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RESEACH ARTICLE

ESTIMATION OF STATURE FROM HAND AND FOOT ANTHROPOMETRIC PARAMETERS AMONG HAUSA ETHNIC GROUP OF KANO STATE, NIGERIA

Datti, S[1]*., Danborno, B[2].,Timbuak, J.A[3]., Tanko, Y[4]., Adamu, L.H[5]., Gudaji, A[1]., Asuku, A.Y[1]., Maharazu, M.M[1]. and Gwarzo I.D.[6]

[1]Department of Anatomy, Faculty of Basic Medical Sciences, Bayero University, Kano
[2]Department of Human Anatomy, Faculty of Basic Medical Sciences, Ahmadu Bello University, Zaria
[3]Department of Anatomy, Faculty of Basic Medical Sciences, Northwest University, Kano
[4]Department of Human Physiology, Faculty of Basic Medical Sciences, Ahmadu Bello University, Zaria
[5]Department of Human Anatomy, Faculty of Basic Medical Sciences, Federal University, Dutse.
[6]Department of Biological Sciences, Faculty of Sciences and Computing, Capital City University, Kano.

Abstract

Background: In anthropometry, identifying a person involves figuring out their sex, age, race, and stature. The importance of stature assessment in human identification has piqued the interest of forensic experts. The aim of this study is to estimate stature of Hausa ethnic group of Kano, using hand and foot anthropometric parameters. **Materials and Methods:** The study was cross-sectional survey conducted on 444 (195 females and 245 males, age range:11-26 years) across selected LGAs (Gwarzo, Gwale and Kibiya) in Kano. Their height was measured using Stadiometer, and hand and foot dimensions were measured using digital vernier caliper. Descriptive statistic was carried out to determine mean ±SD, correlation analysis between height and hand and foot parameters were conducted (highest r-value; height and hand length 0.608 and height with foot length 0.602) and regression analysis was conducted to derive predictive equations between the anthropometric parameters respectively. **Results:** A statistically significant positive correlation between height, hand and foot anthropometric parameters were obtained (with hand length and foot length having highest r-values of 0.608 and 0.602 respectively). **Conclusion:** This predictive equation (H=4.61xHL+72.60 and H=3.83xFL+61.07) obtained can be used successfully for the estimation of height (stature) among Hausa ethnic group of Kano State, Nigeria.

Keywords: Estimation, Stature, hand length, foot length, Kano

INTRODUCTION

In the identification process, the first thing that is always done is DNA and fingerprint analysis. When meeting a victim who cannot be identified in either of these ways, another appropriate identification method is needed to identify the individual (Anjani *et al*., 2024). Identifying a person involves figuring out their sex, age, race, and stature (Kamal and Yadav, 2016). Identification of victims from isolated extremities is crucial in mass catastrophe situations (Ghaleb *et al.,* 2019). In disaster scenarios, the lower extremities, being more robust against taphonomic changes compared to upper extremities, are often found intact, especially feet which are usually protected within shoes and can withstand environmental factors more effectively (Singh *et al*., 2019). Developing a biological profle at the triage stage

* Corresponding Author: Datti S.,
Tel: +2347038234884
E-mail: saaddatti@gmail.com

can provide valuable information for identification before antemortem data is available (de Boer *et al*., 2019).

The importance of stature assessment in human identification has piqued the interest of forensic experts (Moorthy *et al.,* 2014). Stature estimation is an essential indicator of life expectancy, nutritional quality, diagnoses genetic illnesses and overall health (Joerg *et al.,* 2012). Stature which is primarily determined from body physique is known to be influenced by climatic, hereditary, nutritional and racial factors (Pradeep and Abhilasha, 2012).

In the past, determination of anthropological variables such as sex, age and stature has been done from osteological analysis of the hand and foot bones (Shintaku and Furuya, 1990). It is believed that adult stature is usually attained anywhere from the early teens to early twenties, it is most commonly reached during mid-teens in females and in the late-teens in males, however in adolescents, foot measurements are naturally correlated with age but the phenomenon is complicated by differences in rates of growth between individuals (Krishan and Kumar, 2007).

It was reported that body proportions and the dimensions of various body segments, including the long bones of the limbs and the bones of the hand and foot have been used to estimate stature (Bhatnagar *et al.,* 1984; Mall *et al.,* 2001). Many human features have been used to estimate stature from skeletal remains and body parts owing to the established relationship between stature and different parts of the body as there are definitive biological relationships of different degrees between various measurements of the extremities and stature; many studies have used the measurement of the upper and lower limbs including foot and hand dimensions to estimate stature (Krishna and Sharma, 2007; Kanchan *et al.,* 2012).

However, using dimensions of body segments could serve as mainstay of identification in any forensic investigation, whether it is of the suspect from the physical evidence at the crime scene or of the victim from dismembered, mutilated and charred remains (Sanli *et al.,* 2005; Agnihotri *et al.,* 2013). When an individual foot is recovered and brought for examination, the dimensions of the foot can provide valuable information about the stature and sex of the person as stature can be estimated from various measurements of the foot like foot length and breadth based on statistical equations and formulae (Quamara *et al.,* 1980; Saxena, 1984; Sanli *et al.,* 2005; Agnihotri *et al.,* 2013). It was observed that, work has been carried out by different workers on other populations to estimate the stature from foot measurements (Byers *et al.,* 1989) and foot prints (Robbins, 1986; Barker and Scheuer, 1998).

The aim of this study is to estimate stature using hand and foot anthropometric parameters among Hausa ethnic group of Kano. Moreover, due to mass disasters like terrorist attacks, automobile accidents, mass suicide, etc. It will be useful to establish the sex, ethnicities, and stature of an individual of the Hausa population which is a prerequisite for individual identification.

MATERIALS AND METHODS

Measuring tape (to nearest 0.1 cm), questionnaire, Stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, digital standing scales (Model DS-410, Seiko, Tokyo, Japan), to the nearest 0.1 kg, digital vanier calliper (Starrett, 123 Series, U.S.A.)

Anthropometry

I. Height (cm): The subjects stood up in upright position with arm relaxed by the side, ankles and knees placed together. The stadiometer was position the subjects and the measurement was taken was taken to the nearest 0.1cm.
II. Hand length (HL) in cm: Measured from the midpoint of the distal wrist crease, to the tip of the middle finger using a plastic measuring tape (palmer surface of the hand in supine position).
III. Hand breadth (HB) in cm**:** Measured from the head of the 5th to 2nd metacarpal using a sliding vernier caliper (palmer surface of the hand in supine position).
IV. Palm length in cm**:** Was measured as the distance between the midline of the distal wrist crease and the base of middle finger.
V. Foot length (FL) in cm: Was measured as the length between the extreme point of heel and the extreme point of the longest toe (either first or second toe).
VI. Foot breadth (FB) in cm: Measured at the widest point of the sole, which is from the

metatarsophalangeal joint of the 1st metatarsal and that of the 5th metatarsal of the foot using a sliding Vernier caliper

VII. Foot height (FH) in cm: Was measured as the distance between the distal part of the lateral malleolus and the floor (Pheasant, 2003).

Plate I: Statiometer for the measurement of height

Plate II: Techniques used in measuring hand length

Plate III: Digital Vernier caliper

Study Location

Kano State is located between latitude 12.2º North and longitude 9.4º East with Kano City as the capital of the State. The State at present is the most populous in Nigeria, having forty-four (44) local government areas with over 9,000,000 people as of 2007 census. The major inhabitants of Kano are of Hausa and Fulani ethnic groups with minority representing virtually all tribes in Nigeria and a minute fraction of foreigners (Dan-Asabe, 2000). Kano State is composed of three senatorial districts: Kano Central, Kano South, and Kano North senatorial districts. Two local government areas were selected randomly from each district for an even distribution of data.

The local governments that were selected are Gwale and Municipal LGA representing Kano Central, Rano and Kibiya representing Kano South, and Gwarzo and Shanono representing Kano North district.

Study Design

The study was a cross-sectional survey that was carried out in selected secondary across selected LGAs in Kano.

Sampling Technique

A random sampling method was adopted. The subjects were used to obtain hand and foot dimensions, handprints, footprints, and other body variables. The sample size required for this study is calculated using the formula by Oyejide (1991) below;

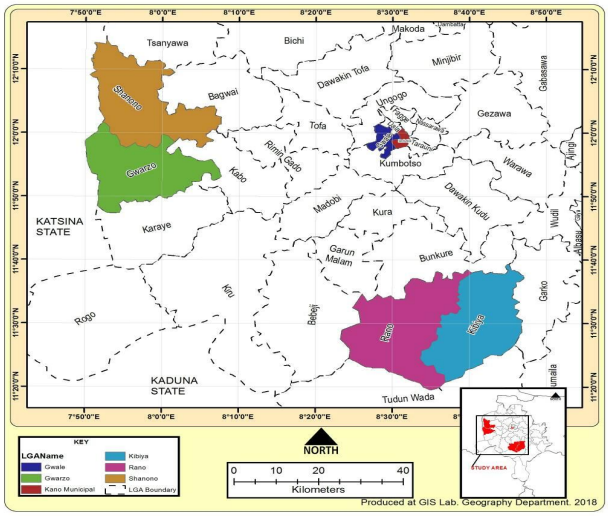

Figure1: Administrative map of Kano showing selected LGAs (GIS Lab, 2018)

Where n= desire sample size, Z= standard normal deviation 1.96 at 95% confidence level, q= 1 – p,

d= degree of precision, p= proportion =0.7 (70%).

The minimum size from the equation above is 384 but the study used a population of 444 for better statistical power.

Selection Criteria

Inclusion Criteria

- ✓ Apparently healthy subjects
- ✓ Hausa of Kano up to the level of grandparents
- ✓ Secondary school pupils
- ✓ Age range 11-20years

Exclusion Criteria

- ✓ Non-Hausa ethnic group were excluded from the study
- ✓ Students with hand or foot deformity
- ✓

Statistical Analyses

The data was presented as mean ± SD. Independent sample t-test was used to test the differences between male and female subjects, while Pearson's correlation was used to measure the relationship between the variables and simple linear regression analysis was used for the estimation of height (stature). Data analysis was conducted using SPSS version 20 and a p-value < 0.05 was deemed to be statistically significant.

RESULTS

Table 1 shows descriptive statistic of the general population of the pupils with the minimum, maximum and mean value of Age, hand and foot anthropometric parameters.

Table 1: Descriptive statistic of the general population with the minimum, maximum and mean value of Age, hand and foot anthropometric parameters (n=444)

Variables	Minimum	Maximum	Mean ± SD
Age (yrs)	11.00	26.00	14.77±1.89
Height (cm)	121.00	177.00	148.78±11.33
Hand length (cm)	12.10	20.04	16.51±1.49
Hand breadth (cm)	4.50	10.10	6.96±0.78
Palm length (cm)	5.40	11.20	8.90±0.94
Foot length (cm)	14.70	28.00	22.89±1.78
Foot breadth (cm)	4.70	11.00	8.43±0.92
Foot height (cm)	3.90	11.00	8.32±1.20

Table 2 presents correlation between heights with the hand and hoot anthropometric measurements. It was observed that, height has positive correlation with all the variables, but having a highest correlation value with the hand length (r=0.608).

Table 2: Correlation between Height and Hand and Foot anthropometric measurement of Hausa ethnic group of Kano (n=444)

Variables	Height (cm)
Hand length (cm)	.608**
Hand breadth (cm)	.478**
Palm length (cm)	.439**
Foot length (cm)	.602**
Foot breadth (cm)	.521**
Foot height (cm)	.310**

** Correlation is significant at the 0.01 level

Table 3 presents predictive linear regression equations for height (Stature) estimation using measured hand and foot anthropometric parameters of Hausa ethnic group of Kano. It was observed that, all the anthropometric variables of hand and foot can be used to derive a predictive equation for the estimation of stature. Hand length and foot length shows highest r value of 0.608 and 0.602 respectively.

Table 3: Linear regression equations for height (Stature) estimation using measured hand and foot anthropometric parameters of Hausa ethnic group of Kano (n=444)

Regression Equation	R	R^2	SEE	F	p-value
H=4.61xHL+72.60	0.608	0.370	9.00	259.16	0.001
H=6.90xHB+100.70	0.478	0.229	9.96	131.06	0.001
H=5.29xPL+101.70	0.439	0.193	10.19	105.46	0.001
H=3.83xFL+61.07	0.602	0.363	9.05	251.67	0.001
H=6.41xFB+94.81	0.521	0.271	9.68	164.51	0.001
H=2.93xFH+124.42	0.310	0.096	10.78	46.84	0.001

H=Height, HL=Hand Length, HB=Hand Breadth, PL=Palm Length, FL=Foot Length, FB=Foot Breadth, FH=Foot Height

DISCUSSION

Identification of an individual is very crucial in forensic science such as in the process of identifying victims from mass disasters as reported by Ghaleb *et al*. (2019). In several studies, the used of the body parts was reported to be very important tools in estimation of stature (Bhatnagar *et al.,* 1984; Mall *et al.,* 2001).

In this study a mean value of height (148.78±11.33) which is shorter then what obtained in Egyptian population (Gheat *et al*., 2020; Moustafa, 2017; Foad *et al.,* 2018) and very close to what is reported in Indian population (Pandey *et al.,* 2017) has been observed.

In the present study, height correlates with all the hand and foot dimensions, this in agreement with previous work done in other population (Ekezie, 2015; Moustafa, 2017; Ibrahim *et al.,* 2018; Farhan *et al*., 2023) and findings of this study on use of foot dimensions agrees with work done in other populations (Ezekie, 2016; Paul, 2020). Many studies have confirmed that, hand and foot length have been found to have a correlation with the stature of an individual and this has emphasize the importance of measuring the hand length as well as foot length to estimate stature as reported (Rastogi et al., 2008; Patel *et al.,* 2012).

However, using dimensions of body segments (i.e hand and foot) could serve as the mainstay of identification in any forensic investigation, whether it is of the suspect from the physical evidence at the crime scene or of the victim from dismembered, mutilated, and charred remains as there are relationship between each part of the body and the whole body.

The findings of this study confirmed that, hand length has the higest correlation value (r=0.608) and agrees with work done by (Purnendu *et al*., 2023; Saleh and Abdel Wahed, 2023), likewise foot length has the highest correlation value (r=0.602) among all hand and foot variables which is consistent with what reported (Malik & Sodhi, 2023) and gives better estimate for stature among Hausa populations as agrees by (Krishan and Sharma, (2007).

Conclusion

In the present study, relationships between variables were determined, predictive equations were developed. Hand and foot dimensions can be used as tools for the estimation of individuals' height (stature). H=4.61xHL+72.60 and H=3.83xFL+61.07 derived will appropriately be used in the estimation of stature with the highest r value of 0.608 and 0.602 respectively. The variation in height between what observed in the present study and across different populations is due to differences in age, geographical location, ethnicity and race of an individual as reported by other researcher (Duello *et al*., 2021).

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Author's contributions:

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