Research article

ESTIMATION OF STATURE FROM HANDPRINT ANTHROPOMETRY OF MALAYSIAN CHINESE FOR FORENSIC INVESTIGATION

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Abstract

Stature estimation is an important element in forensic investigation. Literature review shows that handprint anthropometry has provided useful information to estimate stature for identification purposes. Handprints form an important physical evidence frequently available in scenes of crime like burglary, homicide, sexual assault and firearm incidents. The aim of the present study is to derive linear regression equations to estimate stature from hand print anthropometry of Malaysian Chinese. The study sample consists of 100 males and 100 females of Malaysian Chinese, age ranged from 18 to 58 years. Stature and handprints were recorded following standard procedure. Five length measurements and one breadth measurement from each hand with a total of 12 measurements were taken from a subject. The right hand print measurement is larger than the left, showing the bilateral asymmetry but not significant. The result of the study provided population specific linear regression equations to estimate stature from handprints (complete and partial) of Malaysian Chinese.

Keywords: Forensic Science; Forensic anthropology; Stature; handprint; Malaysian Chinese.

Introduction

It has been shown that estimation of stature can be possible using the measurements of different body parts [1-3]. Examination of hand [4-6], handprint [4,7-8], phalanges [9-10], foot [11-13], footprint [14-16] and foot outline [17-19] can help in estimation of an individual's stature because there exists a strong relationship between stature and hand/handprint/finger/fingerprint/foot/footprint/foot outline. Assessment of height from different body parts is an area of interest to anatomists, anthropologists and to forensic experts [20]. Very limited studies were conducted on stature estimation from handprint anthropometry. It is an accepted fact that the accurate stature can be estimated using population specific standards [21]. There are no population specific formulae for stature determination from handprints in a Malaysian Chinese population. Hence, the aim of the present investigation is to derive population specific regression equations to determine stature from handprint anthropometry in Malaysian Chinese.

Materials and methods

The study was carried out at peninsular Malaysia involving 200 adult Chinese subjects (100 males and 100 females). The subjects were from colleges, universities and general public. Chinese are largely descendants of immigrants who arrived between the fifteenth and the mid-twentieth centuries from various parts of China [22]. Informed consent and ethical approval were obtained following the standard procedure. The participants' age ranged from 18 to 58 years. Subjects with any apparent hand-related disease, orthopaedic deformity or injury were excluded from the study. Stature was measured without head and footwear using a portable body meter measuring device (SECA model 208) following the procedure adopted by Nataraja Moorthy [14-18]. The height of the individual was taken in the evening at a fixed time considering diurnal variation in height. The diurnal change in height of a person was indicated as early as 1726 and the shortening in stature during daytime was reported and confirmed by the researchers [24-24]. The hand was placed on a fingerprint inked plate with mild pressure and then impressed on an A4 size white paper. The thumb was in abducted position and other fingers in extended position [25]. The land marks and measurements on the right hand print are depicted in Figures 1. A total of twelve anthropometric measurements, five lengths and one breadth were taken in the right handprint viz. PT, PI, PM, PR, PL and HB and six in the left hand print, using a 250 mm digital sliding caliper (Mitutoyo CD67-S20PS). All handprints and participants' information were coded with sample ID for anonymity.

Statistical analysis

The data were analyzed using PASW Statistics version 22 (Predictive Analytic Software). Karl Pearson's correlation coefficient (R) between various handprint lengths, breadth and stature was obtained. The linear regression analysis method was employed for stature estimation from various handprint measurements since stature estimation from handprint length and breadth is more accurate and reliable with regression analysis [26].

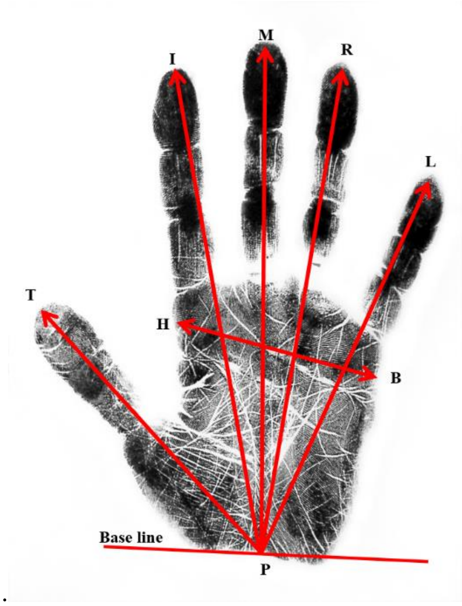

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Figure 1. Land marks and diagonal measurements in right handprint.
P: distal transverse crease of the wrist; T,I,M,R,L: tip of the thumb, index, middle, ring and little fingers; HB: hand breadth (distance between the most lateral point on the head of the 2nd metacarpal to the most medial point on the head of the 5th metacarpal)

Results and Discussion

Table 1 presents the descriptive statistics of stature measurements in males and females. In males, the stature ranges from 148.0 to 184.0 cm (mean 168.53 cm) and in females the stature ranges from 148.0 to 175.0 cm (mean 159.34 cm). The result showed that the mean stature is found to be significantly higher in males than females. The standard deviation (SD) for male is 7.32 while female is 6.67.

Table 1. Descriptive statistics of stature in males and females of adult Malaysian Chinese.

Gender	N	Min(cm)	Max(cm)	Mean ±SD(cm)
Male	100	148.0	184.0	168.53±7.32
Female	100	148.0	175.0	159.34±6.67

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

Table 2 presents the various handprint length and breadth measurements in males and females of both sides. The length and breadth measurements are shown in figure 1. All the handprint measurements in males were found to be larger than females in both sides. The size of left and right hands did not show any significant bilateral asymmetry in both genders. The left and right hands are almost similar in size both in length and breadth prints. The standard deviation is found to be low, showing accuracy in stature estimation in both the genders.

Table 3 and 4 present bilateral linear regression equations derived to estimate stature through various handprint measurements separately for males and females. The standard error of estimate (SEE) in case of females (6.395-6.703) is comparatively lower than that of males (7.157-7.323). The table also present Karl Pearson's correlation coefficients (R) of bilateral handprint measurements with stature for both genders. The R value is statistically significant (<0.001) and all R values have shown positive correlation in terms of the relationship between handprint length, breadth measurements and stature. The R values are almost similar in both the genders. Anyhow handprint length measurements are showing higher correlation with stature than breadth measurements. From the coefficient of determination (R^2), the predictive accuracy is found to be statistically significant for stature determination. Hence, statistically significant positive correlation coefficients exist between stature and all handprint length, breadth measurements in Malaysian Chinese.

Malaysian Chinese represents the second largest ethnic group in Malaysia after the ethnic Malay majority. Malaysian Chinese are dominant in both the business and commerce sectors, controlling an estimated 70% of the Malaysian economy. The investigation shows that stature is found to be larger in males than in females showing the existence of significant sex difference in Malaysian Chinese. This may be attributed to general male-female differences and natural size in both sexes [27]. This finding is in accordance with the results in previous studies [14-19]. The age range of the subjects in this research is appropriate since stature at 18 years is accepted as adult [28-29]. Hence, the minimum age was fixed as 18 years to conduct this study. The result of this study indicated that males have greater hand dimensions than females. This findings in accordance with the findings of previous studies [4,7]. The result of the investigation did not show any significant bilateral asymmetry. The Australian population study showed the existence of significant bilateral asymmetry [4]. Some researchers indicated the existence of insignificant bilateral asymmetry [30-31]. The standard error of estimate (SEE) in case of females is comparatively lower than that of males. Karl Pearson's correlation coefficients (R) value is statistically significant and have positive correlation between handprint length, breadth measurements and stature.

Conclusion

The result of this investigation provided regression equations for stature estimation from handprint measurements (complete or partial) in Malaysian Chinese. It is improper to utilize these regression equations to estimate stature from handprint dimensions of any other populations either in Malaysia or any other population in the world. Hence it is suggested that similar studies should be initiated on other ethnic groups living in different parts of the world so that effect of genetic and environment can be investigated in forensic terms

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Table 2. Descriptive statistics of handprint length, breadth measurements in males (N=100) and females (N=100) of adult Malaysian Chinese (cm).

Variable	Sides	Male				Female			
		Min	Max	Mean	SD	Min	Max	Mean	SD
PT	Left	9.0	14.5	11.9	1.054	9.5	18.0	11.9	1.136
	Right	9.5	14.5	11.8	1.007	9.0	18.5	11.8	1.164
PI	Left	13.5	20.2	16.7	1.327	14.0	19.5	16.3	1.069
	Right	14.0	20.2	16.7	1.294	13.5	19.5	16.4	1.070
PM	Left	15.0	21.0	17.8	1.278	15.0	20.0	17.2	1.079
	Right	15.0	21.0	17.8	1.254	14.5	20.0	17.2	1.100
PR	Left	14.0	20.5	16.8	1.399	14.0	20.0	16.3	1.101
	Right	14.0	20.5	16.9	1.389	13.5	19.5	16.3	1.116
PL	Left	11.5	18.3	14.6	1.335	11.5	17.5	14.0	1.060
	Right	11.5	18.0	14.6	1.343	11.5	17.0	14.1	1.077
HB	Left	6.5	15.0	8.4	1.070	6.2	10.0	7.9	0.657
	Right	6.5	14.5	8.3	1.055	6.0	10.0	7.9	0.638

Min: minimum; Max: maximum; SD: standard deviation; N: sample size. P: distal transverse crease of the wrist; T, I, M, R, L: tip of the thumb, index, middle, ring and little fingers; HB: hand breadth.

Table 3. Linear regression equations for stature estimation from different hand print length and breadth measurements on left and right sides among adult male Malaysian Chinese (N=100).

Variables	Sides	Regression equation	R	R^2	SEE
PT	Left	160.574+161.244PT	0.096	0.009	7.323
	Right	158.813+159.638PT	0.114	0.013	7.309
PI	Left	149.870+150.983PI	0.202	0.041	7.206
	Right	148.479+149.676PI	0.212	0.045	7.190
PM	Left	148.600+149.722PM	0.196	0.038	7.214
	Right	151.341+152.306PM	0.165	0.027	7.256
PR	Left	151.621+152.625PR	0.192	0.037	7.220
	Right	156.071+156.809PR	0.140	0.020	7.285
PL	Left	149.946+151.216PL	0.232	0.054	7.157
	Right	152.425+153.525PL	0.202	0.041	7.206
HB	Left	157.355+158.684HB	0.194	0.038	7.217
	Right	157.990+159.256HB	0.182	0.033	7.234

R: Karl Pearson's correlation coefficient; R^2: coefficient of determination; SEE: standard error of estimate; P: distal transverse crease of the wrist; T, I, M, R, L: tip of the thumb, index, middle, ring and little fingers; HB: hand breadth. $p < 0.001$).

Table 4. Linear regression equations for stature estimation from different hand print length and breadth measurements on left and right sides among adult female Malaysian Chinese (N=100).

Variables	Sides	Regression equation	R	R^2	SEE
PT	Left	141.844+143.319PT	0.251	0.063	6.488
	Right	139.077+140.796PT	0.300	0.090	6.395
PI	Left	140.974+142.099PI	0.180	0.033	6.594
	Right	135.627+137.075PI	0.232	0.054	6.520
PM	Left	144.452+145.319PM	0.140	0.020	6.637
	Right	141.749+142.772PM	0.169	0.028	6.646
PR	Left	147.554+148.277PR	0.119	0.014	6.656
	Right	146.778+147.549PR	0.129	0.017	6.648
PL	Left	148.755+149.509PL	0.120	0.014	6.656
	Right	147.220+148.079PL	0.139	0.019	6.639
HB	Left	158.735+158.812HB	0.008	0.000	6.703
	Right	155.907+156.343HB	0.042	0.002	6.698

R: Karl Pearson's correlation coefficient; R^2: coefficient of determination; SEE: standard error of estimate; P: distal transverse crease of the wrist; T, I, M, R, L: tip of the thumb, index, middle, ring and little fingers; HB: hand breadth. $p < 0.001$).

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Conflict of interest

The authors have no conflict of interest to declare.

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