DETERMINATION OF HEIGHT, SEX AND TRIBE USING PERCUTANEOUS ULNAR AND TIBIAL LENGTH

Ofori, P. A., Abaidoo, C. S., Darko, N. D., Appiah, A. K., Tetteh, J., Diby, T., Okwan, D., Adjei-Antwi, C., Nketiah, J. and Robertson, J.

Anatomy Department, School of Medicine and Dentistry, KNUST.

INTRODUCTION

Many physical characteristics come together to fully distinguish one individual from another but the primary ones considered are age, sex, stature and race or ethnicity (Banerjee *et al.*, 2015). Extensive research has been carried out on stature estimation using body parts such as handprints, arm span, limbs and footprints in different populations. In the absence of the complete skeleton for identification through the anatomical method, long bones like the ulna, tibia and femur can be used in the mathematical method developed by Professor Karl Pearson to give information on the important primary characteristics of an individual (Lemtur *et al.*, 2017). Determining the sex of an individual is very important but in the absence of bones like the pelvis and skull, it becomes very difficult (Lundy, 1998). However, due to the sexual dimorphism existing in the tibia and ulna bones, they can be used as alternative markers for sex determination using population specific regression models (Lemtur *et al.*, 2017). Although a lot of research has been conducted on the tibia and ulna and their association with height and sex in many developed countries, very few published papers exist for the Ghanaian population. Therefore, the present study sought to use the percutaneous lengths of ulna and tibia as models for height and sex determination among some selected tribes in Ghana. Specific objectives were;

. To determine the height of the male and female participants.

. To measure percutaneous ulnar and tibial lengths of both male and female participants.

.To develop models for height and sex determination using the best osteometric indices among the selected tribes

MATERIALS AND METHODS

A descriptive cross-sectional study was carried out at the Department of Anatomy, School of Medicine and Dentistry (SMD), Kwame Nkrumah University of Science and Technology (KNUST) from November, 2018 to April, 2019. Informed participant consent and ethical approval were sought from the Committee on Human Research, Publications and Ethics at the Kwame Nkrumah University of Science and Technology, School of Medical Sciences prior to the study. All persons with previous fractures or congenital defects of the bones were excluded from the study. The height of each participant was measured using a Shahe stature meter (Shanghai, China). The ulnar length was measured from the tip of the olecranon process to the styloid process of the ulna (Figure 1). The tibial length was measured from the medial condyle to the tip of the medial malleolus using a fibre-glass tape measure (Shanghai, China) (Figure 2). The data collated was analysed using SPSS version 20.0.

Figure 1: A photograph showing the measurement of ulnar length (×0.2)

Figure 2: A photograph showing the measurement of ulnar length (×0.3)

RESULTS AND DISCUSSION

A total of 293 participants including 170 males and 123 females were recruited for the study. Amongst the tribes, the Akan ethnic group was the largest (77.47%), followed by the Ewes (6.83%) and then the Ga-Adangbes (5.12%). All other ethnic groups were classified as "Others" making up 10.58% of the participants used in the study.

DESCRIPTIVE STATISTICS OF AGE AND MEASURED PARAMETERS STRATIFIED BY SEX

Males recorded longer ulnar and tibial lengths than the females and the difference was statistically significant ($p < 0.05$) (Figure 3). This was consistent with a study by Lemtur *et al.* (2017) and Owusu *et al.* (2017) who ascribed such observation to the differences in hormonal (oestrogen and testosterone) effect during puberty.

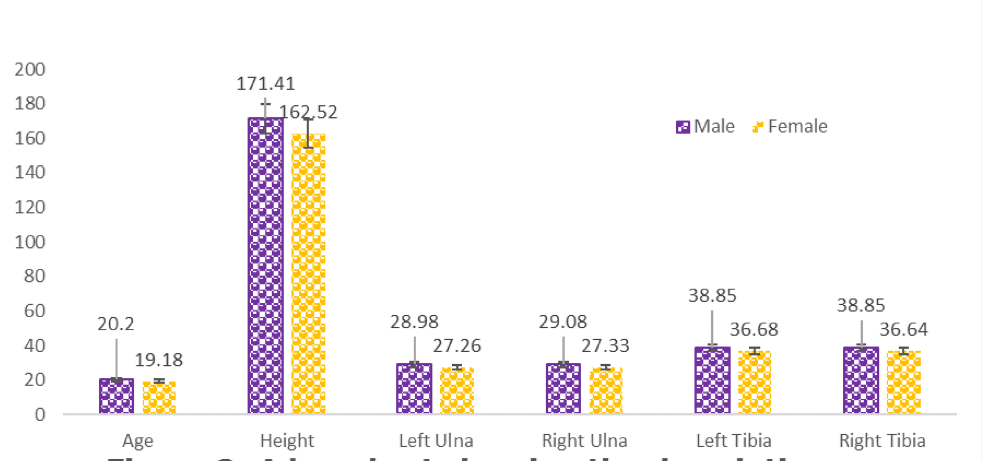

Figure 3: A bar chart showing the descriptive statistics of age and measured parametres stratified by sex

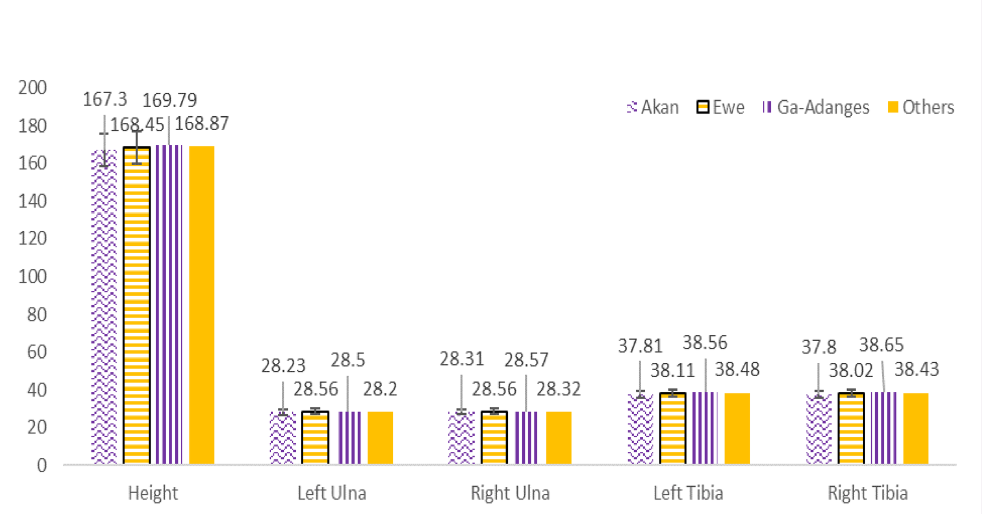

Figure 4: A bar chart showing the descriptive analysis of age and measured parametres stratified by tribe

As shown in figure 4, there was no significant difference between ulnar and fibular lengths of the various tribes considered in the present study.

CORRELATION BETWEEN PERCUTANEOUS ULNAR LENGTH, TIBIAL LENGTH AND HEIGHT STRATIFIED BY TRIBE

Among the tribes, both ulnar and fibular lengths correlated significantly with height as shown in table 1.

TABLE 1 : CORRELATION BETWEEN ULNAR LENGTH, TIBIAL LENGTH AND HEIGHT STRATIFIED BY TRIBE

Variable	Akan	Ewes	Ga-Adangbes	Others
LUL	0.81**	0.68**	0.91**	0.77**
RUL	0.82**	0.70**	0.91**	0.77**
LTL	0.83**	0.72**	0.82**	0.88**
RTL	0.83**	0.77**	0.80**	0.88**

*(**LUL** = Left Ulnar Length; **RUL** = Right Ulnar Length; **LTL** = Left Tibial Length; **RTL** = Right Tibial Length)*

REGRESSION EQUATIONS FOR HEIGHT AMONG THE TRIBES

In predicting height amongst the tribes, the regression equation derived for the Ewe group showed the least accuracy (all parameters used had an accuracy prediction percentage less than 60) whiles that of the Ga-Adangbes recorded the highest predictive value (Table 2).

TABLE 2: REGRESSION EQUATIONS FOR HEIGHT DETERMINATION AMONG THE TRIBES

Tribe	Parameter(cm)	Regression Equation	p-value	Adjusted R^2	± SEE
Akans	Left Ulna	Y = 56.18 + (3.93 * X)	0.000	0.65	4.81
	Right Ulna	Y = 53.56 + (4.01 * X)	0.000	0.67	4.67
	Left Tibia	Y = 61.35 + (2.80 * X)	0.000	0.68	4.58
	Right Tibia	Y = 61.55 + (2.80 * X)	0.000	0.69	4.53
Ewes	Left Ulna	Y = 87.60 + (2.83 * X)	0.001	0.43	5.16
	Right Ulna	Y = 53.56 + (2.73 * X)	0.001	0.45	5.04
	Left Tibia	Y = 73.65 + (2.49 * X)	0.000	0.48	4.91
	Right Tibia	Y = 72.45 + (2.53 * X)	0.000	0.57	4.51
Ga-Adangbes	Left Ulna	Y = 22.86 + (5.16 * X)	0.000	0.82	3.78
	Right Ulna	Y = 26.59 + (5.01 * X)	0.000	0.81	3.85
	Left Tibia	Y = 75.50 + (2.45 * X)	0.001	0.65	5.31
	Right Tibia	Y = 79.34 + (2.34 * X)	0.000	0.61	5.59
Others	Left Ulna	Y = 59.50 + (3.88 * X)	0.000	0.58	4.28
	Right Ulna	Y = 63.79 + (3.71 * X)	0.000	0.58	4.31
	Left Tibia	Y = 61.95 + (2.78 * X)	0.000	0.76	3.23
	Right Tibia	Y = 67.32 + (2.64 * X)	0.000	0.77	3.19

***Y** = Estimated height, **X** = Independent variable, **LUL** = Left ulnar length, **RUL** = Right ulnar length, **LTL** = Left tibial length, **RTL** = Right tibial length, **SEE** = Standard error of estimate, **R^2** = Co-efficient of Determination.*

SEX DETERMINATION USING PERCUTANEOUS ULNAR AND TIBIAL LENGTH AMONG THE TRIBES

Among the tribes, the measured parameters were able to predict the sex of only Akans and Ewes as shown in table 3.

TABLE 3: REGRESSION EQUATIONS FOR SEX DETERMINATION USING PERCUTANEOUS ULNAR AND TIBIAL LENGTH AMONG THE AKANS AND EWES

Tribe	Parameter	Regression Equation	Predicted percentage accuracy (%)			p-value
			Overall	Male	Female	
Akan	RUL	Y = 28.50 - (1.02 * X)	80.2	87.4	71.0	0.000
Ewe	RTL	Y = 49.43 - (1.36 * X)	85.0	93.3	60.0	0.032

Y**= sex of participant; **X**= the value of the parameter used in the equation; **RUL**= right ulnar length; **RTL**= right tibial length Significant level ($P < 0.05$); **= multiplication symbol*

INTER-POPULATION COMPARISON OF MEAN ULNAR AND TIBIAL LENGTHS

Ghanaians recorded significantly higher mean ulnar and tibial lengths than that of Iranians in Chabahar (Borhani-Haghighi *et al.*, 2016), Nepalese (Sah *et al.*, 2014), Indians (Lemtur *et al.*, 2017) and Sri Lankans in Kurdish (Ghanbari *et al.*, 2016) .

CONCLUSION

In the present study, males were significantly taller than females. Males had significantly longer ulnae and tibiae than females. Right tibial length was the best predictor of height among the Akans, Ewes and other tribes. Left ulnar length was the best predictor of height among the Ga-Adangbes. Sex prediction was only possible for Akans and Ewes in the present study. It was noted that the mean ulnar and tibial lengths of the study population differed significantly from those reported for Indians, Iranians, Nepalese and Sri Lankans.

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