

# Estimation of Stature from Hand and Foot Dimensions of Annang Indigene of Akwa Ibom State, Nigeria

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Date of Submission: 12-08-2016

Date of Acceptance: 11-09-2016

Date of Publishing: 04-07-2017

## ABSTRACT

**Background:** Stature is a significant anthropometric determinant of the physical identity of an individual. Aim: This study was carried out to estimate stature of Nigerian Annang indigenes of Akwa Ibom State from hand and foot dimensions. **Methods:** Two hundred (200) adults Annang indigenes (100 male and female each) were randomly selected for this study. Hand and foot dimensions were obtained by direct linear measurements using a 150mm digital vernier caliper (with accuracy of 0.01mm); while stature was determined by stadiometric measurement of the height (to the nearest 0.1m). Measurements obtained include; second (2D), fourth digit (4D) and right foot length (RFL). All measurement were converted to centimeters (cm). SPSS (IBM® version 20, Armonk, New York, USA) t-test was to evaluate gender difference in the measured dimensions; while Pearson's correlation and Generalized Linear Modeling were used to derive Regression equation for estimation of stature from the measured dimensions. The significance level was set at 95% as  $P \leq 0.05$  was considered significant. **Results:** The t-test showed that males displayed significantly higher mean values than the females for all measured parameters ( $P < 0.001$ ). Single regression sex specific regression formulae were derived and the result showed that better prediction (r) values were obtained for females F (2D=0.428, 4D=0.430, RFL=0.587;  $P < 0.01$ ) population when compared to males M (2D=0.319, 4D=0.231, RFL=0.456;  $P < 0.05$ ). **Conclusion:** This study suggests the existence of sexual difference in hand and foot dimension and also the possibility of accurately estimating stature from the right foot length, right second and fourth digit.

**Keywords:** Annang, Dimensions, Hand and Foot, Regression, Stature.

## INTRODUCTION

The diverse ethnic populations with different historical backgrounds in Nigeria provides an exclusive opportunity to study the variations amongst these endogenous sub-populations consisting of different geographical and ecological conditions.<sup>[1]</sup> Body stature (height) is a significant anthropometric determinant of the physical identity of an individual. In forensic investigation, the dimension of the hands and feet have provided insight in ascertaining the sex, age and stature of individuals;<sup>[2-8]</sup> as well as ethnic and ancestral discrimination amongst living and deceased individuals.

Anatomically and anthropometrically, stature can be

derived from the linear measurement of the combination of the skull, vertebral column, pelvis and legs in an upright position.<sup>[9,10]</sup> The human hand normally have five digits, the index finger also referred to as forefinger, is the second digit (2D) of and its located between the thumb and the middle finger, while the ring finger which is also called the index finger is the fourth digit (4D) and it lies between the little and middle finger.<sup>[10,11]</sup> Foot length is defined as the straight distance from the most prominent part of the heel backward (pternion) to the most distal part of the longest toe (acropodion).<sup>[10]</sup> Stature provides insight into various socio-demographic features (nutrition, geographical location, environment and climatic condition) of a population, as well as genetic variations (race, and disease). It is

also considered an important assessment tool in the identification of unknown human remains; hence, the reliability of stature estimation from upper extremity measurements,<sup>[4,7,8,13-15]</sup> as well as lower extremity have been documented.<sup>[3,5,6,16-18]</sup> Also, some foot dimensions have been used to estimate stature in many populations using regression formulae derived from hand dimensions.<sup>[19,20]</sup>

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The Annang people are a cultural and ethnic group with a population strength of over one million people that occupy about seven local government area of the western part of Akwa Ibom State in Nigeria.<sup>[21,22]</sup> The paucity of information on stature estimation for the multi-ethnic population in Nigeria has prompted this study. Therefore, this present study evaluates the linear relationship of the right 2D, 4D, FL and stature of Annang people in Akwa Ibom State.

## MATERIALS AND METHODS

The study was carried out on 200 adult Nigerians that were of Annang ethnic group in Akwa Ibom state of Nigeria. This comprised 100 males and 100 females. Subjects between the ages of 18-65 years were randomly selected from communities representing the tribes. Genealogy of the subjects were determined by establishing parentage up to the 2nd generation.

Height was measured from the highest point on the head of the subject excluding the hair to the sole of the feet without their shoes (Montagu, 1960).<sup>[23]</sup> Each participant was asked to stand upright against the wall with hands hanging down on the sides with both feet kept close together and head oriented in Frankfurt horizontal plane. A none-standing platform, collapsible metric calibrated stadiometer was placed behind the subject, the inferior end touching the solid floor while the folding superior extension was placed on the vertex of the head [Figure 1]. The measurement were read from the calibrated stadiometer height stand in meters (m).

Right second digit (R2D) and right fourth digit (R4D) was measured from the bottom crease to the top of the finger as demonstrated by Manning (2002) [Figure

2].<sup>[24]</sup>

Foot length was measured from the most prominent part of the heel backward (pternion) to the most distal part of the longest toe (Acropodion) with the subject standing bare foot and the weight of the body equally distributed on both feet using Kanchan's method [Figure 2]. The measurement was taken using a digital vernier caliper calibrated in mm. Results were later converted to centimeter (10mm = 1cm = 0.1m).

Subjects with damage and or deformities of the vertebral column and limbs were excluded.

### Data Analysis

The raw data were entered into an excel sheet (2010) and analysis of data was carried out using Statistical Package for Social Sciences (SPSS IBM® version 20, Armonk, New York, USA). Using this software, mean, standard deviation and range were determined. Paired sample test analysis (t-test) was done to determine possible gender differences. Pearson's Moment Correlation was also carried out to determine possible association between height and (R2D), (R4D) and Right Foot Length (RFL). Generalized Linear Modeling was used to derive sex-specific regression equations for estimation of stature from the measured dimensions. The significance level was set at 95% and values with  $P \leq 0.05$  were considered significant.

## RESULTS

The results of the study are presented in [Tables 1-4]. The mean (S.D) values, and range (min –max) for age (yrs), height (cm), RFL (cm), R2D (cm) and R4D of males and females are presented in Table 1, with the result from paired sample t-test analysis of mean difference are shown in [Table 2].

Pearson's correlation coefficient was used to determine the linear relationship between stature and the measured hand and foot dimensions. Correlation coefficient for the relationship between height and age, height, RFL, R2D, R4D of males and females are presented in [Table 3]. The derived sex-specific regression equations for estimating height (stature) are presented in [Table 4].

The mean values and standard deviation (mean±S.D) for age (yrs.), height (cm), RFL (cm), R2D (cm) and R4D (cm) for males are 26.03±7.81cm, 167.72±6.04cm, 25.83±1.30cm, 6.94±0.57cm, 7.20±0.57cm respectively while that of females are, 27.23±10.82cm, 159.04±8.74cm, 24.20±1.44cm, 6.39±0.61cm, 6.74±0.66cm respectively.

The t-test showed that apart from the age ( $t=0.893$ ,  $P=0.374$ ), males had significantly higher mean values for all measured dimensions when compared to

females (Height\* t=10.671, P<0.001; R2D\* t=6.358, P<0.001; R4D\* t=4.788, P<0.001; RFL\* t=8.128, P<0.001).

From the Pearson's correlation and single regression analysis showed that better prediction (r) values were obtained for females F (2D\* r=0.428, P<0.001; 4D\* r=0.430, P<0.001; RFL\* r=0.587, P<0.01) population when compared to males M (2D\* r=0.319, P=0.001; 4D\* r=0.231, P=0.021; RFL\* r=0.456, P<0.001). sex-specific regression models were developed for the Annang population of Akwa Ibom State, Nigeria.

Table 1: Descriptive characteristics of measured parameters among Annang people

Parameter	Sample size		Mean±SD		Minimum value		Maximum value	
	Male	Female	Male	Female	Male	Female	Male	Female
Age(years)	100	100	26.03 ±7.81	27.23 ±10.82	18	18	52	55
Height (cm)	100	100	167.7 ±6.04	159.0 ±8.74	153	143.6	178	178
R2D(cm)	100	100	6.94±0.57	6.39±0.61	5.68	4.81	8.68	8.68
R4D(cm)	100	100	7.20±0.57	6.74±0.66	5.98	5.14	8.94	8.94
RFL(cm)	100	100	25.83 ±1.30	24.20 ±1.44	22.9	20.3	28.7	28.7

Note: SD- standard deviation; RFL- Right foot length; R2D- second right digit length; R4D- Fourth right digit length

Table 2: Test of mean difference between male and female of Akwa Ibom state

Variable or parameter	Degree of freedom	P-value	t-value	Inference
Age	99	0.374	0.893	Not significant
Height	99	<0.001	10.671	significant (M>F)
R2D	99	<0.001	6.358	significant (M>F)
R4D	99	<0.001	4.788	significant (M>F)
RFL	99	<0.001	8.128	significant (M>F)

Note: \* confidence level set at 95%, RFL- Right foot length; R2D- second right digit length; R4D-Fourth right digit length; M-Male; F-Female.

Table 3: The result of Pearson moment correlation between height and other investigated parameters (RFL, R2D and R4D)

Parameters	Sample size		Correlation coefficient(r)		Critical P-value	
	Male	Female	Male	Female	Male	Female
R2D & Height	100	100	0.319**	0.428**	0.001	<0.001

R4D & Height	100	100	0.231*	0.430**	0.021	<0.001
RFL & Height	100	100	0.456**	0.588**	<0.001	<0.001

NOTE: RFL- Right foot length; R2D-Second right digit length; R4D- Fourth right digit length, Correlations is significant at \*0.05; \*\*0.01 (2- tailed)

Table 4: Regression equations for estimation of stature of Annang people

Parameters	Regression equations for estimation of stature	
	Annang males	Annang females
RFL	Height(cm) = 13.0 + 2.1 RFL(cm)	Height(cm) = 92.6 + 2.7 RFL(cm)
R2D	Height(cm) = 144.5 + 3.4 R2D(cm)	Height(cm) = 129.1 + 4.7 R2D(cm)
R4D	Height(cm) = 150.3 + 2.4 R4D(cm)	Height(cm) = 129.6 + 4.4 R4D(cm)

NOTE: RFL- Right foot length; R2D-Second right digit length; R4D- Fourth right digit length

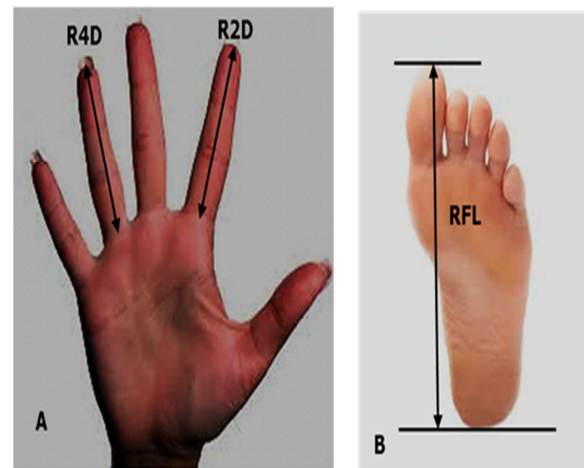


Figure 1: Measurement of A) R2D and R4D dimensions; B) Right foot length

## DISCUSSION

In forensic investigation, information about the sex, age and stature of the living or dead victim can be established from derived predictive models of dimension of the hands and feet. Stature estimation from different body part are very surplus; however, the creation of ethnic specific data is a plus for comparative investigation.

Hand and foot dimensions showed high sexual dimorphic characteristics, with higher mean values for males when compared with the females. Smaller foot length in Nigerian females has been reported by Danboro et al.<sup>[25]</sup> (2007) and Ismaila (2009) and in line with reports by Ozden et al.<sup>[26,27]</sup> (2005), Sanli et al.<sup>[28]</sup> (2005), Oommen et al.<sup>[29]</sup> (2005), Krishan and

Sharma (2007).<sup>[9]</sup> El-Meligy et al.<sup>[30]</sup> (2006), Ozaslan et al.<sup>[31]</sup> (2006), Case and Ross (2007),<sup>[32]</sup> Agnihotri et al.<sup>[3]</sup> (2007), Ashizawa et al., (1997) and Krishan et al.<sup>[33,34]</sup> (2015), for different populations across different regions.

Accurate and reliable anthropometric data and models are of high relevance to the forensic investigator as it can provide information about the history of victims. Hand and foot dimensions have been used to formulate regression models with prediction accuracy (R<sup>2</sup>) ranging from 0.38-0.52.<sup>[2,410,12-15,17-20]</sup> From the multiple regression for estimating the stature of the ethnic group using hand and foot dimensions, 2D produced significant (+ve) weak correlation with stature for both males and females, while 4D and RFL was significantly (+ve) averagely correlated with stature for both sex. However, the models in this study produced similarly low accuracy values for both 2D (R<sup>2</sup>=0.10 for males and 0.18 for females) and 4D (R<sup>2</sup>=0.10 for males and 0.18 for female) for the estimation of the Annag people. The assumption of the correlation between R2D, R4D and RFL with height was based on their predictive equations on the existence of this association which have also been reported by Krishan and Sharma,<sup>[9]</sup> (2007); Danborn et al.<sup>[26]</sup> (2009), Krishan et al.<sup>[26]</sup> (2012) and Bardale et al.<sup>[35]</sup> (2013). In this present study, better stature prediction were observed for females when compared with males.

## CONCLUSION

Observations from this study has shown that prediction of stature using body parts differ across races, ethnic groups and populations even when the same structures are used. Therefore the results of this study would be useful to the anthropologists and forensic and reconstructive anatomist; when identifying unknown persons.

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**How to cite this article:** Oladipo GS, Omuruka TC, Aigbogun EO, Okoro DA, Erezih OF, Osuchukwu W. Estimation of Stature from Hand and Foot Dimensions of Annang Indigene of Akwa Ibom State, Nigeria. *Acad. Anat. Int.* 2017;3(1):26-30.

**Source of Support:** Nil, **Conflict of Interest:** None declared.