB, FL, FB	173.7/160.0	19.85/ 18.51	19.93/ 18.52	8.90/ 7.82	8.68/ 7.72
3	Patel et al ³	502	H, FL	170.96/ 156.14	NM	NM	NM	NM
4	Krishnan K et al ⁴ (2007)	246	H, HL, HB, FL, FB	NA	NA	NA	NA	NA
5	Rastogi et al ⁵	500	HL, HB, H	NA	NA	NA	NA	NA
6	Sen J et al ⁶	450	H, FL, FB	Data not available	NM	NM	NM	NM
7	Kanchan et al ⁷ (2008)	200	H, FL, FB	Data not available	NM	NM	NM	NM
8	Chikhalkar et al ⁸	300	H, W, FAL, HL, HB,	167.26	18.93	18.93	7.53	7.53

			FL, FB					
9	Krishan et al ⁹	246	HL, HB, FL, FB	NA	NA	NA	NA	NA
10	Patel et al ¹⁰ (2012)	273	H, FL, FB, HL, HB, AS	164.59	17.75		7.91	
11	Ibegbu, et al ¹¹	600 children	H, HL	NC	NC	NC	NC	NC
12	Mohite, et al ¹²	230	H, HL, HB, FL	171.12/ 159.43	Male - 19.11, Female - 17.40		Male - 86.45, female - 73.74	
13	Bodorikova and Nescakova ¹³	250	H, HL, HB, FL, FB	NA	NA	NA	NA	NA
14	Kavyashree et al ¹⁴	294	H, HL, HB	SM - 171.73 NM - 169.04 SF - 159.25 NF - 158.42	18.81	18.74	8.24	8.00
15	Dey and Kapoor ¹⁵	147	HL, HB	NM	19.2/ 17.3	19.0/ 16.5	8.3/ 7.57	8.18/7.45
16	Pal, et al ¹⁶	1662 women	HL, HB, W, H, DL	NM	16.3	16.31	7.05	7.03
17	Tandon et al ¹⁷	497	H, HL, HB, FL, FB, DL	172.7/ 157.1	19.3/ 17.3	NM	Male - 8.3, Female - 7.2	
18	Dhaneria et al ¹⁸	500	H, FL, FB	166.43/ 160.91	NM	NM	NM	NM
19	Shankar et al ¹⁹	220	H, HL	Data not available	18.21/ 18.81	18.35/ 18.82	NM	NM
20	Kim, et al ²⁰	5195	H, HL, HB, FL, FB	NA	NA	NA	NA	NA
21	Samoon et al ²¹	158	HL, H	NM	NM	NM	NM	NM
22	Ibrahim et al ²²	350	S, HL, PL, HB, FL	175.44/158.96	20.11/18.65	20.75/18.6	8.76/7.66	8.7/7.62

Table 5. Studies with Observations of Height and Hand Dimensions

H- Height, HL – Hand length, HB – Hand breadth, FL – Foot length, FB – Foot breadth, PL – Palm length, DL – Digit/ finger length, AS-Arm span, FAL – Forearm length, NM – Not measured NC - Not comparable, NA – Data not available, SM –South male, SF – South female, NM – North male, NF – North female.

Sl. No.	Name of Study	Sample Size	Parameters Studied	Observations				
				Mean Height M/F	Mean Foot Length		Mean Foot Breadth	
					Right M/F	Left M/F	Right M/F	Left M/F
1	Anitha Oommen et al ¹	100	HL, FL	NA	26.21/ 23.75	26.0/ 23.68	NM	NM
2	B Danborn, A Elukpo et al ²	400	H, HL, HB, FL, FB	173.7/160.0	28.39/ 24.52	26.42/ 24.70	9.02/ 8.23	9.09/ 8.11
3	Patel SM, Shah GV et al ³	502	H, FL	170.96/ 156.14	Male – 24.44	Female -22.34	NM	NM
4	Krishnan K et al ⁴ (2007)	246	H, HL, HB, FL, FB	NA	NA	NA	NA	NA
5	Rastogi et al ⁵	500	HL, HB, H	NA	NM	NM	NM	NM
6	Sen J et al ⁶	450	H, FL, FB	Data not available	Data not available	Data not available	Data not available	Data not available
7	Kanchan et al ⁷ (2008)	200	H, FL, FB	Data not available	Data not available	Data not available	Data not available	Data not available
8	Chikhalkar BG et al ⁸ (2008)	300	H, W, FAL, HL, HB, FL, FB	167.26	24.008 with SD 1.420		8.895 with SD 0.703	
9	Krishan K et al ⁹ (2011)	246	HL, HB, FL, FB	NA	NA	NA	NA	NA
6	Patel PN, Tanna JA et al ¹⁰ (2012)	273	H, FL, FB, HL, HB, AS	164.59	24.178 with SD 1.809		9.28 with SD 0.865	
7	A. Ibegbu, David et al ⁸ (2013)	600 children	H, HL	NC	NC	NC	NC	NC
8	Prakash M. Mohite et al ⁹ (2015)	230	H, HL, HB, FL	171.12/ 159.43	Male – 25.86, Female – 22.67		NM	NM
9	Uhrova P, Benus R et al ¹⁰ (2015) – Slovak adults	250	H, HL, HB, FL, FB	NA	NA	NA	NA	NA
10	Rati Tandon et al ¹⁷ (2016)	497	H, HL, HB, FL, FB, DL	172.7/ 157.1	Male - 26.22, Female - 23.35		Male – 9.95, female - 8.89	
11	Dhaneria et al ¹⁸	500	H, FL, FB	166.43/ 160.91	Male – 24.71, female – 23.56		Male – 9.07, female – 8.68	
12	Kim W, Kim YM et al ²⁰ (2018)	5195	H, HL, HB, FL, FB	NA	NA	NA	NA	NA

Table 6. Studies with Observations of Height and Foot Dimensions

H- Height, HL – Hand length, HB – Hand breadth, FL – Foot length, FB – Foot breadth, PL – Palm length, DL – Digit/ finger length, AS-Arm span, FAL – Forearm length, NM – Not measured NC - Not comparable, NA – Data not available.

Sl. No.	Name of Study	Correlation Coefficient 'r'					Linear Regression Equation 'b'		Conclusions
1	Oommen et al ¹	Not calculated					Not calculated		Conclusions not relevant to this review study
2	Danborno and Elukpo ²	Male: RHL – 0.53, LHL – 0.55, RFL – 0.58, LFL - 0.61					Male: Ht. = 61.036 +(1.579 x RHL) – (1.003 x LHL) + (3.524 x RFL) + (0.0817 x LFL)		Height can be significant predicted from hand and foot length.
		Female: RHL – 0.43, LHL - 0.40, RFL- 0.61, LFL- 0.40					Female: Ht. = 71.965 + (0.0276 x RHL) – (2.410 x LHL) + (0.268 x RFL) + (1.787 x LFL)		
3	Patel et al ³	Male: 0.65; between height and foot length					Male: Ht. = 75.45+3.64 x FL		Strong relationship between height and foot length.
		Female: 0.80; between height and foot length					Female: Ht. = 75.41 + 3.43 x FL		
4	Krishnan K et al ⁴ (2007)	The correlation coefficients between stature and all the measurements of hands and feet were found to be positive and statistically significant.					Date not available		Foot length provides highest reliability and accuracy in estimating stature of an unknown individual.
5	Rastogi et al ⁵	North Indian male - 0.673 to 0.665, North Indian female: 0.740 to 0.732; South Indian male - 0.752 to 0.732, South Indian female - 0.701 to 0.691					Data not available		HL-2 gives more accurate results in stature estimation than the HL-1.
6	Sen J et al ⁶	Stature, foot length and foot breadth are positively and significantly correlated with each other. The higher correlation coefficient between stature and foot length was seen than that between stature and foot breadth.					Data not available		Stature was strongly dependent on foot length and foot breadth.
7	Kanchan et al ⁷ (2008)	The correlation coefficients between stature and foot dimensions were found to be positive and statistically highly significant. The highest correlation coefficient was observed between stature and foot length in males and foot breadth in females.							Foot length provides the highest reliability and accuracy in estimating stature of an unknown male and foot breadth in a female.
8	Chikhalkar et al ⁸	HL -0.5902, HB- 0.6004, FL - 0.6102, FB - 0.4886					Y = 116.892872 + 2.665389 * X (Y: Stature of individual, X: Hand-length)		The study highlights that hand length, hand width, forearm length foot length & foot width can be reliably used for estimation of stature in the region of Mumbai.
							Y = 113.561732 + 7.139216 * X (Y: Stature of individual, X: Hand-width)		
							Y = 79.72379 + 3.650632 * X (Y: Stature of individual, X: Foot-length)		
							Y = 114.828119 + 5.906901 * X (Y: Stature of individual, X: Foot-width)		
9	Krishan et al ⁹	Data not available					Data not available		Correlation with sex was studied.
10	Patel, et al ¹⁰	HL – 0.806, HB – 0.467, FL – 0.767, FB – 0.665					Ht. = 59.52+5.9163 x HL Ht.=121.69+5.4188 x HB Ht.=70.37+3.8969 x FL Ht.= 99.05+7.063 x FB		The highest correlation was found between stature and Arm span (r=0.908) followed by hand length (0.806), followed by foot length (0.767).
11	Ibegbu, et al ¹¹	Data not comparable					Data not comparable		Data not comparable
12	Mohite, et al ¹²	HL – 0.38, HB – 0.74, FL – 0.00					Height = 65.60 + 0.54 x Hand Length Height = 104.03 + 0.76 x Hand Breadth Height = 64.81 + 0.42 x Foot Length		Foot length is the most reliable predictor for estimating the stature of an Individual as observed in our study.
13	Bodorikova and Nescakova ¹³	The highest correlation coefficient was found for foot length in males (r=0.71) as well as in females (r=0.63).					Data not available		There was a positive and statistically significant correlation between stature and all measurements in both sexes (p<0.01).
14	Kavyashree et al ¹⁴	Correlation Coefficient 'r'	SIF	SIM	NIF	NIM	S= 113.08 + 6.27 * Left hand breadth		Study shows a positive correlation of stature with hand measurements.
							S= 122.49 + 2.07 * Left hand length		
		RHL	0.412	0.414	0.367	0.541	S= 103.89+ 7.52 * Right hand breadth		
							S= 127.15+ 1.8 * Right hand		

							length	NM		
							S= 114.75 + 6.7 * Left hand breadth			
							S= 149.87 + 1.02 * Left hand length			
		LHL	0.397	0.256	0.419	0.398	S= 114.36+ 6.63 *Right hand breadth			
							S= 126.41+ 2.25*Right hand length			
		RHB	0.095	0.256	0.559	0.463	S= 147.47 + 1.65 * Left hand breadth	SF		
							S = 112.61 + 2.71 * Left hand length			
		LHB	0.127	0.271	0.581	0.410	S= 150.12+ 1.27 * Right hand breadth			SM
							S= 112.49+ 2.72 * Right hand length			
							S = 148.17 + 2.94 * Left hand breadth			
							S = 149.47 + 1.18 * Left hand length			
							S = 151.18+ 2.54 * Right hand breadth			
							S = 124.18+ 2.52 * Right hand length			
15	Dey and Kapoor et al ¹⁵	Data not comparable				Data not comparable			Data not comparable	
16	Pal et al ¹⁶	RHL – 0.683, LHL – 0.682 RHB – 0.452, LHB – 0.444				Ht. = 3.88 x HL + 88.1 Ht. = 3.553 x HB + 121.04			The present study showed that stature was significantly and positively correlated with all hand dimensions. Among the hand dimensions, the hand length showed the highest correlation with stature than the other dimensions.	
17	Tandon et al ¹⁷	Not calculated				Male: Ht. = 3.16 x HL + 111.5 Ht. = 5.79x HB + 124.54 Ht. = 3.09 x FL + 91.46 Ht. = 4.55 x FB + 127.39 Female: Ht. = 3.504 x HL + 96.46 Ht. = 7.125 x HB + 105.5 Ht. = 2.896 x FL + 89.55 Ht.= 3.684 x FB + 124.4			Foot dimensions have better correlation with the stature than hand dimensions.	
18	Dhaneria et al ¹⁸	Male: FL – 0.763, FB – 0.677; Female: FL - 0.652, FB – 0.439				Male: Stature = 77.24+ 3.61 x FL; Stature= 104.84+ 6.79 x FB Female: Stature= 88.83+ 3.06 x FL, Stature= 122.28+ 4.45 x FB			The correlation between foot length and stature was more than foot breadth and stature indicating foot length to be a better predictor of stature in males and females.	
19	Shankar et al ¹⁹	Male: RHL – 0.221, LHL – 0.186 Female: RHL -0.172, LHL – 0.264				Male: Height = 7.96+ (0.061 x right hand length) Height = 10.49+ (0.04 x left hand length) Female: Height = 13.96+ (0.024 x right hand length)			Weak positive correlation between height and hand length. However, further analysis revealed that hand length alone is not sufficient for accurate prediction of height.	
20	Kim, et al ²⁰	Data not available				Data not available			Males had the highest prediction accuracy in the regression equation consisting of foot length and hand length, whereas females had the highest accuracy in the regression model consisting of	

				foot length and hand width.
21	Samoon et al ²¹	RHL - 0.787941, LHL - 0.777245	Not calculated	In our present study we correlated the mean hand lengths of both sides with the stature and found a statistically significant correlation.
22	Ibrahim et al ²²	Male: RHL -0.665, LHL-0.388, RHB- 0.560, LHB-0.496; Female: RHL- 0.760, LHL-0.612, RHB-0.490, LHB-0.436	Male: S=92.468+4.132 x HL, S=104.334+4.572 x HB Female: S=88.623+4.567 HL, S=138.022+4.563 HB	The current study cleared a significant positive correlation between the stature and the measured hand dimensions. This correlation is stronger in hand length than other parameters.
Table 7. Studies with Observations of Correlation Coefficient and Equation				

DISCUSSION

Correlation of Height and Dimensions of Hand and Foot

Patel et al,³ Krishnan K et al⁴ (2007), Sen J et al,⁶ Kanchan et al⁷ (2008), Dhaneria et al¹⁸ studied correlation of height with foot dimensions and observed statistically significant correlation between them. Chikhalkar et al,⁸ Patel et al,¹⁰ Mohite et al¹² studied height and dimensions of hand and foot and observed statistically significant correlation between them. Kavyashree et al,¹⁴ Pal et al,¹⁶ Tandon et al,¹⁷ Shankar et al,¹⁹ Samoon et al²¹ studied height with dimensions of hand and observed statistically significant correlation between them. Dhaneria et al,¹⁸ Tandon et al,¹⁷ Patel et al,¹⁰ Mohite et al,¹² Kanchan et al⁷ (2008), Krishnan K et al⁴ (2007) in their studies stated that dimensions of foot especially foot length is a better predictor of stature in males and females.

Comparison of Height in Indian Population

Kavyashree et al,¹⁴ Shankar et al,¹⁹ Oommen et al¹ studied south Indian population while almost all the remaining authors (table 1) studied north Indian subjects. Mean height in north Indian population ranged from 172.7 to 166.43 cm in male and from 160.91 to 156.14 cm in female. Mean height in south Indian population was 171.73 cm in male and was 159.25 cm in female. So, it can be said that mean height is more in north Indian population compared to their south Indian population. (Table 5).

Comparison of Hand Dimensions in Indian Population

Mean hand length in north Indian population on right side ranged from 19.3 to 18.21 cm and on left side from 19.0 to 18.35 cm in male. Mean hand length in north Indian population on right side ranged from 18.81 to 17.3 cm and on left side from 18.82 to 16.5 cm in female.

Mean hand length in south Indian population on right side was 18.21 cm and on left side was 18.31 cm in male. Mean hand length in south Indian population on right side was 18.81 cm and on left side was 18.82 cm in female.

Mean hand width in north Indian population on right side was 8.3 cm and on left side was 8.18 cm in male. Mean hand width in north Indian population on right side was 7.57 cm and on left side was 7.45 cm in female.

Mean hand width in south Indian population was 8.24 cm in male. Mean hand width in south Indian population was 8.00 cm in female.

Hence it can be stated that dimensions of hand are more in north Indian males compared to south Indian males. Hand

width dimensions are higher in south Indian females compared to their north Indian females. (Table 5)

Comparison of Foot Dimensions in Indian Population

Mean foot length in north Indian population on right side ranged from 26.22 to 24.44 cm and on left side from 26.22 to 24.44 cm in male. Mean foot length in north Indian population on right side ranged from 23.75 to 22.34 cm and on left side from 23.68 to 22.34 cm in female.

Only three studies namely Kavyashree et al¹⁴, Shankar et al¹⁹ and Oommen et al¹ were conducted in south Indian population and only Oommen et al¹ studied foot length and height. She stated that mean foot length in south Indian population on right side was 26.21 cm and on left side was 26.0 cm in male. Mean foot length in south Indian population on right side was 23.75 cm and on left side was 23.68 cm in female.

Mean foot width in north Indian population ranged from 9.07 to 9.95 cm in male whereas it ranged from 8.68 to 8.89 cm in female. No data was available for foot width in south Indian population.

Hence it can be commented that mean foot length was observed higher in north Indian males compared to south Indian males. But no significant difference was observed between north and south Indian females. Whereas mean foot width couldn't be compared between north and south Indian population.

CONCLUSIONS

1. Significant positive correlation was observed between human stature and hand and foot dimensions.
2. Foot length was stated as a better predictor of stature compared to other dimensions.
3. Human stature of north Indian population is higher than that of south Indian population.
4. Hand and foot dimensions are higher in north Indian males than in south Indian males.
5. It would be unwise to use the same equations for stature estimation for different Indian populations.
6. The data collected should be useful for anthropologists and forensic experts.

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