ORIGINAL ARTICLE

Holdaway's analysis of the nose prominence of an adult Nigerian population

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Abstract

Background: Facial beauty is a function of harmonious balance among all parts of the face, and the nose plays a dominant role in this because of its location exactly in the middle of the face. Therefore, an evaluation of the nasal form and its position relative to other facial structures should play an important part in the assessment of patients before orthognathic surgery, rhinoplasty or orthodontics.

Aim: The aim was to establish normative values for the nose prominence of an adult Nigerian population using Holdaway's soft tissue cephalometric analysis.

Methodology: Lateral cephalometric radiographs of 100 adults aged 18–25 years, with normal occlusion and a harmonious facial appearance were analyzed. The nose prominence was assessed using Holdaway's analysis. Twenty radiographs randomly selected, were retraced to assess for errors. Data analysis included descriptive statistics, Student's *t*-tests and analysis of variance using the Statistical Package for Social Sciences.

Results: The mean value recorded for the nose prominence of the study population was 3.49 mm (standard deviation [SD], 3.26 mm), with a range of −5.0 mm to 15.0 mm. Mean values obtained for females were 3.73 mm (SD, 2.88 mm) and males 3.19 mm (SD, 3.70 mm). No statistically significant gender difference was observed ($P > 0.05$). In addition, no significant difference was observed between the nose prominence values recorded for different age-groups ($P > 0.05$).

Conclusion: Normative values were established for the nose prominence of an adult Nigerian population. The values obtained for Nigerians in this study are comparatively lower than that reported for other populations. These values would aid in treatment planning for orthognathic surgery, rhinoplasty and orthodontics in Nigerians.

Key words: Cephalometrics, Holdaway's analysis, nose prominence

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Introduction

Facial beauty is a function of harmonious balance among all parts of the face, and the nose plays a dominant role in this because of its location exactly in the middle of the face.[1] Therefore, an evaluation of the nasal form and its position relative to other facial structures should play an important part in the assessment of patients before orthognathic surgery, rhinoplasty or orthodontics.[2]

The nose may be evaluated by direct clinical measurements (morphometry),[3-7] by photogrammetry,[8-10] by radiographs (cephalometry)[2,11] or more recently by three-dimensional stereo-photogrammetric systems.[12,13] Morphometry and photogrammetry both offer cost effective means of carrying out anthropometric studies, however, cephalometry offers a major advantage over these methods in that it is capable of simultaneously imaging the soft tissue profile and the facial skeleton.[2] While three-dimensional scans from cone-beam computed tomography (CBCT) systems can be used to obtain very accurate anthropometric measurements, its use is limited because of the huge cost involved in acquiring such systems.

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A number of nasal morphometric and photogrammetric studies have been carried out in the Nigerian population.[3-7,14,15] Furthermore, some studies have been carried out on the soft tissue cephalometric features of Nigerians.[16-18] However, there is currently a paucity of data on cephalometric studies of the nasal profile of the Nigerian population. This data if available would aid in treatment planning for orthodontics, rhinoplasty and orthognathic surgery.

Holdaway's soft tissue analysis has been used in several studies to report the cephalometric soft tissue findings of different ethnicities, in addition to the comparison of these findings to established Holdaway norms.[19-29] This analysis consists of 13 measurements, one of which is the nose prominence.[19] In previous studies,[16-18] the authors had extensively studied the soft tissue profile of Nigerians using different soft tissue analyses, including Holdaway's analysis. However the nose prominence was not included in these studies. Holdaway described the nose prominence as the distance between the tip of the nose and a perpendicular line drawn to the Frankfort plane (FP) from the vermillion border of the upper lip.[19] The purpose of this study was to establish normative values for the nose prominence of an adult Nigerian population using Holdaway's soft tissue cephalometric analysis.

Methodology

The subjects were made up of the second year to final year medical, dental and pharmacy students of the College of Medicine, University of Lagos, Idi-Araba, Lagos, Nigeria. The sample comprised 100 subjects (56 females and 44 males; mean age 21.63 years) who met the selection criteria. Ethical approval for the study was obtained from the Ethical Committees of the College of Medicine, the University of Lagos and the Lagos University Teaching Hospital, Idi-Araba, Lagos. In addition, informed written consent was obtained from each subject after the nature and purpose of the radiographs had been explained to them. The radiographs used in this study had been used in the previous study to assess the horizontal lip relationships of the study sample.[16]

The lateral cephalometric radiographs were manually traced on 0.003-mm matte acetate sheets (MASEL, 2034-007, AR-MED Ltd., UK), with a 0.5 mm lead pencil. All the radiographs were traced by one of the authors, (GI). All reference points were first identified, located and marked. All reference points were first identified, located and marked. The reference planes were drawn and when bilateral structures cast double shadows on the film, the technique of averaging the bilateral images was used.[16]

Based on the definition by Holdaway,[19] the nose prominence was described as the distance from a line perpendicular to Frankfort horizontal and running tangent to the vermillion border of the upper lip, to the tip of the nose [Figure 1]. The linear measurement was made with a graduated metric ruler to the nearest 0.5 mm.

Definition of the landmarks and reference plane (FP) necessary for measuring the nose prominence:

- Pronasale (Pn): The most prominent or anterior point of the nose (tip of the nose)
- Labrale superius (Ls): The most anterior point of the upper lip
- Orbitale (O): The lowest point of the infra-orbital margin, where two orbitalia were visible, a point midway between the two was used
- Porion (P): The uppermost point of the bony external auditory meatus
- FP: This is a straight line passing through the porion and orbitale.

Statistical analysis

The Statistical Package for Social Sciences version 18, (SPSS Inc., Chicago IL, USA) was used for analyzing data. Descriptive statistics of mean and standard deviation (SD) were obtained. Student's *t*-test was used to determine the gender differences at a significance level of $P < 0.05$. Analysis of variance (ANOVA) was used to compare the mean nose prominence values obtained for the different age-groups, at a level of significance of $P < 0.05$.

To assess errors in the cephalometric tracing, 20 randomly selected lateral cephalograms were retraced after an interval of 7 days. The error was then calculated by using Dahlberg's equation.[30] Paired *t*-tests were also carried out

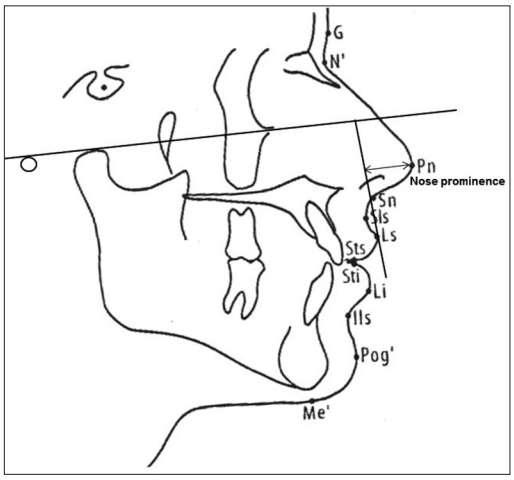

Figure 1: The nose prominence and how it was evaluated using Holdaway's analysis

Table 1: Mean nose prominence values for different age ranges and gender

Age group (years)	Gender				*t*-tests* *P*	Mean (SD) nose prominence for age group (mm)**
	Male		Female			
	n	Mean (SD) mm	*n*	Mean (SD) mm		
18-19	4	2.25 (3.86)	13	3.62 (3.23)	0.4874	3.29 (3.31)
20-21	18	2.81 (3.58)	18	3.75 (2.78)	0.3851	3.28 (3.19)
22-23	8	3.25 (3.62)	15	4.17 (2.63)	0.4908	3.85 (2.96)
24-25	14	3.93 (4.12)	10	3.20 (3.30)	0.6351	3.63 (3.74)
Total	44	3.19 (3.70)	56	3.73 (2.88)	0.4137	3.49 (3.26)

*Student's *t*-test, **ANOVA, $F=0.873$, $P=0.531$. SD=Standard deviation

between the initial and repeat measurements to determine the significance of any error. The level of significance was also set at $P < 0.05$.

The methodological cephalometric tracing error calculated using Dahlberg's equation[30] was found to be 0.74 mm and this falls within the normal range reported by Baumrind and Frantz,[31] for linear measurement errors in cephalometric studies, which is 0.43 mm to 0.86 mm. In addition, a paired *t*-test between the initial sample and 20 randomly selected radiographs showed no statistically significant difference between the first and second tracings ($P > 0.05$).

Results

A total of 100 subjects, (56 females and 44 males), aged 18–25 years with a mean age of 21.63 (2.04) years and a modal age of 21 years, were seen.

The mean value recorded for the nose prominence in this study was 3.49 mm (SD, 3.26 mm), with a range of −5.0 mm to 15.0 mm. The mean value obtained for females was 3.73 mm (SD, 2.88 mm) and males 3.19 mm (SD, 3.70 mm). Student's *t*-tests recorded no statistically significant gender difference between the nose prominence values of the students, across different age-groups, between 18 and 25 years ($P > 0.05$). There was also no significant difference between the overall mean values recorded for the male and female students ($P > 0.05$). Thus, male and female data were pooled together, in comparing the mean nose prominence values obtained in this study, with that reported for other populations from other studies. In addition to this, no statistically significant difference ($P > 0.05$) was observed in the mean nose prominence values across different age-groups, between 18 and 25 years, based on the ANOVA for the mean values recorded for different age-groups [Table 1].

A comparison of the mean value recorded for Nigerians, with that reported for other populations, shows that Nigerians have a comparatively smaller nose prominence than other populations [Table 2].

Table 2: A comparison of the nose prominence recorded in this study with that reported for other populations by different authors

Author (s)	Year of publication	Population studied	Nose prominence (mm)
Holdaway[19]	1983	Caucasian	14-24
Lew *et al.*[21]	1992	Chinese	6.00
Alcalde *et al.*[22]	2000	Japanese	14.54
Basciftci *et al.*[20]	2003	Turkish	18.74
Al-Gunaid *et al.*[23]	2007	Yemeni males	16.70
Hameed *et al.*[24]	2008	Pakistanis	19.36
Al-Azemi *et al.*[25]	2008	Kuwaitis	14.25
Taki *et al.*[26]	2009	Persian adults	16.72
Mehta *et al.*[27]	2010	Indians	13.38
Hussein *et al.*[28]	2011	Palestinians	19.24
Al-Barakati and Bindayel[29]	2012	Saudi Arabians	13.46
Present study	2014	Nigerians	3.49

Discussion

The nose, a striking feature of the human face, is regarded by some clinicians as the keystone of facial esthetics.[32,33] It has also been reported that the perceptions of and attitude to, facial appearance are influenced by the form of the nose and its relationship to other parts of the soft tissue profile.[34] The racial and ethnic features of each patient's nose are dependent on the underlying bony and cartilaginous skeletal frameworks together with the skin and the soft tissue envelopes. These features have a genetic basis, but are also influenced by environmental factors such as trauma, ageing, nutrition and surgery.[35]

The importance of a thorough assessment of the nasal form in treatment planning for orthodontic treatment or surgical procedures such as orthognathic surgery and rhinoplasty cannot be overemphasized. Some forms of therapy, may either directly or indirectly alter the form of the nose and thus facial appearance. For example, orthodontic treatment to reduce protruding incisors, can lead to lip changes that increase the relative prominence of the nose.[2,36] Mandibular surgery may also affect the relative prominence of the nose because of changes in the soft tissue chin and

lower lip.[2,33] Maxillary and nasal surgery, however are more likely to affect the form of the nose directly.[32,33]

This study was focused on assessing the nasal profile of adult Nigerians using Holdaway's nose prominence, as the reference point. Previous studies by the authors had comprehensively looked at other soft tissue features of Nigerians.[16-18] Nose prominence is considered to be a recognizable individual facial characteristic.[29] Its magnitude would affect treatment-planning decisions as it influences the presentation of adjacent circumoral and facial structures.[29] This study would provide baseline data on the nose prominence values of adult Nigerians. Holdaway's analysis was chosen as it has been widely used in different studies to assess the soft tissue profiles of different populations.[19-28] Thus, providing a greater basis for comparing the findings from this study to that reported for other populations.

No significant gender differences were observed in the nose prominence of the adult Nigerians in this study. A similar finding was reported in Indians by Mehta *et al.*[27] However, studies carried out in Turkish,[20] and Persian,[26] populations have reported marked sexual dimorphism with the males having a larger nose prominence than females. Furthermore, anthropometric studies of the nasal profile carried out in Nigerians have reported a higher nasal index in males than in females.[4-6,14] The absence of significant differences across different adult age-groups between 18 and 25 years also indicates that the size of the nose prominence is not significantly affected by age, in young adults.

According to Holdaway,[19] nose prominence has an acceptable range of 14–24 mm. Holdaway suggested that noses < 14 mm are small, and those above 24 mm are large or prominent, with respect to a white Caucasian population. However, the mean value for the nose prominence recorded for Nigerians in this study was 3.49 mm, thus indicating that Nigerians have a significantly smaller nose prominence in comparison to Caucasians. Flynn *et al.*,[37] also reported significantly lower nasal projection (horizontal distance from the subnasale to the pronasale) in Black American adults (11. 9 mm) when compared with the white population (15.7 mm). Ofodile *et al.*,[38] in an anthropometric study of the Black American nose, reported that African noses were the shortest and widest, when compared with Afro-Caucasians or Afro-Indians. The mean value for the nose prominence recorded for Nigerians in this study, is also much lower than that recorded for all other populations as shown in Table 2. The population whose nasal prominence was closest to that of Nigerians were the Chinese with a value of 6 mm as reported by Lew *et al.*[21] The values recorded for several other populations such as the Japanese,[22] (14.54 mm), Turkish[20] (18.74 mm) and Pakistanis[24] (19.36 mm), among others, were all markedly higher than that recorded for Nigerians in this study [Table 2]. The comparatively smaller nose prominence observed in Nigerians may also be contributory to the greater lip protrusion observed in Nigerians as compared to Caucasians, with respect to Ricketts' E Line (a line, which runs from the pronasale to the soft tissue pogonion), which was reported in a previous study investigating the horizontal lip relationships of adult Nigerians.[16]

The low values for the nose prominence recorded in Nigerians may be as a result of a higher percentage of the platyrrhine nose in the Nigerian population, which has previously been reported in several studies.[4-6,14] The platyrrhine nose is characterized by a very prominent alar lobule and a full and rounded nasal tip.[14] The flat dorsum with a poorly projected nasal tip in the platyrrhine nose is due to lack of bony and cartilaginous supports.[35] This lack of skeletal support together with thick skin and a prominent subcutaneous fibro-fatty cushion contributes to a poorly projected nasal tip that is amorphous and lacking in definition.[35] Various studies have been done to classify the nose into plattyrhine (black), mesorrhine (oriental) and leptorrhine (white) noses.[33,39] These classifications are based on nasal morphometric features, and several studies have been carried out on the nasal morphometric parameters of Nigerians.[3-7,14] However, there is currently little information in the literature about cephalometric studies of the adult Nigerian nasal profile. Cephalometry, which is a standardized true lateral radiograph of the skull, confers the advantage of simultaneously assessing the soft tissue with the underlying hard tissue nasal structures. In addition, there is also a paucity of published data on soft tissue cephalometric analysis carried out in African populations, particularly with respect to Holdaway's analysis. Thus, making it difficult to compare the nasal prominence for Nigerians with that for other African populations.

A limitation of Holdaway's nose prominence, as a soft tissue cephalometric parameter for assessing the nasal profile is that although it is relatively easy to measure, it does not provide a detailed cephalometric analysis of the nose.

More detailed cephalometric analyses of the nose have been described by other authors.[1,2,11] Thus, there will be a need for future studies to assess the nasal profile of adult Nigerians using some of these analyses. However, the nasal prominence values obtained for Nigerians in this study will be of use in treatment planning and has produced baseline values for comparison with other populations. The findings from this study further reinforce the findings from different studies carried out in different ethnic groups, which show that soft tissue features are specific for a given ethnic group or population.[19-29]

Conclusion

The mean nasal prominence values obtained for Nigerians in this study was 3.49 mm, and no significant gender differences

were observed. The values established for Nigerians were markedly lower than that reported for Caucasian and other populations. These values will be of benefit for treatment planning for Nigerians undergoing orthodontic treatment or surgical procedures such as orthognathic surgery and rhinoplasty.

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