

## Stature prediction from phalangeal anthropometrics in north Karnataka population; India

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**Abstract:** *Background:* Stature is an important indicator in determining personal identification of an individual. Identification of the deceased has a pivotal role in various medicolegal cases. Attempts have been made by various researchers across the globe to correlate stature with various body parts. But relatively less attention has been given on correlating stature with the phalangeal length. *Objectives:* In the present study an attempt is made to correlate stature and phalangeal lengths of both the hands in males and females separately. Linear regression formulae are also derived to estimate stature of an individual from phalangeal lengths. *Methods:* 300 healthy individuals consisting of 150 males and 150 females belonging to North Karnataka population are selected. Stature is measured using Standard Stadiometer. Phalangeal lengths are measured using Vernier Callipers. *Result:* In present study, the proximal and middle phalangeal lengths of fourth digit (D4P;  $r=0.47$ ,  $p=0.001$ ) (D4M;  $r=0.47$ ,  $p=0.001$ ) showed higher correlation coefficient with stature in males. Among females, the proximal and distal phalangeal length of first digit of right hand showed highest correlation coefficient value and is significantly correlated with stature (D1P;  $r=0.47$ ,  $p=0.001$ ) (D1D;  $r=0.47$ ,  $p=0.001$ ). *Conclusion:* In the present study, phalangeal lengths of first digit in males showed a negligent correlation with stature. Rest of the phalangeal lengths in males showed significant correlation with stature. In females, all the phalangeal lengths showed significant correlation with stature and the values were higher in right hand phalangeal measurements than in left hand.

**Keywords:** Linear Regression Equation, Phalangeal Lengths, Stature.

### Introduction

The stature prediction occupies relatively a central position both in the anthropological research and in the identification necessitated by the medical jurisprudence or by the medico-legal experts [1]. Identification of the deceased in cases of natural disasters like earthquake, tsunami, etc. or manmade events like accidents, explosions or murders carries obvious significance. In such situations, procurement of complete body parts might not be possible. Thus, there is an increasing interest to correlate the stature of an individual with various fragments of body parts. In order to assess height from human remains, an understanding of it in a living person is crucial. Anthropometric techniques are commonly used by anthropologists and adopted by medical

scientists to estimate body size for the purpose of identification [2].

Estimating statures through human remains is based on the principle that there is a linear relationship between stature and various parts of the human body and bones [3]. Based on the correlation, attempts have been made to establish the stature from the dimensions of almost all the body parts/ bones [4].

Less attention has been given on estimating stature from individual phalangeal length. Thus the present study is undertaken to study the correlation between stature and phalangeal lengths in both males and females of north Karnataka population.

**Material and Methods**

In the present study, a sample of 300 healthy individuals consisting of 150 males and 150 females belonging to North Karnataka population are selected.

*Inclusion criteria:* 300 healthy individuals, age ranging from 18years to 30 years

*Exclusion criteria:*

1. Left handed subjects.
2. Subjects with skeletal abnormalities, amputation or previous history of orthopedic surgeries.
3. Subjects with developmental disorders or syndromes.

Informed consent is taken from the subject. Stature was measured using Stadiometer and phalangeal parameters using Sliding callipers from palmar aspect.

*Stature:* Stature was measured using standard stadiometer. Measurement was taken by making the subject on the resting base of stadiometer, bare footed with shoulder blocked and buttocks touching the stadiometer rod. Palms were turned inward with the fingers pointing vertically downward and the head oriented in eye-ear-eye

Plane (Frankfurt Plane). The movable rod of the stadiometer was brought in contact with vertex in the mid sagittal plane [5].

*Phalangeal lengths:* The phalange length was measured as the distance between two phalangeal ridges. The distal phalange length was the straight distance between the most forward projecting point on the tip of a finger to the distal transverse crease [1].

**Fig-1:** Phalangeal length measurement using Vernier Callipers



*Statistical Analysis:* Data was analysed using SPSS software. Mean, Standard deviation, Correlation coefficient and value of Significance are estimated to establish correlation between stature and phalangeal lengths. Regression equations are derived to estimate stature from individual phalangeal lengths.

**Results**

**Table-1: Table showing distribution of age (years) among study population**

	Number	Mean	SD	Minimum	Maximum
Males	150	20.11	1.34	18	22
Females	150	18.47	5.92	18	22

The mean age of study population is found to be 20.11 years in males and 18.47 years in females.

The average height of males is 168+/-6.32cms and that of females was 156.41+/-5.92cms as shown in table 2.

**Table-2: Table showing distribution of height (cms) among study population**

	Mean	SD	Minimum	Maximum
Males	168.3	6.32	157	187
Females	156.41	5.92	144	170

**Table-3: Mean, Standard Deviation, Regression Coefficient and Significance value for Phalangeal length (in mm) among Males**

Parameters		D1P	D1D	D2P	D2M	D2D	D3P	D3M	D3D	D4P	D4M	D4D	D5P	D5M	D5D
Right hand	Mean	28.16	29.59	24.56	24.96	26.75	26.26	28.04	28.59	24.4	26.28	27.81	18.77	19.59	22.89
	SD	4.76	3.84	2.99	2.99	2.65	2.76	2.82	3.51	3.05	2.83	3.39	2.39	2.52	1.73
	r	0.16	0.06	0.29	0.29	0.25	0.41	0.34	0.41	0.47	0.47	0.33	0.33	0.29	0.25
	p	0.02	0.1	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.003
Left hand	Mean	28.53	30.06	24.18	25.38	26.98	25.64	27.26	28.26	24.16	25.92	28.04	18.32	18.94	23.13
	SD	4.2	3.44	2.85	3.4	3.65	2.52	2.44	3.59	3	2.9	3.02	3.95	2.56	2.01
	r	0.17	0.08	0.41	0.36	0.3	0.37	0.29	0.33	0.31	0.37	0.23	0.28	0.24	0.2
	p	0.2	0.1	0.001	0.002	0.0026	0.003	0.002	0.001	0.002	0.001	0.004	0.002	0.002	0.003

As in table 3, mean phalangeal length in males ranged from 18.77mm to 29.59mm in right hand and 18.32mm to 30.06mm in left hand. Correlation coefficient for stature from phalangeal lengths ranged from r=0.06 to r=0.47 in right hand and r=0.08 to r=0.41 in left hand. Except for 1<sup>st</sup> digit (D1P r=0.16 & p=0.02, D1D

r=0.06 & p=0.1), all the phalangeal lengths showed significant correlation with the stature. The proximal and middle phalangeal lengths of fourth digit (D4P; r=0.47, p=0.001) (D4M; r=0.47, p=0.001) showed highest correlation coefficient with stature.

**Table-4: Mean, Standard Deviation, Regression Coefficient and Significance value for Phalangeal length (in mm) among Females**

Parameters		D1P	D1D	D2P	D2M	D2D	D3P	D3M	D3D	D4P	D4M	D4D	D5P	D5M	D5D
Right hand	Mean	28.6	28.6	24.56	24.96	26.75	26.26	28.04	28.59	24.4	26.28	27.81	18.77	19.59	22.89
	SD	3.62	3.62	2.99	2.99	2.65	2.76	2.82	3.51	3.05	2.83	3.39	2.39	2.52	1.73
	r	0.57	0.57	0.29	0.29	0.25	0.41	0.34	0.41	0.47	0.47	0.33	0.33	0.29	0.25
	P	0.001	0.001	0.002	0.002	0.0018	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Left hand	Mean	29.1	29.54	24.18	25.38	26.98	25.64	27.26	28.26	24.16	25.92	28.04	18.32	18.94	23.13
	SD	4.92	4.13	2.85	3.4	3.65	2.52	2.44	3.59	3.0	2.9	3.02	3.95	2.56	2.01
	r	0.22	0.2	0.21	0.26	0.3	0.37	0.29	0.33	0.31	0.37	0.23	0.28	0.24	0.2
	p	0.001	0.0013	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Among females, the mean phalangeal lengths varied from 28.59mm to 18.77mm in right hand and 29.54mm to 18.32mm in left hand. Correlation coefficient for stature from phalangeal lengths ranged from r = 0.25 to r = 0.57 in right hand and r = 0.20 to r = 0.37 in left

hand. The proximal and distal phalangeal length of first digit of right hand showed highest correlation coefficient value and is significantly correlated with stature.(D1P; r=0.47, p=0.001)(D1D; r=0.47, p=0.001).

<b>Table-5: Regression Equations for calculating Stature from Phalangeal lengths of Males and Females included in the study</b>				
	<b>MALES</b>		<b>FEMALES</b>	
	<b>Right hand</b>	<b>Left hand</b>	<b>Right hand</b>	<b>Left hand</b>
Height =	174.5 + 0.223 (D1P)	165.4+ 0.2 (D1P)	110.7+1.59 (D1P)	151.9+0.15 (D1P)
Height =	171.2+0.09 (D1D)	163.35+0.16 (D1D)	79.08+2.56( D1D)	152.9+0.14 (D1D)
Height =	151.8+0.66 (D2P)	146.1+0.91 (D2P)	103.1+2.48 (D2P)	155.5+0.03 (D2P)
Height =	156.9+0.45 (D2M)	151.1+0.67 (D2M)	110.9+2.07 (D2M)	147.5+0.39 (D2M)
Height =	152.3+0.59 (D2D)	154.03+0.52 (D2D)	93.18+2.7 (D2D)	150.9+0.23 (D2D)
Height =	143.5+0.94 (D3P)	144.6+0.92 (D3P)	102.6+2.2 (D3P)	149.9+0.26 (D3P)
Height =	146.9+0.76 (D3M)	147.65+0.75 (D3P)	103.6+2.06 (D3M)	152.9+0.13 (D3M)
Height =	147.05+0.74 (D3D)	151.7+0.58 (D3D)	85.5+2.96 (D3D)	149.5+0.28 (D3D)
Height =	144.4+0.97 (D4P)	152.1+0.66 (D4P)	106.4+2.37 (D4P)	151.6+0.22 (D4P)
Height =	144.3+0.90 (D4M)	147.09+0.88 (D4M)	96.8+2.55 (D4M)	152.7+0.15 (D4M)
Height =	150.6+0.63 (D4D)	154.5+0.48 (D4D)	89.7+2.82 (D4D)	149.5+0.29 (D4D)
Height =	151.4+0.89 (D5P)	170.7+0.13 (D5P)	136.1+1.18 (D5P)	150.8+0.33 ( D5P)
Height =	153.6+0.74 (D5M)	156.9+0.6 (D5M)	127.3+1.17 (D5M)	149.5+0.4 (D5M)
Height =	163.3+0.21 (D5D)	166.7+0.06 (D5D)	102.6+2.49 (D5D)	152.6+0.17 (D5D)

Linear regression equations are also deduced to estimate stature of an individual from various phalangeal lengths in male and females separately, as shown in table 5.

**Discussion**

Dimensional relationship between body segments and the whole body has been the focus of scientists, anatomists and anthropologists for many years. Over many decades, a close relationship between stature and dimensions of various body segments are reported and the data are frequently used in medico-legal investigation [5].

Syeda Z S et al (2009) in Bengali female population. Isurani Ilayperuma et al (2009) in Srilankan population, Chikhalkar BG et al (2010) in a local population of Mumbai, Geetha N (2010) on tribal population of Kasargod district of Kerala, etc are few notable workers successfully correlated hand length with stature of an individual [6-9].

Tyagi A.K. et al.(1999) in young Delhi population [10], Rastogi P et al (2009) in Manipal [11], Pramod Kumar (2008) in Mysore [5], Jaydeep Sen et al (2014) in north eastern population of India [12], and many more researchers correlated stature with finger lengths. They concluded that accurate or near accurate stature can be calculated from the finger length of an unknown individual.

A number of different studies in various population of different ethnicity also proved the same. Few notable workers like Shintaku and Furuya [13], Jasuja OP and Singh G [1] and Habib SR et al [14] made attempts to correlate stature with the phalangeal lengths. Jasuja OP and Singh G (2004) carried out their work on 60 Jat Sikhs (30 males and 30 females) and derived correlation coefficient for stature and phalangeal lengths of all the fingers. It was found that correlation coefficient ranged from r=0.215 to r=0.632 in males right hand, r=0.307 to r=0.681 in males left hand, r=0.279 to r=0. 615 in females, right

hand and  $r=0.322$  to  $r=0.618$  in females, left hand [1].

Habib SR et al. (2010) conducted a similar study in Egyptian population. It was found that correlation coefficient ranged from  $r=0.198$  to  $r=0.443$  in males right hand,  $r=0.174$  to  $r=0.474$  in males left hand,  $r=0.132$  to  $r=0.445$  in females right hand and  $r=0.166$  to  $r=0.469$  in females left hand. All the measurements displayed statistically significant correlation coefficient with stature ( $p<0.05$ ) except 5<sup>th</sup> digit in males and distal phalanges in females [14]. Dr. Bhola Kumar Singh (2017) conducted his study on 50 subjects of North Indian Hospital. An attempt was made to correlate stature with proximal, middle and distal phalanges of medial four fingers. He found that all the measurements in his study were positive as well as a statistically significant correlation existed with the stature. He concluded that multiplication factors are important for establishing the stature from right hand length for both males and females. [15]

In a similar study by Nirupama B et al on 50 male and 50 female participants settled in Mangaluru, Karnataka from the past two generations, significant correlation was found between different length of phalanges of little finger and stature of an individual. Regression formula to estimate stature from little finger length was also derived [16]. From the present study, it is confirmed that all the phalangeal lengths are significantly correlated with the stature of the subjects included in the study. This is true with both the male and female study subjects. In the present study, the proximal and middle phalangeal lengths of fourth digit (D4P;  $r=0.47$ ,  $p=0.001$ ) (D4M;  $r=0.47$ ,  $p=0.001$ ) showed higher correlation coefficient with stature in males.

Among females, the proximal and distal phalangeal length of first digit of right hand showed highest correlation coefficient value and is significantly correlated with stature.(D1P;  $r=0.47$ ,  $p=0.001$ )(D1D;  $r=0.47$ ,  $p=0.001$ ).

### Conclusion

Stature is an important indicator in determining personal identification of an individual. All the parts of the body show biological correlation. This fact can be employed to estimate the size of one part of the body using the other. The same principle holds good to estimate stature from different parts of body. In forensic research, various studies have been conducted to derive a formula for estimating the stature of a specific ethnicity using a variety of anthropometric data, such as upper and lower limb, and facial measurement.

In the present study, phalangeal lengths of first digit in males showed a negligent correlation with stature. Rest of the phalangeal lengths in males showed significant correlation with stature. Significant bilateral difference was observed. In females, all the phalangeal lengths showed significant correlation with stature and the values were higher in right hand phalangeal measurements than in left hand. This study could contribute in understanding the relative status of our population in the context of the anthropometric variations among various populations in the world. It will also be helpful for the future work in this area especially in the various medical disciplines, anthropologists and medicolegal experts.

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