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# DETERMINATION OF STATURE FROM HANDPRINT ANTHROPOMETRY AMONG MALAYSIAN INDIANS FOR PERSON IDENTIFICATION

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## *Abstract*

***Background:*** *A large category of evidence has the potential to suggest the dynamic events in crime scenes such as directionality, movement of the crime operators, leaving body fluids and many other impression evidence. Impression evidence such as footprints, fingerprints, and hand prints forms valuable physical evidence to determine stature, gender and living body weight, followed by person identification.*
***Aim:*** *The present study aimed to determine stature from hand print anthropometry among Indians of Malaysia.* ***Methodology and result:*** *The study recruited 100 males and 100 females of Malaysian Indians and collected hand prints and stature measurements following my earlier research. The data were analysed statistically and derived regression formulae to determine stature from various handprint measurements. There is a strong relationship exists between stature and palm print in the present study population. The correlation coefficient value is higher in the right middle& index handprint (R = 0.545) of males while the R-value of right-hand index handprint length is higher (0.643) in females.* ***Conclusion:*** *The research finally concluded with the creation of population-specific regression formulae to determine stature from handprint lengths among Indians of Malaysia for person identification.*

***Keywords****: Forensic Science, Forensic Anthropology, Stature, Handprint, Identification, Malaysia Indian*

## INTRODUCTION

Once a crime is reported, the first question that arises in the mind of the investigator is "How could it have happened?" As the science of criminal investigation proceeds, oral testimony falls behind and the importance of realistic proof advances [1]. Crime scene investigators are following the traditional way of searching for physical evidence, the collectable clues in the crime scenes which serve to connect the perpetrator with the crime [2]. A similar value-oriented boost does not appear in the utilization of that evidence merely presenting observable features in the crime scene circumstances, which are equally important observed premises when framing hypothesis and testing for acceptance, for example, pattern analysis relating to blood, and allied [3-4] evidence. An intelligent forensic investigator only can utilize the physical evidence, interpret it appropriately and solve the mystery. Careful analysis of physical evidence can be used to establish the guilt or innocence of somebody in court trials [5]. Forensic anthropometry is a technique used to measure the human body parts or impressions left at the crime scene for person identification. Physical evidence can be anything from a massive object to microscopic items recovered at the scenes, generated as part of a crime. Considering all sources of evidence available in the investigations viz. confession, testimony, video surveillance, physical evidence plays a pivotal role. For human identification, important parameters used are stature, gender, age and race, also known as the "Big Four" and stature is considered the most important in the "Big Four" for the development of biological profiles [6]. Researchers have shown that stature can be estimated from the hand [7], handprint[8], foot [9], 2D footprint [10], 3D footprint [11], dynamic footprint [12], fingerprint [13], and bones [14-16]. The present study aimed to develop regression formulae to determine stature from handprint anthropometry among Malaysian Indians.

## METHODOLOGY

The study was carried out in West Malaysia wherein Malaysian Indians are thickly populated and are descendants of those who migrated from India during the British era from the early 19th century. The sample size was calculated and recruited 200 Malaysian Indians with 100 males and 100 females, following the earlier anthropological researchers [10-13]. The consented participants' ages ranged from 20 years to 60 years and are free from any type of hand injuries or deformities. The height of the participants was recorded with a portable

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stadiometer. The participants were advised to clean their hands with a soap solution and wiped them with a cotton towel to remove moisture. On a plain glass plate, fingerprint ink was uniformly smeared using a fingerprint roller and the left hand was advised to place on the inked plate with mild pressure. The hand was then lifted and then impressed on an A4 size white paper, kept aside, thus transferring the left handprint. The procedure was repeated with the right hand and all other participants. There were five measurements taken from the left handprint and five from the right handprint, including all the fingers. The handprint length is the straight distance between the metacarpal-phalangeal crease in the wrist and the most anterior end of the fingers viz. TPL: Thumb handprint length, IPL: Index handprint length, MPL: Middle handprint length, RPL: Ring handprint length and LPL:Little handprint length.

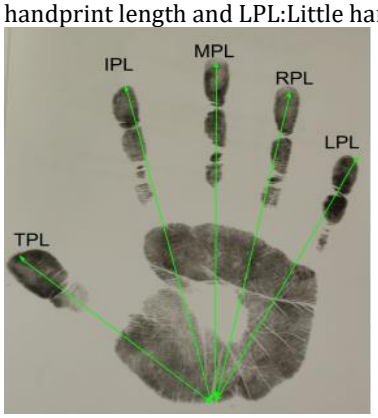


**Figure 1: Landmarks in the right handprint showing the linear measurements**

The height and handprint length measurements were made by the student to avoid interobserver error and the measurements were repeated until to get concordant values. The data were analyzed statistically using SPSS software, version 29.0.1 and the relationship between height and handprint lengths was calculated as R, Pearson correlation coefficient. The dependent variable is the stature and the independent variable is handprint length. There are ten regression equations derived to determine stature from each handprint length.

## RESULT

The stature measurements showing the minimum, maximum and mean values are presented in

**Table 1: Descriptive statistics of stature in males and females of adult Malaysian Indians.**

| Sex | N | Min (cm) | Max (cm) | Mean (cm) | SD |
|---|---|---|---|---|---|
| Male | 100 | 159.00 | 182.00 | 171.43 | 5.256 |
| Female | 100 | 138.00 | 175.00 | 159.39 | 7.191 |

Table 1. The height of males ranged from 159 to 182 cm with a mean value of 171.43 cm while in females, the height ranged from 138 cm to 175 cm with a mean value of 159.39 cm. The mean stature of males is found to be higher than females and the standard deviation (SD) value is lower in males (5.26) than in females (7.19). The results in Tables 2 and 3 show the various left and right handprint length measurements of both genders of the study population.

**Table 2: Descriptive statistics of LEFT-hand print lengths in males and females of Malaysian Indians**

| Measurement | Males (N = 100) | | | | Females (N = 100) | | | |
|---|---|---|---|---|---|---|---|---|
| variable | Min (cm) | Max(cm) | Mean(cm) | SD | Min (cm) | Max(cm) | Mean(cm) | SD |
| TPL | 11.30 | 14.10 | 12.27 | 0.69 | 9.90 | 12.20 | 11.14 | 0.59 |
| IPL | 15.70 | 19.50 | 16.92 | 0.82 | 13.50 | 17.40 | 15.66 | 0.92 |
| MPL | 16.60 | 20.00 | 17.82 | 0.78 | 14.50 | 18.80 | 16.51 | 0.92 |
| RPL | 15.60 | 19.30 | 16.90 | 0.78 | 13.50 | 18.00 | 15.54 | 0.93 |
| LPL | 13.70 | 17.00 | 14.64 | 0.71 | 11.40 | 15.50 | 13.36 | 0.94 |

Min: minimum; Max: maximum; SD: standard deviation; N: sample size

**Table 3: Descriptive statistics of RIGHT-hand print lengths in males andfemales of Malaysian Indians**

| Males (N = 100) Measurement | Females (N = 100) |
|---|---|

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| variable | Min (cm) | Max (cm) | Mean (cm) | SD | Min (cm) | Max (cm) | Mean (cm) | SD |
|---|---|---|---|---|---|---|---|---|
| TPL | 10.70 | 14.00 | 12.02 | 0.77 | 9.50 | 12.40 | 11.12 | 0.71 |
| IPL | 15.50 | 19.60 | 16.77 | 0.89 | 13.00 | 17.40 | 15.71 | 0.92 |
| MPL | 16.40 | 19.90 | 17.69 | 0.79 | 14.50 | 18.50 | 16.56 | 0.88 |
| RPL | 15.40 | 19.10 | 16.73 | 0.77 | 13.60 | 17.70 | 15.59 | 0.84 |
| LPL | 13.30 | 16.90 | 14.58 | 0.71 | 11.40 | 15.30 | 13.46 | 0.84 |

Min: minimum; Max: maximum; SD: standard deviation; N: sample size.

On the left handprints, the mean middle handprint length is longer while the thumb handprint length is shorter, showing the general way of hand formation among human beings. All left handprint lengths of males (T:12.27 cm, I: 16.92 cm, M:17.82 cm, R:16.90 cm, L:14.64 cm) are longer than the female (T:11.14 cm, I: 15.66 cm, M:16.51 cm, R:14.54 cm, L:13.36 cm) handprints. Similarly, on the right handprints, the mean middle handprint length is found to be longer while the thumb handprint length is shorter, showing the general way of hand formation among human beings. The interesting finding observed in the handprint length of males is that all the left handprints are longer than the right handprint whereas in female handprints, all right handprints, except the thumb are longer than the left side. Thus the existence of bilateral asymmetry is reflected in the hand/handprints of both genders of this study and is commonly prevalent in the animal kingdom [17]. Researchers suggested that the differences between the right hand or foot and the left hand or foot in the same person are not a coincidence but may be explained based on the "dominant foot or hand"

Tables 4 and 5 present the linear regression equations to determine stature from various handprint length measurements among male and female Malaysian Indians. There are ten regression equations, separately for males and females were derived for stature determination. There is a statistically significant correlation exists between stature and various handprint length (<0.05). The predictive accuracy ($R^2$) reflected the significance of height prediction in the analysis.

**Table 4:** Linear regression equations for stature determination from handprints among male Indians of Malaysia

| Variable | Right Handprint | | | Left Handprint | | |
|---|---|---|---|---|---|---|
| | Regression equations | $R^2$ | SEE | Regression equations | $R^2$ | SEE |
| TPL | S=127 + 3.68TPL | 0.289 | 4.454 | S=130 + 3.39TPL | 0.195 | 4.739 |
| IPL | S=117 + 3.22IPL | 0.297 | 4.429 | S=122 + 2.93IPL | 0.206 | 4.706 |
| MPL | S=107 + 3.62MPL | 0.297 | 4.428 | S=116 + 3.12MPL | 0.214 | 4.684 |
| RPL | S=111 + 3.62RPL | 0.281 | 4.480 | S=125 + 2.74RPL | 0.166 | 4.823 |
| LPL | S=129 + 2.90LPL | 0.151 | 4.866 | S=138 + 2.26LPL | 0.092 | 5.033 |

$R^2$: Coefficient of determination, SEE: Standard error of estimation. p-value < 0.05.

**Table 5:** Linear regression equations for stature determination from handprints among female Indians of Malaysia

| Variable | Right Handprint | | | Left Handprint | | |
|---|---|---|---|---|---|---|
| | Regression equation | $R^2$ | SEE | Regression equation | $R^2$ | SEE |
| TPL | S=91.08 + 6.14TPL | 0.365 | 5.757 | S=83.87 + 6.78TPL | 0.314 | 5.987 |
| IPL | S=80.75 + 5.01IPL | 0.413 | 5.536 | S=84.26 + 4.8IPL | 0.374 | 5.720 |
| MPL | S=73.2 + 5.21MPL | 0.405 | 5.574 | S=82.18 + 4.68MPL | 0.362 | 5.774 |
| RPL | S=83.28 + 4.88RPL | 0.324 | 5.943 | S=88.47 + 4.56RPL | 0.349 | 5.833 |
| LPL | S=100 + 4.41LPL | 0.266 | 6.194 | S=110 + 3.71LPL | 0.237 | 6.314 |

$R^2$: coefficient of determination, SEE: standard error of estimation. p-value < 0.05.

Based on the statistical analysis, ten linear regression equations were derived to determine stature from left and right-hand prints among male and female Malaysian Indians which are presented in Tables 4 and 5. The correlation coefficient values are positive and statistically significant in stature determination from various handprint length anthropometry. The correlation coefficient values are found to be higher in females (R = 0.465-0.611) than in males (R = 0.275-0.462) with $p < 0.006$. Concerning the coefficient of determination ($R^2$), the predictive accuracy is found to be statistically significant for stature determination for the study population.

## DISCUSSION

Malaysia is a Southeast Asian country occupying parts of the Malay Peninsula (West Malaysia) and Borneo Island (East Malaysia). Malaysian Indians are the third highest population in Malaysia. Malays are the dominant ethnic group (69.7%), followed by Chinese people (22.9%) and Indians (6.6%) in addition to other indigenous ethnic groups. Many Indians are involved in business and trade and the majority of the privately owned businesses. The age of the subjects is above 18 years, considered adult as indicated by the earlier researchers in Malaysia [12,18-19]. Literature review shows that the height of a person and his body parts are closed related. The size of the hand varies based on height variation and importantly ethnicity plays a vital role in stature determination. Even within India, ethnic variation in height is reflected depending upon the states of origin, since India is a multiracial and multi-ethnicity country. For example, Kerala state people speak Malayalam language, Andhra state people speak Telugu, Tamilnadu state people speak Tamil language, Rajasthan state people speak Hindi, Sikkim state people speak Nepali, Odisha state people speak Odia, Punjab state people speak Punjabi and so on. In India, every state has their language, food habits, dress code, culture, environmental factors and many others, thus reflecting ethnic variation. Hence researchers have been conducting and deriving stature estimation formulae from footprint and handprint anthropometry from various state ethnic people and all formulae are different. The equations derived in one state cannot be applied to another state people, if so will lead to error. In Malaysia the scenario is different. Malaysia comprises various ethnic groups, living in different states with similar cultures and languages, viz Malay [20] people, Chinese people [21], and Indian [18] people (with sub-ethnics groups viz.. Telugu [11], Tamil [19], Malayalee [22], Punjabi, Gujarathi etc) mostly living in West Malaysia and other indigenous ethnic groups like Iban [23], Bidayau[24], Melanau [25], Kadasan Dusun [26] Lun Bawang [27] who were settled at East Malaysia or Malaysian Borneo. Thus this study developed population-specific regression equations to determine stature from handprints among Malaysian Indians and not Malaysians who are under mixed population. Thus the stature and hand/handprint length of a particular population is different from other populations, even within the country, because of ethnic variation. Handprint comes under impression evidence like fingerprints, footprints, lip prints, ear prints etc.

In the present study, the mean height of males and females are 171.43 cm and 159.39 cm respectively while the stature of Bangladeshi in Bangladesh males and females are 168.61 cm and 155.27 cm [28], different from the present study population. The mean height of the Pakistan Punjabi population is shown to be 173.42 cm for males and 162.08 cm for females [29]. The mean height of Minang population in Indonesia for male and female are 163.085 cm and 152.39 cm [30]. Also, the present study developed ten regression equations for ten fingers because even in the presence of partial handprints, any one of the equations can be chosen and used to estimate stature. Forensic Science starts from the crime scene with the silent witness, the physical evidence, the only magic to solve the crime mystery. As commented by Kirk, Physical evidence cannot be wrong, it cannot perjure itself, and it cannot be wholly absent. Only human failure to find, study and understand it, can diminish its value [31]. The corresponding author, also a former forensic crime scene investigator in India, solved many mysterious crimes through physical and observable evidence found at the crime scenes [32-37].

## CONCLUSION

The present research provided a population-specific forensic standard for the determination of stature from handprint anthropometry among Malaysian Indians that may form a valuable tool during crime scene investigation.

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