



An aid to Lip Re-Construction Surgeries, Gbeneol & Wichendu ISSN1597-4292

## NORMAL LIP DIMENSION IN FEMALES: AN AID TO LIP RE-CONSTRUCTION SURGERIES

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### ABSTRACT

**Background:** The lip is the predominant structure responsible for the aesthetics of the lower third of the face. With the ethno-racial differences in lip dimensions, there is the need to generate normative anthropometric values which will serve as baseline data for Nigerian females.

The aim of the study was to establish reference standards in lip anthropometry for Eastern Nigerian females, which will serve as a guide to Maxillofacial, Plastic and Reconstructive Surgeons practicing in Nigeria.

**Method:** A gender based cross-sectional study on the anthropometric variables of the lips of 220 females, with ages ranging from 6 months to 55 years, in Enugu, Eastern Nigeria. The results were compared with that of a previous study on females in other populations.

**Result:** There was a progressive increase in mean values of the intercommissural distance with the lips relaxed and measured in a straight line (ICD – Sc) with increasing age (6 months to 12 years). There was progressive increase in the mean values of the intercommissural distance with lips voluntarily retracted maximally laterally, from 6.1 to 12 years, reaching a maximum at 10.1 to 12.0 years. The value became constant from 12.1 years. The height of the upper lip demonstrated a progressive increase from 6 months to 8 years. There was a minimal increase in inter soft tissue gape (ISG) in the subjects in the 10.1 to 12.0 years age group, which subsequently decreases in a fairly constant pattern thereafter.

**Conclusion:** This study provided standard values for lip dimensions for Enugu females which can be used as a guide in reconstructive surgery involving Nigerian females especially those of Enugu extraction.

**Key words:** Anthropometry, Lips, Intercommissural distance, Maxillofacial



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## **INTRODUCTION**

The lips are two musculo-membranous movable folds that form the wall of the entrance surrounding the oral orifice<sup>1</sup>. The lips lie central, dominating the lower third of the face, very visible with diverse functions. They are responsible for the aesthetic appearance of the lower third of the face, and gives the individual facial harmony and expression<sup>1</sup>. The lips are responsible for the maintenance of oral competence, mastication, deglutition, phonetics, expression of emotion, and as a symbol of beauty. Labial morphology is subjected to many anatomic variations according to the individual<sup>2,3,4</sup>. To establish effective prevention strategies for poor lip and palate development, scientists must identify genetic risk factors and understand how gene-gene and gene-environment interactions interfere with lip and palate development<sup>5</sup>.

The age of the person determines modifications in the muscles and cutaneous distension<sup>6</sup>. Osseous reabsorption and the loss of teeth have dramatic consequences for the anatomic and aesthetic characteristics of lips<sup>7,8</sup>. In the muscle apparatus of the oral sphincters, which consists of numerous muscles, the internal and external orbicularis muscles of the lip represent the most important dynamic unit<sup>9,10</sup>. Man is constantly striving to improve his fate. Plastic surgery has been trying to correct congenital, developmental, traumatic, and surgical deformities. The goal of craniofacial and maxillofacial surgical techniques is to obtain an aesthetically superior result for the patients. To judge the appeal of a patient's face, it is compared with beauty norms that today are well defined by canons or anthropometric proportions. The availability of values for facial sizes and proportions enable the reproduction of cosmetically attractive proportions for the patients<sup>11-14</sup>.

Prior to 1979 there was paucity of literature on the scientific measurements of the lips including Intercommissural Distance and lip height. At the 4<sup>th</sup> International Congress of Plastic and Reconstructive Surgeons in Rome in 1967, Hajnisova<sup>15</sup> noted that between the ages of 11 and 13 years, the mean male and female values were close and that after the 14<sup>th</sup> year, the difference in both sexes became very distinct due to more intensive growth in boys. Hajnisova concluded that the growth of the mouth may be considered complete at 14 years in girls, and 16 years in boys<sup>15</sup>. Both functional and aesthetic restoration in the lips and cheeks are restoration of appearance and reinstatement of function. For reconstructive and



cosmetic surgery, realistic sizes and proportions are assessed using anthropometric techniques, which serve as guidelines to correct deformities and disproportions<sup>16</sup>. Essential components of lip reconstruction include - complete skin cover and oral lining, semblance of a vermilion, adequate stomal diameter, sensation and a competent oral sphincter<sup>16</sup>.

In a study by Ferrario et al,<sup>17</sup> it was concluded that, the upper lip of adult patients operated on for cleft lip and palate differed from that of healthy controls of the same age, sex, and ethnic group. Surgical correction of cleft lip and palate failed to provide a completely normal appearance. The analysis pointed out those parts of the lips and mouth, particularly the vermilion of the upper lip, which differ the most from the norm. He suggested that this method may be used to indicate to the surgeon and patient where additional procedures might be performed to approximate the morphologic characteristics of a reference population<sup>17</sup>. Few reports have been undertaken amongst the negroid population. Fasika carried out a study to obtain normal values of upper lip parameters in children at Ibadan Nigeria, and compared his values with those obtained from previous studies<sup>18</sup>. He noted that male values were higher in most of the parameters, and this trend did not conform to that of height and weight in children, in which there is no significant difference between the sexes up till puberty<sup>19</sup>.

Ferrario et al.<sup>20</sup> used an imaging system to demonstrate the independence of the head posture and found the natural head position in the quantitative analysis of facial hard and soft tissues already advocated by several researchers<sup>21-24</sup>, as necessary for the provision of absolute measurements obtained by direct anthropometry, thus eliminating the differences obtained when three dimensional measurements are done in a two dimensional plane<sup>24, 25</sup>. The Intercommissural Distance (mouth width) has been measured using three-dimensional techniques and two-dimensional photographs or video recordings<sup>26,27</sup>. Lip posture is considered a possible source of differences in lip dimensions<sup>28, 29</sup>. Numata et al, demonstrated the importance of the maturity of neonates and sucking pressure. He showed that the measurements of upper and lower lip thickness at its mid portion were statistically proportional to the strengths of maximum of sucking pressure<sup>30</sup>. Discrepancies may appear between measurements taken with relaxed lips, closed lips, and lips with several degrees of contraction in the circumoral muscles<sup>26,30</sup>.



The quantitative analysis of facial proportions, was studied by artists well before modern surgery and dentistry came to be<sup>31</sup>. Classic studies produced aesthetic canons in which the vertical and horizontal dimensions of nose, lips, and chin were stated to conform to more or less exact mathematical ratios<sup>31</sup>. It is of note that all anthropometric data were derived from separate assessments of the two lips, and no male-to-female comparisons could be calculated<sup>32</sup>. The only direct two-dimensional measurement of vermilion height was made by Ferrario et al.<sup>26</sup> who noted highly significant sexual dimorphism in all linear, surface, and volume measurements. However, the mouth ratio (a rough assessment of mouth form) showed no sexual dimorphism. Ferrario et al.<sup>20</sup> published the results of their study using the three-dimensional system of measurements which revealed a lower variability and greater relevance to everyday appearance as compared to conventional intracranial reference planes.

Three-dimensional landmark data can be used both in a conventional metric approach (angles, distances, and ratios) similar to conventional cephalometrics and with other morphometric techniques. In the faces of normal, healthy young adults, three-dimensional quantitative characteristic<sup>21,23,33</sup>, sexual dimorphism<sup>21,23,34,35</sup>, asymmetry<sup>36</sup> and aesthetics<sup>37</sup> have been quantitatively studied. The correlation of three dimensional facial measurements with conventional cephalometrics have also been tested<sup>38, 39</sup>.

The dimensions of facial tissue structures (nose and lips), their reciprocal spatial positions, and their relative proportions are important components in the clinical analysis of orthodontic, maxillofacial and plastic surgery patients. Reports of successful reconstructive surgery for various types of lip defects and malformations abound in literature<sup>11-14</sup>, most of which have been judged on a purely subjective basis. This will lead to an improvement in treatment outcome and serve as a basis of comparison with established standards. Normal anthropometric values are also useful in diagnosing craniofacial syndromes associated with lip abnormalities.

No work has been done in the South-East and South-South parts of Nigeria despite the well-established Plastic Surgery Departments in the various tertiary health institutions in these areas. This present Enugu-based study recognizes the role of age, sex and ethnicity on lip parameters. Data generated from this study will be used as a baseline for further studies in this environment as well as in the management of patients requiring lip reconstruction following lip deformities such as cancrumoris (noma) which is prevalent in



developing countries. The creation of harmonious facial form is an important goal in improving quality of life in these patients.

Therefore the overall aim of this research is to determine the normative anthropometric parameters for age of the lips of female Enugu indigenes of eastern Nigeria, so as to generate baseline standards of lip dimensions that will form the basis for which Plastic and Reconstructive surgical lip procedures can be performed and evaluated.

## **METHODS**

**Study Design and Population:** The study was gender-based and cross sectional involving the anthropometric measurements of normal lip dimensions from female subjects (pupil and staff) of three primary and three secondary schools in Enugu, Eastern Nigeria. The people of Enugu belong largely to the Igbo ethnic group, which is one of the three largest ethnic groups in Nigeria<sup>40</sup>. Enugu metropolis comprises three Local Government Areas: Enugu-North, Enugu-East, and Enugu-South. Its population is about 722,664 and is presently the capital of Enugu State<sup>41</sup>.

**Sampling Method and Sample Size:** The stratified sampling method was used for this study<sup>42, 43</sup>. Enugu metropolis was the sampling frame. Minimum sample size was calculated using the formula<sup>39</sup>:

$n = \frac{Z^2 \times P(1-P)}{d^2}$  Where  $n$  = Sample size,  $Z$  = the standard normal deviation usually set at 1.96, which corresponds to 95% confidence level,  $P$  = the proportion in the target population estimated to have a particular characteristic (i.e. prevalence)  $q = 1 - p$ ,  $d$  = the degree of accuracy desired, usually set at 0.05.

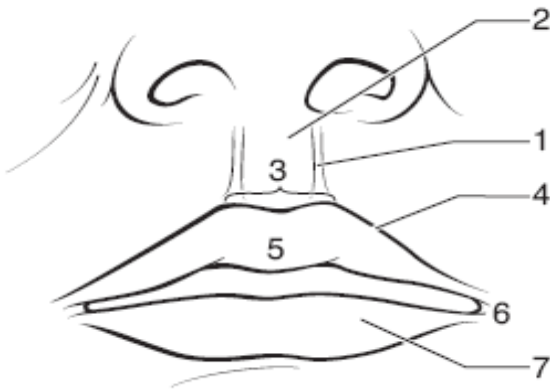
Thus,  $n = \frac{1.96^2 \times 0.05(1-0.05)}{0.05^2}$  giving a sample size of 211.5. A total of 240 subjects were recruited into this study.

A total of 220 females with ages ranging from 0.5 to 55 years were recruited into the study. Those aged less than 18 years constituted 77.40% of the study population.

**Selection Criteria:** Female subjects whose ages ranged from 0.5 to 55 years, who gave their informed consent directly or through their parents (<18yrs) and those with apparently normal lip were included

in the study, while persons with lip abnormalities (congenital or acquired), craniofacial syndromes, history of trauma to the lips, were excluded from the study.

**Data Collection:** All subjects were interviewed and data collected using the study pro forma. All facial examination was in the Natural Head Position. Subjects were weighed, their heights and lip parameters measured to the nearest centimetre. Standard and internationally accepted anthropometric protocol was used to obtain measurements on the gross anatomy and anthropometry of the lips using vernier calliper. The anatomical landmarks and parameters measured are described below:



- |                   |                    |                |               |
|-------------------|--------------------|----------------|---------------|
| 1: Philtral Ridge | 2: Philtral Column | 3: Cupid's Bow | 4: White Roll |
| 5: Tubercle       | 6: Commissure      | 7: Vermillion  |               |

**Figure 1: Diagrammatic illustration showing the description of anatomical landmarks** (Source: Zide, 1990)<sup>6</sup>

1. **Intercommissural Distance Straight (ICDs):** In the horizontal plane, is the distance between the left and right commissures, at the mucocutaneous junction, with the lips in a relaxed state.
2. **Intercommissural Distance Relaxed (ICDr):** Measured using a tape draped over the vermilion border of the lip, using an arc just above the white roll.
3. **Lip Height:** The vertical distance between the white roll and the nasal sill in the midline (Figure 2).
4. **Lip Thickness:** The vertical distance between the mucocutaneous line (red line) and the white roll in the midline.

5. **Intercommissural Distance Contracted (ICDc):** The distance between the commissures with the orbicularis oris muscle maximally contracted.
6. **Intercommissural Distance Grimaced (ICDg):** The widest distance between the commissures with the subject grinning maximally.
7. **Inter Soft Tissue Gape:** The distance between the stretched lower lip mucosa and the mucosa of the upper lip, with the subject opening the mouth maximally so that the pillars of fauces and uvula could be visualized.
8. **Inter Dental Gape:** The distance between the upper and lower incisor teeth, with the subject opening the mouth maximally so that the pillars of fauces and uvula could be visualized.
9. **Coefficient of Upper Lip Curvature** =  $ICDrc - ICDrs / ICDrs$
10. **Lip Elasticity Index** =  $ICDs - ICDg / ICDc$
11. **Extent of Oral Access** =  $STG / 2 \times ICDm / 2\pi$



**Fig. 2: Measurement of the lip height**





**Data Analysis:** The data was analysed using the Statistical Package for Social Sciences (SPSS) version 16. Mean values and standard deviation were calculated for each parameter. The degree of association of lip parameters with the variables such as age was computed by regression analysis. The mean values for the ages were compared using the student's t-test. Tables and charts were drawn for the pictorial presentation of the results. Statistical significance was set at 95% confidence level or at a p-value less than 0.05 (p-value is < 0.05).

**Precautions:** It was ensured that;

- The heads of the subjects were kept in natural head position before measurements were taken.
- The appropriate anatomical landmarks were identified before measurement was taken.
- The vernier caliper was accurately placed at the appropriate landmarks.
- All subjects used in the study met the selection criteria.

**Ethical Considerations:** Ethical approval was sought and obtained from the Ethics Committee of the National Orthopaedic Hospital, Enugu. (See consent form for both the parent of minor and other age at appendix)

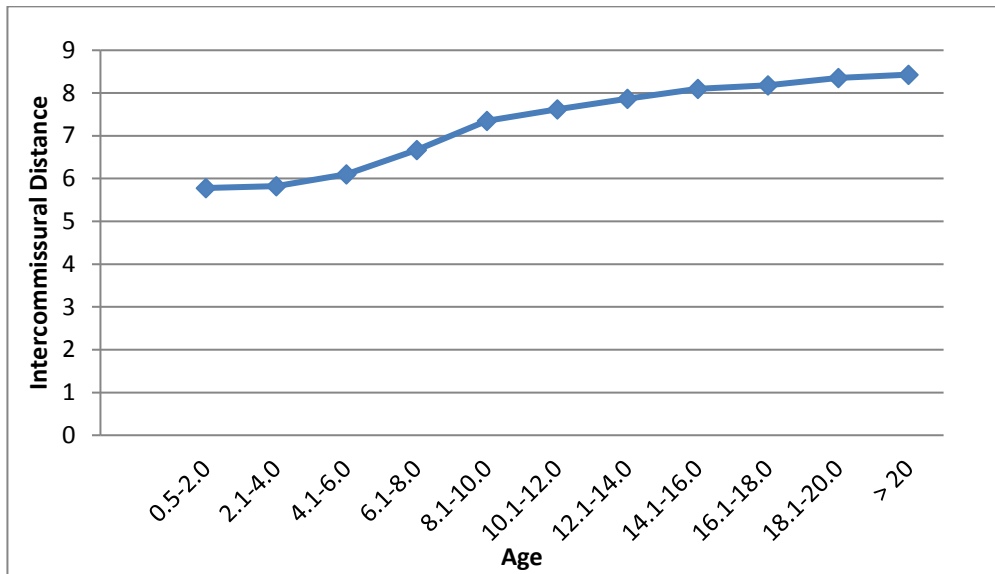
## **RESULTS**

The results of this study are as shown in Figures 3 to 12 in graphs and chart below.

### **Mean Intercommissural distance measured over the arc of the upper vermillion with the lips relaxed against age in female Enugu subjects**

The mean intercommissural distances increased progressively in all ages from 0.5-20yrs and above but the rate of increase was small in the age groups 12.1-20.0yrs.

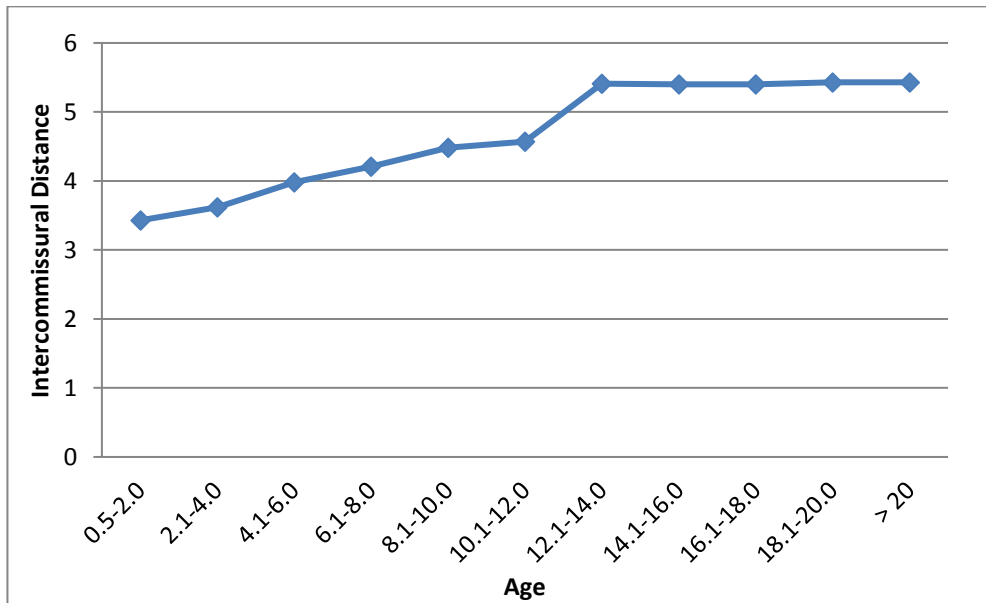




**Fig. 3: Intercommissural distance of female subjects according to their ages**

**Mean Intercommissural distance with the lip relaxed and measured in a straight line (ICD-Sc) against age in female Enugu subjects**

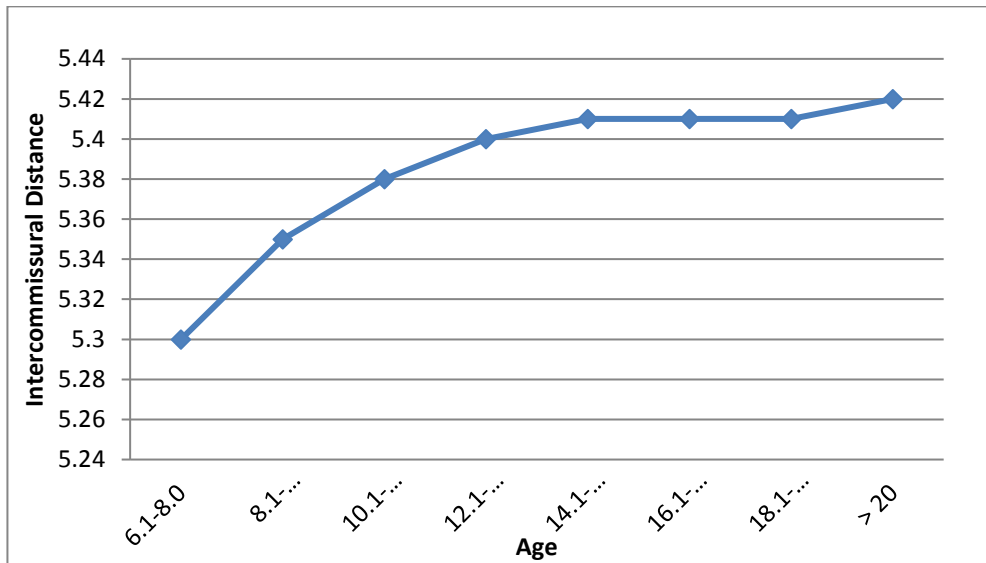
The Intercommissural distance of the lips of the female Enugu subjects measured with the lips relaxed and in a straight line increased progressively with increasing age reaching a maximum in the 12.1 to 14.0 years age group and became fairly constant from 14.1 years to adulthood.



**Fig. 4: Mean intercommissural distance (cm) with lips relaxed in a straight line among female Enugu subjects according to their ages**

#### **Intercommissural Distance (ICDr) with the lip retracted**

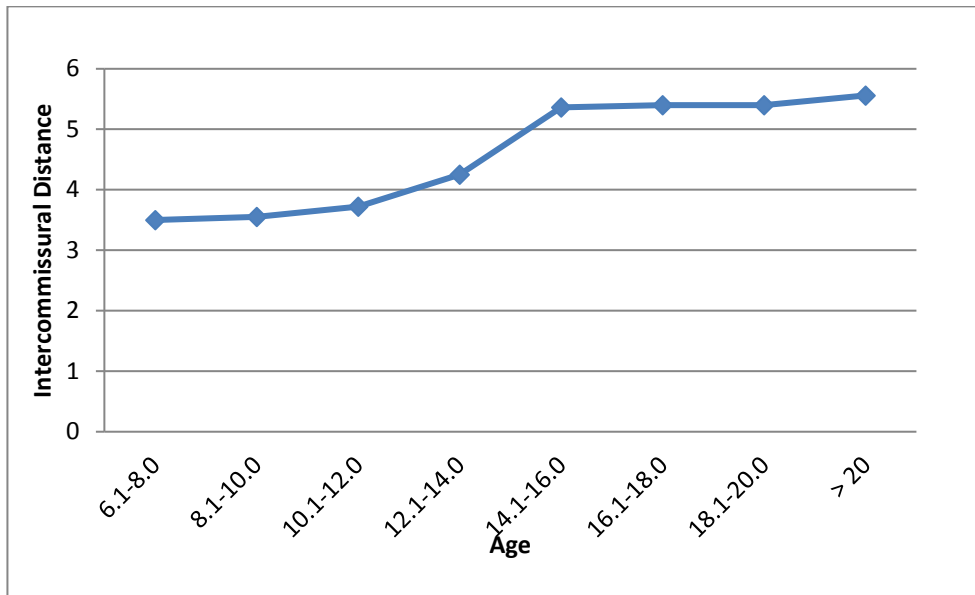
The Intercommissural Distance (ICDr) with the lip retracted maximally, laterally and voluntarily could only be measured in those aged 6.1yrs and above. Mean ICDr showed minimal increase for all ages.



**Fig5: Mean intercommissural distance (cm) against age with the lips grinning maximally, laterally and voluntarily among female Enugu subjects**

**Mean Intercommissural Distance (ICD\_SC)  $\pm$  SD with the lips maximally contracted against age in Enugu females study population**

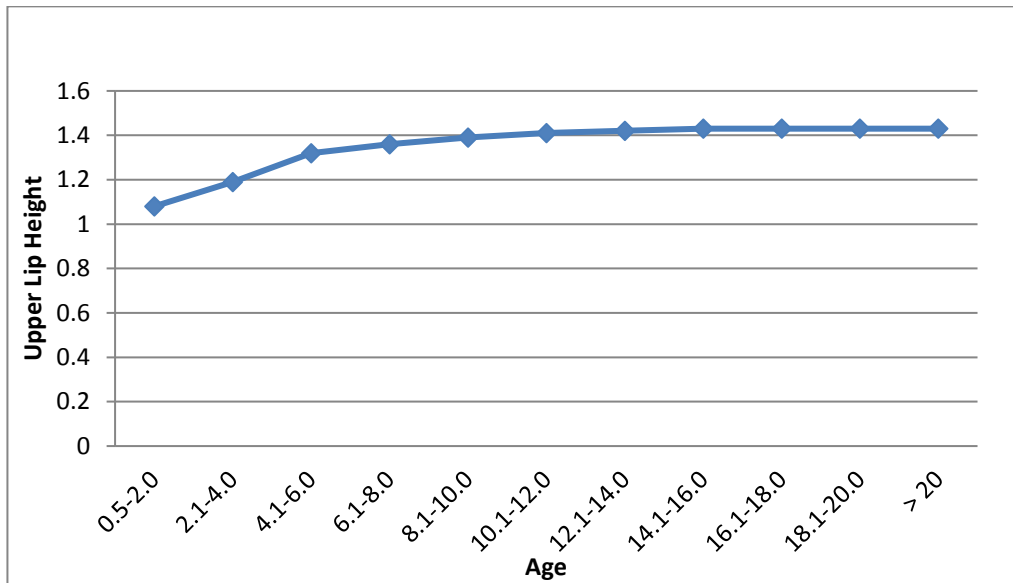
The Intercommissural distance could only be measured in persons aged 6.1yrs and above.



**Fig. 6: Mean Inter-commissural Distance (ICD\_SC) with the lips maximally contracted against age among Enugu females**

**Height of the upper lip against age among female Enugu subjects**

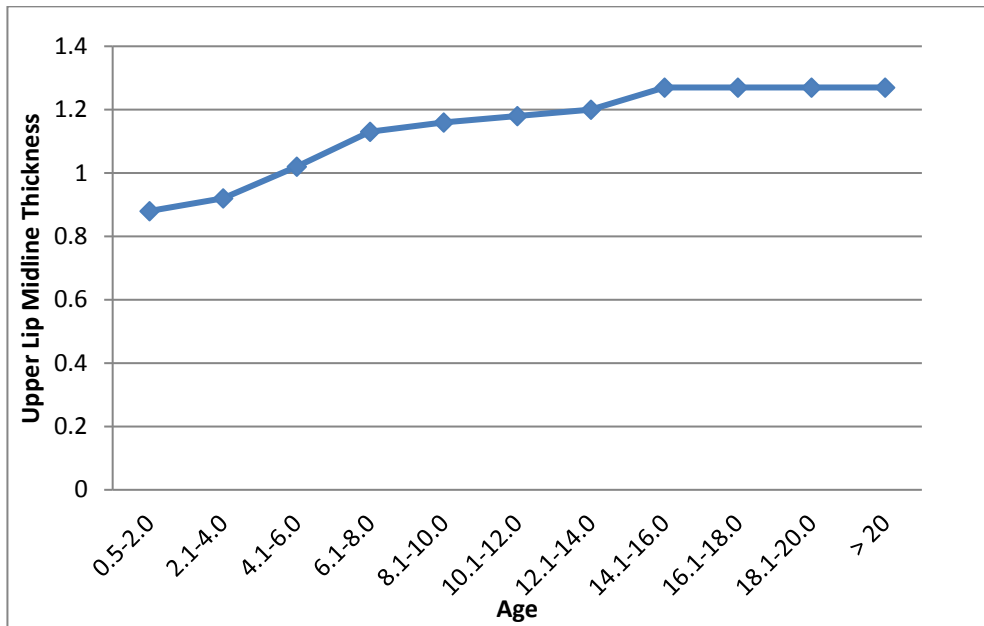
The height of the upper lip (Table 6) showed consistent and progressive increase from 0.5yrs with a peak in the 14.1-16.0yrs age group. Subsequently it became fairly constant from 14.1yrs to adulthood.



**Fig. 7: Mean height of the upper lips among the females according to their ages**

### **The Midline Thickness of the Upper Lip in female Enugu subjects**

The Mean values and SD (cm) of the Midline Thickness of the Upper Lip in the study population as shown in Table 7 demonstrates a progressive increase, rising from 0.88cm at 6 months of age to reach a peak of 1.27cm at 14.1 - 16.0 years. From then the values remained constant despite increasing age.



**Fig. 8: Mean Midline Thickness of the Upper Lip against age among female Enugu subjects**

**The soft tissue and inter dental gape of the oral aperture**

Table 7 shows the difference in the mean value of the soft tissue and inter dental gape of the oral aperture. The inter soft tissue gape increased progressively from 4.1cm in 4.1-6.0yrs age group to reach a peak at the 14.1-16.0yr age group, after which it remained constant into adulthood. Similarly the interdental gape increased from 3.58 to 3.94cm between 4.1years and 16.0 years.

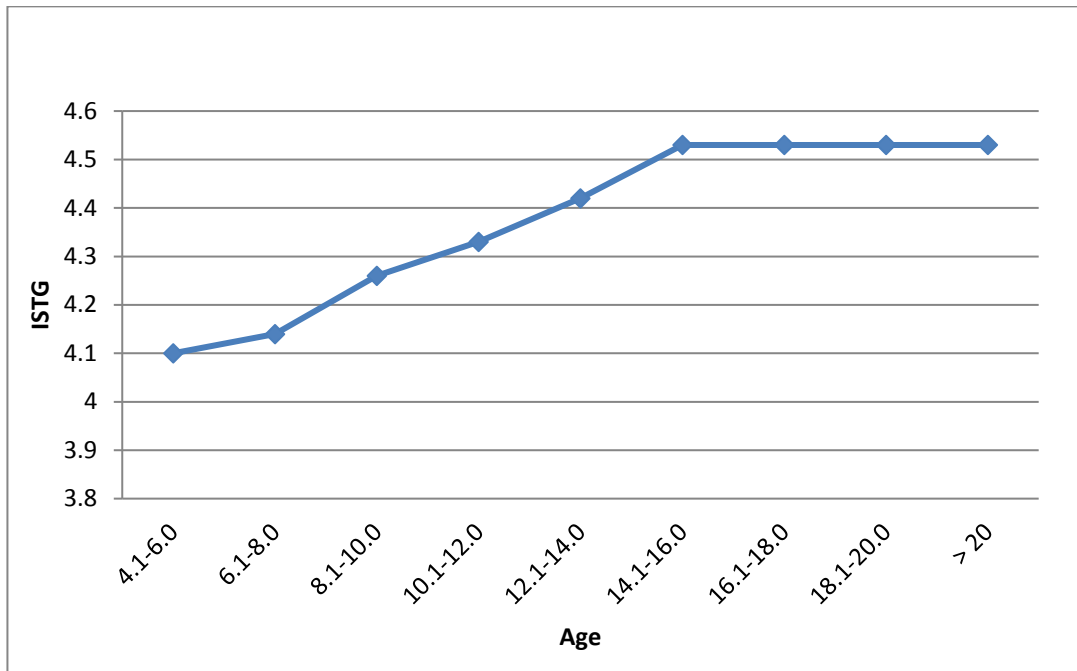
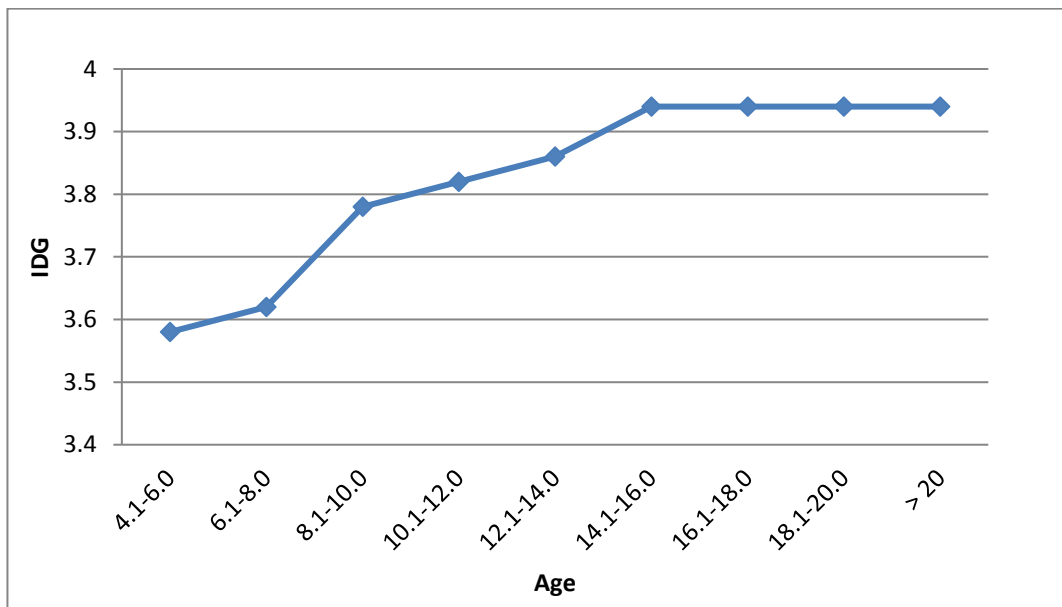


Fig. 9 (a): Mean Soft Tissue (ISTG) of the oral aperture against age in female Enugu subjects

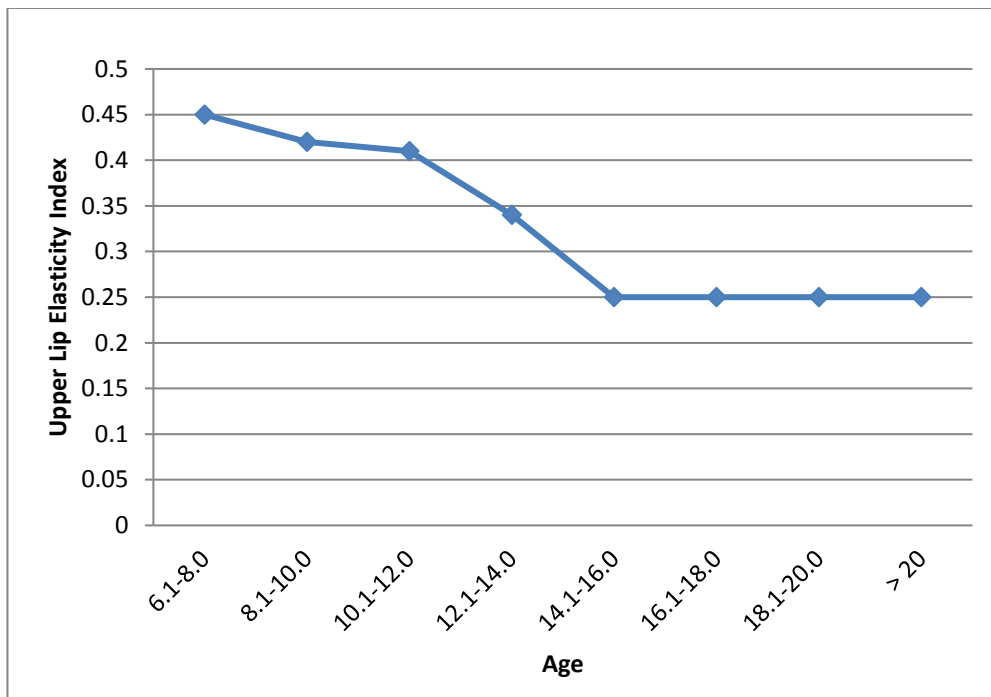




**Fig. 9 (b): Mean Inter Dental Gape (IDG) against age of oral aperture in female Enugu subjects**

**The Elasticity Index of the Lip in the study population**

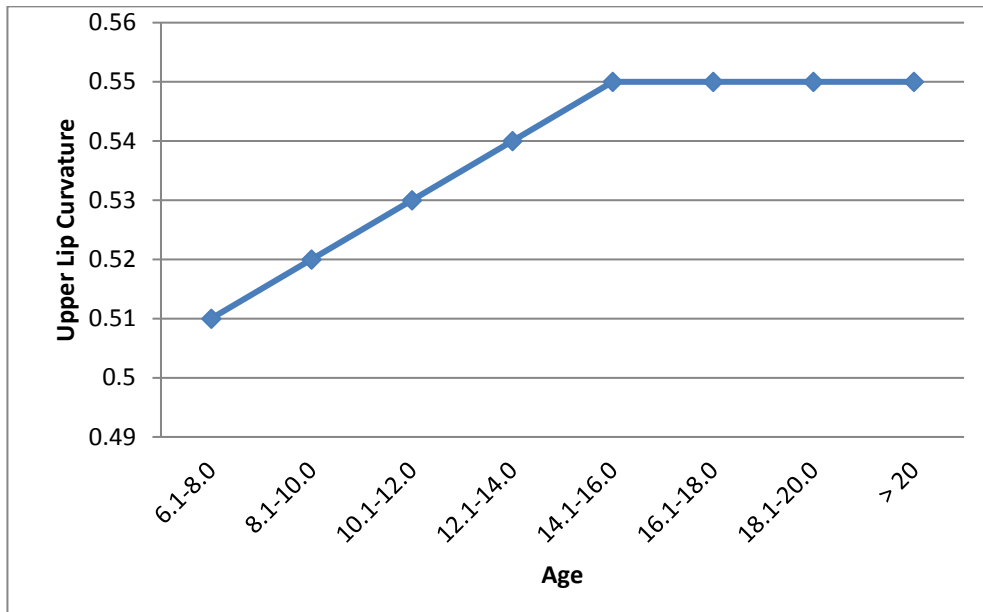
Table 10 shows the mean elasticity index of the lips against age of the Enugu female subjects. In the female, the elasticity index in the lowest age group (6.1 - 8.0yrs) was 0.45 and reduced gradually with age to 0.25 in the 14.1 - 16.0yrs age group, and subsequently became constant at this value despite increasing age.



**Fig. 10: Mean Elasticity Index of the Lip among the females of according to their ages**

**Mean Coefficient of Upper Lip Curvature**

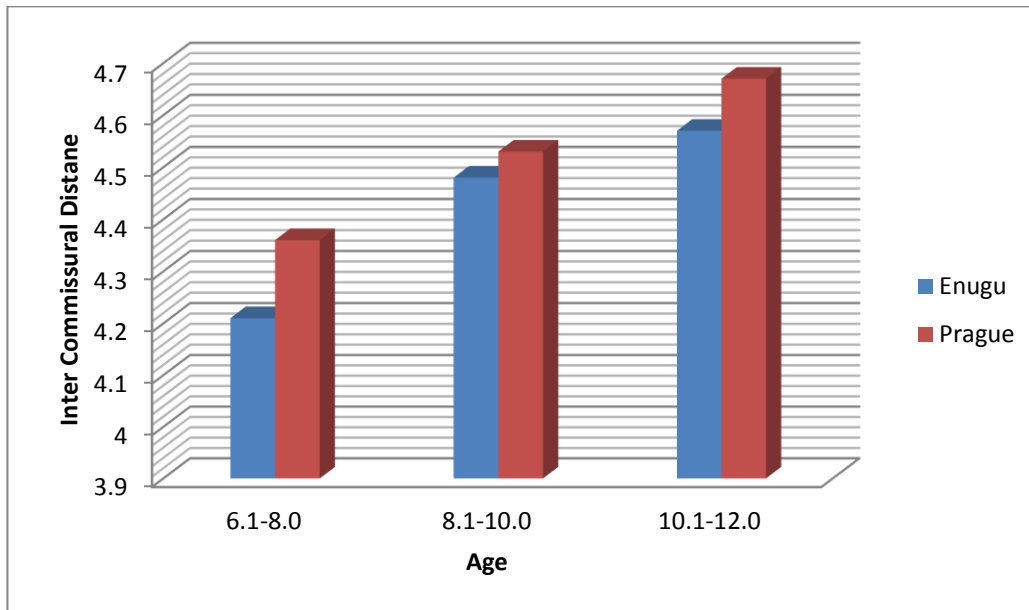
The mean coefficient of upper lip curvature (Table 9) varied from 0.51cm ± 0.22 to 0.55cm ± 0.09 in the age group 6.10 to 20.10yrs and above. There was a very minimal change in value of the coefficient of upper curvature.



**Fig. 11: Mean Co-efficient of Upper Lip Curvature among the females**

### Comparison of Mean Intercommissural Distance among Enugu Females with Previous Study

Table 10 compared the intercommissural distances obtained in this study with those obtained in a study carried out in Prague, Czechoslovakia. The mean ICD in the age group 6.1 to 12.0 years in the study ranged from 4.21cm - 4.57cm compared to 4.36cm - 4.67cm in the Prague study.



**Fig. 12: Comparison of Mean Intercommissural distance (cm) measured in a straight line in female children in Enugu, Nigeria and Prague, Czechoslovakia according to their age**

## DISCUSSION

A similar study by Fasika<sup>16</sup> was restricted to children where congenital lip defects are a major concern. However, this study included all age groups prone to assaults and road traffic injuries hence constituting a much larger population of persons who would benefit from lip reconstruction. With similar demographic characteristics, the lip parameters measured would be similar and can be applied to normal lip parameters in the country.

Data collected in the present investigation could therefore represent a first database for the quantitative description of human lip morphology in adult female subjects. These data could be used in computerized simulations of surgical or orthodontic treatments<sup>47</sup>. Moreover, the same protocol for data collection and analysis could be applied to normal children and adolescents, as well as to older adults, in order to analyze age-related modifications in lip morphometry.

The findings of this agree with the overall progressive increase observed in Fasika's study regarding the growth of the lips. There is progressive moulding of the lips and alveolus with age, reaching maturity as

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the skull bone growth ceases between 7 and 9 years of age<sup>7, 17</sup>. The growth of the cranium and surrounding soft tissues also peaks between 7-9 years<sup>17</sup>. The constancy of values for the lip parameters after 15 years was not observed by Fasika whose study included only children aged less than 14 years<sup>18</sup>. This study demonstrates that the mean value of the intercommissural distance measured with the lips contracted maximally and voluntarily ( $6.40 \pm 0.20$ ) showed an increasing trend from ages 6-15 years. Similar studies were carried out by Hajnisova<sup>15</sup>, Fasika<sup>18</sup> and Sivan et al.<sup>48</sup>. The studies by Hajnisova<sup>15</sup> and Fasika<sup>18</sup> were done among children. It was observed from Hajnisova's study that female children in Prague aged between 6.1 – 8.0 had intercommissural distance ( $4.36 \pm 0.16$ ) higher than that of female children of the same age in Enugu from the current study ( $4.21 \pm 0.50$ ). Similarly, the intercommissural distance of children aged 8.1-10.0 and 10.1-12.0 in both studies were ( $4.48 \pm 0.29$ ) for Enugu and ( $4.53 \pm 0.28$ ) for Prague, and ( $4.57 \pm 0.23$ ) for Enugu and ( $4.67 \pm 0.22$ ) for Prague respectively. This implies that the mouth width (intercommissural distance) of school children aged 6-12 years was consistently shorter in Nigerians than in Czechoslovakians of the same age group. In the same vein, the height of the upper lip and the intercommissural distance were smaller in Nigerian neonates than in their Israeli counterparts. These findings tend to support previous reports of Juberg et al.<sup>49</sup> that these measurements show racial differences.

There are different degrees of variations observed in the measurements of lip parameters among various studies. Several reasons have been postulated for these differences. Head and Lip postures, techniques of measurements and the activities of the lip muscles are possible reasons<sup>49, 50</sup>.

The dimensions of the lip aperture measured relaxed and contracted as demonstrated by the lips being actively contracted or relaxed varies with the anatomy of the face which is an index of the facial bony anatomy and the soft tissues lining the oral cavity<sup>10</sup>. Different races are marked with the peculiarity of the projection of their maxilla and mandible, hence varying degrees of prognathism which would reflect in the lip height and thickness dimensions<sup>13</sup>.

In this study, the two dimensional measurements done were subjective in that each individual contracted and relaxed the circum-oral muscles at will without any form of standardization. The development of this muscle could depend on the individual's general physique and diet pattern which may lead to the fullness



of development of these circum-oral muscles. The alveolar and teeth dimensions and presence of dental diathesis and projections could tense or relax the lip thickness and height, hence influencing its two dimensional measurements.

The lip elasticity index of the upper lip in this study reduces as the age of the subject advances. At age 6.1 – 8.0 years, it was maximal with a mean of 0.45. The mean values were high at 6 years and progressively rose to a maximum at 10 years, then subsequently fell with increasing age. The circum-oral muscles are skeletal in origin and are permanent cells, their pliability may be reaching a maximum at this 6-10 years of age and subsequently lose their elasticity as age progresses. Fasika<sup>18</sup> also noted that elasticity of the lips decreased with age from 4-12 years. Lip elasticity is conferred by the elastic fibres that are present in the dermal layer of the skin and also by the muscles acting around the oral aperture. The lip elasticity index is thus likely to be altered in diseases involving the orbicularis oris, buccinators, zygomaticus major and the depressor angulioris muscles or their nerve supply through the mandibular or buccal branches of the facial nerve.

The coefficient of upper lip curvature has been stated by Bardach et al.<sup>50</sup> to depend on the lips, nostril floor and on the age of the subject which are indices of lip elasticity index. In this study, the mean coefficient of upper lip curvature was fairly constant with a slight increase from 0.46 at 6.1 – 8.0 years to a maximum of 0.50 at 14.1 – 16.0 years.

## **CONCLUSION**

The study concluded that the approximate reference values for lip parameters in the study population are as follows for the age ranging from six months to fifty-five years; the intercommissural distance ranged from 5.85cm at 0.5 – 2.0 years to 9.0cm at 20.1 and above years, lip height 1.10cm - 1.60cm, lip thickness 0.88cm - 1.60cm and mean intercommissural distance from 3.40cm - 6.40cm. No statistically significant increase in the lip parameters was noticed with the tape draped along the vermilion border of the upper lip of the subjects at different ages. The lip parameters in the different age groups were similar to findings in other studies, and can be used as mean reference values for individuals needing reconstruction in Eastern Nigeria. Therefore, mean values obtained from this study can be useful to reconstruct lip parameters in individuals needing lip surgery following burns, trauma and malignancies in Eastern

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Nigeria. It is recommended that further studies using three – dimensional techniques are carried out on the same target population to corroborate these findings and validate the results. It is also necessary to conduct similar studies on other ethnic groups, in order to generate normative baseline values that can be utilized in surgical reconstruction of the lips in these ethnic populations.

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