ORIGINAL ARTICLE

Body Weight Estimation from Hand Anthropometry among Minangs, an Indigineous Ethnic Group in West Sumatra, Indonesia for Person Identification

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Abstract:

Background: Prediction of stature, body weight and gender form a scientific path for person identification during forensic investigation. Researchers are showing interest in developing standards for the prediction of the same from foot and hand anthropometry, considering the ethnicity or population. Human dismembered body parts are mostly found in natural calamities and bombing incidences, wherein person identity is a key element in the investigation. *Aim and Objective*: The present study was aimed to develop population specific standards for body weight prediction from hand anthropometry among Minang population in West Sumatra, Indonesia. *Material and Methods*: The study recruited 200 consented Minang people including 100 males and 100 females, following inclusion and exclusion criteria. Following the standard procedure, the body weight and ten hand length measurements from each subject were collected. The data were analyzed statistically using SPSS software and developed standards for body weight prediction from hand length measurements. *Results*: The mean body weight of the male was 60.02 kg while female showed 57.57 kg. The mean left hand lengths were slightly longer than mean right hand lengths, thus showing the bilateral asymmetry in the population. This study developed linear regression equations separately for males and females to predict body weight from left and right hand lengths. The correlation coefficient values were found to be higher in right hand lengths than left hand lengths. *Conclusion*: The present investigation concluded with the development of standards to predict body weight from hand length measurements of the study population. Even the presence of hand pieces with any one of the hand lengths is enough to determine body weight for person identification.

Keywords: Forensic Anthropology, Body weight, Hand anthropometry, Minang population, West Sumatra, Indonesia.

Introduction:

Human identity is the key factor in any forensic investigation and that can be achieved through scientific means in the legal system [1]. In the crime scenes, forensic investigators are searching for physical evidence to bridge the missing link between crime and criminal [2]. Physical evidence such as fingerprint [3], 2D footprint [4], 3D footprint [5], hair [6], soil [7], and firearm evidence [8-9] etc. are commonly found in burglary, sexual assault and homicide crime scenes, used to identify the live offenders. In the incidences of natural calamities and major bombing incidents, human body parts and tissues are the valuable clue used to identify the dead. But in dead body crime scenes like homicide and

suspicious death, the visit of forensic medicine expert to crime scene provides valuable guidance to the crime investigators [10].

The requirement for human identification is warranted during mass disasters which may be natural or man-made catastrophe, because during mass disasters the body is extremely deteriorated or dissected. The process of scientific crime scene investigation is not only the mechanical aspects of scene security, documentation, and evidence collection, but also demands keen crime scene analysis and hypotheses development through the linkage of the scenes and crime reconstruction [11]. Physical evidence plays a vital role in death scenes wherein the evidence can link the crime and criminal as well as primary and secondary crime scenes [12]. Researchers have shown that palm [13] and hand [14] are used to determine gender and stature, lead to person identification. Literature review shows seldom publication on body weight determination from hand anthropometry [15]. Hence the present study was aimed to develop regression standards to determine body weight from hand anthropometry among Minangs of West Sumatra, Indonesia.

Material and Methods:

The study recruited 200 consented Minangs including 100 males and 100 females living in West Sumatra, Indonesia. To start with, the participants' information such as name, age, gender and native place were obtained and recorded. The subjects were explained about this research and advised to wash their hands with soap solution, then wiped with white cloth. The height of a subject was measured using standard weighing machine. The hand length is the distance between the point inter-stylion (RT in right hand, LT in left hand) and the most anterior projection of all fingers (T,I,M,R,L) in both hands. The hand lengths were measured with digital vernier caliper for analysis.

Fig. 1 shows the example of various hand lengths (RTT,RTI,RTM,RTR,RTI) in right hand of the subjects and hand lengths in left sides are represented by LTT,LTI,LTM,LTR,LTI. The measurements were made by the same researcher. The hand length measurement was repeated for all other subjects. The data were analyzed statistically by using SPSS software version 25 and developed ten regression equations to predict body weight, five from left hand and five from right hand lengths. The results were presented in the form of tables and figures.

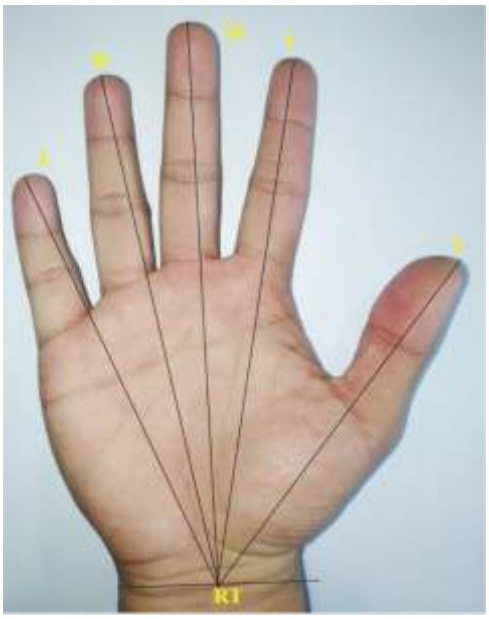

Fig. 1: Various Hand Length Measurements in Right Hand

Results:

Table 1 presents the living body weight of Minang ethnic group recruited in this study. The mean body weight of male was 60.02 kg while that of female was 57.57 kg. Tables 2 and 3 present the various hand length measurements of male and female Minangs on both sides. In males, the middle hand lengths were longer in both sides and thumb hand lengths were shorter. Fig. 2 shows the example of bar graph showing the middle hand lengths among the population. It is interestingly noted that all left hand lengths were slightly longer than the right hands, thus reflecting the bilateral asymmetry. Similarly the female left hands were slightly longer than right hand lengths and showing bilateral asymmetry. Tables 4 and 5 show the various linear regression formulae to determine body weight from various hand length measurements among male and female Minangs. The study developed ten regression formulae for male and ten for female to predict body weight from hand anthropometry. Standard Error Estimates (SEE) were found to be lower in females than males. Correlation coefficient (R) values were found to be higher in females. For males, the correlation coefficient values ranged from 0.110 to 0.156 on left side and 0.123 to 0.152 on right side. For females, R values ranged from 0.296 to 0.357 on left side while right side ranged from 0.329 to 0.411. The study showed that R values between body weight and hand lengths were found to be larger in females (0.296-0.411) as compared to males (0.110-0.156). The coefficient determination (R^2) values ranged from 0.012 to 0.024 for males and from 0.087 to 0.169 for females.

Table 1: Body Weight of Minang People of Male and Female

Sex	N	Min (kg)	Max (kg)	Mean (kg)	SD
Male	100	39.0	91.0	60.02	11.232
Female	100	33.2	81.0	57.57	11.452

Table 2: Various Hand lengths of Male Minang People

Left Side					Right Side				
Hand lengths	Min (cm)	Max (cm)	Mean (cm)	SD	Hand lengths	Min (cm)	Max (cm)	Mean (cm)	SD
LTT	9.6	13.0	11.33	0.743	RTT	9.6	12.9	11.20	0.705
LTI	13.5	18.3	16.03	1.014	RTI	13.9	18.1	15.87	0.966
LTM	14.8	19.5	17.04	0.947	RTM	14.8	19.3	16.89	0.943
LTR	13.8	18.4	16.12	0.914	RTR	13.9	18.2	16.03	0.867
LTL	11.9	16.0	13.86	0.853	RTL	11.8	15.9	13.80	0.805

Table 3: Various Hand lengths of Female Minang People

Left Side					Right Side				
Hand lengths	Min (cm)	Max (cm)	Mean (cm)	SD	Hand lengths	Min (cm)	Max (cm)	Mean (cm)	SD
LTT	8.2	12.3	10.45	0.755	RTT	8.2	12.0	10.33	0.784
LTI	12.1	17.2	14.94	0.928	RTI	12.9	17.2	14.88	0.949
LTM	14.0	18.0	15.92	0.900	RTM	13.7	18.4	15.78	0.986
LTR	13.0	17.6	15.12	0.888	RTR	12.5	17.4	14.91	0.920
LTL	10.4	14.9	12.89	0.787	RTL	10.3	15.3	12.91	0.879

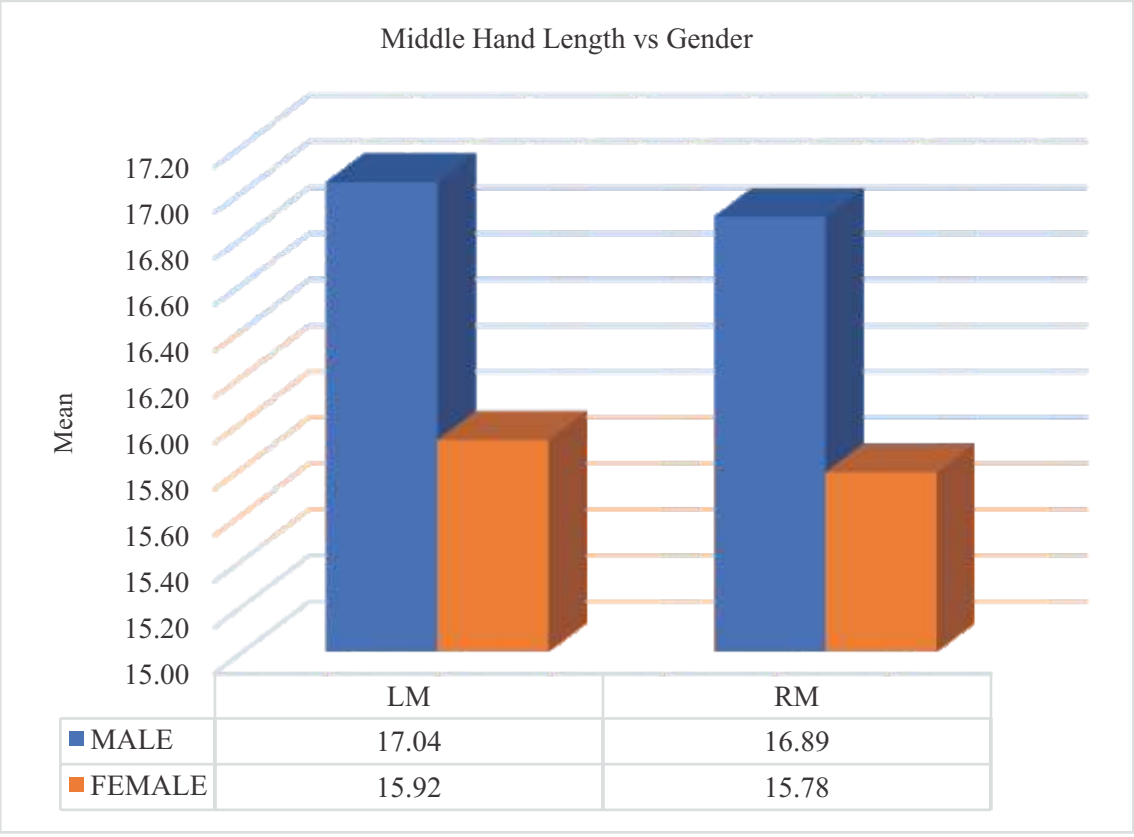

Fig. 2: Illustrative Example of Middle Hand Length Measurements among Minangs

Table 4: Linear Regression Formulae to Determine Body Weight for Male Minang People

Left hand				Right hand			
Formulae	**R**	**R^2**	**SEE**	**Formulae**	**R**	**R^2**	**SEE**
W = 41.187 + 1.662 (LTT)	0.110	0.012	11.220	W = 38.014 +1.600 (RTT)	0.123	0.015	11.203
W = 60.063 – 0.003 (LTI)	0.120	0.014	11.289	W = 54.274 + 0.362 (RTI)	0.130	0.017	11.283
W= 58.615 + 0.082 (LTM)	0.146	0.021	11.289	W = 57.542 + 0.147 (RTM)	0.124	0.015	11.288
W = 68.789 – 0.544 (LTR)	0.144	0.021	11.278	W = 62.921 – 0.181 (RTR)	0.142	0.015	11.288
W = 70.168 + 0.732 (LTL)	0.156	0.024	11.271	W = 65.173 – 0.374 (RTL)	0.152	0.023	11.285

P<0.001

Table 5: Linear Regression Formulae to Determine Body Weight for Female Minang People

Left hand				Right hand			
Formulae	**R**	**R^2**	**SEE**	**Formulae**	**R**	**R^2**	**SEE**
W = 10.705 + 4.485 (LTT)	0.296	0.087	10.995	S = 1.688 + 5.413 (RTT)	0.371	0.137	10.691
W = - 8.259 + 4.406 (LTI)	0.357	0.127	10.752	S = - 16.245 + 4.963 (RTI)	0.411	0.169	10.493
W = - 12.514 + 4.404 (LTM)	0.346	0.120	10.800	S = - 7.180 + 4.103 (RTM)	0.353	0.125	10.769
W = - 4.621 + 4.115 (LTR)	0.319	0.102	10.910	S = - 10.600 + 4.573 (RTR)	0.367	0.135	10.705
W = - 1.897 + 4.615 (LTL)	0.317	0.101	10.917	S = 2.260 + 1.243 (RTL)	0.329	0.108	10.870

P<0.001

Discussion:

Minang ethnic is unique compared to other ethnic groups in Sumatra Island, Indonesia and their societies are matrilineal [16]. It is a mandatory requirement for personal identification in man-made disasters like terrorist bomb blasts using high power explosives and natural disasters like earth quakes, landslides wherein dismembered body parts are found and decomposed dead body under the earth, an example of crime concealment, a secondary crime scenes [12,17]. In such incidences, even the presence a portion of hand or partial hand, form a valuable clue for personal identification. Earlier researchers have developed equations for only one hand length, the longest middle hand length and for example, if little hand length area found in the bombing scenes, the only

developed equation become unfit to use and lost the chance of identification. But the present investigation derived 10 regression equations for body weight determination, and hence even the presence of partial hands may be enough for analysis and identification. This research provided valuable information and encouraging result in living body weight prediction from hand anthropometry among the Minangs in Sumatra, Indonesia.

The study result showed that the mean middle hand lengths of male Minang population were 17.4 cm (left) and 16.89 cm (right), while female were 15.92 cm (left) and 15.78 cm (right). The Bangladeshi population study reported that mean middle hand length of male (L:18.51 cm, R:18.48 cm) and female (L:16.61 cm, R:16.71 cm) were longer than Minang population [18]. The Bengalee female population in West Bengal, India study showed that the mean middle hand lengths were (L: 16.31 cm, R: 16.30 cm) also longer than Minang population but shorter than Bangladeshi population. Also the mean body weight of Minang female was 57.57 kg, comparatively heavier than Bengalee women (47.53 kg). Similar hand study on Malaysian Malay population showed that the middle hand length/longest hand lengths of male (L:18.7 cm, R: 18.6 cm) and female (L:16.9 cm, R: 17.0 cm) were found to be longer than Minang population [19]. The mean middle hand lengths of Nigerian male and female were reported as 18.68 cm and 18.14 cm respectively, longer than present study population [20]. The variation in hand lengths and body weight was because of varied ethnicity.

Literature review shows that only countable number of studies were conducted for body weight determination. The mean body weight of East Malaysia populations like, Ibans (Male: 55.6 kg, Female: 52.3 kg) [21], Bidayuhs (Male: 63.9 kg, Female: 54.6 kg) [22], Melanaus (Male: 58.7 kg, Female: 49.4 kg) [23], and Slovaks (Male: 78.27 kg, Female: 58.16 kg) [24] were found to be different from the body weight of present study population, thus reflecting the ethnic variation. Anyhow, body weight of Slovaks are found to be heavier than other populations. Stature and body weight determination from mutilated limbs in mass disaster incidents are pivotal for victim identification. In these incidences, the visit of forensic medicine expert, an autopsy officer to the crime scenes provide more information and guidance to the investigating agency and even to arrive a positive conclusion in the crime scene itself [25].

Conclusion:

Present researchers are showing interest in body weight determination from hand and foot anthropometry for use in crime scene and medical process. The body weight determination found useful in the elimation process of pooled sample of suspects with reasonable accuracy. Also, weight and height are important measurements for many medical procedures. It is difficult to measure the body weight in bedridden patients and thus can be estimated through equations based on anthropometric measurements generated by the researchers but different ethnical groups show different measurements of hands and feet. Hence, the present study

concluded with the development of formulae for body weight determination from hand anthropometry among Minang population in West Sumatra, Indonesia for forensic and medical application. It is cautioned that the regressions formulae developed in this study were suitable only for Minang population and it is incorrect to utilize these formulae for any other populations in the world.

Acknowledgements:

The authors are grateful to Minang population for their generosity during data collection. Also thankful to the reviewers for their positive comments and guidance. Thanks are due to RMC, Management and Science University for the encouragement in research and publication. The authors are thankful to the reviewer and journal editors for publishing this valuable manuscript.

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How to cite this article:
Nataraja Moorthy T, Noor Hafizah H, Henky. Body Weight Estimation from Hand Anthropometry among Minangs, an Indigenous Ethic Group in West Sumatra, Indonesia for Person Identification. *J Krishna Inst Med Sci Univ* 2021; 10(2):35-42

Submitted: *14-Feb-2021* ***Accepted:*** *15-Mar-2021* ***Published:*** *01-Apr-2021*