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Comparative Analysis of Craniofacial Parameters of the Atyap, Bajju, Chawai and Ham Ethnic Groups from Southern Kaduna, Kaduna State, Nigeria.

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ABSTRACT

Populations vary genetically and geographically in their craniofacial features, which are largely influenced by race, age, sex, and culture. The aim of this study was to comparatively analyze the craniofacial parameters of the Atyap, Bajju, Chawai, and Ham ethnic groups from southern Kaduna, Kaduna State. These ethnic groups share common geographical and cultural attributes. The study involved 830 subjects: 210 Atyap (121 males, 89 females), 200 Bajju (117 males, 83 females), 215 Chawai (134 males, 81 females), and 205 Ham (116 males, 89 females), aged between 17 and 50 years. The data were collected randomly using a systematic sampling method from districts covering the four ethnic groups. The results showed that there is a significant difference between males and females of the four ethnic groups in their craniofacial parameters, except in the middle 3rd parameter. Additionally, the results showed sexual dimorphism between males and females of the four ethnic groups, except for the Chawai ethnic group. In conclusion, the study indicates that there is a significant difference in the craniofacial parameters of the four ethnic groups. The ethnic groups have mesocephalic cranial shapes and hyper-euryprosopic facial shape

Keyword: Craniofacial**,** Parameters, photogrammetric, facial index, cranial index.

INTRODUCTION

Variations of the human face are so extensive and obvious that one can distinguish even identical twins with relative ease. The reason for and substance of these variations and differences are more difficult to define unless they are carefully studied and measured [1].

Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of the human body and skeleton, it has a long tradition of use in forensic sciences and medical sciences, especially in the discipline of forensic medicine [2].

Swedish Professor of Anatomy, Anders Retzius (1796– 1860), first used the cephalic index in physical anthropology to classify ancient human remains found in Europe. He classified head form into three main categories, "dolichocephalic" (long and thin), "brachycephalic" (short and broad), and "mesocephalic" (intermediate length and width), The measures used by Retzius when applied to living individuals are known as a cephalic index, when applied to dry skulls are known as cranial index [3. 4]. The term used to describe the taking of precise measurements from photographs is photogrammetry, it is the measurements taken from photographs rather than from bodies of living or Cadaver. Two-dimensional (2D), photogrammetry has the advantage of being a basic, non-invasive, cost-effective, and quick method that requires minimal time and equipment in the assessment of soft tissue [5]. The craniofacial features of a person are unique and critical in the evaluation of the age, gender, and ethnic background of individuals [6].

The aim of the study is to characterize the craniofacial parameters of the Atyap, Bajju, Chawai, and Ham Ethnic Groups from Southern Kaduna, Kaduna State. Additionally, it seeks to compare the cranial and facial indices of these ethnic groups and investigate the occurrence of sexual dimorphism and probable gene flow between the four ethnic groups by using the craniofacial parameters as a proxy.

The cephalic index is measured as the breadth of the skull multiplied by 100 and divided by length. The Cephalic index is classified into three broad categories: dolichocephalic (less than 75), mesocephalic (75 to less than 80), and brachycephalic (80 and above). Australian and native Southern Africans have dolichocephalic skulls, Chinese and European skulls are mesocephalic, and Andaman Islanders and Mongolians have brachycephalic skulls [7, 8.]

Classification of the head according to the cephalic Index.

Head shape	Range of cephalic index
1. Hyper dolichocephalic (very long and narrow head)	65.5-69. 9
2. Dolichocephalic (long and narrow head)	70.0-74.9
3. Mesocephalic (average head)	75.0-79.9
4. Brachycephalic (broad and short head)	80.0-84.9
5. Hyper brachycephalic (very broad and short head)	85.0-89.9

(Kumari *et al.*, 2015; Shah and Koraila, 2015).

The Cranial index is calculated using the formula below

$$\text{Cranial Index (CI)} = \frac{\text{Head width}}{\text{Head Length}} \times 100$$

The facial index is the ratio of morphological facial height obtained by measuring the distance from nasion to menton and facial width a distance between two zygomatic prominences multiplied by 100. The values of the facial index were used to determine the incidence of certain facial types according to Martin-Saller's scale. Based on the facial index, the facial phenotype was classified as: hypereuryprosopic (≤ 78,9), euryprosopic (79,0 < to <83,9), mesoprosopic (84,0 < to < 87,9), leptoprosopic (88,0 < to < 92,9) and hyperleptoprosopic (≥ 93,0) (Martin and Saller, 1957) [9].

Face classification according to facial index.

Face shape	Range of Facial index
1. Hypereuroprosopic (very broad face)	<79.9
2. Europrosopic (broad face)	80–84.9
3. Mesoprosopic (round face)	85–89.9
4. Leptoprosopic (long face)	90–94.9
5. Hyperleptoprosopic (very long face)	>95

(Yesmin *et al.,* 2014; Shah and Koraila, 2015).

The facial (prosopic) index is calculated using the formula below

$$\text{Facial index (FI)} = \frac{\text{Facial length}}{\text{Facial width}} \times 100$$

Study population: "The Atyap, Bajju, Chawai, and Ham ethnic groups are found in Zangon Kataf, Jaba, Kachia, and Kauru Local Government Areas. These ethnic groups belong to the Nok Terracotta ancient civilization named after a Nok village in Jaba land with evidence of clay artifacts of human and animal faces and Iron Age tools buried underground. Nok terracotta (baked clay) was first discovered in 1928 by Col. Dent Young during mining between 1000 BC and 500 AD[10].

Ethnologically the four ethnic groups are classified under the Benue-Congo large language family. Bajju, Atyap, and Ham belong to the platoid central languages while Chawai (Atsam) belongs to the East Kainji language family[11]. A language family is a set of languages deriving from a common ancestor or "parent." Languages with a significant number of common features in phonology, and morphology, are said to belong to the same language family [11, 12, 13].

METHODOLOGY

Approval and clearance for this study were obtained from the research and Ethical committee of the Ahmadu Bello University Zaria, with the Approval Number ABUCUHSR/2021/23

The data was collected randomly using a systematic sampling method from Districts that make up each ethnic group and secondary schools in those districts covering the four (4) ethnic groups in Zangon Kataf Local Government Area Jaba, Local Government Area, part of Kachia and Kauru Local Government Area. Permission was taken from District heads, village heads, and the directors of the Zonal Education authorities of the concerned Local Government Councils, and informed consent was also sought from participants.

Sample size: The study involves subjects from each of the four ethnic groups of Atyap, Bajju, Chawai, and Ham with ages between 17 to ≥ 50 years.

Sample size was determined using the formulae;

$$N = \frac{Z^2 PQ}{D^2}$$ (Naing *et al*., 2006).

For this study, a total of Eight hundred and thirty (830) participants were used to increase the statistical power. 210 Atyap (121 males, 89 females), 200 Bajju (117 males, 83 females), 215 Chawai (134 males 81 females), and 205 Ham (116 males, 89 females).

Study location: Kaduna State, found in Northern Nigeria is located just to the North of Abuja. Within its boundaries is the Southern part of Kaduna State located between latitudes 9° and 11° north and longitudes 7° and 9° East [15].

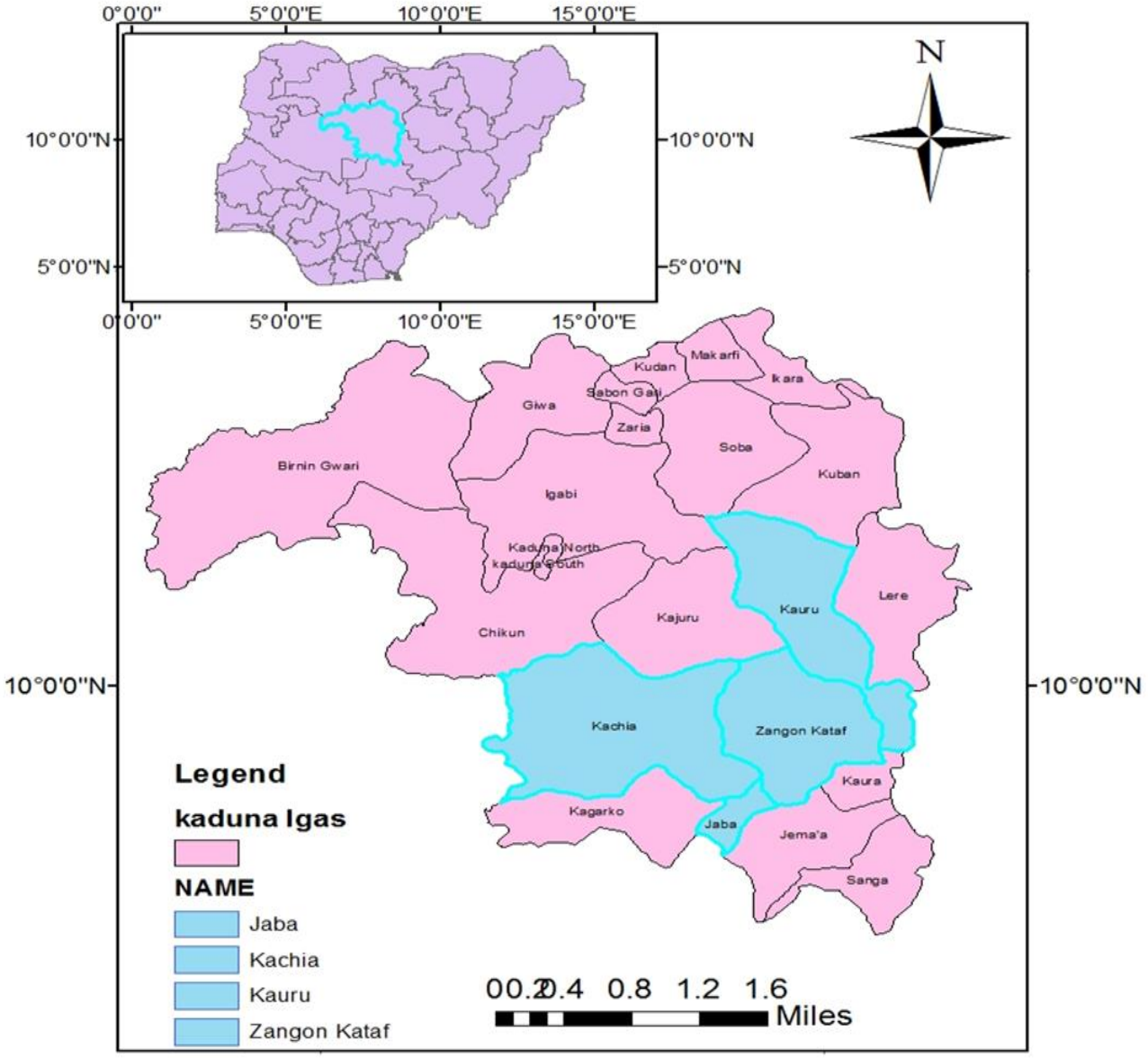

Figure 1: An Administrative map of Kaduna State showing the Four (4) Local Government areas of Zangon Kataf, Jaba, Kauru, and Kachia indicated in blue color.

Photographic Set-Up: A distance of 50cm was measured using steel tape and marked, the tripod camera stand was fixed at one end, and the subject on the other end with a digital camera on a tripod stand which was used in adjusting the position of the camera to the subject's height to ensure the camera was positioned at the ear level of the participant to provide a good quality image. The frontal and right lateral view photographs were captured with each subject sitting in a relaxed position with their heads held in the natural head position [16].

Digitization and Photogrammetry: The photographs taken were transferred into a computer by a universal serial bus (USB) cord. Craniofacial variables such as length, height, and breadth were measured using a

design software program for the Windows operating system (FACAD version 3,4,0,3; copyright©: llexis AB 2010; 3.4.0.3A)

Photogrammetric Measurements and Landmarks

Cranial Length (CL): Distance from Glabella to inion

Cranial Width (CW): Distance between parietal eminences

Cranial Height (CH): Distance between the external acoustic meatus and the highest point of the vertex

Facial length (FL): Distance from nasion to menton

Face width (FW): Distance between Zygomatic arches.

Face middle 3rd (MT): Distance from nasion to subnasal

Face lower 3rd (LT): Distance from subnasal to menton

Statistical Analysis: Data obtained were expressed as Mean ± SD (Standard Deviation). One-way ANOVA was used to compare the means of craniofacial parameters of the four ethnic groups. Tukey post-hoc was used to find the factor for the difference. An Independent t-test was used to investigate the occurrence of sexual dimorphism within each ethnic group. $P < 0.05$ was considered statistically significant.

SigmaStat 3.5 for Windows ™ was used for the analysis.

RESULTS

"The statistical analysis of data collected from the photos is presented in tables shown below. Table 1 presents a descriptive analysis of males and females from the Atyap ethnic group, while Table 2 is for males and females from the Bajju ethnic group. Tables 3 and 4 are for males and females of the Chawai and Ham ethnic groups, respectively.

The cranial index mean ± standard deviation values for the four ethnic groups were determined as follows: Atyap males (73.16 ± 5.95), Atyap females (70.84 ± 5.89), Bajju males (68.71 ± 6.88), Bajju females (67.30 ± 6.88), Chawai males (68.32 ± 7.33), Chawai females (68.67 ± 6.87), and Ham males (69.70 ± 6.99), Ham females (70.68 ± 7.84). The facial index mean ± standard deviation values for the four ethnic groups were determined as follows: Atyap males (86.30 ± 10.47), Atyap females (83.97 ± 4.62), Bajju males (83.61 ± 6.14), Bajju females (79.57 ± 5.88), Chawai males (80.07 ± 7.87), Chawai females (82.59 ± 8.39), and Ham males (82.81 ± 6.19), Ham females (78.73 ± 5.96).

Table 1: Descriptive Statistics for Craniofacial parameters of males and females of the Atyap Ethnic group

	Males (n=121)				Females (n=89)			
Variables	**Mean ± S.D**	**Min**	**Max**	**Range**	**Mean ± S.D**	**Min**	**Max**	**Range**
Age (yrs)	23.50 ± 9.03	17.00	50.00	33.00	21.53 ± 7.83	17.00	50.00	33.00
Cranial Length (mm)	196.38 ± 15.21	163.06	241.51	78.45	195.70 ± 19.36	162.78	253.50	90.72
Cranial Width (mm)	143.36 ± 12.91	118.59	185.30	66.71	138.21 ± 14.12	109.22	184.13	74.91
Cranial Height (mm)	133.93 ± 14.11	80.00	164.52	84.52	134.23 ± 16.70	80.05	180.51	100.46
Cranial Index	73.16 ± 5.95	60.96	92.84	31.88	70.84 ± 5.89	56.94	87.06	30.12
Facial Length (mm)	121.12 ± 17.17	54.00	159.03	105.03	115.32 ± 13.75	95.01	163.50	68.49
Facial Width (mm)	140.50 ± 12.91	115.66	183.54	67.88	137.30 ± 13.87	112.08	187.18	75.10
Facial Index	86.30 ± 10.47	41.80	121.60	79.80	83.97 ± 4.62	74.08	96.04	21.96
Middle 3rd (mm)	51.80 ± 7.59	37.51	82.10	44.59	49.35 ± 7.51	33.09	72.03	38.94
Lower 3rd (mm)	74.02 ± 11.23	56.18	115.03	58.85	65.99 ± 7.87	51.52	94.52	43.00

Table 2: Descriptive Statistics for Craniofacial parameters of males and females of the Bajju Ethnic group

Variables	**Males (n=117)**				**Females (n=83)**			
	Mean ± S.D	**Min**	**Max**	**Range**	**Mean ± S.D**	**Min**	**Max**	**Range**
Age (yrs)	24.90 ± 10.02	17.00	49.00	32.00	23.17 ± 9.27	17.00	48.00	31.00
Cranial Length (mm)	184.60 ± 10.72	151.92	217.87	65.95	180.18 ± 11.79	156.32	213.64	57.32
Cranial Width (mm)	126.60 ± 12.57	100.08	156.12	56.04	120.79 ± 10.21	99.51	152.05	52.54
Cranial Height (mm)	126.70 ± 10.83	103.94	162.10	58.16	126.22 ± 11.18	95.69	154.15	58.46
Cranial Index	68.71 ± 6.88	52.28	88.79	36.51	67.30 ± 6.88	50.98	87.53	36.55
Facial Length (mm)	110.47 ± 12.46	59.55	147.01	87.46	101.66 ± 9.29	82.12	135.57	53.45
Facial Width (mm)	132.22 ± 12.43	107.64	162.04	54.40	127.90 ± 9.02	109.04	156.35	47.31
Facial Index	83.61 ± 6.14	49.62	102.78	53.16	79.57 ± 5.88	62.88	91.61	28.73
Middle 3rd (mm)	49.79 ± 6.40	32.52	71.56	39.04	47.12 ± 4.67	36.00	59.58	23.58
Lower 3rd (mm)	61.33 ± 7.74	44.05	82.10	38.05	54.365 ± 7.15	38.01	82.52	44.51

Table 3: Descriptive Statistics for Craniofacial parameters of males and females of the Chawai Ethnic group

	Males (n=134)				Females (n=81)			
Variables	**Mean ± S.D**	**Min**	**Max**	**Range**	**Mean ± S.D**	**Min**	**Max**	**Range**
Age (yrs)	21.77 ± 7.94	17.00	50.00	33.00	23.17 ± 8.98	17.00	50.00	33.00
Cranial Length (mm)	188.38 ± 20.56	142.90	264.77	121.87	188.24 ± 21.22	148.35	268.63	120.28
Cranial Width (mm)	128.14 ± 15.18	91.17	173.05	81.88	128.74 ± 15.39	97.03	168.65	71.62
Cranial Height (mm)	132.53 ± 13.97	101.56	168.41	66.85	132.43 ± 14.94	103.50	169.69	66.19
Cranial Index	68.32 ± 7.33	51.40	89.30	37.90	68.67 ± 6.87	44.86	85.69	40.83
Facial Length (mm)	107.07 ± 16.66	50.25	148.57	98.32	109.49 ± 14.69	67.01	158.50	91.49
Facial Width (mm)	133.53 ± 14.57	96.01	181.91	85.90	132.95 ± 15.04	101.54	179.51	77.97
Facial Index	80.07 ± 7.87	42.38	95.37	52.99	82.59 ± 8.39	41.35	125.74	84.39
Middle 3rd (mm)	50.07 ± 7.80	34.86	73.11	38.25	51.45 ± 7.47	36.00	74.17	38.17
Lower 3rd (mm)	59.13 ± 11.29	40.00	107.67	67.67	59.37 ± 10.78	44.50	110.51	66.01

Table 4: Descriptive Statistics for Craniofacial parameters of males and females of the Ham Ethnic group.

	Males (n=116)				Females (n=89)			
Variables	**Mean ± S.D**	**Min**	**Max**	**Range**	**Mean ± S.D**	**Min**	**Max**	**Range**
Age (yrs)	29.52 ± 10.91	17.00	50.00	33.00	23.303 ± 8.29	17.00	47.00	30.00
Cranial Length (mm)	182.19 ± 17.74	143.47	233.29	89.82	171.d24 ± 19.25	135.72	228.27	92.55
Cranial Width (mm)	126.38 ± 12.57	103.60	163.53	59.93	120.42 ± 14.50	91.01	159.58	68.57
Cranial Height (mm)	125.61 ± 14.31	95.52	174.95	79.43	119.66 ± 15.02	87.12	173.44	86.32
Cranial Index	69.70 ± 6.99	55.81	94.41	38.59	70.68 ± 7.84	51.44	96.07	44.63
Facial Length(mm)	109.16 ± 13.89	75.04	146.62	71.58	100.93 ± 14.62	68.76	140.70	71.94
Facial Width(mm)	131.75 ± 12.76	105.06	167.03	61.97	128.13 ± 15.00	97.05	173.19	76.14
Facial Index	82.81 ± 6.19	63.29	98.37	35.08	78.73 ± 5.96	45.99	88.86	42.86
Middle 3rd (mm)	50.01 ± 7.66	36.55	71.71	35.16	47.10 ± 8.15	31.02	72.09	41.07
Lower 3rd (mm)	59.92 ± 7.75	42.55	79.04	36.49	54.57 ± 8.05	39.00	76.11	37.11

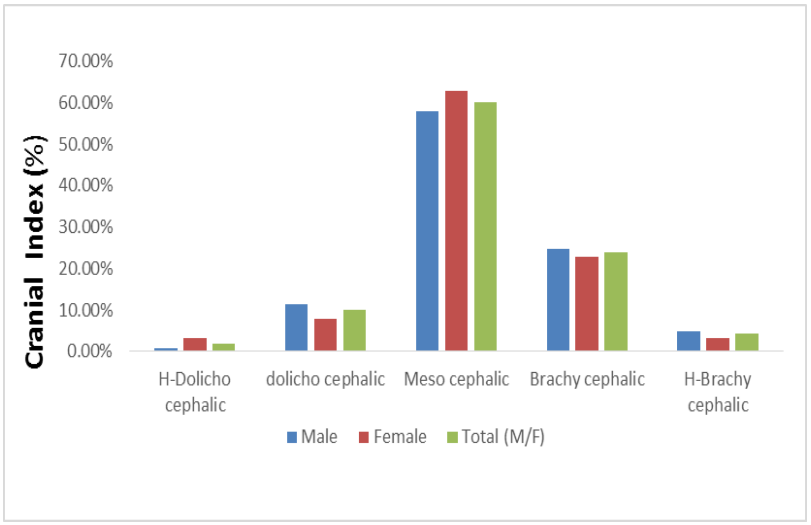

Figure 1: Cranial Index for Atyap Ethnic groups

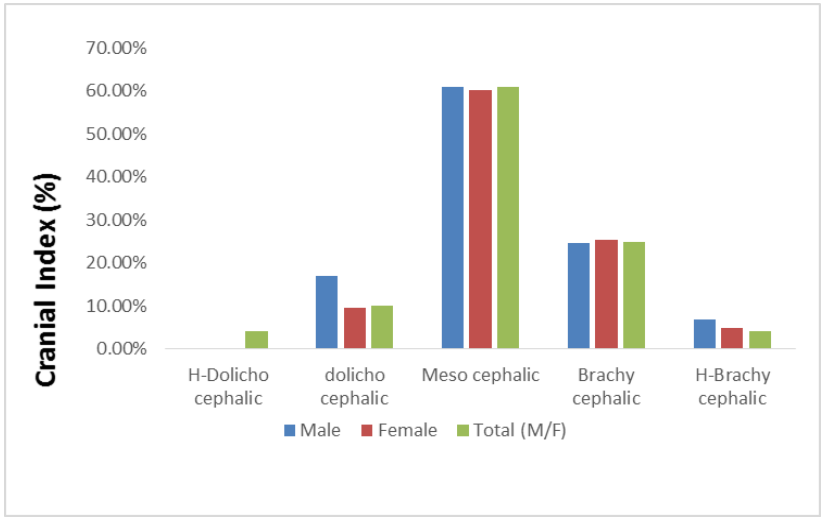

Figure 2: Cranial Index for Bajju Ethnic groups

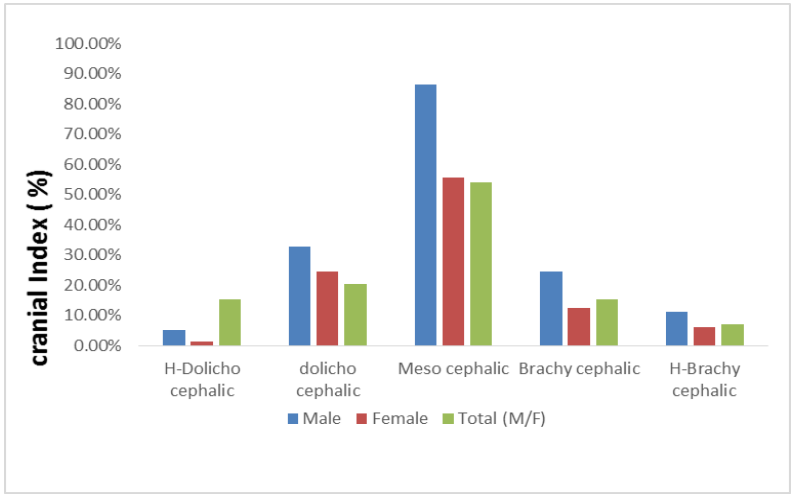

Figure 3: Cranial Index for Chawai Ethnic groups

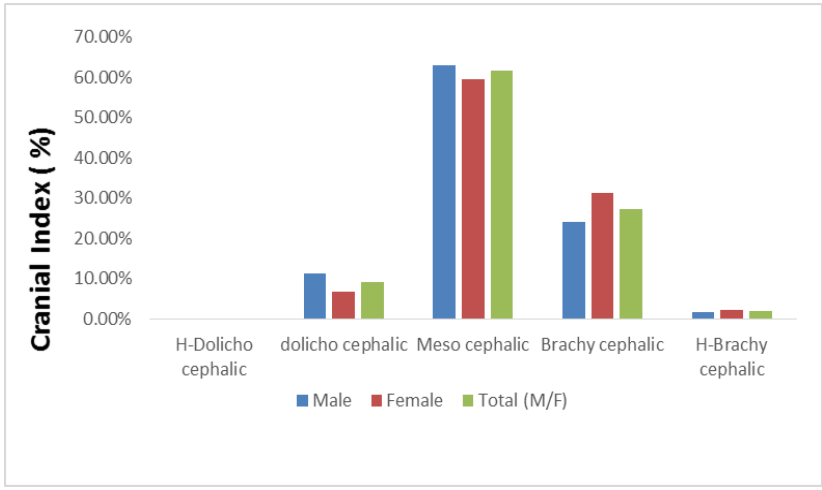

Figure 4: Cranial Index for Ham Ethnic groups

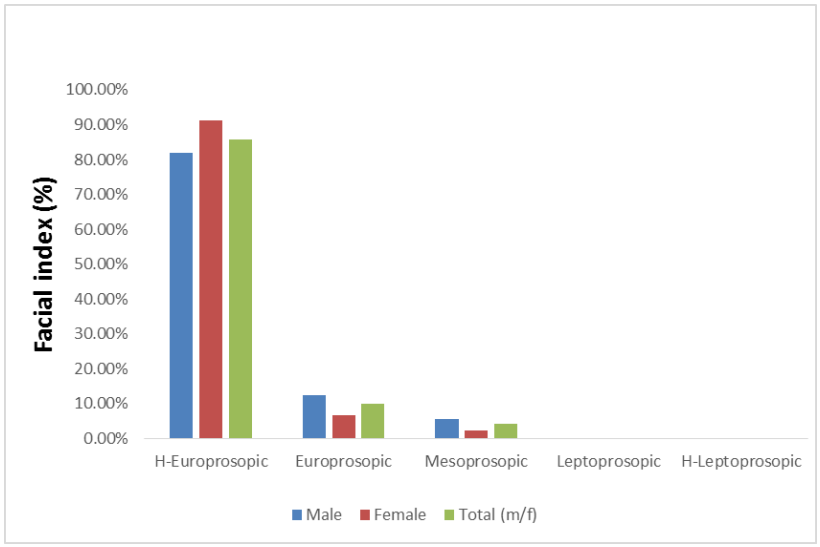

Figure 5: Facial Index for Atyap Ethnic group

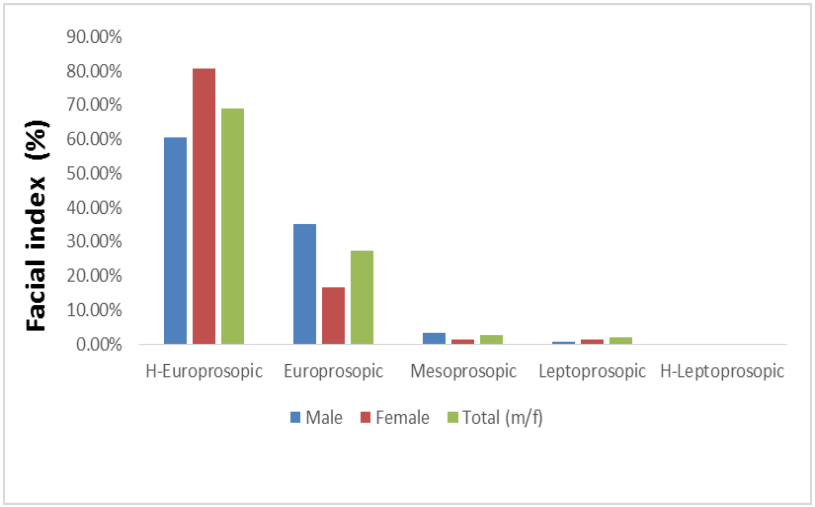

Figure 6: Facial Index for Bajju Ethnic group

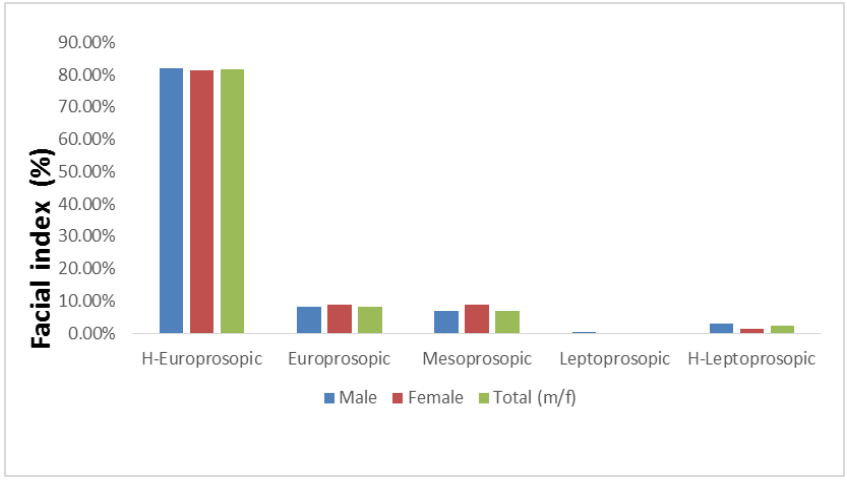

Figure 7: Facial Index for Chawai Ethnic group

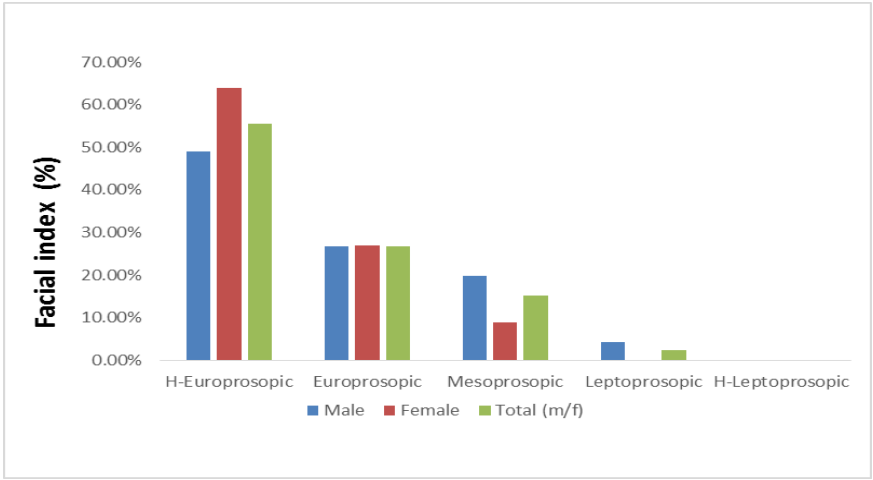

Figure 8: Cranial Index for Ham Ethnic group

Table 5: Comparison of Craniofacial Parameters for Males of the Four Ethnic Groups

Variables	Atyap Males (n=121) Mean ± S.D	Bajju Males (n=117) Mean ± S.D	Chawai Males (n=134) Mean ± S.D	Ham Males (n=116) Mean ± S.D	F	P
Age (yrs)	22.67 ± 8.58	24.18 ± 9.73	22.30 ± 8.35	26.82 ± 10.30	10.23	0.001
Cranial Length (mm)	196.38 ± 15.21	184.60 ± 10.72	188.38 ± 20.56	182.19 ± 17.74	16.68	0.001
Cranial Width (mm)	143.36 ± 12.91	126.60 ± 12.57	128.14 ± 15.18	126.38 ± 12.57	45.02	0.001
Cranial Height (mm)	133.93 ± 14.11	126.70 ± 10.83	132.53 ± 13.97	125.61 ± 14.31	11.56	0.001
Cranial Index	73.16 ± 5.95	68.71 ± 6.88	68.32 ± 7.33	69.70 ± 6.99	12.85	0.001
Facial Length(mm)	121.12 ± 17.17	110.47 ± 12.46	107.07 ± 16.66	109.16 ± 13.89	20.81	0.001
Facial Width(mm)	140.50 ± 12.91	132.22 ± 12.43	133.53 ± 14.57	131.75 ± 12.76	11.33	0.001
Facial Index	86.30 ± 10.47	83.61 ± 6.14	80.07 ± 7.87	82.81 ± 6.19	13.46	0.001
Middle 3rd (mm)	51.80 ± 7.59	49.79 ± 6.40	50.07 ± 7.80	50.01 ± 7.66	1.91	0.127
Lower 3rd (mm)	74.02 ± 11.23	61.33 ± 7.74	59.13 ± 11.30	59.92 ± 7.75	63.09	0.001

Table 6: Comparison of Craniofacial Parameters of Females of the Four Ethnic Groups

Variables	Atyap Females (n=89) Mean ± S.D	Bajju Females (n=83) Mean ± S.D	Chawai Females (n=81) Mean ± S.D	Ham Females (n=89) Mean ± S.D	F	P
Cranial Length (mm)	195.70 ± 19.36	180.18 ± 11.79	188.24 ± 21.22	171.24 ± 19.25	29.24	0.001
Cranial Width (mm)	138.21 ± 14.12	120.79 ± 10.21	128.74 ± 15.39	120.42 ± 14.50	32.75	0.001
Cranial Height (mm)	134.23 ± 16.70	126.22 ± 11.18	132.43 ± 14.94	119.66 ± 15.02	17.88	0.001
Cranial Index	70.84 ± 5.89	67.30 ± 6.88	68.67 ± 6.87	70.68 ± 7.84	5.18	0.002
Facial Length(mm)	115.32 ± 13.75	101.66 ± 9.29	109.49 ± 14.69	100.93 ± 14.62	23.17	0.001
Facial Width(mm)	137.30 ± 13.87	127.90 ± 9.02	132.95 ± 15.04	128.13 ± 15.00	9.62	0.001
Facial Index	83.97 ± 4.62	79.57 ± 5.88	82.59 ± 8.39	78.73 ± 5.96	13.42	0.001
Middle 3rd (mm)	49.36 ± 7.51	47.12 ± 4.67	51.45 ± 7.47	47.10 ± 8.15	7.16	0.001
Lower 3rd (mm)	65.99 ± 7.87	54.37 ± 7. 15	59.367 ± 10.78	54.57 ± 8.06	35.84	0.001

Table 7: Comparison of Craniofacial Parameters Between males and Females of the Atyap Ethnic Group

Variables Age (yrs)	Males (n=121) Mean ± S.D	Females (n=89) Mean ± S.D	T-Value	P-Value
Cranial Length (mm)	196.4 ± 15.2	195.7 ± 19.4	-0.28	0.781
Cranial Width (mm)	143.4 ± 12.9	138.2 ± 14.1	-2.71	0.007
Cranial Height (mm)	133.9 ± 14.1	134.2 ± 16.7	0.14	0.892
Cranial Index	73.16 ± 5.95	70.84 ± 5.89	-2.81	0.006
Facial Length(mm)	121.1 ± 17.2	115.3 ± 13.8	-2.72	0.007
Facial Width(mm)	140.5 ± 12.9	137.3 ± 13.9	-1.70	0.091
Facial Index	86.3 ± 10.5	83.97 ± 4.62	-2.18	0.031
Middle 3rd (mm)	51.80 ± 7.59	49.36 ± 7.51	-2.32	0.021
Lower 3rd (mm)	74.0 ± 11.2	65.99 ± 7.87	-6.09	0.001

Table 8: Comparison of Craniofacial Parameters between males and Females of the Bajju Ethnic Group

Variables	Males (n=117) Mean ± S.D	Females (n=83) Mean ± S.D	T-Value	P-Value
Cranial Length (mm)	184.6 ± 10.7	180.2 ± 11.8	-2.71	0.007
Cranial Width (mm)	126.6 ± 12.6	120.8 ± 10.2	-3.60	0.001
Cranial Height (mm)	126.7 ± 10.8	126.2 ± 11.2	-0.30	0.763
Cranial Index	68.71 ± 6.88	67.30 ± 6.88	-1.43	0.155
Facial Length(mm)	110.5 ± 12.5	101.66± 9.29	-5.73	0.001
Facial Width(mm)	132.2 ± 12.4	127.90± 9.02	-2.85	0.005
Facial Index	83.61 ± 6.14	79.57 ± 5.88	-4.70	0.001
Middle 3rd (mm)	49.79 ± 6.40	47.12 ± 4.67	-3.41	0.001
Lower 3rd (mm)	61.33 ± 7.74	54.36 ± 7.15	-6.56	0.001

Table 9: Comparison of Craniofacial Parameters between Males and Females of the Chawai Ethnic Group

Variables Age (yrs)	Males (n=134) Mean ± S.D	Females (n=81) Mean ± S.D	T-Value	P-Value
Cranial Length (mm)	188.4 ± 20.60	188.20 ± 21.2	-0.05	0.961
Cranial Width (mm)	128.1 ± 15.20	128.70 ± 15.4	0.28	0.781
Cranial Height (mm)	132.5 ± 14.00	132.40 ± 14.9	-0.05	0.960
Cranial Index	68.32 ± 7.33	68.67 ± 6.87	0.35	0.726
Facial Length(mm)	107.10 ± 16.70	109.50 ± 14.7	1.11	0.267
Facial Width(mm)	133.50 ± 14.60	132.90 ± 15.00	-0.28	0.779
Facial Index	80.07 ± 7.87	82.59 ± 8.39	2.19	0.030
Middle 3rd (mm)	50.07 ± 7.80	51.45 ± 7.47	1.29	0.198
Lower 3rd (mm)	59.10 ± 11.30	59.40 ± 10.80	0.15	0.879

Table 10: Comparison of Craniofacial Parameters Between males and Females of the Ham Ethnic Group

Variables Age (yrs)	Males (n=116) Mean ± S.D	Females (n=89) Mean ± S.D	T-Value	P-Value
Cranial Length (mm)	182.2 ± 17.70	171.20± 19.20	-4.18	0.001
Cranial Width (mm)	126.4 ± 12.60	120.40± 14.50	-3.09	0.002
Cranial Height (mm)	125.6 ± 14.30	119.70± 15.00	-2.87	0.005
Cranial Index	69.69 ± 6.99	70.68 ± 7.84	0.93	0.352
Facial Length(mm)	109.20±13.00	100.90± 14.60	-4.08	0.000
Facial Width(mm)	131.80±12.80	128.10± 15.00	-1.83	0.070
Facial Index	82.81 ± 6.19	78.73 ± 5.96	-4.78	0.001
Middle 3rd (mm)	50.01 ± 7.66	47.10 ± 8.15	-2.60	0.010
Lower 3rd (mm)	59.92 ± 7.75	54.57 ± 8.05	-4.79	0.001

Figures 1 to 4 are bar charts of the cranial indices of the four ethnic groups, showing the pattern of distribution. The values indicate that 60% to 80% of the population within these four ethnic groups have mesocephalic cranial shapes.

Figures 5 to 8 are bar charts of the facial indices of the four ethnic groups, showing the pattern of distribution. About 60% to 90% of the four ethnic groups have hyper-europrosopic facial shapes (very broad face).

Table 5 is a comparison of the males of the four ethnic groups using the one-way analysis of variance (ANOVA). The results from the table reflect a significant difference between them in their craniofacial parameters, except in the middle 3rd parameter.

Table 6 is a comparison between the females of the four ethnic groups to detect variation. The results indicate that there is a significant difference between them in their craniofacial parameters.

Tables 7 to 10 are a comparison between males and females of each ethnic group to observe sexual dimorphism using the t-test. The results from all four tables show that there is a significant difference between males and females of these ethnic groups, except the Chawai ethnic group, which showed no statistical difference in almost all the parameters.

DISCUSSION

The comparison of the Atyap, Bajju, Chawai, and Ham ethnic groups revealed a significant difference in craniofacial parameters and facial proportion, except for the middle third facial proportion. This finding is similar to previous studies on cephalometric indices parameters and cephalofacial dimorphism among various indigenous ethnic groups, which also demonstrated differences between ethnic groups despite sharing similar environmental factors, nutritional values, and language affiliation [17, 18]. Also, a multiracial facial evaluation of Malaysian Malay, Malaysian Chinese, and Malaysian Indians, showed a significant difference in facial height, proportion, and facial index with some exceptions in a few variables across the races which are in line with this study [19]. However, a study on cranial dimensions among three ethnic groups namely, Fulani, Tangale, and Tera of Gombe State region of North-Eastern Nigeria, showed no significant inter-ethnic difference existing between the ethnic groups in their cranial dimension [20].

The Cranial Index and Facial Index of the four (4) ethnic groups, showed a similar pattern of head shape, head size, and face shape in the males and females. 60% to 90% have Mesocephalic cranial shape and Hyper-euryprosopic facial shape. The findings of this study is in line with the outcome of the anthropometric study of cephalometric indices of Idoma and Igede Ethnic groups in Benue, Nigeria, where the majority of the population who are of the same clusters of language family have mesocephalic cranial shape hyper-euryprosopic facial shape as reported by [17].

The variations in craniofacial parameters between the males and females within the four ethnic groups indicate that the values for males are higher than those of females. These differences have been reported to be likely due to differences in genetic make-up

and inheritance [19], which is indicative of sexual dimorphism as also reported by this study. The presence of sexual dimorphism was observed among the study's ethnic groups except for the Chawai ethnic group. This corresponds to the work of Ajayi, (2005), which showed no significant gender difference in cephalometric measurements between boys and girls in the Igbos in Enugu, Nigeria [21]. There were also no sexual differences found between males and females in the analysis of facial Angles of the Urhobos in Nigeria. Within a restricted geographical region and historical period, patterns of sexual dimorphism sometimes vary significantly [22]. Traits that are sexually dimorphic in one population may be much less in another [23]. The genetic makeup and environmental influences, socioeconomic status, diet pattern, and physical activities all contribute to inter-population variations [24].

The comparison across all males and all females of the four ethnic groups indicated a significant difference within the study population, this implies that there may be no evidence of gene flow in this study. Also, the post hoc test showed that Ham ethnic group constituted the major influence in the observed divergence, with outlier values distant from the other ethnic groups of Atyap, Bajju, and Chawai. The lack of congruence in the phenotypes studied could be attributed to sampling errors as the general finding presents a contrasting view from a study by Timbuak et al; which suggested a genetic proximity in the apportionment of mitochondrial DNA haplotypes of the Atyap, Bajju, and Chawai, corroborating their oral history and shared geography [25].

CONCLUSION

The comparative study of the craniofacial parameters of the Atyap, Bajju, Chawai, and Ham ethnic groups has made the following conclusions: there is a significant difference among the four (4) ethnic groups despite their historic background of common descent and migration, similar traditional/cultural practices, environmental clusters, nutrition and way of life. There was observed sexual dimorphism in facial parameters within these four ethnic groups. The cranial index and facial index were characterized and determined to be Mesocephalic and hyper euryprosopic for Atyap, Bajju, Chawai, and Ham ethnic groups.

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