

# Facial Morphometry of the Mwaghavul Ethnic Group in Plateau State, Nigeria

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## Abstract

The face is the most striking feature which distinguishes an individual. Human body dimensions are affected by ecological, biological, geographical, racial, gender, age and nutritional factors. Anthropometrics vary from tribe to tribe, and from race to race and, also differs amongst different age groups and between the two sexes of a given population. The aim of the study was to determine the facial morphometry of the Mwaghavul ethnic group of Plateau State, Nigeria. The objectives were to determine facial dimensions, facial index and facial types of Mwaghavul ethnic group. Four hundred and five (405) participants (231, males; 174, females) aged 18-30 years were involved in this study. The study was carried out on Mwaghavul students of College of Education Gindiri, Mangu LGA of Plateau State in Nigeria. The photographic setup consisted of a tripod stand and digital camera. The participants were positioned at a distance of 120 cm from the camera. The camera was raised to the ear level of the participants to provide good quality of image and to prevent distortion of the face. The photographs were captured at a standard resolution of 12.1 megapixels. A digital vernier caliper was then used to measure the facial linear dimensions. The photographic records were analysed using a bioanalyser (version 6). The program was customized with the landmarks used in this study. Facial width higher in females than in males ( $p=0.047$ ) while facial and lower facial indices were higher in males than in females ( $p<0.001$ ) respectively. The facial type of Mwaghavul ethnic group was found to be dominantly hyperleptoprosopic in both sexes. These variations were possibly due to age, inter- and intra-ethnic, nutritional, socio-economic, genetic, gender, racial and climatic factors

**Keywords:** Facial index, facial types, Mwaghavul, Plateau State, Nigeria

## INTRODUCTION

Physical anthropology, also known as bioanthropology or biological anthropology, deals with the study of the human evolutionary origin, human diversity and adaptation. It depends mainly on external measurements and descriptions of the human body (Adelaja, 2016; Ekezie *et al.*, 2016).

It is even stated that human body dimensions are affected by ecological, biological, geographical, racial, gender, age and nutritional factors (Umar *et al.*, 2006); and physical anthropology provides the avenue to assess the human body dimensions and to describe the morphological variations that exist among different human population. Therefore, anthropometrics vary from tribe to tribe, and race to race (Umar *et al.*, 2006). It also differs

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amongst different age groups and between the two sexes of a given population (Umar *et al.*, 2006). Several measurable anthropometric means and parameters or variables have been developed over the years for establishing possible differences amongst different groups (Umar *et al.*, 2006; Aynechi *et al.*, 2011; Adamu *et al.*, 2016a; Adamu *et al.*, 2016b).

The face is the most striking feature which distinguishes an individual. Facial profile is usually characterized by a set of three facial prominences – the chin, nose and lips (Ukoha *et al.*, 2016). These prominences often call for attention when evaluating the human face, such that beauty and attractiveness of the face depend on their reciprocal proportion and aesthetic harmony to some extent. Therefore the face can serve as an important tool in the studies of human variations. Marked variations that have been observed in the course of researches have led to the categorization of the human faces and noses into different facial and nasal types; based on facial index and nasal index, respectively (Martin & Saller, 1957; Williams *et al.*, 1995)

The Mwaghavul ethnic group is indigenous to Plateau State of central Nigeria; primarily occupying the northern, eastern and southern parts of Mangu Local Government Area of Plateau State (Dazyam, 2005).

In Nigeria, different parameters of the facial morphology have been studied including, facial height, mandibular height and maxillary height, orbital dimensions and canthal distances, nasal parameters (Ewunonu & Anibeze, 2013), facial asymmetry (Adamu *et al.*, 2016a; Adamu *et al.*, 2016b). Anthropometry as part of anthropology deals with the measurement of human beings (Omotosho *et al.*, 2011), living or dead or of skeletal materials and constitutes a series of systemized measuring techniques of expressing quantitatively the form of the human body and skeleton (Ewunonu & Anibeze, 2013; Obaje *et al.*, 2015). It deals with the measurement of physical sizes and shapes of human body and the data obtained have been very useful in differentiating people of different ethnic backgrounds, nutritional status, and gender (Oladipo *et al.*, 2014). In 2012, Kanan *et al.* stated that two persons are never alike in their measurable characters. Anthropometric characteristics have direct relationship with sex, shape and form of an individual; and these factors are intimately linked with each and are manifestation of the internal structure, tissue components which in turn are influenced by environmental and genetic factors (Obaje *et al.*, 2015).

Anthropometric measurements have been suggested as a means for studying variations in human population (Anibor *et al.*, 2013; Yesmin *et al.*, 2014); and these variations occur in different parts of the body. These variations should be established for a particular population (Salve *et al.*, 2012). Anthropometry has the advantages of being in-expensive, simple to be applied and relatively non-invasive (Ewunonu & Anibeze, 2013).

Digital anthropometry (photogrammetry), which could be two dimensional (2D) or three dimensional (3D) are employed in face recognition systems for computing biometric parameters (Adelaja, 2016). This face recognition system employs computerized algorithms and is the most widely used way of identification or authentication of identity in civil and criminal investigations for forensic analyses and face detection purposes (Adelaja, 2016). Making measurements from photos are more convenient (Ozkul *et al.*, 2009). Studies have been carried out using photogrammetry to determine the facial traits of several ethnic groups of Nigeria (Ezeuko & Eboigbe, 2015; Adamu *et al.*, 2016a; Adamu *et al.*, 2016b; Adelaja, 2016). Facial shape depends on many factors like gender, race and ethnicity, climate, socio-economic, nutritional, and genetic factors (Jeremić *et al.*, 2013; Obaje *et al.*, 2015).

The facial index known as prosopic index (PI) is a very useful anthropometric tool used to find out racial and sexual differences and also give a clue to genetic transmission of inherited characteristics from parents to their offsprings (Orish & Oladipo, 2017). The facial and nasal indices are among the most important cephalometric parameters useful in inter-racial classification and intra-racial categorization (Oludiran *et al.*, 2014). The facial index (FI) is the percentage ratio of morphological facial height. Morphology of the human face is determined by the values of the facial index. Upper facial index is the percentage ratio of upper facial height and lower facial index is the percentage ratio of lower facial height (Umar *et al.*, 2006; Aynechi *et al.*, 2011).

In 2010, Raji *et al.* reported that Nigerians, especially from North-East are hyperleptoprosopic in both genders and suggested that studies like this should be done in other regions of Nigeria according to sex, age, culture and environmental parameters. Orish and Oladipo (2017) also stated that the predominant face type for Nigerian population is hyperleptoprosopic for females and mesoprosopic for males. A study on the craniofacial forms of dominant ethnic group of Gombe State, Nigeria reported facial shape of Fulani and Tera males were hyperleptoprosopic; Tangale and Tera females were both leptoprosopic (Maina *et al.*, 2011).

## MATERIALS AND METHODS

### Materials

1. Nikon D60 digital camera manufactured by Nikon Inc., USA
2. Tripod stand Zhuhai Qinetech Co., Ltd, China
3. Tape rule Shah & Co., Mumbai
4. White board Marker HL-006, China
5. Laptop computer, Asus EE Pc
6. Chair Hassan plastic industry Kano Nigeria
7. Masking tape Abro industries Inc., USA
8. NEIKO 6 – INCH stainless steel digital caliper with fractional and decimal display.

### Study design

A cross-sectional study involving four hundred and five (405) Mwaghavul students comprising of 231 males and 174 females from College of Education Gindiri, Mangu LGA of Plateau State in Nigeria.

### Ethical consideration

Ethical permission was sought and granted via a letter (MOH/MIS/202/VOL.I/X) issued by ethics and research committee, Plateau State Ministry of Health after submitting an introductory letter from the Department of Anatomy, Bayero University, Kano. Informed consent was verbally sought from each participant before the commencement of the study.

### Sample size determination

Sample size was determined using the formula

$$n = Z^2Pq/d^2 \quad (\text{Lwanga and Lemeshow, 1991})$$

Where;

n= minimum sample size

z= standard normal deviation at 95% confidence level ( $\pm 1.96$ )

p= proportion at 50% (0.5)

q= complementary probability 1- p (0.5)

d= 5% error (0.05)

therefore,  $n = (1.96)^2(0.5)(0.5)/(0.05)^2 = 384.16$

However four hundred and five (405) participants were used to increase power of statistics.

### Sampling technique

Convenience sampling method was used for this study. Subjects were measured according to the way they were gotten, every day, until the desired number of the sample size was reached.

### Study area

The study was conducted at College of Education Gindiri, Plateau State, Nigeria. Gindiri (latitude 8°30" to 10°10" N and longitude 8°30" to 10°00"E) is a town located in Mangu Local Government of Plateau State, Nigeria.

### Participants

A total of four hundred and five (405) students comprising of 231 males and 174 females were used. The study was carried out on Mwaghavul students of College of Education Gindiri, Mangu LGA of Plateau State in Nigeria; their ethnicity was confirmed through the administration of a brief verbal questionnaire. The age of the participants was between 18-30 years. The Mwaghavul are indigenously found within the central zone of Plateau state in Nigeria; precisely Mangu and western fringes of Pankshin local government areas. Their indigenous area of abode is located within latitude 8°30" to 10°10" N and longitude 8°30" to 10°00"E; and they are one of the larger ethnic groups in the State; the others are Berom, Ngas and Goemai. They are bounded in the west by the Ron and Mushere of Bokkos LGA; in the south by the Pan of Quan Pan LGA; in east by the Ngas and Mupun of Pankshin LGA; in the northeast by the Pyem of Mangu LGA and Kadung of Pankshin LGA and in the north by the Berom of Barkin Ladi LGA (Dazyam, 2005; Dahip, 2011).



Figure 1: Plateau State map showing Mangu LGA.

## SELECTION CRITERIA

### Inclusion Criteria

Students of the Mwaghavul College of Education Gindiri, Mangu LGA of Plateau State whose parents, paternal and maternal grandparents were all of Mwaghavul origin and aged from 18-30 Years. Subjects with no history of facial surgery were also included.

### Exclusion Criteria

The following participants were excluded from the study; participants whose parents, paternal and maternal grandparents were not all of Mwaghavul origin. Participants that were less than 18 years and above 30 years during the conduct of the study. Participants with obviously visible facial deformity.

## METHODS

### Photographic Set-up

The photographic setup consisted of a tripod stand and digital camera (Nikon D60, manufactured by Nikon Inc., USA). The tripod was stable and easily adjustable so as to maintain the optic axis of the lens at a horizontal level with the head of the subject when capturing photographs.

The participants were positioned at a distance of 120cm from the camera (Ozkul *et al.*, 2009). Their heads were in the Frankfurt position, with the gaze facing the camera and parallel to the floor (Fernández-Riveiro *et al.*, 2003). The camera was raised to the ear level of the participant to provide good quality of image and to prevent distortion of the face (Ozkul *et al.*, 2009). The photographs were captured at a standard resolution of 12.1 megapixels. A digital vernier caliper (Neiko 01407A, China) was then used to measure the facial linear dimensions. This helped in the determination of the factor (0.71) to be used for real-size measurements of the photographs. The photographic records were analysed using a bioanalyser (customized software using Microsoft visual basic version 6). The program was customized with the landmarks used in this study.

### Anthropometry

1. Upper facial height: The distance from the nasion (n) to subnasion (sn)
2. Facial length: The distance from nasion (n) to menton (m)/gnathion
3. Lower facial length: The distance from the subnasion (sn) to the menton (m)
4. Facial width: The distance from the right zygion (zy) to the left zygion (zy) (Ewunonu and Anibeze, 2013; Harsha *et al.*, 2022)



Plate I: Facial photograph of a participant indicating the facial landmarks used

Key: n = nasion, sn = subnasion, m = menton, zyR = right zygion, zyL = left zygion, alR = right alar, alL = left alar

**Determination of facial index**

The index was calculated as:

1. The facial index (FI) is the percentage ratio of morphological facial height and facial width;  
Calculated according to the formula:  $FI = (n-m / zy-zy) \times 100$ .

Table 1: Classification of Human Faces into five International Anatomical Categories (Banister *et al.*, 1995; Williams *et al.*, 1995)

S/N	Facial types	Facial index
1	Hypereuryprosopic (very broad face)	≤ 78.9
2	Euryprosopic (broad face)	79.0 - 83.9
3	Mesoprosopic (round face)	84.0 - 87.9
4	Leptoprosopic (long face)	88.0 - 92.9
5	Hyperleptoprosopic (very long face)	≥ 93.0

2. Upper facial index is the percentage ratio of upper facial height to facial width (bizygomatic distance) (Umar *et al.*, 2006).
3. Lower facial index is the percentage ratio of lower facial height to facial width (bizygomatic distance) (Umar *et al.*, 2006; Aynechi *et al.*, 2011).

**Data Analyses**

The data were analyzed as Mean±SD. Independent sample *t*- test was used to compare the level of facial asymmetry between cases and control groups and in determining sexual differences. The data were analyzed using statistical package for social scientists (SPSS) (IBM 20 software). *P* < 0.05 was considered statistically significant.

**RESULTS**

Table 2 shows the descriptive statistics of the selected facial parameters of the Mwaghavul ethnic group of Plateau State aged 18-30 years.

Table 2: Descriptive Statistics of the selected Facial parameters.

Parameters	Males Mean ± SD (n=231)	Females Mean ± SD (n=174)	Minimum	Maximum
Facial height (mm)	167.57 ± 22.61	169.17 ± 22.68	100.82	228.80
Lower facial height (mm)	90.32 ± 13.40	90.54 ± 13.90	36.92	129.29
Facial width (mm)	167.35 ± 23.37	168.48 ± 24.44	114.48	245.07
Upper facial index	46.85 ± 3.80	47.73 ± 4.10	35.03	61.33
Facial index	101.55 ± 6.31	100.75 ± 6.26	74.72	115.10
Lower facial index	54.42 ± 5.31	53.92 ± 5.26	27.36	69.37

Figures 3 – 7 show the sexual dimorphism in the selected facial parameters of the Mwaghavul ethnic group. It was observed that there was significant sexual dimorphism in upper facial height, facial width, facial index and lower facial index. Of all the parameters that exhibited sexual dimorphism, the females tend to have higher mean value compared to the males except for the facial and lower facial indices in which the males have higher values than the females.

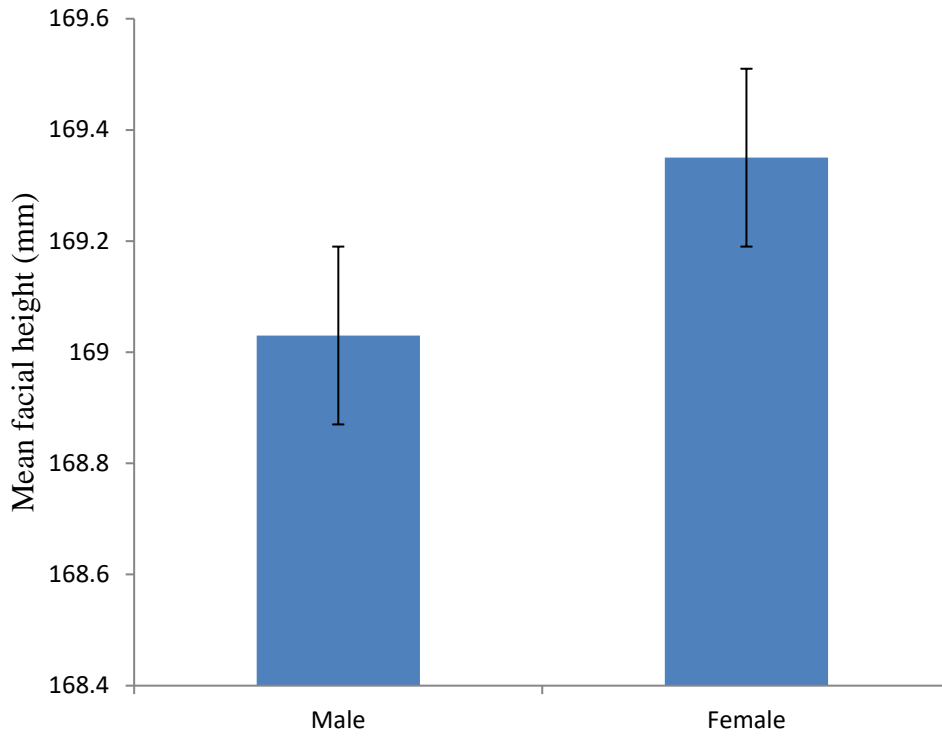


Figure 3: Sexual dimorphism of Facial height among Mwaghavul ethnic group of Plateau State.

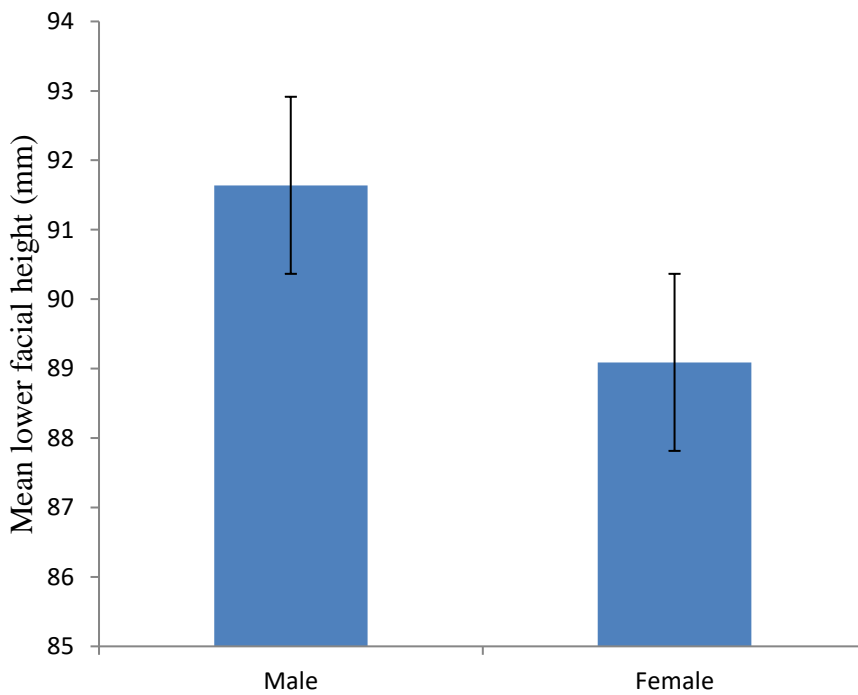


Figure 4: Sexual dimorphism of Lower facial height among Mwaghavul ethnic group of Plateau State.

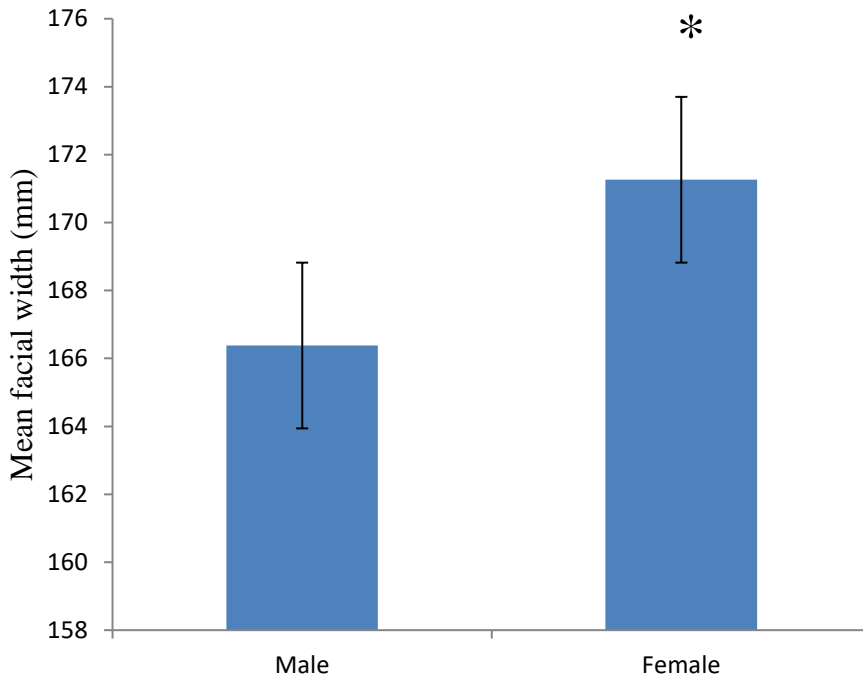


Figure 5: Sexual dimorphism of Facial width among Mwaghavul ethnic group of Plateau State (\*P = 0.047).

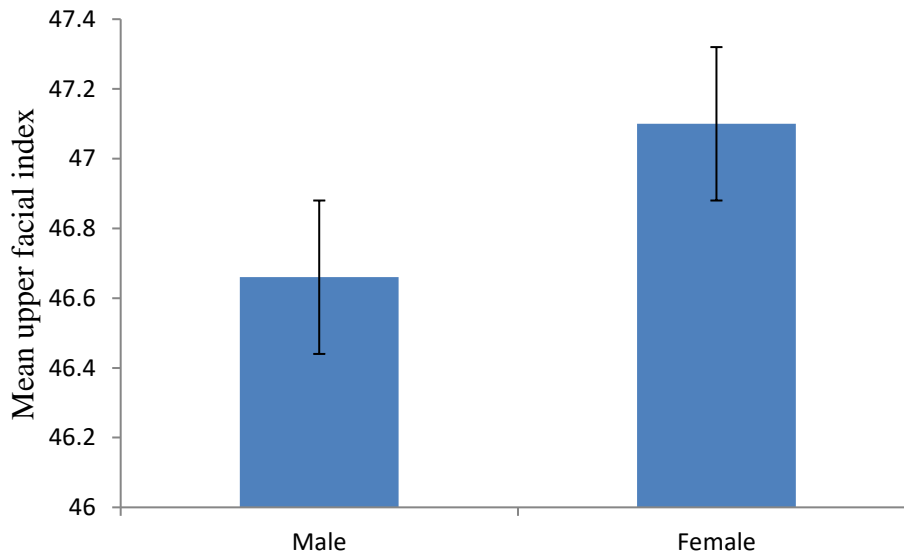


Figure 6: Sexual dimorphism of Upper facial index among Mwaghavul ethnic group of Plateau State.



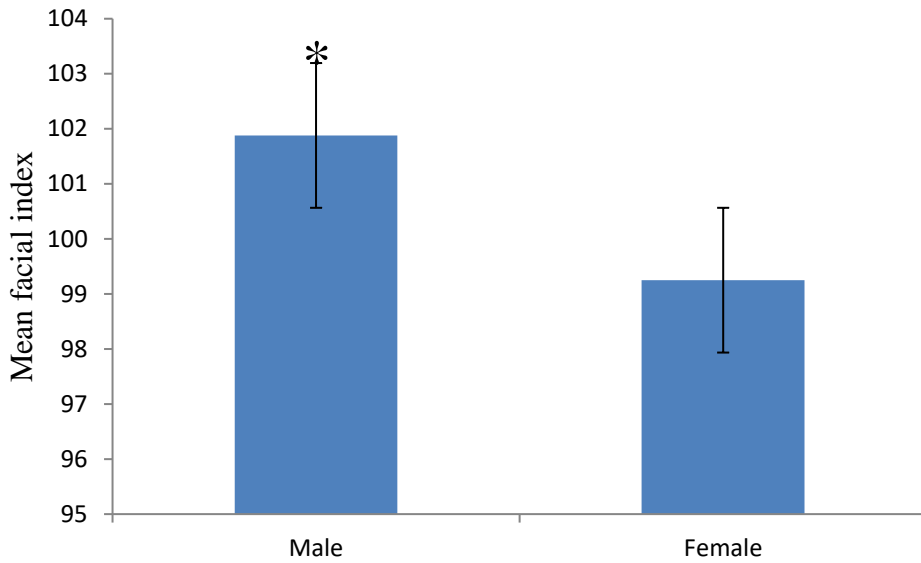


Figure 7: Sexual dimorphism of Facial index among Mwaghavul ethnic group of Plateau State (\*p<0.001)

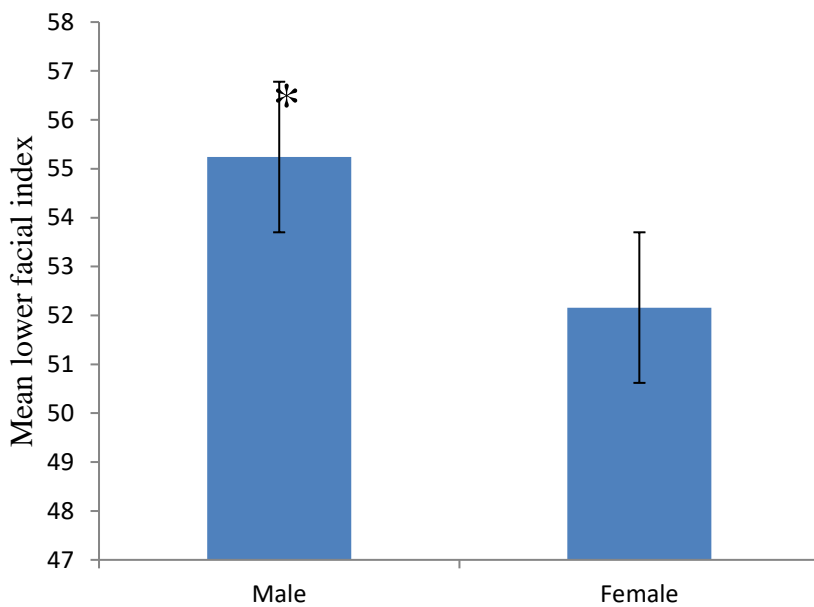


Figure 8: Sexual dimorphism of Lower facial index among Mwaghavul ethnic group of Plateau State (\*p <0.001)

Table 3 shows the association of facial index with sex of the Mwaghavul ethnic group according to the values of Banister *et al.* A significant association was noted between the sex and facial types. The four types of the facial morphology are found in the male population while the hypereuroprosopic is not found in the female population. In both sexes, the hyperleptoprosopic has the highest percentage followed by the leptoprosopic, then mesoprosopic and europrosopic has the least in the females whereas hypereuroprosopic has the least in males.

Table 3: Association of Facial Index with sex according to Banister *et al.*, 1995

Classification	Sex		Total (%)
	Males (%)	Females (%)	
Hypereuroprosopic	1 (0.2)	0 (0.0)	1 (0.2)
Europrosopic	1 (0.3)	1 (0.2)	2 (0.5)
Mesoprosopic	1 (0.2)	4 (1.0)	5 (1.2)
Leptoprosopic	12 (3.0)	23 (5.7)	35 (8.7)
Hyperleptoprosopic	216 (53.3)	146 (36.1)	362 (89.4)
<b>Total</b>	<b>231 (57.0)</b>	<b>174 (43.0)</b>	<b>405 (100.0)</b>

Pearson Chi-Square = 12.01, df = 4, p = 0.017

Table 4 shows inter-correlation amongst the upper facial height, facial height, lower facial height, facial width, and facial index of the male population. The highest positive correlation is between the facial height and lower facial height while the lowest positive correlation is between the lower facial height and the facial index. The highest negative correlation is between the upper facial index while the lowest negative correlation is between the upper facial index and lower facial index.

Table 4: Correlation amongst the Selected Facial parameters for the male population

Parameters	FH	LFH	FW	NW	UFI	FI	LFI	NI
NL/UFH	0.874**	0.605**	0.841**	0.834**	0.329**	-0.032	-0.271**	-0.351**
FH		0.916**	0.907**	0.822**	-0.013	0.099	0.123	-0.143*
LFH			0.790**	0.656**	-0.293**	0.189**	0.426**	0.056
FW				0.868**	-0.227**	-0.324**	-0.211**	-0.017
NW					-0.006	-0.198**	-0.224**	0.214**
UFI						0.507**	-0.129*	-0.598**
FI							0.789**	-0.264**
LFI								0.123

\*\*P< 0.01, \*P< 0.05

UFH=Upper facial height, FH=Facial height, LFH=Lower facial length, FW=Facial width, UFI=Upper Facial Index, FI=Facial Index, LFI=Lower Facial Index.

Table 5: shows inter-correlation amongst the upper facial height, facial height, lower facial height, facial width, facial index of the female population. The highest positive correlation is between the facial height and lower facial height while the lowest positive correlation is between the lower facial height and the lower facial index. The highest negative correlation is between the facial width and facial index while the lowest negative correlation is between the facial height and the upper facial index.

Table 5: Correlation amongst the Selected Facial parameters for the female population

Parameters	FH	LFH	FW	NW	UFI	FI	LFI	NI
NL/UFH	0.900**	0.697**	0.829**	0.767**	0.146	-0.042	-0.182*	-0.230**
FH		0.940**	0.908**	0.817**	-0.149*	-0.006	0.119	-0.025
LFH			0.844**	0.743**	-0.359**	0.024	0.339**	0.139
FW				0.854**	-0.425**	-0.420**	-0.213**	0.130
NW					-0.276**	-0.282**	-0.152*	0.441**
UFI						0.688**	0.091	-0.614**
FI							0.786**	-0.373**
LFI								0.012

\*\*P< 0.01, \*P< 0.05

UFH=Upper facial height, FH=Facial height, LFH=Lower facial length, FW=Facial width, UFI=Upper Facial Index, FI=Facial Index, LFI=Lower Facial Index.

## DISCUSSION

Factors such as gender, race and ethnicity, climate, socio-economic, nutritional, and genetic factors have been reported by many authors to be of significant impact of the morphology of the human face. This then implies that it's not uncommon to find facial variations based on differences in gender, age race and ethnicity (Umar *et al.*, 2006; Ewunonu & Anibeze 2013; Jeremic *et al.*, 2013; Ezeuko & Eboigbe 2015).

Sexual dimorphism was observed in facial width, facial index and lower facial index which agrees with those reported among central Serbians (Jeremic *et al.*, 2013); among Hausas and Yorubas (Adelaja, 2016); in Nigerian Skulls (Orish & Oladipo, 2017) implying that gender affects facial anthropometrics.

The facial morphology of the Mwaghavuls is hyperleptoprosopic. The hyperleptoprosopic observed agrees with Raji *et al.* (2010), who reported that Nigerians, especially from North-East are hyperleptoprosopic; hyperleptoprosopic South Indian adult (Radha, 2020). However this expectedly disagreed with mesoprosopic reported among the children of Southern Nigeria (Oludiran *et al.*, 2012); mesoprosopic Indian students (Shetti *et al.*, 2011); Fulani and Tera males were hyperleptoprosopic while Tangale and Tera females were leptoprosopic (Maina *et al.*, 2011); leptoprosopic reported among central Serbians (Jeremic *et al.*, 2013); leptoprosopic among South-Eastern Nigerian Population (Ewunonu & Anibeze, 2013); mesoprosopic reported among Malay population (Yesmin *et al.*, 2014); hypereuryprosopic among Benue ethnic groups (Obaje *et al.*, 2015); leptoprosopic reported among Yorubas (Adelaja, 2016); Turkish population was mesoprosopic (Senol *et al.*, 2019); Jaunsari tribe population was leptoprosopic (Ansari *et al.*, 2019); central Indian population were mesoprosopic (Vaidya *et al.*, 2020); Western Indian population were mesoprosopic (Harsha *et al.*, 2022). These variations were possibly due to age, ethnic, nutritional, socio-economic and geographic, genetic, gender, racial and climatic factors (Jeremić *et al.*, 2013; Obaje *et al.*, 2015).

.The observed variation and similarities of this work to the ones conducted in other populations further confirm that factors such as age, sex, geographical location, ethnicity and race can influence cephalometrics especially facial indices.

## CONCLUSION

The study showed that the predominant facial type of the Mwaghavul population is hyperleptoprosopic. The Mwaghavuls are sexually dimorphic in facial width, facial and lower facial indices.

**ACKNOWLEDGEMENTS:** The authors acknowledge the cooperation of the participants.

**Conflict of interest:** None declared

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