A PRELIMINARY ANTHROPOMETRIC STUDY OF HEIGHT ESTIMATION USING PERCUTANEOUS ULNAR AND FEMORAL LENGTHS

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INTRODUCTION

Height of an individual is an inherent character and is considered as one of the vital parameters for human identification (Bhavana, 2009). Thus apart from sex, age and race the identity of an individual could be detected by measuring the height of the individual (Nanrah, 2010). Race, sex, age and stature of an individual have been shown to have associations with osteometric indices and hence useful in human identification. Identification of unknown persons is very crucial in medico-legal investigations. Several studies have documented on the use of long bones in the measurement and prediction of standing height and tribe (Smith *et al.,* 2007; Sladek *et al.,* 2014). The length of lower limb has been shown to be one of the greatest contributors to standing height since the lower limb forms one third of the complete height of an individual (Mohanty, 1998). Therefore, measurement of the bones of the lower limb can be used to estimate height. In situations where the measurement of standing height is compromised, for example in bedridden, old or frail patients or patients with limb and/or vertebral column deformity, the determination of height and tribe from the long bones of the lower limb such as tibia and fibula, becomes very necessary (Mondal *et al.,* 2012). Due to this relation, many developed countries have established population-specific percutaneous standards for matching dismembered remains in the events of natural disasters or accidents to identify height, sex and tribe of victims (Ilayperuma *et al.,* 2009). However, there is limited data on the use of the percutaneous tibia and fibula lengths to determine standing height of Ghanaians. Therefore, the present study was designed to throw light on the possible use of percutaneous tibial and fibular lengths in the determination of height and tribe in Ghana.

Specific objectives were;

- To determine sexual dimorphism in percutaneous tibial and fibular lengths of participants.
- To identify the relationship between percutaneous tibial and fibular lengths and height.
- To determine the height and tribe using percutaneous tibial and fibular lengths.

MATERIALS AND METHODS

This study was a descriptive cross-sectional study. A total of 226 participants composed of 135 males and 91 females were recruited for this research. The participants were Ghanaian undergraduate students within the age range of 18 to 30 years of the School of Medicine and Dentistry, KNUST. Out of the total number of the participants, 181 (80.1%) were Akans, 15 (6.6%) were Ewes, 7 (3.1%) were Ga-Adangbe and the others tribes were 23 (10.2%) respectively. The study took place from October, 2018 to April, 2019. Prior to the study, ethical approval was obtained from the Committee of Human Research Publication and Ethics and informed consent was sought from the participants. Participants with lower limb and vertebral column deformities were excluded from the present study. The height of the participants was measured with a Shahe's Stature Meter (Shanghai, China) and percutaneous tibial and fibular lengths were obtained using a Dritz C150 Fiberglass measuring tape (Prym consumer USA Inc) (Figure 1).

A B C

Figure 1: A photograph showing the measurement of the A) height (×0.7) B) tibial length(×0.5) C) fibular length (×0.5)

The data collected were recorded in Excel and analyzed statistically using IBM Statistical Package for Social Sciences (SPSS) version 20.0. The measured parameters were subjected to statistical analysis and the mean and standard deviation were obtained. Pearson correlation coefficient was used to establish the relationships between height, tibia and fibula. Regression analysis of tibial and fibular lengths were used to derive regression equations for height estimation. A p-value < 0.05 was considered significant at a confidence interval of 95%.

RESULTS AND DISCUSSION

DESCRIPTIVE STATISTICS

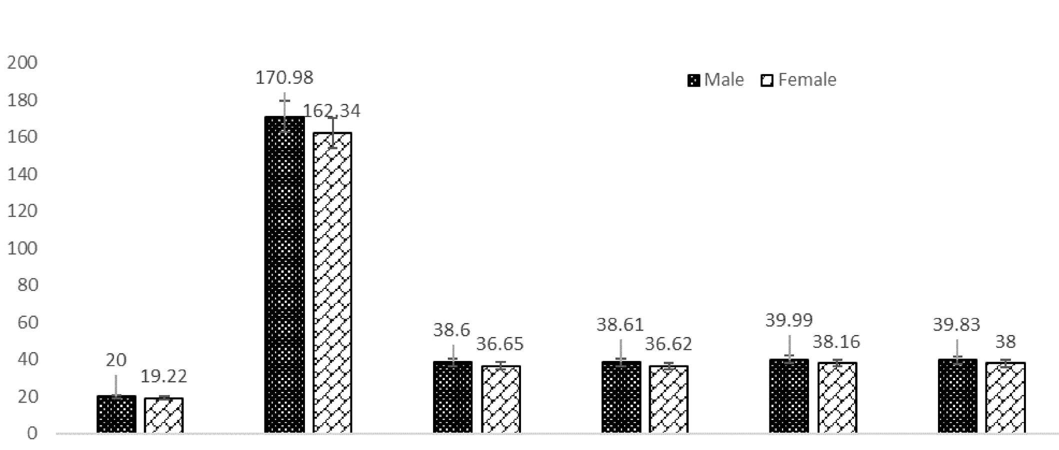

Figure 2: Descriptive analysis of age and measured parameters stratified by sex

Age and measured parameters of the participants are shown in figure 2 Bilateral asymmetry was exhibited by the fibular lengths in both sexes (p < 0.05). Bilateral asymmetry, according to Kanchan *et al.* (2008) occur as a result of differences in the mechanical stress and strain on the underlying bones of the particular part of the body being used during growth. Sexual dimorphism existed for all the dimensions used in the present study. The sexually dimorphic traits evident in all the dimensions are as a result of hormonal differences between males and females (testosterone and oestrogen), hereditary and environmental factors (Hasegawa *et al.,* 2009).

INTER-ETHNIC DIFFERENCES IN TIBIAL AND FIBULAR LENGTH MEASUREMENTS

There were no statistically significant differences in the percutaneous tibial and fibular lengths among the tribes (Table 1 and 2). Manning *et al.* (2002) reported the inter-ethnic differences to be attributed to the differences in the oestrogen-testosterone ratio. Inter-tribal marriages could cause the differences to be insignificant.

Table 1: Comparison of fibular and lengths among the tribes

Parameter	Tribe	N	Mean ± SD (cm)	Min. (cm)	Max. (cm)	p
Left Fibula	Akan	181	39.01 ± 2.23	33.4	45.0	0.376
	Ewe	15	39.16 ± 1.72	37.0	42.5	
	GA-Adangbe	7	40.46 ± 2.40	36.8	43.2	
	Others	23	39.27 ± 2.16	36.0	43.2	
Right Fibula	Akan	181	39.18 ± 2.32	33.2	45.2	0.202
	Ewe	15	38.86 ± 2.03	35.6	42.2	
	GA-Adangbe	7	40.90 ± 2.48	36.4	43.7	
	Others	23	39.59 ± 2.32	35.6	43.6	

Others" refer to tribes other than Akan, Ewe and Ga-Adangbe, N = number of observations, SD = standard deviation, cm = centimeter, p = level statistical significance at 0.005

Table 2: Comparison of tibial lengths among the tribes

Parameter	Tribe	N	Mean ± SD (cm)	Min. (cm)	Max. (cm)	p
Left Tibia	Akan	181	37.74 ± 2.30	31.8	45.5	0.569
	Ewe	15	37.79 ± 1.61	35.3	41.5	
	GA-Adangbe	7	38.89 ± 2.36	35.4	40.5	
	Others	23	38.04 ± 2.20	35.5	42.3	
Right Tibia	Akan	181	37.71 ± 2.34	31.7	43.8	0.477
	Ewe	15	37.67 ± 1.84	34.9	41.2	
	GA-Adangbe	7	39.01 ± 2.25	35.7	40.7	
	Others	23	38.03 ± 2.25	34.6	42.6	

Others" refer to tribes other than Akan, Ewe and Ga-Adangbe, N = number of observations, SD = standard deviation, cm = centimeter, p = level statistical significance at 0.005

CORRELATION BETWEEN PERCUTANEOUS TIBIAL AND FIBULAR LENGTHS AND HEIGHT

The pooled left tibial length presented correlation coefficient of 0.81 with the pooled measured height of participants. Also, the pooled right tibia length also showed stronger significant correlation with the pooled height of participants (r = 0.82). The left fibula also showed a statistically significant correlation with the pooled heights of participants (r = 0.79). For males, the left tibia length showed statistically significant correlation with the measured height of males (r = 0.75) whereas the right tibia length showed a slightly stronger significant positive correlation (r = 0.76) (Table 3). Some studies have also shown significant correlation between stature and tibial and fibular lengths (Trivedi *et al.,* 2014; Gaur *et al.,* 2016)

Table 3: Correlation between tibial and fibular lengths and height

VARIABLE	POOLED SAMPLE r	POOLED SAMPLE p	MALE r	MALE p	FEMALE r	FEMALE P
Left tibia	0.812	0.000	0.752	0.000	0.776	0.000
Right tibia	0.817	0.000	0.762	0.000	0.773	0.000
Left fibula	0.799	0.000	0.740	0.000	0.779	0.000
Right fibula	0.789	0.000	0.744	0.000	0.758	0.000

r = correlational coefficient; p = level of statistical significance

REGRESSION ANALYSIS FOR HEIGHT ESTIMATION USING TIBIA AND FIBULA LENGTHS STRATIFIED BY SEX

The best model for the estimation of height for the pooled population was the model that encompassed the right tibial and left fibular lengths. The adjusted coefficient of determination (Adj. R^2) for the model was 0.721 (Table 4). The best linear model for height estimation in males and females also encompassed the right tibial length (Adj. R^2 = 0.616) and left fibular length (Adj. R^2 = 0.607) respectively. On the other hand, the linear regression models with the left fibular length and right fibular lengths recorded the least coefficient of determination for males and females respectively. The respective coefficients of determination were Adj. R^2 = 0.568 and Adj. R^2 = 0.570 (Table 4 and 5).

Table 4: Linear Regression model for estimating height from tibial and fibular lengths stratified by sex.

SEX	EQUATION	R^2	Adj. R^2	SEE
MALE	2.367 (LTL) + 79.623	0.603	0.600	3.90
	2.415 (RTL) + 77.861	0.619	0.616	3.88
	2.247 (LFL) + 81.622	0.571	0.568	4.12
	2.180 (RFL) + 83.922	0.578	0.574	4.09
FEMALE	2.353 (LTL) + 76.202	0.602	0.598	3.96
	2.284 (RTL) + 78.849	0.598	0.593	3.98
	2.599 (LFL) + 63.556	0.607	0.603	3.94
	2.260 (RFL) + 76.092	0.575	0.570	4.10

Adj. R^2*= adjusted coefficient of determination,* ***LTL****=left tibia length,* ***RTL****=right tibia length,* ***LFL****= left fibula length,* ***RFL****= right fibula length;* ***SEE*** *= standard error of the estimate*

Table 5: Linear Regression Models for estimating height from tibial and fibular lengths from pooled sample

EQUATION	R^2	Adj. R^2	SEE
2.773 (LTL) + 62.731	0.693	0.691	4.17
2.790 (RTL) + 62.277	0.711	0.709	4.10
2.764 (LFL) + 59.454	0.638	0.636	4.59
2.588 (RFL) + 65.906	0.623	0.621	4.68
1.925 (RTL) + 0.985 (LFL) + 56.469	0.724	0.721	4.01

Adj. R^2*= adjusted coefficient of determination,* ***LTL****=left tibia length,* ***RTL****=right tibia length,* ***LFL****= left fibula length,* ***RFL****= right fibula length;* ***SEE*** *= standard error of the estimate*

CONCLUSION

Males had significant higher mean values for tibial and fibular lengths than the females. Percutaneous tibial and fibular lengths could be used to estimate height. Right tibial length was the best estimator of height among the males with the left fibular length being the best estimator of height among the females.

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