Estimation of Stature Using Length of Fingers of Recessive Left Hand in Nepalese Population

Acharya J,[1] Shrestha R,[2] Pandey N[3]

[1] Dr. Jenash Acharya, Department of Forensic Medicine, Kathmandu Medical College Teaching Hospital, [2] Dr. Rijen Shrestha, Assistant Professor, Department of Forensic medicine, Institute of medicine, Kathmandu,Nepal [3] Dr. Niraj Pandey, Department of Anatomy, Kathmandu Medical College Teaching Hospital, Kathmandu, Nepal,

Corresponding Author: Dr. Jenash Acharya,Lecturer, Department of Forensic Medicine, Kathmandu Medical College Teaching Hospital / Secretary, Medico-legal Society of Nepal (MeLeSoN), PO Box 21266, Clinical Science Complex, Sinamangal, Kathmandu; E mail: jenashacharya@gmail.com

ABSTRACT

Forensic anthropology involves identification of individuals from various types of evidence left at the scene of crime. Crime fighting has taken leaps and bounds since the advent of dactylography. However, forensic scientists are boggled in instances where the ridge prints are not adequately visualized to be used for fingerprinting. In instances where the prints of entire fingers are present, as is seen in hand prints, impressions and casts, the length of the fingers may provide information that can assist in developing an anthropological profile.

The authors independently measured the stature and lengths of fingers in the recessive left hand of 100 (50 m, 50 f) medical students at Kathmandu Medical College, Kathmandu, Nepal. These were subjected to paired samples t-test and showed no statistical significance.

The finger lengths were analyzed for correlation and regression equations derived for the measurements. Finger length was found to have a correlation ranging from 0.141 to 0.623 with S.E.E. ranging from 5.30 to 6.73. The finger length was found to be significant for all fingers when the gender was not relevant. In females, finger length was found to be statistically significant for regression equations for all fingers except the little finger. In males, finger length was found to be statistically significant only for the index finger. Results reveal that correlation increases if gender is not taken into account but S.E.E. also increases.

These studies, however, are population specific and should be interpreted with caution. Larger studies over the same population as well as extending to multiple populations should be conducted to further validate and corroborate available evidence in literature.

INTRODUCTION

Establishing the individuality by examining comingled or mutilated remains by forensic anthropologists, especially during mass deaths, following conflicts or natural catastrophes, has always presented a challenge for the scientific community. The variability of morphologic characters among individuals with similar age, race, gender and stature can make the identification process more complicated and subjective, when examined by different experts, or sometimes even by the same expert at different periods of time. Clandestine graves, mutilated body parts and mass burials are other complex examples where the identification of skeletal remains is subject to time-related changes; as well as other elements, including but not limited to air, water, mud or sand and fire. Contributions by forensic scientists over the last few centuries have now helped set up a steady platform, helping create a profile based on the 'big four' indicators; age, ancestry (ethnicity), gender and stature.1·2 This profiling helps death investigators in narrowing down the exhibits from large numbers into smaller groups and simultaneously aids forensic anthropologists in classifying the entire sample based on their biological profile for precise individualization.The entire human skeleton has been examined by scientists and these analyses have acknowledged that standards of skeletal identification show population-specificity,3·4 based on geographic, nutritional, occupational and genetic factors. In particular, long bones of extremities,5·6·7 skull bone,8 and bones of thorax have always intrigued forensic anthropologists in creating a biological profile, based on the 'big four' discussed above. 9

Multiple studies have shown the importance of anthropological analysis of hands for estimation of sex, [10,11,12,13] and stature. [14,15,16] The hand is the commonest body part that is exposed, in all cultures, and therefore features including rings, creases, moles, deformities, etc are more likely to be remembered and expressed during collection of ante-mortem data. [17,18] Individuals invariably leave evidence at the scene of the event; [19] this principle of exchange of materials on mutual contact is used primarily in dactylography. Mutilation of fingers have long been used in contemporary culture as a form of retaliation, or as a means of conveying a gruesome message, e.g. during kidnapping.

Similarly, hand prints and palm prints left at the crime scene, especially those where the ridges are masked, could be examined to establish an anthropological profile. Laterality influences the symmetry and development of the musculo-skeletal system. [20,21] The nature of work, specifically the physicality, also leads to further differential development. These variations affect the recessive hand to a lesser degree. Taking into account these considerations, an attempt is made through this paper to approximate stature from finger length in the recessive hand.

MATERIAL AND METHODS

The study was conducted on 100 (m=50, f=50) medical students from Kathmandu Medical College, Nepal, aged between 20 and 25 years. All participants were recessive for left hand.

1. **Finger length measurements:** Measurements from fingers of recessive (left) hands were taken since the study conducted by Means and Walters [22] suggested influence of hand dominance on its dimensions. Using standard procedures and landmarks as suggested HV Vallois [23] in their study, all the measurements of fingers were taken from the midpoint of the proximal crease at the base of each finger to the tip of respective finger. The finger measurements taken using standard sliding calipers in centimeters to the nearest millimeter were accurate to 0.1 cm.
2. **Stature measurement:** The vertical distance between plane of the floor and vertex of the head is measured as stature of an individual. The participants stood barefoot in erect posture against a wall with head in Frankfort Horizontal plane. The measurement was taken along mid sagittal plane.
3. The measurements were taken by two authors individually, at different times and were blind to the other's findings to avoid bias.

The data collected was analyzed using SPSS v 20.0. The data was analyzed to develop descriptive statistics, as well as for developing regression equation for estimating stature from finger lengths.Participants with deformities of the vertebral column and limbs, poorly defined proximal flexion crease of fingers, left hand dominant students and subjects with history of any injuries causing deformities to any fingers in the past, were excluded from the study.

RESULTS

The data was collected by two authors, a week apart, with each author blinded of the other author's findings. The data collected was analyzed to test for inter-observer error using paired sample t-test. The results were found to have no difference of statistical significance. The results are provided in **Table (1).**

Table 1. Paired Samples Test showing statistically not significant inter-observer error

	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Stature	- 0.0948	0.5513	0.0512	- 0.1962	0.0066	- 1.852	99	.067
Thumb(LT)	-.0230	.3711	.0371	-.0966	.0506	-.620	99	.537
Index(LI)	.0040	.4483	.0448	-.0850	.0930	.089	99	.929
Middle(LM)	.0380	.3139	.0314	-.0243	.1003	1.211	99	.229
Ring (LR)	-.0260	.4199	.0420	-.1093	.0573	-.619	99	.537
Little(LL)	.0290	.5360	.0536	-.0774	.1354	.541	99	.590

The data collected by the two authors was averaged before being subjected to descriptive statistic analysis. The mean and standard deviation for the variables were calculated to be 21.90 years and 0.94 years for age, 165.09 cm and 7.27 cm for stature, 6.03 cm and 0.47 cm for Left Thumb, 6.97 cm and 0.48 for Left Index, 7.68 cm and 0.48 cm for Left Middle, 7.19 cm and 0.47 cm for Left Ring and 5.94 cm and 0.62 cm for Left little finger respectively. The descriptive statistics after classifying the data based on gender is presented in **Table (2)**.

Table 2. Descriptive Statistics

Descriptive Statistics				
	Male		**Female**	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Stature	169.04	6.19	161.14	6.07
LT1	6.23	.45	5.83	.41
LI1	7.28	.34	6.66	.39
LM1	7.93	.42	7.43	.41
LR1	7.43	.45	6.97	.38
LS1	6.22	.61	5.65	.47

The Pearson correlation coefficients for the variables ranged from 0.390 for little finger to 0.623 for the index finger, with all variables showing statistical significance for estimating stature. The data was then analyzed for uni-variate regression equation to develop the best-fit regression for estimating stature from finger lengths. The results are shown in **Tables (3).**

Table 3. Univariate Linear Regression analysis for estimation of stature from fingers

	Both (Male/Female)				**Female**				**Male**			
Model	**B**	**S.E.E.**	**R**	**p**	**B**	**S.E.E.**	**R**	**p**	**B**	**S.E.E.**	**R**	**p**
(Constant)	127.387	6.69	.405	.000	125.914	5.60	.408	.003	163.695	6.25	.062	.670
LThumb	6.251				6.042				0.858			
(Constant)	99.481	5.72	.623	.000	108.901	5.30	.504	.000	125.625	5.91	.330	.019
LIndex	9.413				7.846				5.962			
(Constant)	108.400	6.36	.493	.000	111.729	5.46	.454	.001	152.671	6.20	.141	.330
LMiddle	7.381				6.649				2.064			
(Constant)	107.772	6.25	.519	.000	107.051	5.37	.484	.000	145.134	6.08	.235	.101
LRing	7.963				7.764				3.218			
(Constant)	137.702	6.73	.390	.000	144.308	5.97	.232	.105	159.657	6.19	.149	.300
LLittle	4.614				2.979				1.508			

DISCUSSION

Literatures on sex estimation using finger lengths have reported that absolute length of any given finger is longer in males compared to females.[13,14,15,24,25] Any person's stature is known to augment from intra-uterine life to the age of 20-21 years of age under normal circumstances, following which there is gradual loss of stature every two decades once the person reaches age of 30. Males have two more years of physical growth attributed by early skeletal maturity in females.[26,27,28] Hence, the subjects chosen for the study ranged within the age where the expected growth of bones are completed and not started to decline for both sexes.

Previous studies, conducted in India and Africa, have suggested statistically significant correlation between stature and finger length. The results are discussed in **Table 4.** [29,30,31]

The present study focused on deriving regression equations to estimate stature from finger length from live, adult, Nepalese medical students at Kathmandu Medical College; therefore, the result of the study cannot be extrapolated on children, adolescents or geriatrics. The sample was specific to students from Kathmandu Valley and therefore the results should be used in context. In addition, the length of finger as well as stature of a person vary during peri-mortem and post-mortem period due to thanatological changes like rigor mortis, bloating of tissues as a result of gaseous distention and other decomposition artifacts. It is therefore imperative to remember that these limitations require that the results of this study be interpreted with caution. Studies from various authors corroborate with our results that stature can be estimated from finger length, specifically index, mi ddle and ring fingers. The regression equations however should be population specific.

Table 4. Comparison of results obtained with previous studies

		Rastogi 2009				Krishan 2013		Sunday 2016		Present Study	
		North		South							
		M (L)	F (L)	M (L)	F (L)	M (L)	F (L)	M (R)	F (R)	M (L)	F (L)
Stature	**Mean**	171.6	158.66	171.95	158.57	161.65	153.13	162.72	159.04	169.04	161.14
	SD	6.62	6.06	7.05	5.1	8.09	5.11	6.04	8.74	6.19	6.07
Middle Finger	**Mean**	7.99	7.35	8	7.29					7.93	7.43
	SD	0.5	0.46	0.52	0.41					0.42	0.41
	SEE	5.59	4.943	5.218	4.413					6.20	5.46
	R	0.542	0.582	0.679	0.504					0.141	0.454
Index Finger	**Mean**					6.97	6.55	6.94	6.39	7.28	6.66
	SD					0.47	0.4	0.57	0.61	0.34	0.39
	SEE					5.41	4.49	-	-	5.91	5.30
	R					0.748	0.489	0.319	0.428	0.330	0.504
Ring Finger	**Mean**					7.26	6.73	7.2	6.74	7.43	6.97
	SD					0.48	0.41	0.57	0.66	0.45	0.38
	SEE					6.03	4.79	-	-	6.08	5.37
	R					0.674	0.367	0.231	0.428	0.235	0.484

ACKNOWLEDGEMENT

We express our sincere gratitude to all the students of Kathmandu Medical College who volunteered for the study as well as Er. Yogesh Raj Joshi for his contribution in the development of figures and tables.

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