RANGE OF MOUTH OPENING AMONG THREE MAJOR ETHNIC GROUPS IN NIGERIA

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ABSTRACT

Background: **Maximum mouth opening (MMO) is an important parameter in the assessment of several clinical situations and its measured value is documented to have racial, gender, age and anthropometric variation.**

Objective: **To determine the maximal mouth opening and its predictors among the different major ethnic groups in Nigeria.**

Methods: **Study subjects were 449 adults (232 males, 215 females), age range 18-74 years from the three major ethnic groups in Nigeria. MMO measurements and anthropometric parameters were recorded. Data analysis was done using SPSS Version 22 and variables subjected to univariate analysis to determine association and a linear regression model was performed to determine variables that could predict maximum mouth opening with p-value set at < 0.05.**

Result: **The overall mean MMO across the ethnic groups was 49.33 ± 7.91mm. Mean MMO for the Yoruba ethnic group, 53.06 ± 6.27 mm was found to be significantly higher than values obtained for Hausa tribe 52.77 ± 8.06 mm and Igbo tribe 47.59 ± 8.61 mm (p=<0.001). Age, weight and height were observed to correlate significantly with MMO. A multivariate linear regression model revealed that age and height were independent predictors of maximum mouth opening across the ethnic groups.**

Conclusion: **There is ethnic variation in MMO among the 3 major ethnic groups in Nigeria with mean MMO values of 53.96 (± 6.27 mm), 52.77 (± 8.06 mm) and 47.59 (± 8.61 mm) for the Yoruba, Hausa and Igbo ethnic groups respectively. Age and height are important predictors of MMO.**

Keywords: Maximum mouth opening, Ethnicity, Weight, Height, Gender

INTRODUCTION

Maximum Mouth Opening (MMO) can be described as the distance between the incisal edges of the maxillary and the mandibular central incisors when the mouth is maximally opened.[1,2]

Assessment of mouth opening is carried out routinely during clinical examination by a number of dental, medical and surgical specialties. Range of mouth opening is used in the assessment of the stomathognathic system and is a significant factor in the diagnosis of many clinical conditions.[3-7] It is also essential in the evaluation of therapeutic interventions following treatment of various conditions affecting the stomathognathic system like temporomandibular joint disorders.[8] Range of mouth opening can also be used in predicting possible difficulties that may be associated with a number of procedures involving the stomathognathic system and can as well have implications for the management and treatment of patients.[9-12]

Mouth opening can be limited by a wide range of conditions that include odontogenic and non-odontogenic orofacial infections, trauma, neuromuscular disorders, temporomandibular joint diseases, congenital and developmental anomalies and oral neoplastic conditions among others.[13-16] Normal maximum mouth opening varies with age, race and gender.[13] There is need to know the normal range of mouth opening for a particular population before abnormal or limitation in mouth opening can be properly appreciated.[3] A number of authors in

different studies have characterized the mouth opening of their population and have been able to establish the normal and abnormal range for their population.[3-15] Few studies have been done in Nigeria on maximum mouth opening, these studies relied on population sample from specific regions of the country.[17,18] Studies however have shown that degree of mouth opening can be affected by ethnicity.[16,19] There are three major ethnic groups in Nigeria (Yoruba, Hausa and Igbo) with about 250 other ethnic groups commonly referred to as minor ethnic groups.[20] To the best of our knowledge, no previous study had been conducted to determine the maximum mouth opening among the different ethnic groups in Nigeria. Therefore, this study aims to determine the maximum mouth opening and its predictors among the three major ethnic groups in Nigeria. Findings from this study will be useful in characterizing the mouth opening among Nigerians and also serve as baseline for researchers in future.

METHODS

This cross-sectional descriptive study was carried out in three tertiary health facilities located in three different geo-ethnic zones of Nigeria (so designed to be able to get the desired representative samples); (1) Dental Hospital, University College Hospital, Ibadan, Oyo State, located in the South western part of the country where the predominant major ethnic group is Yoruba; (2) Dental Hospital, University of Nigeria Teaching Hospital, Enugu, Enugu State, located in the South eastern part of Nigeria where the predominant major ethnic group is Igbo; and (3) Dental unit of Federal Medical Centre, Kebbi, Kebbi State, where the predominant major ethnic group is Hausa. Ethical approval for the study was obtained from the Institutional Ethical Review Committees of the recruiting centres.

Participants consisted of healthy consenting adult staff (18 years and above) of the three health facilities where the study took place as well as healthy adult relatives (18 years and above) of patients attending the health facilities who consented to participate in the study after the study objectives were explained to them. A total of 150 participants that met the inclusion criteria were recruited in each study centre.

All recruited participants were interviewed to assess for any factor/s that may affect mouth opening e.g. past history of any facial trauma, pain or clicking sound in the temporomandibular joint at rest or during function as well as head and neck disorders such as submucous fibrosis, neoplasm, rheumatoid arthritis etc. that may cause limitation in mouth opening. History of any systemic disease, neurological disorders or craniofacial deformity that will affect the ability to open the mouth.

This was followed by clinical examination of the maxillofacial region that included inspection of the preauricular area for swelling and erythema. Palpation and auscultation over the temporomandibular joint when the patient opens and closes the mouth as well as assessing the degree and synchronism of movement of the mandibular condyles. Masticatory and cervical muscles were palpated for tenderness and any abnormality. Mouth opening and closure was observed for any deviation or obvious limitation (presence of any of these abnormalities constituted exclusion criteria).

Following the history and examination, consenting participants in which no abnormality was detected were recruited into the study, but those that had any of the aforementioned abnormalities (and so excluded from the study) were further investigated, counseled and referred to appropriate unit for further assessment or management.

Weight and height of each participant were measured (with the shoes removed) with the use of weighing scale and metric scale in kilogramme and centimetres respectively.

The mouth opening was measured with the use of Vernier calipers (J&S UK). The Vernier Caliper is a versatile and precision instrument used for measuring distances of objects accurately. It is capable of taking measurements that are accurate to within 0.001 of an inch or 0.02 of a millimeter.

Since it was a multicenter study, calibration of the Vernier and examiners was first carried out by measuring the inner diameter of a standard fixed object separately by each of the digital verniers, which was repeated for different objects and the readings compared to be sure that all the readings corresponded. One digital Vernier caliper was used in each centre to calibrate the manual vernier calipers (because of the risk of parallax error with manual caliper) that were used for the MMO measurement in the participants. We used the manual Vernier caliper to take MMO measurements in our participant because they were reliable (apart from the risk of parallax error) and could easily be washed, dried and sterilized by autoclaving after each use, (5 manual calipers were available for use in each centre) unlike the digital vernier caliper that might be easily damaged by washing and autoclaving. Before taking the interincisal measurement, the participants were comfortably seated and made to first

relax in the waiting room for at least 15 minutes. After this, the participants were made to sit upright with the head placed in a neutral position and resting against the wall (not flexing nor extending the neck). After about two minutes, he/she was asked to open as wide as possible without feeling pain. The smaller jaws of the vernier caliper was then inserted in between the midpoint of the upper and corresponding lower right central incisors (however for the right central incisor that was inappropriate either because the opposing incisor is missing or there is a fracture or wear of the crown, then the left central incisor was used). The measured value was then recorded. This measurement was taken three times at 15 minutes interval; and the highest value obtained was used. Readings were done three times because of the probability of the patient having an initial anxiety of an "instrument" being inserted into his mouth. But after the 2nd exercise, realizing the instrument gives no pain, he/she is likely to be more relaxed and more cooperative and the mouth opening is likely to be more accurate at the 3rd attempt. However, more than three measurements may have the tendency of fatigue on the side of the subject which may likely affect the opening ability. To control for inter-examiner and intra-examiner reliability, each step was performed by a single examiner

A structured questionnaire was used to collect the demographics, relevant medical information as well as weight, height and interincisal distance. Data were entered into electronic format at each centre and at specific intervals forwarded to the principal investigator who then scrutinized them for completeness. The study participants consisted of 150 participants from each of the three major ethnic groups in Nigeria, however, the data of one of the participants from the east (Igbo ethnic group) was excluded due to incomplete information, leaving a total of 449 available for final analysis.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) Version 22. Categorical variables were presented using frequency tables while quantitative variables were presented as means and standard deviation. The comparison of means for quantitative variables were done using the Student t-test while the associations between qualitative variables were tested using the Chi-square test. The strength of associations for quantitative variables was determined using Pearson's correlation analysis for normally distributed data. A linear regression model was used to determine the predictors of maximum mouth opening. All statistical analysis were carried out at a level of significance < 0.05.

RESULTS

Socio-demographic Characteristics

Table 1 below shows the socio-demographic characteristics of the participants. A total of 449 participants, 232 men (51.7%) and 215 women (47.9%) were included in the study. The mean age of the participants was 29.35 ± 9.57 years. More than half 251 (55.9%) of the participants were aged between 20 and 29 years with 7 (1.5%) of participants above 59 years. Among the participants, 33.4% belong to the Yoruba tribe, Hausa (33.4%) and Igbo (33.2%).

Table 1: Socio-demographic characteristics

Variable	Frequency (%)/Mean (SD)
Age (years)	29.35 ± 9.57
<20	48 (10.7)
20 – 29	251 (55.9)
30 – 39	84 (18.7)
40 – 49	46 (10.2)
50 – 59	12 (2.7)
60 – 69	6 (1.3)
70 and above	1 (0.2)
Gender	
Male	232 (51.7)
Female	215 (47.9)
Tribe	
Hausa	150 (33.4)
Igbo	149 (33.2)
Yoruba	150 (33.4)

Anthropometry and Mouth Opening Measurements

Table 2 below shows the anthropometry and mouth opening measurements of the participants. The mean weight (Kg) of the participants was 65.31 ± 14.48 and mean height (cm) was 164.41 ± 11.48. The maximum mouth opening (MMO) varied from 21.4 to 77.0 mm and the mean was 49.33 ± 7.91 mm.

Mean Maximum Mouth Opening Across Ethnic Groups

Table 3 below shows the maximum mouth opening (MMO) across the ethnic groups. From the table below it can be observed that the MMO of those from the Hausa tribe varied from 34.0 to 77mm with mean MMO of 52.77 ± 8.06 mm as compared to those from the Yoruba (53.06 ± 6.27 mm) and Igbo (47.59 ± 8.61 mm) tribes. ANOVA test revealed a significant effect of ethnicity ($p = 0.000$).

Relationship between Maximum Mouth Opening and Gender

Table 4 shows the relationship between maximum mouth opening (MMO) and gender. From the table, it can be observed that the mean MMO of male

Table 2: Anthropometry and mouth opening measurements

Variable	Mean ± SD	Minimum	Maximum
Weight (Kg)	65.31 ± 14.48	41.00	179.0
Height (cm)	164.41 ± 11.48	37.00	192.0
Vernier caliper 1st reading	49.33 ± 7.91	21.40	77.00
Vernier caliper 2nd reading	50.07 ± 8.04	21.50	76.45
Vernier caliper 3rd reading	50.90 ± 8.03	21.60	75.10

Table 3: Mean maximum mouth opening across ethnic groups

Ethnic Group	Mean ± SD	Minimum	Maximum	p-value	*t-test*
Hausa	52.77 ± 8.06	34.00	77.00		
Igbo	47.59 ± 8.61	21.60	72.00	<0.001	28.73
Yoruba	53.96 ± 6.27	33.40	71.00		
All groups*****	51.61 ± 8.14	21.60	77.00		

*The three major ethnic groups (Hausa, Igbo, Yoruba)

participants (53.51 ± 8.91 mm) was significantly higher than those of female participants (49.27 ± 6.67 mm) with *p* value of 0.01.

Relationship between Maximum Mouth Opening and Age
Table 4 shows the relationship between maximum mouth opening (MMO) and age. The mean ± SD maximum mouth opening increased from <20 years of age till age 30-39 years after which a sharp reduction was recorded up to 70 years and above. The results revealed a significant relationship between age of

patients and maximum mouth opening (p=0.004). Table 5 revealed in detail the relationship across the ethnic groups. It was observed that only the Igbo tribe shows a significant relationship between maximum mouth opening and age as compared to Hausa/Fulani and the Yoruba tribe.

Relationship between Maximum Mouth Opening and Anthropometric Measurements
Table 6 shows the relationship between maximum mouth opening and anthropometric parameters. Age was found to be inversely correlated with maximum
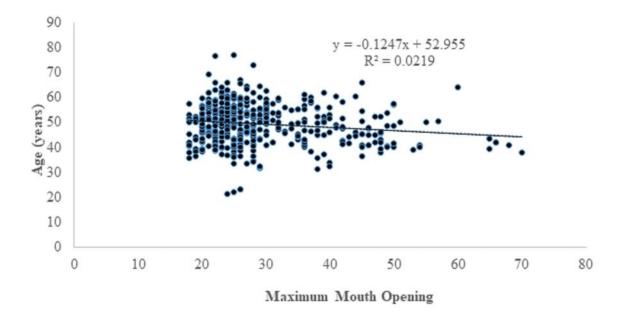

Fig 1: Linear relationship between maximum mouth opening and age

Table 4: Relationship between maximum mouth opening, gender and age.

Variable	Mean ± SD	p-value	*t-test*
Gender			
Male	53.51 ± 8.91	0.01	6.38
Female	49.27 ± 6.67		
Age			
<20	49.21 ± 6.98		
20 – 29	52.46 ± 9.03		
30 – 39	52.51 ± 6.35	0.001	3.20
40 – 49	48.42 ± 6.32		
50 – 59	48.13 ± 6.03		
60 – 69	47.33 ± 8.74		
70 and above	38.00 ± 9.64		

mouth opening (rs = -0.104). Weight measured in kilograms was weakly correlated with maximum mouth opening (rs = 0.083) while height measured in centimeters was moderately correlated with maximum mouth opening (rs = 0.294). Figure 1 shows the linear relationship between maximum mouth opening and Age. Age showed an inverse relationship ($R^2 = 0.021$).

Predictors of Maximum Mouth Opening
A linear regression model was used to determine the predictor of maximum mouth opening. The three parameters showed significant predictor of maximum mouth opening. Age and height were found to be an independent predictor of maximum mouth opening (Table 7).

Table 5: Relationship between maximum mouth opening and age across ethnicity

Ethnicity	Age	Mean ± SD	p-value	t-test
Hausa	<40years	52.15 ± 8.27		
	≥40years	49.44 ± 7.81	0.61	0.21
Igbo	<40years	47.16 ± 8.62		
	≥40years	43.81 ± 2.57	0.00**	17.02
Yoruba	<40years	52.84 ± 6.18		
	≥40years	49.44 ± 5.89	0.46	0.73

***p<0.001**

Table 6: Relationship between maximum mouth opening and anthropometric parameters

Variables	MMO	Age	Weight	Height
MMO	1.00			
Age	-0.104	1.00		
	0.02*			
Weight	0.083	0.411	1.00	
	0.03*	0.00**		
Height	0.241	0.114	0.218	1.00
	0.00**	0.00**	0.00**	

*** p<0.01; * p<0.05**

Table 7: Regression analysis with age, height and weight (predictor) and MMO as the dependent variable using linear regression model

Predictor	Univariate Analysis		Multivariate Analysis	
	β coefficient	p-value	β coefficient	p-value
Age	-0.15	0.001	-0.02	<0.001
Weight	0.07	0.11	0.18	<0.001
Height	0.19	<0.001	0.23	<0.001

DISCUSSION
The present study shows inter-ethnic variation between the major ethnic groups in Nigeria with mean values of 53.96 (Yoruba), 52.77 (Hausa) and 47.59 (Igbos) as well as intra ethnic variation among the studied population. The mean value of MMO among the three major ethnic groups in this study was found to be 51.39 mm (53.51 for males and 49.27 for females). This is similar to the value of 51.58 mm (54.19 mm for males and 48.96 mm for females) reported by Dosumu *et al.* in a study carried out in the western

part of Nigeria but lower than the value of 54.2 mm (56.1mm for males and 52.3mm for females) reported in the study of Chima et al. in a study carried out in the eastern part of Nigeria (although apart from the region where the studies were carried out, these studies did not state categorically the ethnicity of the study participants).[18,17] Race and ethnicity have been previously reported to be significant factors that influence the range of maximum mouth opening.[16,19]

The different regions of Nigeria have different predominant ethnic groups that domicile there and this may explain the reason for the variation in values obtained by studies from the different regions. A similar pattern was also found in studies carried out in different regions of India. Khare et al. in their study of normal mouth opening among healthy Indian adults reported a mean maximal mouth opening of 47.8 mm (51.3 mm for males and 44.3 mm for females).[15] In the study of Mathur et al. among North Indian population, an average value of 47.6 mm (50.3 mm for males and 44.9 mm for females) was reported for MMO.[21] Whereas in the study of MMO among south Indian population by Ranganathan et al. a mean value of 46.05 mm (47.5 mm for males and 44.6 mm for females) was recorded.[22]

Another possible reason for the noted variations in MMO values in different studies by different authors could be difference in methodology of measuring the MMO. Different instruments have been employed in the measurement of MMO. In the studies among Nigerian population, Dosumu et al. employed the use of disposable paper bite gauge,[18] Chima and Obiechina employed the use of a pair of dividers and graduating scale[17] while Vernier Calipers was employed in the present study. Likewise different documented studies in the literature have employed different techniques of measuring MMO with each author reporting satisfactory result with the technique employed. Similarly, the manner of recording the MMO values obtained from subjects varied, measurements were performed once in some studies,[2,23] in others, measurements were performed more than once and the maximum value[24,25] or average value[15] recorded.

In the present study, measurements were performed three times and the maximum value recorded. Although the different techniques of measurements have been reported to produce satisfactory results, yet since there is no universal standardization it is not unexpected to have variations in the results obtained. Ranganathan et al. comparing the results of their studies of MMO among south Indian population with an earlier study by Mathur in north Indian population

attributed the observed difference in the MMO values between the two studies to difference in measurement technique.[22] However the present study utilized the same technique of measurement for participants from the different regions of the country and included participants representing the three major ethnic groups in the country in order to obtain a more objective national MMO value for the country.

Across the different ethnic groups studied, the least MMO was recorded among the Igbos 47.59 mm (range 21.60 - 72.0 mm; SD 8.61) followed by the Hausas with a mean value of 52.77 mm (range 34.0 – 77.0 mm), with the highest value of 53.96 mm (range 33.40 – 71.00 mm) among the Yorubas. As previously suggested, variation in anatomic characteristics (including craniofacial morphology, mandibular length, body height and weight) among different ethnic groups is a possible explanation for this observed difference.[26] Another possible explanation for this is variation in diets, each ethnic groups in Nigeria have varying predominant diet, and diet has been suggested as a possible factor affecting jaw growth, (in which those on predominant coarse diet tend to have a bigger jaw size than those on a predominant refined and soft diet),[27] however this reason is presumptuous and merits further studies to clarify.

Across the ethnic groups, the value of MMO obtained in the present study was significantly higher for males than for females (P = 0.01). This is in agreement with previous studies carried out among adolescents and adults, and the difference has been attributed to difference in the physical size between males and females.[28,29,30] It has been suggested that MMO is directly related to mandibular length and since males are generally larger and taller than females, the correspondingly larger bony structure (including mandibular length) may explain the higher MMO in males.[2,4]

Considering the relationship between maximum mouth opening and age, the present study shows a trend for the MMO increasing till 30-39 year age group (age group at which it reached a peak) thereafter it decreased progressively throughout to the maximum age included. This is in agreement with previous studies that have reported MMO to initially increase with age after which it peaks and then declines progressively. Possible reason for the decline in MMO include progression and severity of osseous changes in the condylar head and glenoid fossa increase with age.[31] In the present study, the noted progressive decrease in age after it had peaked was about 0.17 mm for each age in years this is slightly higher than the average of

0.12mm reported in the study of Yao et al.,[25] this variance could have been due to the higher value of MMO obtained among our own study population.

Reports from previously documented studies are conflicting in terms of the relationship between MMO and stature, while some studies reported a positive relationship,[3,18] others reported none.[15,30] Landtwig reported that mouth opening increases significantly with stature and suggested that both age and stature should be taken into account when measuring MMO.[32] In contrast, Agerberg reported a weak correlation between MMO values in relation to height and weight in all age groups.[33] Khare et al. in their study also reported that the decrease in mouth opening with age does not seem to correlate directly with stature,[15] while Gallagher et al. found no correlation between mouth opening and stature in their study.[30] In the present study, MMO showed a positive correlation to height and weight. Pearson correlation coefficient showed a positive correlation of 0.29 between MMO and height which is similar to the value of 0.27 reported in the study of Abou-Atme et al.[34] We also found age, height and weight to be the three significant predictors for MMO.

Possible limitations of this study include it's been a hospital based study as well as the fact that we did not assess for biethnicity of the study subjects which could limit the generalizability of the findings.

In conclusion, mean MMO of 53.96 (± 6.27 mm), 52.77 (± 8.06 mm) and 47.59 (± 8.61 mm) was obtained for the three major ethnic groups in this Nigerian hospital-based study. This study also suggests that ethnicity influences range of mouth opening and that age, height and weight correlate with and may be able to predict MMO among the major ethnic groups in Nigeria. We recommend that these parameters should be taken into account when measuring MMO.

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