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Original Article

Relationship between Somatotype and Cephalofacial Anthropometry among Adolescents of Ngamo Ethnic Group of Fika Local Government Area of Yobe State, Nigeria

[1]Ganga, A.M. and [2]Usman, M.I.

Abstract

BACKGROUND AND AIM: Cephalofacial anthropometry is very important in surgery and syndromology. The aim of the study was to investigate the relationship between cephalofacial anthropometry and somatotype among adolescents of Ngamo lineage in Fika Local Government Area of Yobe State.
METHODOLOGY: The sample size for the study was 391 subjects comprising male (196) and female (195) subjects with mean age 15.46 ± 1.82 from selected secondary schools in Fika Local Government. The design was cross sectional and participants were classified into three basic somatotypes; endomorph, mesomorph and ectomorph. Cephalic, facial and nasal anthropometric variables were measured using standard protocol. Spearman's correlation was used to determine the relationship between somatotype and cephalofacial anthropometry, stepwise logistic regression analysis was deployed to predict somatotype components from cephalofacial parameters.
RESULTS: Significant sexual dimorphism was found in somatotype components and cephalofacial anthropometry. A significant correlation was found between some cephalofacial measurements and somatotype components, somatotype components were significantly predicted from cephalofacial parameters and facial breadth was the best predictor.
CONCLUSION: A relationship was found between somatotype and cephalofacial parameters among adolescents of Ngamo tribe of Fika LGA, Yobe state, Nigeria.

Keywords:
Adolescents, lineage, somatotype, regression.

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[1]Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, Yobe State University, Damaturu, Nigeria; [2]Department of Medical Biochemistry, Faculty of Basic Medical Sciences, College of Medical Sciences, Yobe State University, Damaturu, Nigeria.

Address for Correspondence:
Ganga, A.M.
Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, Yobe State University, Damaturu, Nigeria
abdumoiganga@ysu.edu.ng
+2348066406474

INTRODUCTION

Anthropometric studies are very important area for craniofacial surgery and syndromology (Choudhary and Chowdhary, 2012). Somatotype is a taxonomy used in describing body physique or shape. The term somatotype and its three components (endomorph, mesomorph and ectomorph) were first described in 1940 by Sheldon and his co-workers (Sheldon *et al.,* 1940). Endomorphy means relative predominance of soft roundness throughout the various regions of the body, while mesomorphy refers to the relative predominance of muscle, bone and connective tissue and - Ectomorphy is the relative predominance of linearity and fragility (Sheldon *et al.* 1940). Later Heath and Carter introduced the simplified method for somatotyping and in the last few decades anthropometric somatotyping is one of the most used methods which describes the body shape and composition. It has been the most used for studying body physique variations in children, adolescents and adults among populations, age changes and sex differences (Cameron and James, 2010; Carter and Heath, 1990). Cephalofacial anthropometry is an objective technique based on a series of measurements and proportions performed on the head, which facilitate the characterization of phenotypic variation and quantification of dysmorpology (Yasas *et al.* 2014).

Many of the research studies reported sexual dimorphism in somatotypes. Bojadzieva *et al.*

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(2018) reported that Macedonian adolescent males and females are more endomorphic, they also reported that Albanian adolescent males are mesomorphy and females are ectomorphy. Buffa *et al,* (2005) reported that male Sardinians are mostly mesomorphic, they also reported that female Sardinians are mostly endomorphic. There is a study that showed both male and female Venezuelans to be mesomorphic (Herrera *et al,* 2004). Jilani *et al.* (2019) reported that Turkish males have long nose and females have broad type of nose. Pandey and Atreya, (2018) worked on Devdaha Medical College students and reported significant sexual dimorphism in facial length and breadth. Mauritanian population recorded significant sexual dimorphism in cephalic length and breadth (Agnihotri *et al.* 2011and Kpela *et al.* (2019) also reported significant sexual dimorphism in nasal length and breadth among TIV and Idoma tribes of Nigeria. Facial length and breadth of Malay population were found to be sexually dimorphic with females having higher values (Ngeow and Aljunid, 2009, Anizebe, 2013) conducted research and reported significant correlation between somatotype and cephalic length and breadth among Igbo tribe of Abakaliki, Nigeria.

There have been cases of insurgency around the northern part of Nigeria and Nigeria as a whole, the problem of child abduction and change of identity to another region of the country is also alarming. Studies has been done on somatotypes, cephalofacial aspect of the body aiming at identification of individuals, ethnic and age differences etc. There has been scarcity of data or literatures on the relationships between somatotypes and cephalofacial anthropometry among Ngamo tribe of Fika Local Government of Yobe State which is very important in human identification. Reference data on the distribution of cephalofacial anthropometry and somatotypes will be of paramount importance in individual identification and ethnic differences. The indices will bring about head, facial and nasal classifications and these play an important role in the identification of individuals. Furthermore, it also plays a role in crime detection. Somatotype determination may help in providing useful information in evaluating the health status of an individual. This study may also lessen the burden of individual identification by a great percentage. The aim of this study was to determine the relationship between cephalofacial anthropometry (cephalic length and breadth; facial length and breadth; nasal length and breadth) and somatotype among adolescents of Ngamo ethnic group of Fika Local Government Area of Yobe state.

MATERIALS AND METHODS

Study Population

The study was conducted in Fika Local Government Area, Yobe State and sixteen (16) secondary schools were randomly selected out of twenty seven (27) schools. The sample size was determined by the following formular (Cochran, 1977).

$$n = \frac{z^2pq}{d^2} = \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 384$$

Where;

n = desired sample size, z = confidence level (How confident the actual mean falls within your confidence interval) 1.96 at 95%. p = prevalence/standard deviation (How much variance expect in the responses) 50% (0.5). q = 1 – p. d = degree of precision/ margin of error which is 5%.

The sample size of the study was 391 subjects comprising of 196 male and 195 female subjects. The participants were adolescent which were confirmed up to two generations as Ngamos aged between 11 and 19 years. The study included any student belonging to the selected secondary schools, any student that belongs to Ngamo ethnicity and any student without physical deformity on the area of interest of the study. Cross sectional design was used in the study.

Measurement of Anthropometric Variables

Cephalic length was measured with spreading caliper (model M-HT10136; manufactured by Hank minerals) as the distance between the glabella and the inion in the midline (Kanchankumar *et al.* 2012). Cephalic breadth was measured spreading caliper (model M-HT10136; manufactured by Hank minerals) as the distance between the two euryons (Kanchankumar *et al.* 2012). Cephalic index was calculated as the ratio of head breadth to head length multiplied by 100 (Kanchankumar *et al.* 2012). Facial length was measured using vernier caliper (model M-6 150mm LCD guage; manufactured by Crimp Supply) as the distance between the nasion and gnathion (Farkas *et al.* 2005). Facial breadth was measured with spreading caliper (model M-HT10136; manufactured by Hank minerals) as the distance between the two zygomatic arches (Kanchankumar *et al.* 2012). Nasal length was measured with vernier caliper (model M-6 150mm LCD guage; manufactured by Crimp Supply) as the distance between the nasion and pronasale (Farkas *et al.* 2005). Nasal breadth was measured using vernier caliper (model M-6 150mm LCD guage; manufactured by Crimp Supply) as the distance between the two ala of the nose (Farkas *et al.* 2005). Height was measured with a stadiometer as the distance between the calvaria and the sole of the foot (Kanchankumar *et al.* 2012). Body mass (weight) was measured while the subject was wearing minimal clothing, stands in the center of the scale platform and recorded to the nearest tenth of a kilogram. Skinfold thicknesses were measured by raising a fold of skin and subcutaneous tissue firmly between thumb and forefinger of the left hand and away from the underlying muscle. The edge of the plates on the caliper were placed 1 cm below the fingers of the left hand and were allowed to exert their full pressure before reading at 2 sec the thickness of the fold. All skinfolds were measured on the right side of the body. Triceps skinfold was measured with the subject's arm hanging loosely in the anatomical position, a skinfold was raised at the back of the arm at a level halfway on a line connecting the acromion and the olecranon processes. Subscapular skinfold was measured by raising a fold of skin on a line from the inferior angle of the scapula in a direction that is obliquely downwards and laterally at 45 degrees. Supraspinale skinfold was measured when a fold of skin was raised above the anterior superior iliac spine on a line to the anterior axillary border and on a diagonal line going downwards and medially at 45 degrees. Medial calf skinfold was measured by raising a vertical skinfold on the medial side of the leg, at the level of the maximum girth of the calf (Carter and Heath, 1990).

The following formulae were used to determine the somatotypes:

Endomorphy = $-0.7182 + 0.1451 (X) - 0.00068 (X^2) + 0.0000014 (X^3)$

Where X = (sum of triceps, subscapular and supraspinale skinfolds (mm)) × (170.18/height (cm))

Mesomorphy = 0.858 × humerus breadth (cm) + 0.601 × femur breadth (cm) + 0.161 × arm girth (cm) + 0.161 × calf girth (cm) height (cm) 0.131 + 4.5

Ectomorphy: The following are formulae for ectomorphy depending on the value of height-weight ratio (HWR): -

Height-weight ratio (HWR) = $\frac{\text{Height}}{3\sqrt{\text{Weight}}}$

- Ectomorphy = 0.732 HWR - 28.58 **(If HWR is ≥ 40.75)**
- Ectomorphy = 0.463 HWR- 17.63 **(If HWR is < 40.75 > 38.25)**
- Ectomorphy = 0.1 **(If HWR is ≤ 38.25)**

(Carter and Heath, 1990).

An extreme somatotype will be 711, 171 and 117 for Endomorph, Mesomorph and Ectomorph respectively (Carter and Heath, 1990).

Measurement Error

Measurement error was determined using intra class correlation (ICC). Repeated measure was employed at an interval of one week and the average of the two measurements was taken.

The Cronbach's Alpha of the parameters measured ranged from 0.82 to 1, except for cephalic breadth that have 0.72. Where Cronbach's Alpha of > 0.70 indicates strong reliability (Cochran, 1977). The measurements were carried out on only 30 selected participants.

Statistical Analyses

Data was analyzed using SPSS (IBM, corporation, NY) version 20. Data were expressed as descriptive statistics (mean ± standard deviation) for the directly measured variables. Kolmogorov-Smirnov normality test was performed to check the distribution nature of the directly measured data. Since the data were not normally distributed, non-parametric tests were used. Comparisons of cephalofacial dimensions, somatotypes of two sexes was made using Mann-Whitney U test, relationship between cephalofacial variables and somatotypes was made using Spearman correlation, the stepwise logistic regression analyses was performed to predict the somatotypes from cephalofacial anthropometry. Statistical significance was declared at $P<0.05$.

RESULTS

Table 1 shows descriptive statistics and distribution of selected cephalofacial measurements, somatotype measurements and components. It was observed that the average cephalic length was greater than average cephalic breadth. In somatotype measurements height recorded higher mean value than the rest.

Table 2 shows sexual dimorphism in selected cephalofacial anthropometry and somatotype measurements among adolescents of Ngamo ethnic group in Fika LGA of Yobe State. A significant sexual dimorphism was observed in height (P=0.046), cephalic breadth (P<0.001), cephalic length (P<0.001), cephalic index (P<0.001), facial breadth (P<0.001), facial length (P=0.001), nasal breadth (P<0.001), nasal index (P<0.001), biepicondylar breadth of humerus (P<0.001), biepicondylar breadth of femur (P<0.001), triceps skin fold (P<0.001), subscapular skin fold (P<0.001), supraspinale skin fold (P<0.001), medial calf skin fold (P<0.001) and calf circumference (P<0.001). In all the variables that exhibited significant sexual dimorphism the males have higher values except for triceps skin fold, subscapular skin fold, supraspinale skin fold, medial calf skin fold and calf circumference where females exhibit higher values.

Figure 1 shows sexual dimorphism in somatotype components among adolescent age group of Ngamo ethnic group in Fika LGA of Yobe State. It was documented that endomorph have significant sexual dimorphism (P<0.05) with female having the higher number; mesomorph have significant sexual dimorphism (P<0.05) in with males having higher values; and ectomorphs did not exhibit significant sexual dimorphism (P=0.126).

Table 3 shows correlation between selected cephalofacial anthropometry and somatotype components among adolescents of Ngamo ethnic group in Fika LGA of Yobe state. Cephalic length, cephalic breadth and facial breadth recorded significant correlation (P<0.001) with mesomorphs and ectomorphs. Cephalic, nasal and facial indices correlate significantly with mesomorph (P<0.001). Facial length correlates significantly with mesomorph (P<0.05) and ectomorph (P<0.001).

Table 4 shows prediction of endomorph, mesomorph and ectomorph from cephalofacial anthropometry among adolescents of Ngamo ethnic group in Fika LGA of Yobe State. In females, it was observed that cephalic length and facial breadth significantly predicted endomorph (P= 0.003 and P= 0.008), it was also observed that cephalic breadth (P= 0.002) and facial breadth (P<0.001) significantly predicted mesomorph, cephalic breadth and facial breadth also predicted ectomorph significantly (P<0.001). And in males, cephalic breadth (P<0.001) and facial length (P=0.027) significantly predicted endomorph, cephalic length (P= 0.002), cephalic length and breadth (P= 0.001) and facial breadth (P<0.001) predicts mesomorph significantly. And cephalic breadth (P<0.001) and facial breadth (P=0.001) significantly predicted ectomorph.

Table 1: Descriptive Statistics and Distribution of Selected Cephalofacial Anthropometry, Somatotype Measurements and Components

Variables	Min-Max	Mean ±S D
Age (Years)	12-19	15.46±1.82
Height (cm)	128.00-184.30	158.06±9.55
Weight (kg)	25.00-96.00	45.48±10.15
Cephalic Breadth (cm)	8.00-19.00	13.73±1.14
Cephalic Length (cm)	11.00-24.00	18.45±1.35
Cephalic Index	44.44-118.18	74.69±7.33
Facial Breadth (mm)	60.00-140.00	113.45±8.57
Facial Length (mm)	71.67-133.57	106.15±7.95
Facial Index	61.07-160.46	107.27±9.25
Nasal Length (mm)	29.43-59.32	43.28±4.27
Nasal Breadth (mm)	23.56-52.70	37.80±3.94
Nasal Index	50.70-127.09	88.13±12.04
Biepicondylar B H (mm)	30.09-84.90	61.15±6.28
Biepicondylar B F (mm)	54.24-126.91	82.56±8.96
Triceps S F (mm)	3.30-32.40	10.09±4.51
Subscapular S F (mm)	2.90-31.50	10.11±3.89
Supraspinale S F (mm)	2.20-30.60	9.48±4.15
Medial Calf S F (mm)	3.80-34.50	11.14±4.67
Arm Circumference (cm)	13.80-39.00	22.91±3.09
Calf Circumference (cm)	19.50-45.00	29.58±3.23
Endomorph	0.629-8.042	3.191±1.160
Mesomorph	-1.765-11.63	3.071±1.473
Ectomorph	0.100-10.322	4.096±1.503

BH= Biepicondylar breadth of humerus, BF= Biepicondylar breadth of femur, SF= Skinfold

Table 2: Sexual Dimorphism in Selected Cephalofacial Anthropometry and Somatotype Measurements among Adolescents of Ngamo Ethnic Group in Fika LGA of Yobe State

	Mean ± S D		
Variables	Female	Male	P value
Age (Years)	15.10±1.62	15.83±1.95	0.06
Height (cm)	157.11±7.89	159.07±10.97	0.046
Weight (kg)	44.68±9.24	46.33±10.99	0.107
Cephalic Breadth (cm)	13.27±1.21	14.21±0.83	<0.001
Cephalic Length (cm)	18.13±1.47	18.79±1.11	<0.001
Cephalic Index	73.64±8.77	75.81±5.23	<0.001
Facial Breadth (mm)	111.67±8.53	115.32±8.23	<0.001
Facial Length (mm)	104.99±8.24	107.37±7.45	0.001
Facial Index	106.88±10.34	107.68±7.94	0.498
Nasal Length (mm)	43.56±4.05	42.99±4.47	0.07
Nasal Breadth (mm)	36.47±3.26	39.21±4.11	<0.001
Nasal Index	84.49±11.08	91.96±11.86	<0.001
Biepicondylar B H (mm)	59.51±6.12	62.87±6.00	<0.001
Biepicondylar B F (mm)	78.08±6.74	87.28±8.59	<0.001
Triceps S F (mm)	12.39±4.83	7.66±2.40	<0.001
Subscapular S F (mm)	11.42±4.39	8.73±2.66	<0.001
Supraspinale S F (mm)	10.67±4.69	8.23±3.04	<0.001
Medial Calf S F (mm)	13.69±4.64	8.45±2.86	<0.001
Arm Circumference (cm)	22.75±2.97	23.08±3.21	0.306
Calf Circumference (cm)	28.99±2.92	30.20±3.41	<0.001

B H=Breadth of Humerus. B F= Breadth of Femur, S F= Skin fold

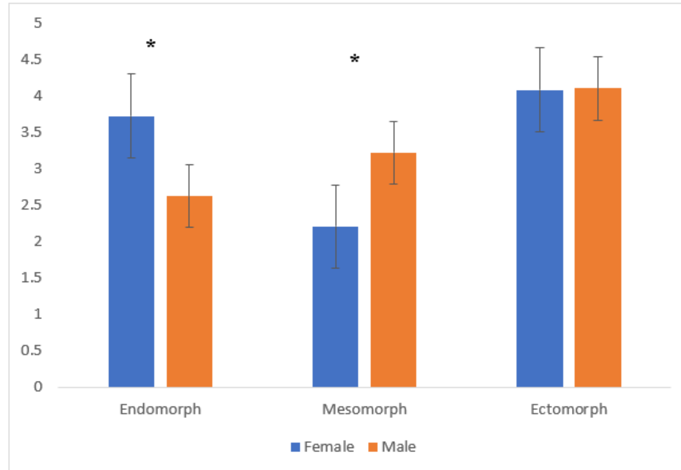

Figure 1: Sexual Dimorphism in Endomorph, Mesomorph and Ectomorph among Adolescent Age Groups of Ngamo Ethnic Group in Fika LGA of Yobe State (* *P*<0.05)

Table 3: Correlation between Selected Cephalofacial Anthropometry and Somatotype components among Adolescents of Ngamo Ethnic Group in Fika LGA of Yobe State

Variables	Endomorph	Mesomorph	Ectomorph
Cephalic Breadth (cm)	-0.120*	0.290**	-0.187**
Cephalic Index	-0.062	0.161**	-0.091
Cephalic Length (cm)	-0.046	0.162**	-0.132**
Facial Breadth (mm)	0.061	0.272**	-0.299**
Facial Length (mm)	0.063	0.114*	-0.180**
Facial Index	0.006	0.134**	-0.102*
Nasal Length (mm)	0.035	-0.092	0.027
Nasal Breadth (mm)	-0.074	0.216**	-0.166
Nasal Index	-0.091	0.223**	-0.121*

DISCUSSION

Modern human is inclined to making comparison of various body parts in living or in cadaver for research and knowledge purpose (Kolar and Salter, 1997). It was evident that head length and breadth are determinant factors in differentiating between sexes of the Malays (Ngeow and Aljunid, 2009) which is similar to the result obtained in the present finding.

Agnihotri *et al.* (2011) conducted a study on young and healthy students of age group ranging from 20 to 28 years and deduced that stature was significantly correlated with head length. This is in agreement with the present study. Krishan, 2008 also suggested that cephalic length and breadth are positively and significantly correlated with stature.

Bojadzieva *et al.* (2018) conducted a study on 11 years old Macedonian and Alabanian adolescents and recorded no

Table 4: Prediction of Endomorph, Mesomorph and Ectomorph from Cephalofacial Anthropometry among Adolescents of Ngamo Ethnic Group in Fika LGA of Yobe State

	Gender	Step	Equation (DV=β×IV + Constant)	r^2	SEE	F	P
Endomorph	**Female**	1	Endo=0.189(CL)+0.020	0.116	0.880	9.541	0.003
		1	Endomorph=0.018(FB)+1.153	0.018	1.150	7.012	0.008
	Male	1	Endo=0.309(CB)+(-1.763)	0.110	0.716	24.393	<0.001
		1	Endomorph=0.026(FL)+0.390	0.038	0.955	5.017	0.027
Mesomorph	**Female**	1	Meso= (0.188CB)+(-3.123)	0.063	1.490	6.689	0.002
		1	Meso=0.055(FB)+(-3.194)	0.103	1.399	44.752	<0.001
	Male	1	Meso= (0.337CL)+(-9.838)	0.224	1.113	7.355	0.002
		2	Meso= (0.23CB)+(0.431CL)+ (-9.231)	0.290	1.075	6.795	0.001
		1	Meso=0.049(FB)+(-2.652)	0.046	1.386	15.161	<0.001
Ectomorph	**Female**	1	Ecto=(-0.216CB)+12.324	0.132	1.605	11.637	<0.001
		1	Ecto=(-0.054FB)+10.242	0.093	1.431	41.103	<0.001
	Male	1	Ecto=(0.057CB)+10.655	0.132	1.199	28.848	<0.001
		1	Ecto=(-0.046FB)+9.311	0.053	1.467	11.565	0.001

DV =dependent variable, β =coefficient of independent variable, IV =independent variable, CB=Cephalic breadth, CL=Cephalic length, FB = Facial breadth

significant sexual dimorphism in all the somatytope components among Macedonian adolescents which is disagrees with the present study that shows significant sexual dimorphism in endomorph and mesomorph with females being more endomorphic and males more mesomorphic. The disagreement in the findings might be because of the age as the previous researcher did his work on 11 years subjects. While Alabanian females recorded more endomorphic characters than their male counterparts and males have more mesomorphic characters than females (Bojadzieva *et al.* 2018) which is in agreement with the present result. Similarly, in Mexico, Urrutia-Garcia *et al.* (2015) documented significant sexual dimorphism in endomorph and mesomorph with females endomorphic and males mesomorphic which also agrees with the present finding. This is due to the fact that females are built with predominantly adipose tissue and fats within their superficial fascia thereby bringing about roundness of the body and males are muscular in nature.Agnihotri *et al.* (2011) conducted a study on young and healthy students of age group ranging from 20 to 28 years and deduced that stature was significantly correlated with facial length among females while among the males, stature was significantly correlated with head length, nasal breadth and morphological facial length. This is in agreement with the present study. Krishan, (2008) also suggested that cephalofacial parameters (cephalic length and breadth; facial length and breadth) are positively and significantly correlated with stature, and that cephalic length and breadth show stronger correlation than facial length and breadth.

The estimation of somatotype from body parts involves specialized anthropometric techniques applied with great precision. For such estimation, regression analysis is the best method as far as the accuracy or reliability of the estimate is concerned (Iscan, 2005). Studies have demonstrated a strong correlation between cephalic measurements and somatotype, allowing for accurate prediction of somatotype from cephalic length and breadth (Agnihotri *et al.* 2011; Krishan and Kumar, 2007; Ukoha *et al.* 2016). This correlation have been observed in diverse populations, including Malays (Ngeow and Aljunid, 2009), Igbo people (Ewunonu and Anibeza, 2013), Punjabi subjects (Seema, 2011), North Indian population (Krishan and Kumar, 2007) and Kosovo Albanian populations (Rexhepi and Brestovci, 2015). Moreover, cephalic measurements have been shown to predict somatotype with significant accuracy independent of age and racial factors (Krishan, 2008; Wankhede *et al.* 2015). The present study confirms these findings, demonstrating that cephalofacial measurements can reliably predict somatotype of adolescents regardless of ethnicity and race.

Conclusion

It can be concluded that cephalic parameters, somatotype measurements and components are sexually dimorphic. Somatotypes can be predicted significantly from cephalic measurements and cephalic breadth is the best predictor of somatotype components among adolescent population of Ngamo ethnic origin of Yobe state Nigeria.

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Conflict of Interest

No conflict of interest declared among the team members.

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