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STATURE ESTIMATION FROM HAND ANTHROPOMETRY AMONG TAGALOGS, AN INDIGENOUS ETHNIC GROUP IN THE PHILIPPINES FOR PERSONAL IDENTIFICATION

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Abstract: *Any forensic investigator aims to identify the individual through physical evidence found at crime scenes. In the event of a natural disaster or manmade disaster, human body parts are found scattered in the larger area. In this event, the initial investigation process starts with the estimation of stature and sex from dismembered body parts. This research aimed to estimate stature from hand anthropometry among the Tagalog population in the Philippines. The study recruited 360 adult Tagalog people, ages above 18 years old, following the standard procedure. The sample collection was done by a student Mr Ivan Nikkimor in the Philippines under the supervision of a Philippine Police Officer Mr Ariel and analysis was conducted at Management and Science University (MSU), Malaysia. The materials used in this research include a stadiometer, Digital vernier callipers, A4 size white papers and writing instruments. Following the standard procedure, the height and hand length measurements were recorded. The data were analysed statistically using SPSS software, version 23 and developed ten regression equations to estimate stature from various hand lengths. The result shows that the correlation coefficient (R) values of males (0.57-0.69) and females (0.57-0.68) are found to be similar. The standard error of estimate (SEE) is found to be lower in females (3.93-4.98) than in males (4.95-5.83). The research findings were presented in the form of figures and tables. The research concluded with the development of regression equations to estimate stature from hand anthropometry among Tagalogs in the Philippines for crime scene application.*

Keywords: *Stature, Hand, Tagalog population, Phillippines.*

1. INTRODUCTION

It is a well-known fact that forensic science starts from the crime scene, wherein the treasure of information is available in the form of physical evidence. The investigator must recognize, and locate the evidence for individual identification [1]. Forensic is a fascinating and catching term that attracts mostly non-forensic personnel and the general public for many purposes. Globally forensic science has become popular as influenced by big screens and TVs that make it very interesting to the viewers. Movie and drama directors include forensic elements in their storylines which use forensic techniques to contribute to the crime scene investigation and solve the mystery within hours. The gap between forensic science fiction and reality is far wide. The aspects of forensic fiction are different from a real-life forensic investigation [2]. Physical evidence such as footprints, fingerprints, hair, fibre, paint flakes bloodstains is mostly found in burglary, suicide, violence, sexual assault, accident cases etc. while bones and human body parts are found in homicide and scenes of natural and manmade disasters [3]. Researchers have shown that the estimation of stature, sex, age and ancestry or race is considered the “big four” of forensic

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anthropology. Using the estimation, a field scientist can narrow down the pool of possible suspects or victims in the initial state of investigation [4]. The biological and genetic relationship exists between stature and different body parts because of their director proportionality [5]. Researchers have estimated stature from various body parts by using anatomical and mathematical techniques [6]. The present research aimed to estimate stature from hand anthropometry among the Tagalog population in the Philippines.

2. METHODS

The study recruited 360 adult volunteers of Tagalog ethnicity in the Philippines with ages above 18 years old. Before starting the sample collection, informed consent was obtained from all participants with a brief explanation about this research and followed the procedures following the ethical standards of the University Research Ethics Committee. Subjects with any apparent hand-related disease, orthopaedic deformity, injury or disorder were excluded from the study. Also, to avoid inter-observer error, the sample collection and all the measurements were taken by one observer, a Filipino forensic science student, from Management and Science University (author 2) in the Philippines under the field supervisor, also the Philippine Superintendent of Police (author 4). The corresponding author (TN), also the principal investigator (author 1) had designed the research project to study master's degree (for author 2) and visited the Philippines and guided the sample collection. The sample collection was conducted under the supervision of a Philippine Police Officer Mr Ariel. After sample collection, the analysis was conducted at MSU by the student who completed the research work under the supervision of TN, a former Government Forensic Crime Scene Investigator in India for more than two decades and currently an Academician in Malaysia Universities for about two decades.

3. MATERIALS AND MEASUREMENTS

The materials used in this research include a stadiometer, Digital vernier callipers, A4 size white papers and writing instruments. Following the standard procedure, the stature and hand length measurements (in cm) were recorded. The stature of a subject is the vertical distance from the floor to the vertex when standing barefoot with the head in the Frankfort plane of the SECA 213 portable stadiometer. From each hand, left and right side, there are five hand length measurements (in cm) were made, the distance between the midpoints of the distal traverse crease of the wrist (H) and the most anterior tips of the thumb (T), index (I), middle (M), ring (R) and little (L) fingers. Figure 1 shows the landmarks and measurements in the right hand of a subject

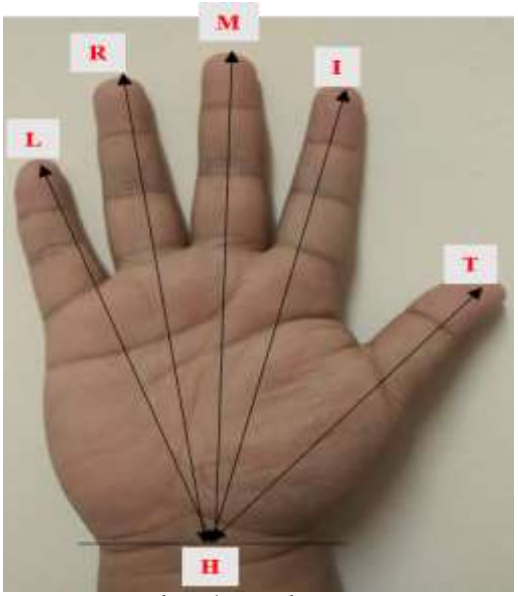

Figure 1: Landmarks and measurements in a right hand.

There were ten hand measurements were made from each volunter using their both left and right hands. The measurement of each subject was performed by the same author, until the concordant values are obtained. The data were analyzed statistically using SPSS software, version 23 and developed ten regression equations to estimate stature from various hand lengths anthropometry. Pearson's correlation coefficient (R) was used to assess the relationship between the stature and various hand lengths. The standard error of estimate (SEE) values are small that indicating better accuracy in estimating stature from hand lengths.

4. RESULTS

Table 1 presents the descriptive statistic of stature measurements, separately for males and females in the study population.

Table 1: Descriptive statistic for stature measurements (in cm) in males and females among Tagalogs.

Sex	N	Min (cm)	Max (cm)	Mean (cm)	SD

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Male	180	147	184	163.04	6.81
Female	180	135	163	151.57	5.16

N: sample size; Min: Minimum; Max: Maximum; SD: Standard Deviation

The stature of the males ranged from 147 cm to 184 cm with a mean value of 163.04 cm while females ranged from 135 cm to 163 cm with a mean value of 157.57 cm. The mean stature of males is found to be higher than that of females, showing the natural gender variation. The standard deviation (SD) is found to be lower in females than in males.

Table 2: Descriptive statistics of left and right-hand measurements (in cm) among male Tagalogs in the Philippines. (N=180)

Left side(L)			**Right side (R)**		
Variables	Mean (cm) ±SD	Range (cm)	Variables	Mean (cm) ±SD	Range (cm)
LHT	12.93 ±0.79	11.05 - 14.90	RHT	13.28 ±0.77	11.42 - 14.86
LHI	17.25 ±0.98	15.00 - 19.89	RHI	17.30 ±0.95	14.95 - 19.22
LHM	18.22 ±1.01	16.17 - 21.01	RHM	18.10 ±1.04	15.46 - 21.28
LHR	17.28 ±0.99	15.03 - 20.52	RHR	17.02 ±0.90	14.77 - 19.64
LHL	14.93 ±0.90	13.20 - 17.53	RHL	14.59 ±0.87	12.81 - 16.79

LHT: Left hand thumb; LHI: Left hand index finger; LHM: Left hand middle finger; LHR: Left hand ring finger; LHL: Left hand little finger; RHT: Right hand thumb; RHI: Right hand index finger; RHM: Right hand middle finger; RHR: Right hand ring finger; RHL: Right hand little finger; SD: Standard deviation

Tables 2 and 3 show the various hand length measurements of both sides among male and female Tagalog people. In males, the mean middle hand length is found to be longer in both hands. Also, the hand lengths left and right sides show bilateral asymmetry. In females also bilateral asymmetry is reflected and the mean middle hand length is found to be longer in both hands.

Table 3: Descriptive statistics of left and right-hand measurements (in cm) among female Tagalogs
in the Philippines. (N=180)

Left side (L)	
Variables	Mean (cm) ±SD
LHT	11.72 ±0.57
LHI	15.92 ±0.79
LHM	16.76 ±0.84
LHR	15.81 ±0.77
LHL	13.55 ±0.81

LHT: Left hand thumb; LHI: Left hand index finger; LHM: Left hand middle finger; LHR: Left hand rin finger; LHL: Left hand little finger; RHT: Right hand thumb; RHI: Right hand index finger; RHM: Right hand middle finger; RHR: Right hand ring finger; RHL: Right hand little finger; SD: Standard deviation

Table 4: Linear regression equations for stature estimation from various hand anthropometry on left and right sides among male Tagalogs (N=180)

Left side				**Right side**			
Regression Formulae	R	R^2	SEE	Regression Formulae	R	R^2	SEE
S = 98.856 + 4.965LHT	0.572	0.328	5.601	S = 96.002 + 5.050RHT	0.573	0.329	5.598

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S = 81.188 + 4.744LHI	0.685	0.469	4.976	S = 85.377 + 4.488RHI	0.626	0.392	5.324
S = 83.914 + 4.342LHM	0.643	0.414	5.231	S = 86.747 + 4.217RHM	0.602	0.362	5.457
S = 91.695 + 4.129LHR	0.602	0.362	5.455	S = 92.967 + 4.117RHR	0.547	0.299	5.720
S = 96.189 + 4.477LHL	0.590	0.348	5.515	S = 108.602 + 3.730RHL	0.477	0.227	6.005

Stature; LHT: Left hand thumb; LHI: Left hand index finger; LHM: Left hand middle finger; LHR: Left hand ring finger; LHL: Left hand little finger; RHT: Right hand thumb; RHI: Right hand index finger; RHM: Right hand middle finger; RHR: Right hand ring finger; RHL: Right hand little finger; SEE: standard error of estimate. N: Sample size; R: Correlation coefficient; R^2: Coefficient of determination ($p<0.001$)

Table 5: Linear regression equations for stature estimation from various hand anthropometry on left and right sides among female Tagalogs (N=180)

Left Hand				**Right Hand**			
Regression Formula	R	R^2	SEE	Regression Formula	R	R^2	SEE
S = 88.870 + 5.351LHT	0.595	0.354	4.159	S = 101.724 + 4.146RHT	0.533	0.284	4.377
S = 89.632 + 3.892LHI	0.599	0.359	4.142	S = 87.956 + 3.985RHI	0.642	0.413	3.964
S = 85.763 + 3.927LHM	0.637	0.406	3.987	S = 80.337 + 4.267RHM	0.666	0.443	3.859
S = 95.990 + 3.516LHR	0.527	0.278	4.395	S = 92.323 + 3.781RHR	0.608	0.370	4.105
S = 105.465 + 3.402LHL	0.532	0.283	4.380	S = 107.0333 + .336RHL	0.546	0.298	4.333

Stature; LHT: Left hand thumb; LHI: Left hand index finger; LHM: Left hand middle finger; LHR: Left hand ring finger; LHL: Left hand little finger; RHT: Right hand thumb; RHI: Right hand index finger; RHM: Right hand middle finger; RHR: Right hand ring finger; RHL: Right hand little finger; SEE: standard error of estimate. N: Sample size; R: Correlation coefficient; R^2: Coefficient of determination ($p<0.001$)

Tables 4 and 5 present the linear regression equations for stature estimation in adult males and females through various hand-length measurements. The tables also show Karl Pearson's coefficients (R) of bilateral hand length measurements with stature for all the Tagalog study subjects, namely males and females. R is regarded as a mathematical expression of the degree of association existing between paired measures and R-value is statistically significant (<0.001). All the R values have shown a positive correlation in terms of the relationship between hand length and stature and the values are almost similar among the gender. From the coefficient of determination (R^2), the predictive accuracy is found to be statistically significant for stature examination The standard error of estimate in the case of females (3.859-4.395) is comparatively lower than that of males (4.976-6.005). Hence, in Tagalog ethics of the Philippines, a statistically significant positive correlation coefficient exists between stature and all hand length measurements.

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5. DISCUSSION

The Tagalog people are the largest ethnolinguistic group in the Philippines, numbering around 30 million in the country. Tagalog settlements are generally lowland, oriented towards the bank near the delta or mouth of the river. Tagalog is one of the major languages spoken in the Philippines. Most Tagalog are farmers. Stature is found to be larger in males than females, showing the existence of a statistically significant sex difference in Tagalog people. This may be attributed to general male–female differences and natural size in both sexes [7] and the findings following the previous studies [8-10]. The age of the subject is above 18 years since the average length of an adult's hand is attained by the age of 16 years and stature at 18 is accepted as an adult [11]. Mass disasters may be caused by natural events such as earthquakes, volcanic eruptions or severe flooding while manmade caused by terrorists wherein the bodies are highly fragmented and found scattered in a vast area [12]. Person identification from the body parts is a challenge to forensic investigators. Over a century Forensic anthropological knowledge has been used in disaster victim identification (DVI). Recognizing height, gender, race, and age is the hallmark of the forensic identification of an unknown. Since, there exists a mathematical correlation between total body height and various body parts like hand, foot, head etc [13]. Earlier researchers have used only one hand length measurement between the distal wrist crease and the tip of a middle finger, for stature estimation [14-18]. The present used five hand-length measurements from each with a total of ten length measurements from each subject and developed ten regression equations for stature estimation. There are incidences wherein, partial hands either with thumb or index or ring or little finger found at the crime scenes and in these situations, any one of the equations can be chosen to estimate stature and to arrive at a conclusion. Similarly, the corresponding author had already developed ten regression equations to estimate stature from footprint [19], foot outline [20], hand [21] and handprint [22] for better crime scene application. But if only one equation was developed, then the study finding may not be used to estimate stature and the potential evidence found at the crime scene lost its value.

6. CONCLUSION

The study concluded with the development of ten regression equations to estimate stature from hand anthropometry among the Tagalog population in the Philippines. It is important to note that the developed equations are population specific and cannot be used for any other populations.

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• CONFLICT OF INTEREST

The authors have no conflict of interest to declare

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