ORIGINAL ARTICLE

Determination of Stature from Hand Anthropometry among Visayan Population in Philippines for Person Identification

Nataraja Moorthy T[1], Ivan Nikkimor LD[1], Pravina D[1], Ariel Philip IP[2]*

[1]Department of Diagnostic and Allied Health Science, Faculty of Health and Life Sciences, Management and Science University, Shah Alam, Selangor State, Malaysia,[2]Chief Lieutenant Colonel, Gingoog City, Misamis Oriental, Mindanao-9014, Philippines

Abstract:

Background: Stature or height determination from amputated, mutilated limbs, skeletal remains or dispersed human body parts in mass disaster incidents is pivotal for victim identification. But it shows racial variations among different populations. *Aim and Objectives:* The present study was aimed to develop formulae to determine stature from hand anthropometry among Visayan/Bisaya population in Philippines since no anthropological data exists in the literature. *Material and Methods:* This study recruited 120 males and 120 females of Visayan population in Philippines. The sampling area is Philippines. Following the standard procedure, stature and ten hand measurements were collected from the participants. The obtained data were analysed statistically with SPSS software, version 23 and developed population specific regression equations to determine stature from hand anthropometry separately for males, females and pooled sample. *Results:* The mean stature of male (161.57 cm) was comparatively higher than female (150.84 cm). Similarly the mean hand length measurements of males are higher than female hand length measurements. The study developed regression equations to determine stature from and hand anthropometry. *Conclusion:* The developed population specific equations can be used to determine stature, even from partial hands with unknown gender. It is cautioned that these equations are population specific and unsuitable to apply for any other populations in the world or Philippines for stature determination.

Keywords: Forensic Anthropology, Stature, Hand, Visayan

Introduction:

Person identification is the primary task of any forensic investigator. With frequent occurrence of mass disasters and fatal assaults, the identification of isolated extremities and their parts is the ultimate goal for victim identification [1]. Hence, forensic experts work on skeletal remains, amputated or mutilated limbs, dispersed human body parts in mass disaster incident sites for identification [2]. While a disaster may be natural or human induced, a few countries escape events which result in multiple fatalities [3]. The process begins with a formation of biological profile, specifically determination of stature, gender, age and ethnicity.

Researchers have shown the dimension relationship between the segments of the body and whole body [4]. The stature shows a definite biological and genetic relation with body parts [5]. This relationship has been used to compare and highlight variations between different ethnic groups. Using stature estimation, a forensic scientist can narrow down the pool of possible victim matches in any ongoing investigation [6]. Stature has an inherent characteristic, the estimation of which is considered to be an important assessment in the identification of unknown human remains [7]. In forensic research,

stature determination uses either anatomical or mathematical methods. The anatomical method is preferable if all components of the skeleton are available but in real crime scenarios, only mutilated body parts or incomplete skeletal materials are available and hence this technique is cumbersome to use. The mathematical method yields better results to generate regression formulae to determine stature from hand anthropometry [8].

The anthropological researcher have been considering the ethnicity in the population study since height shows population variation. Thus, separate regression formulae should be developed to predict stature for each population group [9-11]. Literature review shows that no study was conducted on stature determination from hand anthropometry among Visayan/Bisaya, an indigenous ethnic group living in Philippines. Hence, the present study was aimed to develop regression formulae relating stature and hand anthropometry among the study population.

Material and Methods:

The sampling area was in Philippines and the sample collection was conducted under the field supervision of an experienced Superintendent of Police. Based on the sample size calculation (author 3 who guided the statistical part), 240 adult Visayan subjects (120 males and 120 females), born and lived in Philippines were recruited in this study. The age range of the study subject is 18-55 years old. The purpose and method of research were well explained to the participants and informed consent was obtained from all participants. Approval was obtained from Research Ethics Committee (Human) (MSU-RMC-02/FR01/05/L2/007) Management and Science University. The age range of the subjects was considered appropriate since the average length of the adult's hand and stature was attained by the age of 16 years in males and 14 years in females [12, 13]. Commonly, stature at 18 years was accepted as adult, although there are small increments in stature after this [14, 15]. The height of the subjects were recorded with a portable statiometer [4-7,10,11,16-18]. From each hand, five hand length measurements with a total of 10 measurements were made from each subject and recorded. The five length measurements in left hand are the inter-distance between the distal traverse crease of the wrist (LH) and tip of (i) thumb (T), (ii) index finger (I), (iii) middle finger (M), (iv) ring finger (R) and (v) little finger (L), as abbreviated LHT, LHI, LHM, LHR and LHL. Similarly the right hand lengths were abbreviated as RHT, RHI, RHM, RHR and RHL. Fig. 1 shows the five length measurements in right hand of a study subject. The data were statistically analysed by using SPSS software, version 25. The correlation coefficient (R), standard error of estimate (SEE) and the

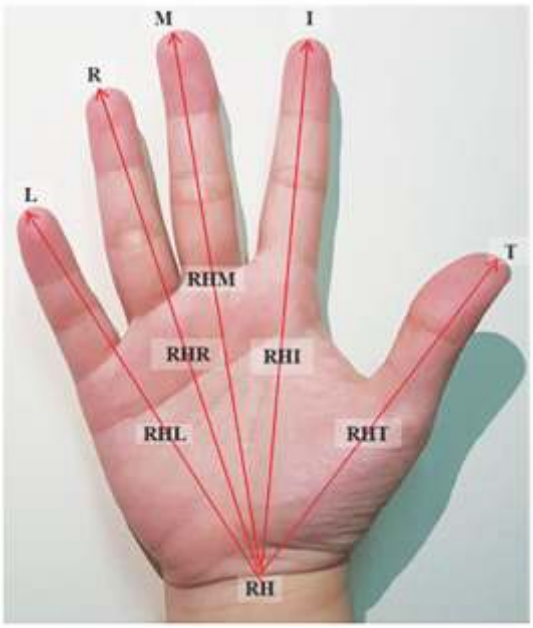

Fig. 1: Land Marks and Right Hand Length Measurements of Visayan

coefficient of determination (R^2) were calculated and developed regression formulae to determine stature from hand anthropometry. The participants' information, such as age, gender, name and place of origin were recorded and coded with sample ID for anonymity.

Results:

The results are categorized into (i) overall analysis and subsequent regression equations for males (ii) overall analysis and subsequent regression equations for females and (iii) overall analysis and subsequent regression equations for unknown gender (pooled sample). Table 1 presents the mean stature of males, females and pooled sample. It also depicts the sample size (N), minimum height, maximum height of study subjects and Standard Deviation (SD).

Here pooled sample means, 120 males and 120 female samples were combined together with a total size of 240 subjects. The gender of the pooled sample is considered 'unknown gender'. The gender of the dismembered hands is mostly unknown and thus the formulae developed for the pooled sample may be used for stature determination of hands with unknown gender. The mean height of male was comparatively higher (161.57 cm) than female (150.84 cm). SD of female was found to be lower than male and pooled sample.

Table 2-4 displayed the various hand length measurements among males, females and unknown gender (pooled sample) on both hands. The result showed that the mean middle finger hand length of male was comparatively longer than other lengths and the left hand length was not the mirror image of right hand length. It means that the left hand lengths and right hand lengths are not similar. Thus the male hand lengths showed bilateral asymmetry in this population. SD values were found to be low. Similar bilateral asymmetry was observed in the hands of female Visayans. The standard deviation values of pooled samples were slightly higher than the values of male and female.

Table 5-7 showed various linear regression equations for stature determination from different hand length measurements in adult males, females and pooled sample. The correlation coefficient (R) is the statistical measure of the strength of the relationship between the stature and various hand length measurements and R values are positive and statistically significant (<0.001) for stature determination. The correlation coefficient values were found to be higher in the pooled sample (0.692–0.774) than males (0.437–0.648) and females (0.471–0.654).

The coefficient of determination (R^2), the predictive accuracy, was also found to be higher in the pooled sample (0.479-0.600) when compared with males (0.191-0.424) and females (0.222-0.428). The SEE in case of females (4.371-5.098) was comparatively lower than that of males (4.851-5.750) and the pooled sample (5.134-5.853).

Table 1: Stature Measurements (in cm) of Viasayan Population

Gender	N	Minimum	Maximum	Mean	SD
Male	120	146	179	161.57	6.37
Female	120	137	167	150.84	5.75
Pooled sample	240	137	179	156.20	8.10

Table 2: Hand Length Measurements (in cm) of Male Visayans

Side	Hand length	Min	Max	Mean	SD
Left	LHT	11.15	14.40	12.89	0.66
	LHI	15.06	18.90	17.03	0.84
	LHM	15.91	20.35	17.90	0.90
	LHR	14.51	19.41	16.94	0.91
	LHL	12.40	16.54	14.68	0.81
Right	RHT	11.63	14.54	13.08	0.66
	RHI	14.58	19.32	17.05	0.85
	RHM	15.82	20.30	17.88	0.90
	RHR	14.99	19.50	16.91	0.86
	RHL	12.45	16.80	14.53	0.84

Left hand thumb LHI- Left hand index LHM- Left hand middle, LHL- Left hand little, RHT-Right hand thumb RHM- Right hand index middle RHL- Right hand little

Table 3: Hand Length Measurements (in cm) of Female Visayans

Side	Hand length	Min	Max	Mean	SD
Left	LHT	10.42	13.66	11.83	0.65
	LHI	14.14	18.02	15.91	0.79
	LHM	15.11	19.04	16.76	0.81
	LHR	14.20	17.62	15.79	0.78
	LHL	11.03	15.32	13.48	0.80
Right	RHT	10.51	13.98	12.07	0.63
	RHI	14.13	17.97	15.95	0.79
	RHM	14.54	18.95	16.73	0.86
	RHR	13.58	17.45	15.76	0.84
	RHL	11.19	17.27	13.45	0.86

Left hand thumb LHI- Left hand index LHM- Left hand middle, LHL- Left hand little, RHT-Right hand thumb RHM- Right hand index middle RHL- Right hand little

Table 4: Hand Length Measurements (in cm) of Pooled Sample of Visayans

Side	Hand length	Minimum	Maximum	Mean	SD
Left	LHT	10.42	14.40	12.36	0.84
	LHI	14.14	18.90	16.47	0.99
	LHM	15.11	20.35	17.33	1.03
	LHR	14.20	19.41	16.37	1.02
	LHL	11.03	16.54	14.08	1.00
Right	RHT	10.51	14.54	12.57	0.82
	RHI	14.13	19.32	16.50	0.99
	RHM	14.54	20.30	17.31	1.05
	RHR	13.58	19.50	16.33	1.03
	RHL	11.19	17.27	13.99	1.01

Left hand thumb LHI- Left hand index LHM- Left hand middle, LHL- Left hand little, RHT-Right hand thumb RHM- Right hand index middle RHL- Right hand little

Table 5: Linear Regression Equations to Determine Stature from Hand Length of Male Visayans

Sides	Length	Regression equation	R	R^2	SEE
	Left hand				
Left	LHT	S = 107.607 + 4.186 LHT	0.437	0.191	5.750
	LHI	S = 86.406 + 4.413 LHI	0.581	0.338	5.204
	LHM	S = 88.528 + 4.080 LHM	0.579	0.335	5.214
	LHR	S = 91.456 + 4.139 LHR	0.589	0.347	5.167
	LHL	S = 98.064 + 4.327 LHL	0.549	0.302	5.343
	Right hand				
Right	RHT	S = 92.872 + 5.251 RHT	0.541	0.292	5.378
	RHI	S = 78.835 + 4.852 RHI	0.648	0.420	4.871
	RHM	S = 79.451 + 4.592 RHM	0.651	0.424	4.851
	RHR	S = 88.437 + 4.325 RHR	0.587	0.345	5.174
	RHL	S = 103.929 + 3.968 RHL	0.524	0.275	5.445

Left hand thumb LHI- Left hand index LHM- Left hand middle, LHL- Left hand little, RHT-Right hand thumb RHM- Right hand index middle RHL- Right hand little

Table 6: Linear Regression Equations to Determine Stature from Hand Length of Female Visayans

Sides	Length	Regression equation	R	R^2	SEE
	Left hand				
Left	LHT	S = 85.733 + 5.504LHT	0.618	0.382	4.541
	LHI	S = 77.881 + 4.585LHI	0.627	0.394	4.500
	LHM	S = 73.778 + 4.597LHM	0.649	0.421	4.397
	LHR	S = 81.215 + 4.409LHR	0.597	0.356	4.637
	LHL	S = 104.994 + 3.402LHL	0.471	0.222	5.098
	Right hand				
Right	RHT	S = 82.533 + 5.662RHT	0.621	0.386	4.529
	RHI	S = 74.715 + 4.772RHI	0.654	0.428	4.371
	RHM	S = 78.587 + 4.318RHM	0.645	0.416	4.416
	RHR	S = 88.909 + 3.930RHR	0.574	0.329	4.732
	RHL	S = 101.907 + 3.638RHL	0.545	0.297	4.844

Left hand thumb LHI- Left hand index LHM- Left hand middle, LHL- Left hand little, RHT-Right hand thumb RHM- Right hand index middle RHL- Right hand little

Table 7: Linear Regression Equations to Determine Stature from Hand Length of Pooled Samples of Visayans

Sides	Length	Regression equation	R	R^2	SEE
	Left hand				
Left	LHT	S = 70.592 + 6.927 LHT	0.721	0.520	5.619
	LHI	S = 55.065 + 6.140 LHI	0.748	0.559	5.388
	LHM	S = 54.313 + 5.878 LHM	0.748	0.559	5.385
	LHR	S = 60.127 + 5.871 LHR	0.740	0.547	5.458
	LHL	S = 76.010 + 5.697 LHL	0.705	0.497	5.754
	Right hand				
Right	RHT	S = 62.960 + 7.415 RHT	0.751	0.564	5.354
	RHI	S = 51.311 + 6.357 RHI	0.774	0.600	5.134
	RHM	S = 53.688 + 5.923 RHM	0.769	0.591	5.185
	RHR	S = 62.001 + 5.768 RHR	0.732	0.535	5.531
	RHL	S = 78.309 + 5.568 RHL	0.692	0.479	5.853

Left hand thumb LHI- Left hand index LHM- Left hand middle, LHL- Left hand little, RHT-Right hand thumb RHM- Right hand index middle RHL- Right hand little

Discussion:

Visayan (Bisaya or Binisaya) is an ethnic group in Philippines, native Visayas, the southernmost islands of Luzon and most part of Mindanao. Visayans speak one of the Visayan languages which are commonly referred to as Bisaya or Binisaya. Most Visayans are Roman Catholics. In this research, three types of regression equation have been derived to determine stature from hand lengths: (i) for males; (ii) for females and (iii) regardless of sex (pooled sample) and hand length forms the independent variable in all these equations. The mean stature of Visayan males and females are 161.57 cm and 150.84 cm respectively. Researchers have shown that Malaysia Malay [16] stature is 168.14 cm for males and 155.24 cm for females while Malaysia Chinese [10] stature is different (male:171.50 cm, female: 158.2 cm) and thus showing ethnic variation in stature. Also the stature of the study sample is found to be different from Indian (male: 169.62 cm, female: 156.82 cm) population [19], Melanau population (male: 165.70, female: 153.30) in Malaysian Borneo [11], Australian (male 178.50 cm, female: 163.70 cm) population [20], Sri Lankan (male: 168.03 cm, female: 156.06 cm) population [21], Nigerian (male: 164.80 cm, female: 153.50 cm) population [22]. Accordingly the hand size or lengths of the present population is different from other populations. Thus the variations in hand dimensions and stature may be attributed to the population and ethnic differences. The study developed 10 different equations to determine stature determination from hand anthropometry for males, 10 for females and 10 for pooled samples or unknown gender in Visayan population in Philippinnes for crime scene application and ease the investigation process.

Conclusion:

The present study provided regression formulae to determine stature from hand anthropometry among Visayan population in Philippines. The formulae can be used for stature determination even partial dismembered hands with unknown gender are found in the disaster sites. Also, it should be noted in mind that these equations are population specific and unsuitable to apply for stature determination from hand anthropometry to any other populations.

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[*]***Author for Correspondence:*** *Dr. Nataraja Moorthy T, Department of Forensic Sciences, Faculty of Health and Life Sciences, Management and Science Unversity, Shah Alam, Selangor State, Malaysia. Email: natrajamoorthy@rediffmail.com, HP: +6 0129224610*