Original Article

Analysis of facial pattern among 12–16-year-old students in Lagos, Nigeria

ABSTRACT

Background: Facial patterns or biotypes have been known to influence the treatment plan of orthodontic patients and analyze the facial patterns described by Ricketts. Determining the facial type is extremely important for orthodontic diagnosis and planning since the muscular and skeletal configuration of each facial type responds differently to the orthodontic treatment.

Materials and Methods: A sample of 100 individuals was recruited by multistage sampling from three schools in Ikeja local government, Lagos State. Those aged between 12 and 16 years who met the inclusion criteria were enrolled in the study after obtaining informed consent and assent from the parents and participants. Lateral cephalometric radiographs were taken for all participants, and the final sample after analysis of the radiographs was 84. The error of the cephalometric method was assessed using the intraclass correlation coefficient. Facial axis angle (Ptm-Gn/Ba-N) was used to classify the facial pattern into brachyfacial (<87°), mesofacial (87 –93°), and dolichofacial (>93°)

Results: Out of the 84 participants, 60 (71.4%) had mesofacial facial pattern which consisted of 27 (32.1%) males and 33 (39.3%) females. 10 (11.9%) had brachyfacial pattern out of which 9 (10.7%) were male and 1 (1.2%) was a female. This difference between the males and females in the brachyfacial pattern was statistically significant with a *P* value of 0.014 ($P \leq 0.05$). 14 (16.67%) participants had dolichofacial pattern with 5 (6.0%) males and 9 (10.7%) females.

Conclusion: The mesofacial pattern had the highest frequency among the facial pattern types studied in this Nigerian population and was found to be more predominant among females. The brachyfacial pattern was seen more frequently in males while the dolichofacial pattern was more prevalent among females. The facial pattern assessment should guide the orthodontist in the use of appropriate mechanics to achieve an overall balanced occlusion and facial profile following orthodontic treatment.

Keywords: Brachyfacial, dolichofacial, facial pattern, mesofacial

INTRODUCTION

Facial patterns or biotypes have been known to influence the treatment plan of orthodontic patients. Determining the facial type is extremely important for orthodontic diagnosis and planning since the muscular and skeletal configuration of each facial type responds differently to the orthodontic treatment, influencing either positively or negatively the final treatment results.[1] Assessing the facial type or pattern also impacts positively on facial esthetics, a major goal of orthodontic treatment.[1] A good facial analysis, both qualitative[2] and quantitative[3] must be observed when defining the treatment plan. Classifying orthodontic diagnosis according to facial patterns allows the orthodontists to treat malocclusions based on the location of skeletal discrepancies if present.[4] It has been suggested that there is more variation among human faces than in any other mammalian species except domestic dogs.[5]

Olawande A. Ajisafe, Babatunde O. Ogunbanjo[1], Kikelomo O. Adegbite, Afolabi Oyapero[2]

Department of Child Dental Health, Lagos State University Teaching Hospital, Departments of [1]Child Dental Health and [2]Preventive Dentistry, Faculty of Dentistry, Lagos State University College of Medicine, Lagos, Nigeria

Address for correspondence: Dr. Afolabi Oyapero, Department of Preventive Dentistry, Lagos State University College of Medicine, Ikeja, Lagos, Nigeria.
E-mail: fola_ba@yahoo.com

Access this article online	
Website: www.orthodrehab.org	Quick Response Code
DOI: 10.4103/ijor.ijor_22_18	

How to cite this article: Ajisafe OA, Ogunbanjo BO, Adegbite KO, Oyapero A. Analysis of facial pattern among 12–16-year-old students in Lagos, Nigeria. Int J Orthod Rehabil 2018;9:134-40.

Variation in facial appearance among individuals is influenced by the cranial base, and the soft-tissue structures overlying the facial skeleton: the mimetic musculature, the superficial fasciae, and adipose tissue deposits. Frankfort-mandibular plane angle (FMA) which is a component of Tweed's facial triangle has also been used to classify facial pattern into mesofacial, dolichofacial, and brachyfacial.[6] When the FMA is between 20° and 30°, the patient tends toward a mesofacial pattern but has a dolichofacial tendency when the FMA is above 30°. A brachyfacial tendency is seen when FMA is <20°. Ricketts[7] also classified facial pattern into three main types as follows: dolichofacial (long face), mesofacial (normal face), and brachyfacial (short face). He associated the direction of the condyle with the types of facial patterns.

Brachyfacial describes a horizontal growth pattern in which the face appears short and wide. The mandible is strong and squared off in appearance.[7] The dolichofacial pattern describes a vertical growth pattern where the face is long and narrow with the dental arches exhibiting crowding of teeth.[7] In most cases, people with this facial pattern may present with anterior open bite resulting from a long face. A higher anterior facial height against a smaller posterior facial height and prominent vertical against horizontal components are characteristics of dolichofacial participants which differ from that of mesofacial participants.[8] The mesofacial pattern consists of a well-balanced face with harmonious musculature and a pleasant soft-tissue profile.[9] The mesofacial pattern tends to exhibit a normal relationship between the maxilla and mandible with the face appearing neither too long nor wide. This is in contrast with the dolichofacial participant who tends to have a high mandibular plane-sella nasion angle (MP-SN) resulting in a steep MP and a longer face and the brachyfacial participant with low MP-SN angle[5,10] (flat MP angle) and a shorter face. The upward and forward growth of the condyle tends to be consistent with increased depth of the face (brachycephalic tendency) while upward and backward growth was found to be more consistent with increased length of the face (dolichocephalic tendency).[11] These patterns, including factors of growth, have been applied for the prediction of growth in each facial pattern and for the establishment of treatment goals.

Furthermore, when the facial pattern of a patient is not determined before orthodontic treatment commences, the facial esthetics and occlusal function of the patient may be further compromised if the lower facial height (LFH) is unnecessarily increased or reduced by the mechanics used in treatment. Determining a patient's facial pattern will also assist the orthodontist to know if a patient would require orthognathic surgery in addition to orthodontic treatment in cases of long- or short-faced individuals. When the patient's facial pattern is not appropriately determined before treatment, the use of unsuitable orthodontic mechanics may lead to an increase or decrease in the vertical dimension and the worsening of the facial pattern compromising facial esthetics and occlusal function by reducing or increasing the overbite. The facial pattern assessment, therefore, guides the orthodontist in the use of appropriate treatment mechanics to achieve an overall balanced occlusion and facial profile following orthodontic treatment.

Since this assessment has not been previously done in Nigeria, the aim of this study was to evaluate the facial pattern and to establish baseline norms in a population of 12–16-year-old Nigerian students situated in Ikeja, Lagos State.

MATERIALS AND METHODS

Study design and study setting

A cross-sectional study was carried out in three secondary schools and Lagos State University Teaching Hospital (LASUTH) in Ikeja local government area (LGA) of Lagos state. This was grounded on the ease of the participants' accessibility to taking the lateral cephalometric radiographs.

Description of the study area

Lagos is a metropolitan urban center with a heterogeneous population of Nigerians in the southwestern part of Nigeria. It has a population of about 22 million people who are mainly of the Yoruba tribe. The city is about 3345 square kilometers, and it is bounded by Ogun state to the north and east and the Bight of Benin to the south and the Republic of Benin to the west and remains a commercialized and industrial state up to date.[12]

Sample size determination

The Fisher's formula[13] was used for determining the study sample size using a prevalence of 24.7% based on a study describing the prevalence of normal occlusion in Nigeria.[14] About 30% attrition was added to the calculated sample size of 72 to accommodate dropouts, and the sample size was rounded up to 100.

Inclusion criteria

Study participants were of the Nigerian origin, aged 12–16 years, were a combination of consenting parent and assenting child and had normal occlusion. They also had no previous orthodontic treatment and had a full complement of permanent dentition excluding the third molars.

Exclusion criteria

Non-Nigerians or patients of mixed race, aged below 12 years and above 16 years of age, with overjet <2 or >4 mm and

overbite less than one-third or greater than half of lower incisors as well as those unwilling to participate in the study were excluded from the study.

Diagnostic criteria for normal occlusion

Participants should have skeletal pattern 1; anteroposterior relationship of Class I.; normal overjet of 2–4 mm; normal inclination and angulation of teeth; normal overbite of one-third to half vertical overlap of lower incisors; absence of rotations; absence of crossbites; and absence of arch length discrepancy (no spacing or crowding).[15]

Sample selection

A multistage sampling method was used to select the participants with the first stage utilizing simple random sampling to select three schools in Ikeja LGA using the list of schools in the LGA obtained from the Lagos State Ministry of Education as the sampling frame. A total of 100 participants were distributed among the three public schools by stratified random sampling as follows: 33 participants each in two schools and 34 participants in the third school with a male: female ratio of 1:1. The second stage utilized simple random sampling for one class in each arm with most children aged between 12 and 16 years (JSS 2, JSS 3, and SS1). At this stage, questionnaires were administered by the researcher to all the students of the classes, and oral examination was carried out to determine those who met the inclusion criteria. Participants that fell within 12–16 years of age and that met the other inclusion criteria outlined below were enrolled into the study and allowed to proceed to the third stage. Another arm was selected by balloting, and the same process repeated until the sample size was adequate. The third stage involved balloting to enlist the number of participants in each gender required per class to complete the sample size. Before balloting, eligible students were grouped by their sex in each arm of the selected classes and requested to select a ballot paper each. Students who picked "yes" were enlisted in the study, while those who picked "no" were dropped.

Ethical considerations

Approval for the study was obtained from the Health Research and Ethics Committee of LASUTH and from the Lagos State Education Review Board of the Ministry of Education. Informed consent and assent were also obtained from the parents of the participants and the participants consecutively before proceeding with the study.

Data collection

The participants who assented and whose parents or guardians gave consented for the study had the questionnaire administered to them by the principal researcher. The participants' demographic data consisting of age, gender, tribe, nationality, and student's class were obtained in the first section while the dental and orthodontic histories were obtained in the second section. Clinical examination was carried out to assess normal occlusion by the use of a sterile mouth mirror or wooden spatula by the principal investigator under natural light. The overjet was measured as the most prominent point on the incisal edge of the upper central incisor to the most prominent labial edge of the lower central incisor with the subject in centric occlusion using a metric ruler to the nearest millimeter while the overbite was determined by viewing the vertical overlap of the upper and the lower central incisors. The amount of vertical overlap of the maxillary incisors on the mandibular incisors was marked with an indelible pencil on the labial surface of the mandibular incisors, using the incisal edge of the maxillary incisor to guide the pencil. Participants having less than one-third vertical overlap or greater than half overlap of the lower central incisors were termed as having reduced overbite and increased overbite, respectively, as well as those with reverse overbite were excluded from the study.

The anteroposterior molar and canine relationships were determined by the Angle's classification as Class I, Class II, or Class III and participants that had Class I Angle's molar and canine relationships and who met other inclusion criteria were included in the study, and those with Class II or III molar relationships were also excluded from the study. Any crossbite seen was documented as anterior or posterior crossbite, and tooth bone ratio was recorded as crowding or spacing; mild (0–3 mm), moderate (4–7 mm), and severe (>8 mm), while lip competence was assessed and recorded as competent or incompetent using the Jackson's lip classification.

The mirrors used were sterilized in sterilization pouches, and adequate infection control measures were observed. Face masks and latex gloves were worn after applying 70% alcohol and triethanolamine gel to the hands before examining each participant and were discarded after examination of each participant. Indelible pencils and rulers used were also wiped with 95% isopropyl alcohol before examining each participant.

Cephalometric radiographs

Appointments were prearranged for participants who met the inclusion criteria and they were conveyed to the Orthopantomogaph and Cephalometry Radiology Unit of the Lagos State University College of Medicine, to take the lateral cephalometric radiographs. The lateral cephalometric radiographs were done with a digital orthopantomograph/cephalostat, (Vatech PaX-400C IEC60601-2-7 by Vatech Ltd Gyeonggi, Korea) with the head positioned in the natural position and with the teeth in maximum intercuspation. Before taking the radiograph, each participant was provided

with a lead apron to shield the vital organs, and the number of images taken was limited to 1 or 2 exposures to minimize the risks associated with radiation exposure. Each participant was positioned at 150 cm from the source of radiation and 15 cm from the film[16] and exposed to the radiation for 5 s at a setting of 70 kV and 4 mA. The precautions were taken to achieve the As Low As Reasonably Achievable principle.[17] Each lateral cephalogram was traced by the principal investigator with a lead pencil on a 0.003-mm matte finish acetate tracing paper on a light viewing box in a dark room [Figures 1 and 2]. The results of the cephalometric tracing were documented in a section of the questionnaire by the researcher. The cephalometric ear rods, forehead supporter, and nasion pointers were cleaned after each patient with iodine disinfectant solution.

Landmarks and planes identified and used in the analysis

- Sella (S): Center of the hypophyseal fossa (sella turcica)
- Nasion (N): Junction of the nasal and frontal bones at the most posterior point on the curvature of the bridge of the nose
- Anterior nasal spine (ANS): Tip of the bony ANS in the median plane
- Posterior nasal spine (PNS): Tip of the PNS of the palatine bone at the junction of the soft and hard palate
- A point (Subspinale): Point at the deepest midline concavity on the maxilla between the ANS and prosthion. It is an arbitrary measure point on the innermost curvature from the maxillary ANS to the crest of the maxillary alveolar process
- B point (Supramentale): Point at the deepest midline concavity on the mandibular symphysis
- Orbitale (Or): The lowest point in the inferior margin of the orbit, midpoint between the right and left images
- Porion (Po): The most superior point of the external auditory meatus
- Gonion (Go): The constructed point of intersection of the ramus plane and the MP
- Gnathion (Gn): The most anteroinferior point on the symphysis of the chin
- Pogonion (Pg): The most anterior point on the contour of the bony chin in the median plane.[18]

Planes

- Frankfort horizontal plane (Po-Or)
- Mandibular plane (Go-Me)[20]
- Sella–Nasion (S-N) plane
- Long axis of the mandibular incisor
- Basion-Nasion plane.

Angles

- Frankfort-mandibular plane angle (FMA)
- Frankfort-mandibular incisor angle
- Incisor mandibular plane angle
- Facial axis angle (Ptm-Gn/Ba-N)
- Sella-Nasion-A point angle
- Sella-Nasion-B point angle
- A point–Nasion–B point angle
- SN-Go. Gn angle.

Diagnostic criteria for facial pattern

Facial axis angle (Ptm-Gn/Ba-N) classifies the facial pattern into the following types;[10]

1. Brachyfacial: <87°
2. Mesofacial: 87°–93°
3. Dolichofacial: >93°.

Assessment of tracing error

Twenty cephalometric radiographs were retraced by the principal investigator (A. O.) 4 weeks after the first set of tracing was done, and intraclass coefficient was done to assess the intra-examiner error.

Data analysis

Data were entered into Microsoft Excel and stored in a personal computer. Data were analyzed using the Statistical Package for the Social Sciences for Windows Version 20 (IBM Corp., Armonk, New York, USA). Descriptive statistics for continuous variables was carried out using mean, standard deviation, and minimum and maximum values while categorical variables were represented using frequencies and percentages. Test of association between categorical variables was carried using the Pearson Chi-square test. Test of normality was performed for continuous variables using the Kolmogorov–Smirnov test, and data were found to be normally distributed. Parametric test (independent student *t*-test) was used to compare means for cephalometric values while Pearson's correlation was used to test for the agreement between continuous variables. The *P* value was set at $P < 0.05$.

Cost of treatment

The researcher was responsible for all costs during the period of the study. This included the cost of transportation to the hospital where the radiographs were taken and the cost of the lateral cephalometric radiographs. There was no conflict of interest to declare.

Duration of study

The duration of the study was 12 months.

RESULTS

An assessment of intra-examiner error in tracing the cephalometric radiographs revealed a high degree of reliability of the angles measured [Table 1]. The sociodemographic characteristics of the participants in this

study revealed that out of the 100 participants, 16 did not satisfy the required criteria; hence, the final sample was 84. Of the 84 participants, 41 (48.8%) were male and 43 (51.2%) were female and the participants were aged between 12 and 16 years with a mean age of 14.1 ± 1.3 years. Majority of the participants were from the Yoruba tribe 44 (52.4%) while the Hausa tribe consisted of the least group 8 (9.5%). There was no statistically significant difference among the age group, ethnic group, or secondary school class [Table 2].

Evaluation of facial pattern according to gender (using facial axis angle (Ptm-Gn/Ba-N): This was depicted by a bar chart in Figure 3. Out of the 84 participants, 60 (71.4%) had mesofacial facial pattern which consisted of 27 (32.1%) males and 33 (39.3%) females. Ten (11.9%) had brachyfacial pattern out of which 9 (10.7%) were male and 1 (1.2%) was a female. This difference between the males and females in the brachyfacial pattern was statistically significant with $P = 0.014$ ($P \leq 0.05$). 14 (16.67%) participants had dolichofacial pattern with 5 (6.0%) males and 9 (10.7%) females.

Figure 4 shows the facial pattern distribution according to the ethnic group. The mesofacial pattern had the highest frequency in all the ethnic groups except the dolichofacial pattern which had the highest number among the Hausa tribe. The Yoruba ethnic group had the highest number of

Table 1: An assessment of error method coefficient of reliability

Angular measurements	Reliability values
FMIA	0.903
IMPA	0.903
FMA	0.879
SN-Go.GN	0.812
Facial axis angle	0.913

FMIA: Frankfort-mandibular incisor angle, IMPA: Incisor mandibular plane angle, FMA: Frankfort-mandibular plane angle

Table 2: Sociodemographic characteristics of participants ($n=84$)

	Gender		Total ($n=84$), *n* (%)	*P*
	Male ($n=41$), *n* (%)	Female ($n=43$), *n* (%)		
Age (years)				
12	5 (6.0)	7 (8.3)	12 (14.3)	0.253
13	9 (10.7)	7 (8.3)	16 (19.0)	
14	8 (9.5)	14 (16.7)	22 (26.2)	
15	13 (15.5)	6 (7.1)	19 (22.6)	
16	6 (7.2)	9 (10.7)	15 (17.9)	
Ethnic group				
Yoruba	20 (23.8)	24 (28.6)	44 (52.4)	0.265
Igbo	14 (16.7)	7 (8.3)	21 (25.0)	
Hausa	3 (3.5)	5 (6.0)	8 (9.5)	
Others	4 (4.8)	7 (8.3)	11 (13.1)	
Secondary school class				
JSS2	13 (15.5)	13 (15.5)	26 (31.0)	0.958
JSS3	14 (16.7)	16 (19.0)	30 (35.7)	
SSS1	14 (16.7)	14 (16.7)	28 (33.3)	

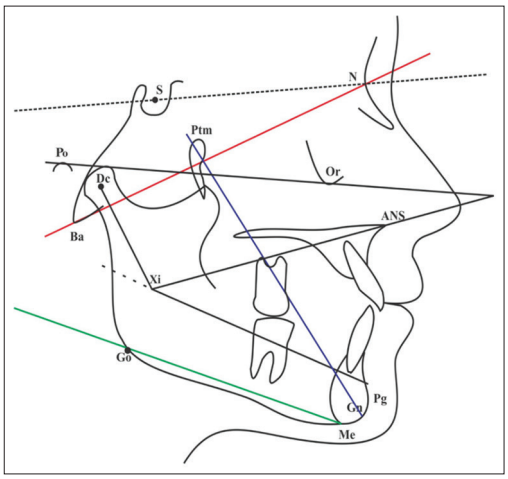

Figure 1: Ricketts' analysis illustrating landmarks and planes in the measurement of the VERT index: Xi point and Dc, S-N plane (black dotted line), Frankfort plane (Po-Or) – black solid line, Ptm-Gn plane (blue line), Ba-N plane (red line), Mandibular plane (Go-Me) - green line. a - FMA, b - FMIA, c - IMPA, d - Facial axis angle, e - SNA, f - SNB, g - SN.Go-Gn

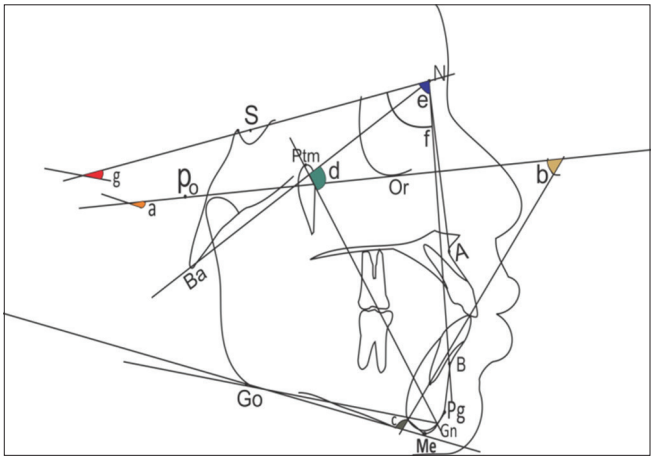

Figure 2: Angular measurements in this study

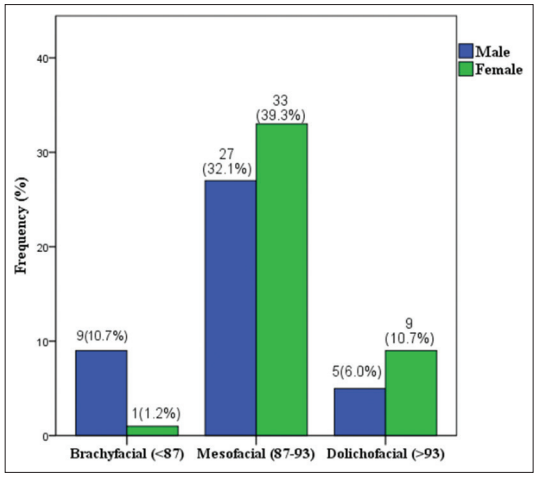

Figure 3: Component bar chart comparing facial patterns by gender

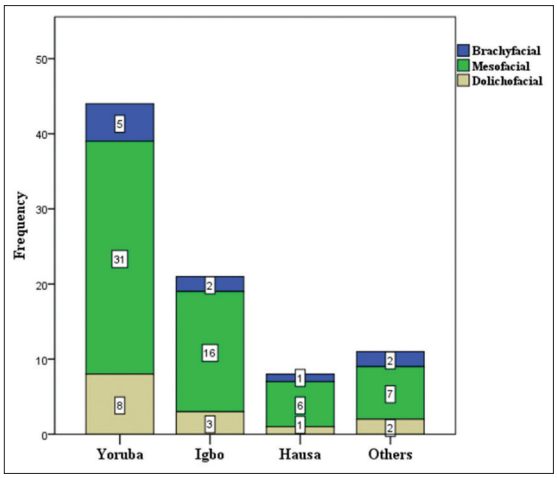

Figure 4: Comparison of facial pattern according to the ethnic group

participants. There is no significant association between facial pattern and ethnic group.

DISCUSSION

The aim of this study was to evaluate the facial pattern in a population of Nigerian students in Ikeja, Lagos State. All participants were from secondary schools in the aforementioned area of Lagos state, and they were aged between 12 and 16 years. The age range was representative of that at which majority of adolescent patients present to the orthodontic clinic. Some researchers are in agreement with this age group[19,20] while others are in support of an older age group.[21,22] Although it is reported that the facial pattern is best assessed when the individual has stopped growing, the age range in this sample was selected because some facial types have the tendency to worsen during the period of adolescence and the detection may only be achieved during this period.[4] The patients also tend to present for orthodontic treatment at this adolescent stage when the facial pattern can be assessed.

The results of this study show that there is a higher value of FMA in males (24.45° ±4.83°) than females (22.20° ± 4.51°). The disparity of about 2° suggests an increased lower vertical height (LFH) in males than females, and this difference in FMA values between males and females was found to be statistically significant. In a study by Knight and Keith[23] increased anterior LFH was found to be associated with less attractive faces for females but was not found to be so for males. Males tend to have broader faces and physique compared to females, and this may attribute to the difference in the LFH. The higher value of FMA in males also points to the tendency of having a dolichofacial pattern in males compared to females with probability of anterior open bite and excessive gingival display associated with the long face type, which could be associated with a prolonged treatment time.

Filho[24] defines the facial pattern as the configuration or outline of the face over a period of time whose characteristics are established very early in childhood and do not change throughout the years. The mesofacial pattern was found to have the highest frequency in all the ethnic groups. However, facial pattern assessment in relation to the ethnic groups was not statistically significant implying the random distribution of these facial patterns types among the different ethnic groups in this study. In relation to gender, the mesofacial facial pattern was more prevalent among females (55%) than males (45%), and this suggests a more balanced facial growth in females. This was similar to the finding by de Magnani *et al*.[8] where more of the females had mesofacial pattern in comparison to males. The mechanics involved also do not need to be complex to achieve the result projected.

While the brachyfacial pattern was predominant among the males, the mesofacial and dolichofacial patterns were more prevalent in females in this study. This was, however, contrary to a study by Feres *et al*.[25] where majority of all the participants in all three facial patterns were males. The basis for the gender significance in males among the brachyfacials may be due to more males with the facial type presenting for the study. Since brachyfacials have more horizontal growth of the jaw, they tend to have larger arches with more space for the teeth. There is an increase in intercanine and intermolar width which supports the fact that they present with less crowding[26] and therefore less likelihood of extractions to align the teeth during orthodontic treatment. Siriwat and Jarabak[27] reported the brachyfacial pattern (hypodivergent) to be predominant in Class II and Class III malocclusions.

There was a female preponderance in the dolichofacial pattern participants (66.67%) which is at variance to a study by de Magnani *et al*.,[8] where there was a higher number of males with this facial type. The dolichofacial facial type has been considered a long narrow and manly type of face[8] though it is not exclusive of male characteristics. The female predominance of the dolichofacial facial pattern in this study may be due to racial differences. Since the dolichofacial pattern has been associated with increased incisor exposure and gummy smile with a nonpleasing esthetic appearance, it is important to consider the treatment outcome, especially in females, who are more concerned about their esthetics. Ijaz[28] associated the dolichofacial pattern otherwise known as hyperdivergent pattern with Class II malocclusion. The arch tends to be narrow with the teeth proclined usually giving a Class II division I malocclusion. This cannot, however, be

generalized for all dolichofacial patients.

It is of utmost importance that correct mechanics be used by the orthodontist as most dolichofacial pattern individuals would be treated with Class II mechanics or mechanotherapy. Isaacson *et al*.[29] also reported a decreased maxillary intermolar width in dolichofacial patients, and this may be associated with a long and narrow face and crowding. Nasby *et al*.[30] reported a similar finding in long-faced individuals and a tendency toward open bite. The clinician may have to consider extractions to have a balanced occlusion. These individuals also tend to present with anterior open bite, gummy smile, increased incisal exposure, and incompetent lips associated with the long face.[31] Mechanics that would further elongate the face or increase the LFH should therefore be avoided to give a balanced and pleasing profile after treatment. In severe dolichofacial individuals, orthognathic surgery may be considered to correct the skeletal malocclusion.

CONCLUSION

The mesofacial pattern had the highest frequency among the facial pattern types studied in this Nigerian population and was found to be more predominant among females. The brachyfacial pattern was seen more frequently in males while the dolichofacial pattern was more prevalent among females. The facial pattern assessment should guide the orthodontist in the use of appropriate mechanics to achieve an overall balanced occlusion and facial profile following orthodontic treatment. It is, however, recommended that a study with a larger sample size which would be more representative of all Nigerian ethnic groups is carried out.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Martins L, Vigorito J. Photometric analysis applied in determining facial type. Dent Press J Orthod 2012;17:71-5.
2. Angle EH. Treatment of malocclusion of the teeth. In: Angles System. Philadelphia PA: SS White Dental; 1907. p. 50-2.
3. Jacobson A. Planning for orthognathic surgery – Art or science? Int J Adult Orthodon Orthognath Surg 1990;5:217-24.
4. Augusta S, Reis B, Abrão J, Aparecida C, Claro A. Agreement among orthodontists regarding facial pattern diagnosis. Dent Press J Orthod 2011;16:60-72.
5. Enlow D, Hans MG. Essentials of Facial Growth. Philadelphia: W.B. Saunders Company; 1996. p. 81-106.
6. Tweed CH. The Frankfort-mandibular plane angle in orthodontic diagnosis, classification, treatment planning, and prognosis. Am J Orthod Oral Surg 1946;32:175-230.
7. Ricketts RM. Cephalometric synthesis. Am J Orthod 1960;46:647-73.
8. de Magnani MB, Nouer DF, Kuramae M, Lucato AS, Boeck EM, Vedovello SA. Evaluation of facial pattern in black Brazilian subjects. Braz J Oral Sci 2007;6:1428-31.
9. Clark JW. Twin Block Functional Therapy Applications in Dentofacial Orthopedics. 2nd ed. St. Louis: Mosby-Wolfe Press; 2002. p. 1-272.
10. Ricketts RM. Perspectives in the clinical application of cephalometrics. The first fifty years. Angle Orthod 1981;51:115-50.
11. Ricketts RM. Planning treatment on the basis of the facial pattern and an estimate of its growth. Angle Orthod 1957;27:14-37.
12. World Population Review- Lagos Population. Available from: http://www.worldpopulationreview.com/world-cities/lagos-population/2016. [Last accessed on 2017 Nov 03].
13. Fisher AA, Laing JE, Stoeckel JE, Townsend JW. Handbook for Family Planning Operations Research Design. 2nd ed. New York, USA: Population Council; ???. p. 43.
14. Isiekwe M. Classified occlusal problems in young Nigerians: A clinical study. Odontostomatol Trop 1987;10:67-71.
15. Andrews LF. The six keys to normal occlusion. Am J Orthod 1972;62:296-309.
16. Bergersen EO. Enlargement and distortion in cephalometric radiography: Compensation tables for linear measurements. Angle Orthod 1980;50:230-44.
17. Ostensen H, Ingolfsdottir G, Munro L, Diagrammes AL, Conway M, Walters F. Basics of Radiation Protection for Everyday Use. How to Achieve ALARA: Working Tips and Guidelines. Geneva: World Health Organization; 2004. p. 1-93.
18. Athanasiou AE. Orthodontic Cephalometry. 1st ed. England: Mosby-Wolfe Publishers; 1997. p. 63-170.
19. Sharma BP, Xin C, Sharma JN. Comparative study of tweed triangle in Nepali and Chinese. J Patan Acad Health Sci 2014;1:8-12.
20. Dacosta OO. The prevalence of malocclusion among a population of Northern Nigeria school children. West Afr J Med 1999;18:91-6.
21. Rajbhandari A. Tweed's diagnostic facial triangle for Nepalese adults. Orthod J Nepal 2011;1:11-5.
22. Atit MB, Deshmukh SV, Rahalkar J, Subramanian V, Naik C, Darda M. Mean values of Steiner, Tweed, Ricketts and McNamara analysis in Maranatha ethnic population: A cephalometric study. APOS Trends Orthod 2013;3:137-51.
23. Knight H, Keith O. Ranking facial attractiveness. Eur J Orthod 2005;27:340-8.
24. Filho LC. Diagnosis in Orthodontics. Maringá: Dental Press; 2012. p. 544.
25. Feres MF, Hitos SF, Paulo de Sousa HI, Matsumoto MA. Comparison of soft tissue size between different facial patterns. Dent Press J Orthod 2010;15:84-93.
26. Christie TE. Cephalometric patterns of adults with normal occlusion. Angle Orthod 1977;47:128-35.
27. Siriwat PP, Jarabak JR. Malocclusion and facial morphology is there a relationship? An epidemiologic study. Angle Orthod 1985;55:127-38.
28. Ijaz A. A Cephalometric study to identify classification of malocclusion in patients attending orthodontic unit of the dental section at CH & ICH Lahore. J Pak Dent Assoc 2004;13:130-8.
29. Isaacson JR, Isaacson RJ, Speidel TM, Worms FW. Extreme variation in vertical facial growth and associated variation in skeletal and dental relations. Angle Orthod 1971;41:219-29.
30. Nasby JA, Isaacson RJ, Worms FW, Speidel TM. Orthodontic extractions and the facial skeletal pattern. Angle Orthod 1972;42:116-22.
31. Angelillo JC, Dolan EA. The surgical correction of vertical maxillary excess (long face syndrome). Ann Plast Surg 1982;8:64-70.