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Patterns of Nasal Anthropometry in relation to Dominant Somatotypes among Hausa Adolescents of Kano State, Northwestern Nigeria

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ABSTRACT

Craniofacial anthropometry has important applications in forensic science, clinical practice, and biological profiling. Nasal morphology varies across populations and is influenced by genetic, environmental, and developmental factors. Somatotype is also an important tool for describing body composition and structural variation. Although numerous studies have investigated nasal anthropometry and somatotypes independently, there is limited data on the relationship between nasal anthropometry and somatotypes among adolescents. The study aimed to determine the relationship between nasal anthropometry and somatotypes among Hausa adolescents in Kano State. The study was conducted among adolescents selected from schools within the Kano metropolis using a random sampling. A total of 392 male and female participants were recruited. Sex differences in somatotypes and nasal variables were assessed using the Mann–Whitney U test. Spearman's correlation analysis was applied to determine associations between somatotypes and nasal anthropometry, while linear regression was used to predict somatotypes from nasal parameters. Statistical significance was set at $p<0.05$. We observed significant sexual dimorphism in somatotypes, where females and males recorded higher values in endomorph and mesomorph, respectively. Significant sexual dimorphism was also observed in nasal breadth and nasal index, where males exhibited higher values. Furthermore, nasal anthropometry demonstrated significant predictive capacity for somatotypes, with nasal breadth emerging as the strongest predictor. Nasal anthropometric parameters and dominant somatotypes exhibited significant sexual dimorphism; nasal parameters demonstrated a meaningful association with dominant somatotypes. Furthermore, nasal anthropometry showed predictive potential for dominant somatotypes with nasal breadth as the most reliable predictor among Hausa adolescents in Kano State, Nigeria.

Keywords: adolescents, lineage, somatotype, physique, regression

INTRODUCTION

Anthropometric studies involve scientific methods and techniques used to obtain quantitative measurements and observations of the human body and skeletal framework. These studies represent an important domain within anatomical sciences, particularly in craniofacial surgery and syndromology [1]. Human morphological variation is a universal phenomenon influenced by factors such as mutation and natural selection. A study has demonstrated the usefulness of anthropometric measurements in documenting variation among human populations and their relevance in forensic science, particularly in criminal investigations [2].

Somatotype is a classification system used to describe body physique or build. The concept of somatotype and its three components, endomorph, mesomorph, and ectomorph were first introduced by Sheldon and his colleagues in 1940. According to this classification, endomorphy reflects a predominance of soft tissue roundness, mesomorphy indicates relative dominance of muscular and skeletal development, while ectomorphy denotes linearity and structural delicacy [3]. Subsequently, Heath and Carter developed a simplified and more practical approach to somatotyping[3]. Over the past few decades, anthropometric somatotyping has become one of the most widely applied methods for describing body shape and composition. It has been extensively utilized in studies examining physique variation

across different age groups and sexes within various populations [4,3].

Craniofacial measurements constitute a fundamental aspect of anthropological research and are widely employed to assess variation in facial morphology. Craniofacial anthropometry relies on objective linear and proportional measurements that facilitate the characterization of phenotypic variation and the quantification of dysmorphology [5,6]. Despite extensive documentation of nasal anthropometry and somatotype independently, limited attention has been given to their interrelationship, particularly among adolescent populations. This study, therefore, seeks to investigate the relationship between nasal anthropometric parameters and dominant somatotypes among Hausa adolescents in Kano State, Nigeria.

Many of the research studies reported significant sexual dimorphism in dominant somatotypes. A study in Macedonia reported that adolescent males and females are more endomorphic; they also reported that Albanian adolescent males are mesomorphic and females are ectomorphic[16]. Buffa and his colleagues recorded mesomorphic male Sardinians and endomorphic female Sardinians[24]. There is also another study that showed both male and female Venezuelans to be mesomorphic [25].

Turkish males reported a longer nose, and females have broad type of nose[26].

MATERIALS AND METHODS

Study population

The study was carried out among adolescents attending selected secondary schools within Kano metropolis, Kano State, Nigeria. A random sampling technique was employed. All secondary schools within the selected local government areas were first enumerated, after which two schools were randomly chosen from each local government area. A total of 392 adolescents, comprising both males and females, participated in the study. Eligible participants were Hausa adolescents aged between 12 and 19 years. Inclusion criteria required that participants belonged to the selected secondary schools, were of Hausa ethnic origin, and had no observable physical deformity affecting the anatomical regions of interest. Ethical approval for the study was obtained from the Kano State Ministry of Health Ethics Committee. Informed consent was secured before data collection.

Collection of biodata and somatotype measurements

A structured proforma was used to obtain participants' biodata, including age, sex, and ethnicity. Standardized anthropometric procedures were followed for all measurements. Nasal length was measured using a vernier caliper, while nasal breadth was obtained using a spreading caliper. Stature was measured with a stadiometer, and body weight was recorded using a weighing scale.

Skinfold thicknesses, including triceps, subscapular, supraspinale, and medial calf, were measured using a skinfold caliper. Biepicondylar breadths of the humerus and femur were assessed with a vernier caliper, while arm and calf circumferences were measured using a flexible measuring tape. Nasal length was defined as the linear distance between the nasion and pronasale, while nasal breadth was measured as the maximum distance between the two alae of the nose. The nasal index was calculated as the ratio of nasal breadth to nasal length. Stature was measured with participants standing erect against a vertical surface or stadiometer, ensuring contact with the heels, buttocks, and upper back. Body mass was recorded to the nearest 0.1 kg with participants wearing minimal clothing and standing centrally on the scale platform[5].

Skinfold measurements

Skinfold measurements were obtained by firmly grasping a fold of skin and subcutaneous tissue between the thumb and forefinger of the left hand, ensuring separation from the underlying muscle. The caliper jaws were applied approximately 1 cm below the fingers, and full pressure was allowed before reading the measurement at 2 seconds. All skinfold measurements were taken on the right side of the body.

The triceps skinfold was measured with the arm relaxed in the anatomical position, midway between the acromion and olecranon processes on the posterior aspect of the arm. The subscapular skinfold was measured by raising a fold of skin below the inferior angle of the scapula along an oblique line running downward and laterally at approximately 45 degrees. The supraspinale skinfold was obtained above the anterior superior iliac spine along a diagonal line extending downward and medially at 45 degrees. This site was formerly referred to as the suprailiac skinfold but was renamed to distinguish it from other suprailiac locations. The medial calf skinfold was measured as a vertical fold on the medial aspect of the leg at the level of maximum calf girth[3].

Measurement error

Measurement reliability was assessed using intraclass correlation coefficients (ICC). Repeat measurements were obtained after a one-week interval, and the mean of the two measurements was used for analysis. Cronbach's alpha values for the measured parameters ranged from 0.82 to 1.00, indicating strong internal

consistency and measurement reliability, as values greater than 0.70 are considered acceptable[21].

Ethical consideration

Ethical clearance for the study (MOH/Off/797/T.I/1915) was granted by the Kano State Ministry of Health Ethics Committee. Consent forms were signed by the principals of the selected secondary schools, who acted as legal guardians for the students. A proforma was used to document biodata and record all measured variables for the research participants.

Statistical analysis

Descriptive statistics, expressed as mean ± standard deviation, were computed for all directly measured variables. Sex differences in nasal anthropometric parameters, somatotype variables, and dominant somatotypes were assessed using the Mann–Whitney U test. Relationships between nasal parameters and somatotypes were examined using Spearman's correlation analysis. Linear regression analysis was employed to predict dominant somatotypes from nasal anthropometric variables. Statistical significance was established at $p < 0.05$. Data analysis was performed using SPSS software (IBM Corporation, New York, USA), version 20.

RESULTS

Table 1 presents the descriptive statistics and distribution characteristics of selected nasal anthropometric variables, somatotype measurements, and somatotype components. The findings indicate that the mean nasal length exceeded the mean nasal breadth within the study population. Among the somatotype-related variables, stature recorded the highest mean value relative to other parameters. Analysis of distribution revealed negative skewness for height and bi-epicondylar breadth of the humerus, while age exhibited negative kurtosis. Subscapular skinfold thickness and ectomorphy demonstrated the highest and lowest skewness values, respectively. With respect to kurtosis, subscapular skinfold thickness showed the highest value, whereas age exhibited the lowest.

Table 2 illustrates sexual dimorphism in selected nasal anthropometric and somatotype variables among Hausa adolescents in Kano State. Statistically significant sex differences were observed for age, stature, nasal breadth, nasal index, bi-epicondylar breadths of the humerus and femur, triceps skinfold, subscapular skinfold, supraspinale skinfold, medial calf skinfold, and calf circumference. For all variables exhibiting significant sexual dimorphism, males demonstrated higher mean values than females. Sex-related differences in nasal dimensions further revealed that nasal breadth and nasal index were significantly greater in males compared to females, whereas nasal length did not demonstrate a statistically significant difference between the sexes. In relation to somatotype-related variables, significant sexual dimorphism was evident in several skeletal breadths and skinfold measurements, with males generally presenting larger skeletal dimensions and females exhibiting higher skinfold thickness values in selected regions.

Figure 1 depicts the distribution of dominant somatotypes by sex among Hausa adolescents. Significant sexual dimorphism was observed in endomorphy and mesomorphy, while no significant sexual dimorphism was observed in ectomorphy. Females recorded higher mean endomorphic values, males exhibited significantly higher mesomorphic values, while females recorded slightly higher ectomorphic values, which was not significant within the study population.

Figure 2 shows the frequency distribution of dominant somatotypes among the participants. Endomorphy emerged as the most prevalent dominant somatotype, accounting for approximately 53.1% of the population, followed by mesomorphy at 45.4%. Ectomorphy was least represented, comprising only 1.5% of the study population.

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Table 3 presents the correlation between selected nasal anthropometric parameters and dominant somatotypes. Nasal breadth and nasal index demonstrated statistically significant correlations with mesomorphic and ectomorphic somatotypes, whereas nasal length did not show a significant association with any of the somatotype components.

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Table 1: Descriptive Statistics and Distribution of Selected Nasal Anthropometry and Somatotype Variables

Variables	Min-Max	Mean ±S D	Skewness	Kurtosis
Age (Years)	12-19	15.46±1.82	0.13	-0.78
Height (cm)	128.00-184.30	158.06±9.55	-0.25	0.13
Weight (kg)	25.00-96.00	45.48±10.15	0.75	1.51
Nasal Length (mm)	29.43-59.32	43.28±4.27	0.19	0.60
Nasal Breadth (mm)	23.56-52.70	37.80±3.94	0.15	0.99
Nasal Index	50.70-127.09	88.13±12.04	0.11	0.63
Biepicondylar B H (mm)	30.09-84.90	61.15±6.28	-0.08	1.58
Biepicondylar B F (mm)	54.24-126.91	82.56±8.96	0.44	1.34
Triceps S F (mm)	3.30-32.40	10.09±4.51	1.70	3.68
Subscapular S F (mm)	2.90-31.50	10.11±3.89	2.08	6.66
Supraspinale S F (mm)	2.20-30.60	9.48±4.15	1.96	5.46
Medial Calf S F (mm)	3.80-34.50	11.14±4.67	1.37	2.86
Arm Circumference (cm)	13.80-39.00	22.91±3.09	0.90	2.68
Calf Circumference (cm)	19.50-45.00	29.58±3.23	0.64	2.25

Table 2: Sexual Dimorphism in Selected Nasal Anthropometry and Somatotype Variables among Adolescents of Hausa Ethnic Group in Kano State

Variables	Min-Max	Mean ±S D	Skewness	Kurtosis
Age (Years)	12-19	15.46±1.82	0.13	-0.78
Height (cm)	128.00-184.30	158.06±9.55	-0.25	0.13
Weight (kg)	25.00-96.00	45.48±10.15	0.75	1.51
Nasal Length (mm)	29.43-59.32	43.28±4.27	0.19	0.60
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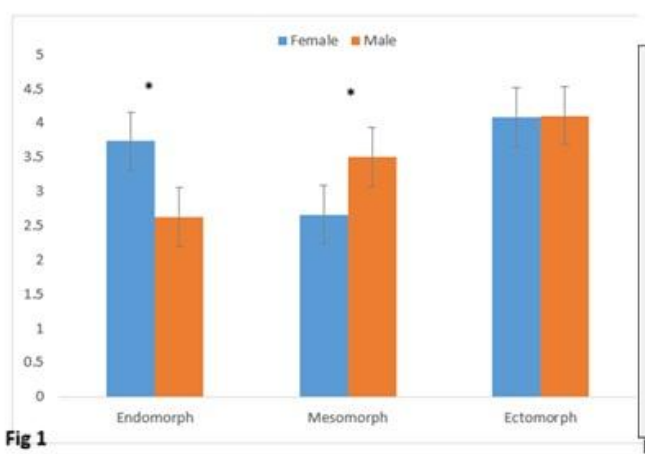
Supraspinale S F (mm)	2.20-30.60	9.48±4.15	1.96	5.46
Medial Calf S F (mm)	3.80-34.50	11.14±4.67	1.37	2.86
Arm Circumference (cm)	13.80-39.00	22.91±3.09	0.90	2.68
Calf Circumference (cm)	19.50-45.00	29.58±3.23	0.64	2.25



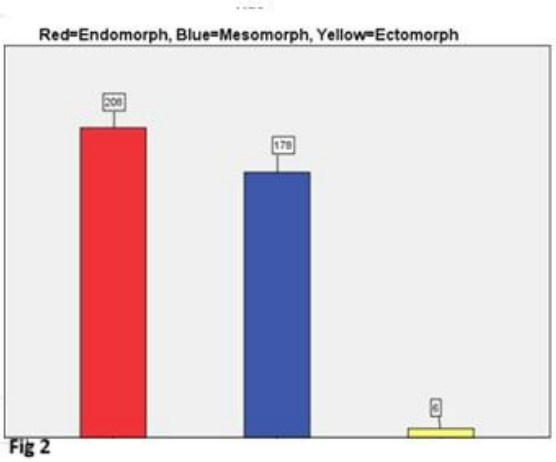
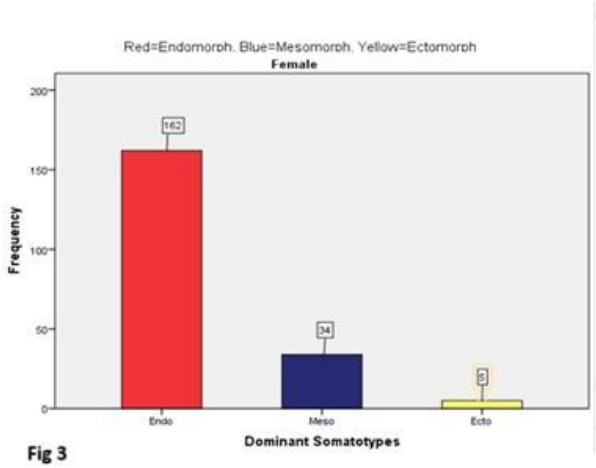


Figure 1: Sexual dimorphism in dominant somatotypes among adolescents of Hausa Ethnic Group in Kano State (* p <0.05). **Figure 2:** Frequency Distribution of Dominant Somatotypes among Adolescents of the Hausa Ethnic Group in Kano State.



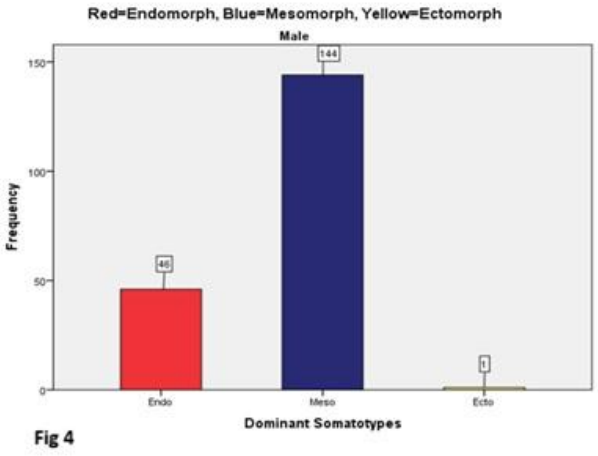


Figure 3: Frequency Distribution of Dominant Somatotypes among Female Adolescents of the Hausa Ethnic Group in Kano State. **Figure 4:** Frequency Distribution of Dominant Somatotypes among Male Adolescents of the Hausa Ethnic Group in Kano State.

Table 3: Correlation between Selected Nasal Anthropometry and Dominant Somatotypes among Adolescents of the Hausa Ethnic Group in Kano State

Variables	Endomorph	Mesomorph	Ectomorph
Nasal Length (mm)	0.035	-0.092	0.027
Nasal Breadth (mm)	-0.074	-0.216**	-0.166**
Nasal Index	-0.091	-0.121*	-0.659**

* p <0.05, ** p<0.001 n=392

Table 4: Prediction of Dominant Somatotypes from Nasal Anthropometry among Adolescents of the Hausa Ethnic Group in Kano State

Somatotype	Equation (DV=β×IV + Constant)	r^2	SEE	F	P
Endomorph	Endo = -0.481(NL) + (-0.131)	0.018	1.150	37.012	0.076
	Endo = 0.476 (NB) + 0.140	0.212	1.553	42.650	0.112
	Endo = -0.703(NI) + (-0.068)	0.321	1.654	40.254	1.234
Mesomorph	Meso = -0.367 (NL) + (-0.130)	0.103	1.399	44.752	0.155
	Meso = 0.519 (NB) + 0.194	0.139	1.372	31.492	<0.001
	Meso = -0.393 (NI) + (-0.048)	0.149	1.366	22.732	0.041
Ectomorph	Ecto = 0.498 (NL) + 0.176	0.093	1.431	41.103	0.781
	Ecto = -0.606 NB + (-0.231)	0.214	1.214	43.012	<0.001
	Ecto = 0.595 (NI) + 0.074	0.135	1.378	44.047	<0.001

DV = dependent variable, β = coefficient of independent variable, I V = independent variable, NL = Nasal length, CL= Cephalic length, Endo= Endomorph, Meso= Mesomorph, Ecto= Ectomprph

DISCUSSION

Cephalofacial anthropometry has long been recognized as a valuable tool in biological profiling, particularly for sex estimation in forensic and anthropological contexts. Several studies have demonstrated that craniofacial dimensions, including nasal parameters, exhibit measurable sexual dimorphism and can be applied with considerable accuracy for sex determination[1,2]. Nasal anthropometry focuses on quantifying nasal size, shape, and proportional relationships, thereby providing objective indices for evaluating phenotypic variation within and between populations[5].

The nasal index remains one of the most informative cephalofacial parameters used in both inter- and intra-population morphological classification. It has been widely applied in describing nasal morphology among populations residing in different climatic and geographical regions[5]. In the present study, significant sexual dimorphism was observed in nasal breadth and nasal index, with males demonstrating higher mean values than females. These findings are consistent with reports among the Tiv and Idoma ethnic groups in Nigeria, where males exhibited significantly larger nasal dimensions[8]. Similar observations have also been documented among populations in northern India, further supporting the biological basis of sex-related variation in nasal morphology[9].

Sexual dimorphism was also evident in postcranial skeletal breadths, particularly the biepicondylar breadths of the humerus and femur. The significantly higher values recorded among males align with findings reported in German, French, Thai, Chinese, and Indian populations [10–15]. Although most previous investigations focused on adult populations, the present findings demonstrate that such sex-based differences are already established during adolescence among the Hausa population of Kano State. This suggests that sexual differentiation in skeletal breadths occurs early and remains relatively stable across age groups and ethnic backgrounds, thereby enhancing their forensic applicability.

Regarding dominant somatotypes, the present study revealed significant sexual dimorphism in endomorphy and mesomorphy. Females exhibited higher endomorphic tendencies, whereas males demonstrated greater mesomorphic characteristics. These findings are consistent with earlier studies conducted among Balkan and Mexican adolescent populations, which similarly reported higher adiposity-related components in females and greater muscularity in males[16,17].

Stature is considered one of the most critical parameters in biological identification due to its strong association with multiple body segments, including craniofacial dimensions[18]. Regression-based approaches have demonstrated reliable stature estimation from skeletal and soft-tissue measurements[18,19]. Previous studies have also documented significant relationships between nasal dimensions and stature, supporting the concept of proportional growth between craniofacial structures and overall body size [2,21].

In the present study, nasal breadth and nasal index showed significant correlations and predictive

capacity for mesomorphic and ectomorphic somatotypes. Given that stature constitutes an essential component of somatotype assessment, these findings suggest an indirect but meaningful association between nasal morphology and body build. Overall, the findings highlight the combined anthropological and forensic relevance of nasal anthropometry and somatotype analysis among Hausa adolescents, particularly for sex estimation and biological profiling within population-specific contexts.

CONCLUSION

Nasal anthropometric parameters and somatotype components demonstrated clear sexual dimorphism among Hausa adolescents in Kano State, with significant associations observed between nasal measurements and dominant somatotypes. Nasal anthropometry also showed predictive utility for somatotype determination, with nasal breadth identified as the strongest predictor.

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Conflict of interests

The authors have no conflict of interest to declare.

Authors' contribution

AMG – Data collection, manuscript writeup; MIS – Data collection, Analyses; MU – Analyses; TMM – Interpretation; LHA – Design, Analyses

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