Influence of Nasolabial Angle on Facial and Smile Attractiveness

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ABSTRACT

Objective: To identify the effect of the nasolabial angle (NL) on smile and facial profile attractiveness.

Study Design: A cross-sectional study.

Place and Duration of the Study: Department of Surgery, Section of Dentistry (Orthodontics), The Aga Khan University Hospital, Karachi, Pakistan, from 31 November 2021 to 28 March 2022.

Methodology: Profile photographs of one adult male and one female subject at rest and on smile were altered by the Photoshop software to NL angles of (85°, 90°, 95°, 100°, 105°, and 110°). These photographs were shown to a panel of raters comprising of three groups, laypersons (LP), general dentists (GD), and orthodontists (OD). The Kruskal-Wallis test was used to compare the NL angle scores among raters. Mann-Whitney U test was used for pairwise comparison between groups and gender-wise comparison of raters. Wilcoxon signed-rank test was used to analyse the effect of smile on the NL angle.

Results: Statistically significant differences ($p \leq 0.05$) were seen between rest and smile scores in three groups of raters. LP gave the highest scores to 95° for males ($p < 0.001$) and females ($p = 0.011$). GD found 90° for both males ($p = 0.009$) and females ($p = 0.014$) to be attractive, while OD gave the highest scores to 95° for both males ($p < 0.001$) and females ($p = 0.002$).

Conclusion: There was a significant difference in preference of nasolabial angle between male and female raters. All groups of raters gave the highest scores to smiling photographs. The clinical significance is to ensure that, upon completion of orthodontic treatment, the nasolabial angle should be finished in a manner that enhances rather than detracts the attractiveness of the smile.

Key Words: *Nasolabial angle, Smile, Facial aesthetics, Profile photographs*.

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INTRODUCTION

Aesthetic enhancement of the oro-facial region is of prime importance to the orthodontic patients, which depends to a great extent on the presence of a bright, pleasing, and attractive smile. This makes it one of the most significant aspects and goals of the orthodontic treatment.[1] Facial appearance with an attractive smile and good facial harmony are considered key factors in the treatment plan. Facial balance is determined by the facial skeleton and soft tissue musculature.[2]

Up to the 20th century, diagnosis and treatment planning in orthodontics had been based on angle's paradigm considering ideal dental occlusion as nature's expected ideal form.[3] With the evolving soft tissue patterns, trends in orthodontic diagnosis and treatment planning are surprisingly changing. The soft tissue paradigm states that the objectives of today's orthodontic treatment are not regulated by dental and skeletal structures but by the improvement in facial soft tissues.[4]

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Enhancement of facial beauty is one of the primary elective goals of patients seeking dental care. The lower one-third of the face plays a major role in the perception of facial aesthetics due to the presence of teeth, and their relation with the chin and nose in determining facial attractiveness. Facial features can be studied in profile view with various angular and linear measurements consisting of E-line, S-line, Burstone line, Z angle, and nasolabial angle (NL).[5]

The lower border of the nose and perioral musculature, both change their morphology on smile. Therefore, these alterations also bring changes in the aesthetic zone of a smile. According to Rubin *et al*., nasolabial angle is the keystone of the smile which is defined as the angle between the columella of the nose and the philtrum of the upper lip.[6] NL angle is one of the key factors in an orthodontic diagnosis for the aesthetics of the nose and facial profile.[7] The ideal NL angle considered by Aufricht for young males is slightly obtuse and for the female is less acute.[8]

NL angle can vary in individuals as acute (<90°), normal (90° - 120°), and obtuse (>120°).[7] It depends on several factors which include the anteroposterior position of the maxilla, anteroposterior position of the maxillary incisors, vertical position and rotation of the nasal tip, and soft tissue thickness of the upper lip.[9] Either of these factors present as an acute or obtuse NL angle. Many authors in the literature have reported aesthetically acceptable ranges of NL angle for male and female subjects but

none have evaluated the effect of smile in improving or aggravating the discrepancies and facial attractiveness specifically in the Asian population.[10,11] Smile is also considered an important part of orthodontic treatment as it can hide various dental and soft tissue discrepancies present at rest in an individual's face. This is described in the literature as smiloflage.[12] Hence, parameters affecting NL angle are important to achieve successful and predictable orthodontic treatment outcomes in order to improve smile aesthetics.[13] The primary objective of this study was to assess the influence of different degrees of NL angles on a smile in compensating the facial profile attractiveness both at rest and during smiling. The secondary objective was to investigate the preference in NL angle amongst the raters between male and female subjects. The null hypothesis was that there would be no influence of different degrees of NL angles on smiles in compensating the facial profile attractiveness as perceived by the raters.

METHODOLOGY

A cross-sectional (observational) study that included 69 (N) participants was conducted at a tertiary care hospital after approval from the institutional Ethical Review Committee (ERC # 2021-6741-19751). The sample size was calculated with OpenEpi® software version 3.01, using the findings of De Freitas *et al*. who reported a mean ideal NL angle of 103.37 ± 8.07 degrees at rest and 108.76 ± 8.91 degrees during smiling, for male subjects.[13] Whereas, they found NL angles of 106.50 ± 7.90 degrees and 112.58 ± 8.92 degrees for female subjects at rest and during smiling, respectively. Keeping $\alpha = 0.05$ and the power of study as 85%, this gave us a sample size of 18 participants. The sample size was inflated by 30% to account for sample size attrition, therefore, a total of 23 (n) subjects were included in the study. Since there were three groups, laypersons (LP), general dentists (GD), and orthodontists (OD), the total sample size was 69 (N).

Data were collected by using profile photographs of adult male and female subjects both at rest and during smiling which were rated by the panel of raters using a Likert scale. During the acquisition of the photographs, the subjects were asked to keep their head in a natural position (straight) so that the face was not inclined up or down. The camera was adjusted to the position parallel to the apparent occlusal plane. Two profile photographs were taken for male and female subjects by using a digital camera Sony DSC-WX200, (megapixels approx. 18.2 and maximum resolution 4896 × 3672) which was adjusted at a distance of 4 feet from the standing subject. One photograph was taken in a normal resting posture with relaxed lips and the other one with a social smile. Photographs were stored in a JPEG format. Full-face profile photographs were utilised for the rating without a black strip that was placed over the eyes to hide the identity of the subject[12] (Figure 1, 2). For standardisation of the image, guidelines published by Desai *et al*.[14] and Chetan *et al*.[15] were followed. The principal investigator then modified these photographs by altering the NL angle to 85°, 90°, 95°, 100°, 105°, and 110° by using (Adobe Photoshop CS [version 8.0; Adobe, San Jose, Calif] and Adobe Illustrator CS5 [version 15.0.1; Adobe]). Modified photographs of both genders were rated by three panels of raters that included, LP, GD, and OD, on a 7-point Likert scale with one being extremely unattractive and seven being extremely attractive.

The raters were recruited from the tertiary care hospital which included individuals between eighteen to fifty years of age. LP who had an understanding of the English language and had no knowledge regarding dentistry were included. GD who had a minimum of one-year experience after graduation, while OD having a minimum of one-year postgraduate training experience were included. The inclusion criteria for subjects recruited for the photographs were adult individuals with complete permanent dentition aged eighteen to thirty years. Male and female subjects having a normodivergent and an orthognathic profile, Class I skeletal relationship, and normal NL angle with normal overjet and overbite were included.

The exclusion criteria for raters were those individuals who did not fall into the afore-mentioned age group, individuals with visual disturbances, and those who were not willing to be a part of the study. The exclusion criteria for subjects were the presence of any dental / craniofacial anomaly or syndrome such as hemifacial microsomia, Down's syndrome, Treacher Collins syndrome, *etc*. History of surgery or trauma involving facial structures. Subjects who had orthodontic or orthopaedic treatment were also excluded.

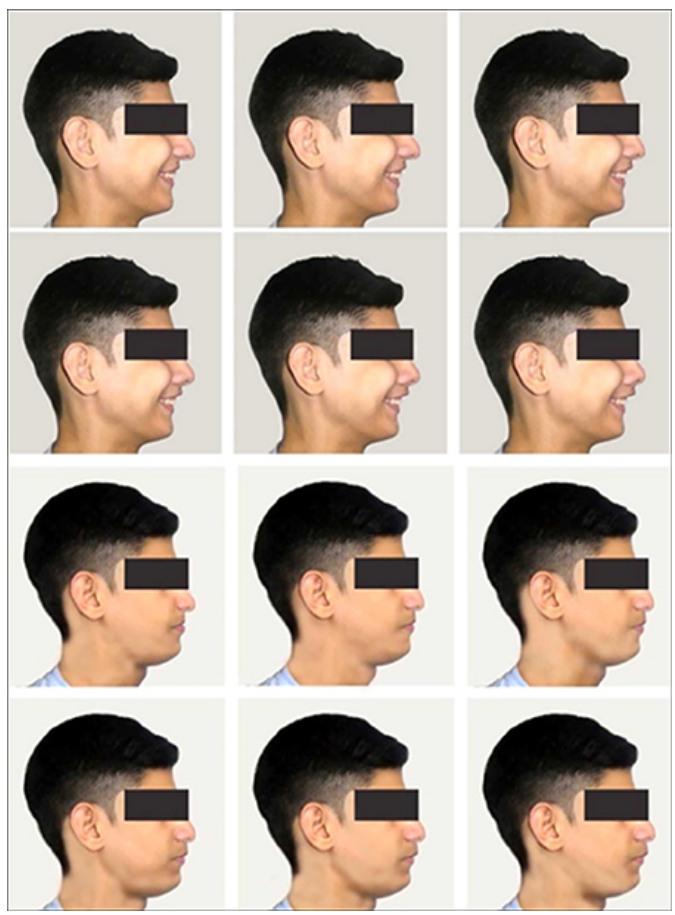

Figure 1: Photographs of male subject at rest and smile.

Figure 2: Photographs of female subject at rest and smile.

Data were analysed using SPSS version 23.0. Shapiro-Wilk's test was used to determine the normality of the data which showed a non-normal distribution. Frequencies were reported for categorical variables such as gender. Descriptive statistics such as mean and standard deviations were reported for age. Median and IQR range were reported for NL angle and smile scores. Intra-class correlations (ICC) were applied by selecting ten raters randomly after two weeks for re-assessing the photographs to determine the intra-examiner reliability. A comparison of NL angle scores among raters was done using the Kruskal-Wallis test. Mann-Whitney U test was applied for pairwise comparison between groups and gender-wise comparison of preference of NL angle between male and female raters. Wilcoxon signed-rank test was applied to compare the improvement of NL angle scores from rest to smile. A p-value of ≤0.05 was considered as statistically significant.

RESULTS

The mean ages of raters were 25.76 ± 7.77 years for LP, 28.17 ± 4.24 years for GD, and 34.39 ± 7.23 years for OD. The gender distribution for the raters was 12 males and 11 females (LP), six males and 17 females (GD), and 14 males and nine females (OD), respectively. The ages of male and female subjects recruited for photographs were 18 and 23 years, respectively.

On comparing the aesthetic scores of nasolabial angles among all three groups of raters, significant differences were found. The aesthetic scores of 85° at rest ($p = 0.050$) for males were found to be significantly different in all three groups of raters. Score of 110° was found to be significantly different for males on smiling ($p = 0.009$) and for females at rest ($p = 0.005$). The 100° smile for male was found to be significantly different ($p = 0.003$) in all three groups of raters (Table I). On comparison of aesthetic scores between the panel of raters, significant differences were observed at 85° at rest ($p = 0.018$), and 110° at rest ($p = 0.003$) and during smile ($p < 0.001$) between the LP and OD groups. Additionally, a 100° smile ($p < 0.001$) was significant between the LP and OD as well as between LP and GD groups ($p = 0.039$, Table II).

A statistically significant improvement in smile scores in all the three groups of raters was found when rest-to-smile scores were compared on different degrees of nasolabial angle. LP gave the highest scores to 95° for males ($p < 0.001$) and females ($p = 0.011$). GD found 90° for males ($p = 0.009$) along with 90° ($p = 0.014$) and 95° ($p = 0.025$) for females to be most attractive on smiling. OD gave the highest scores to 95° for both males ($p < 0.001$) and females ($p = 0.002$, Table III).

When gender-wise comparison between raters was assessed, a statistically significant difference in perception of NL angle was found. Male raters preferred 90° and 95° for male subjects ($p = 0.002$) and 95° for females subject ($p = 0.009$). Females raters found 90° and 95° for males ($p = 0.002$) whereas for females, 95° ($p = 0.009$) and 100° ($p = 0.030$) were found to be attractive during smiling (Table IV).

DISCUSSION

In this study, the null hypothesis was rejected as the role of smile in compensating the facial attractiveness in all three groups of raters was not depicted. LP preferred 95° of nasolabial angle for male and female subjects to be most attractive for a smile. GD preferred 85°, 90°, and 95° for male and female subjects, while OD found 90° and 95° for male subjects and 95° for female subjects to be the most attractive for a smile.

In literature, several studies have investigated the mean ideal NL angle in male and female subjects at rest in profile view and have analysed the NL angle by cephalometrics with the patient at rest but the clinical or facial NL angle has been less explored, specifically the effect of smile in masking the discrepancies of NL angle present at rest.[16,17] Skeletal class I subjects were taken to eliminate the effect of malocclusion on the soft-tissue profile. According to Fernandez *et al*. most of the facial changes occur before the age of 18 years; however, growth and reshaping continue throughout life.[18] Therefore, to achieve more accurate results, photographs of male and female subjects aged between 18 and 23 years, respectively, were included. According to the results, there was a statistically significant improvement in facial attractiveness from rest to smile. All three panels of raters gave high scores to the NL angle during smiling as compared to rest and preferred the NL angle during smiling in improving facial attractiveness. This similar concept has been proved in literature as smiloflage i.e., smile can hide various dental and soft tissue discrepancies present at rest.[12]

Table I: Comparison of nasolabial angle scores among raters.

Variables NL	Gender	LP median (IQR)	GD median (IQR)	OD median (IQR)	p-value
85° (Rest)	Male	4 (3, 5)	4 (2, 4)	3 (2, 4)	0.050*
90° (Rest)	Male	4 (3, 5)	4 (3, 5)	3 (3, 4)	0.223
95° (Rest)	Male	4 (3, 5)	4 (2, 4)	2 (2, 4)	0.076
100° (Rest)	Male	4 (2, 4)	4 (2, 4)	3 (2, 3)	0.151
105° (Rest)	Male	4 (3, 5)	4 (2, 4)	4 (2, 4)	0.074
110° (Rest)	Male	3 (1, 5)	3 (2, 4)	2 (2, 3)	0.097
85° (Smile)	Male	5 (4, 6)	5 (4, 6)	5 (3, 5)	0.106
90° (Smile)	Male	5 (4, 6)	4 (2, 5)	5 (3, 6)	0.009
95° (Smile)	Male	6 (4, 7)	5 (4, 6)	5 (3, 6)	0.098
100° (Smile)	Male	5 (4, 6)	5 (4, 5)	4 (2, 5)	0.003*
105° (Smile)	Male	5 (4, 6)	5 (3, 5)	4 (2, 5)	0.144
110° (Smile)	Male	5 (4, 6)	4 (2, 5)	3 (2, 5)	0.009*
85° (Rest)	Female	4 (3, 5)	4 (2, 5)	3 (2, 4)	0.320
90° (Rest)	Female	4 (4, 5)	4 (3, 5)	4 (3, 5)	0.485
95° (Rest)	Female	4 (3, 5)	4 (3, 5)	4 (3, 5)	0.535
100° (Rest)	Female	4 (3, 5)	4 (2, 5)	3 (2, 5)	0.446
105° (Rest)	Female	4 (2, 5)	4 (2, 5)	3 (2, 3)	0.250
110° (Rest)	Female	4 (3, 5)	3 (2, 5)	3 (1, 3)	0.005*
85° (Smile)	Female	5 (5, 6)	5 (4, 6)	5 (3, 5)	0.159
90° (Smile)	Female	5 (5, 6)	5 (4, 6)	5 (4, 6)	0.843
95° (Smile)	Female	5 (5, 7)	5 (4, 6)	5 (5, 6)	0.853
100° (Smile)	Female	5 (5, 6)	5 (3, 6)	5 (4, 6)	0.701
105° (Smile)	Female	5 (4, 6)	5 (2, 6)	5 (4, 5)	0.315
110° (Smile)	Female	5 (4, 6)	4 (3, 6)	4 (3, 5)	0.274

*N = 69, NL = Nasolabial angle, LP = laypersons, GD = General dentisits, OD = Orthodontists, IQR = Interquartile range, *p = ≤0.05. Kruskal-Wallis test*

Table II: Pairwise comparison between groups.

Variables NL	Gender	LP *vs.* GD	GD *vs.* OD	LP *vs.* OD
85° (Rest)	Male	0.173	0.271	0.018*
100° (Smile)	Male	0.039*	0.148	0.001**
110° (Smile)	Male	0.070	0.148	0.003*
110° (Rest)	Female	0.158	0.145	0.001**

*N = 69, NL = Nasolabial angle, LP = Laypersons, GD = General dentisits, OD = Orthodontists, IQR = Interquartile range, *p = ≤0.05. **p = <0.001 Man-Whitney U-test.*

Table III: Perception of raters.

Variables NL	Gender	Rest median (IQR)	Smile median (IQR)	p-value
Laypersons				
85°	Male	4 (3, 5)	5 (5, 6)	0.041*
90°	Male	4 (3, 5)	5 (5, 6)	0.023*
95°	Male	4 (3, 5)	6 (4, 7)	0.001**
100°	Male	4 (2, 4)	5 (4, 6)	0.002*
105°	Male	4 (3, 5)	5 (4, 6)	0.111
110°	Male	3 (1, 5)	5 (4, 6)	0.009*
85°	Female	4 (3, 5)	5 (5, 6)	0.041
90°	Female	4 (4, 5)	5 (5, 6)	0.010*
95°	Female	4 (3, 5)	5 (5, 7)	0.011*
100°	Female	4 (3, 5)	5 (5, 6)	0.016*
105°	Female	4 (2, 5)	5 (4, 6)	0.001**
110°	Female	4 (3, 5)	5 (4, 6)	0.035*
General dentists				
85°	Male	4 (2, 4)	5 (4, 6)	0.013*
90°	Male	4 (3, 5)	5 (4, 6)	0.009*
95°	Male	4 (2, 4)	5 (4, 6)	0.004*
100°	Male	4 (2, 4)	5 (4, 5)	0.043*
105°	Male	4 (2, 4)	5 (3, 5)	0.023*
110°	Male	3 (2, 4)	4 (2, 5)	0.116
85°	Female	4 (2, 5)	5 (4, 6)	0.009*
90°	Female	4 (3, 5)	5 (4, 6)	0.014*
95°	Female	4 (3, 5)	5 (4, 6)	0.025*
100°	Female	4 (2, 5)	5 (3, 6)	0.019*
105°	Female	4 (2, 5)	5 (2, 6)	0.082
110°	Female	3 (2, 5)	4 (3, 6)	0.086
Orthodontists				
85°	Male	3 (2, 4)	5 (3, 5)	0.016*
90°	Male	3 (3, 4)	5 (3, 6)	0.012*
95°	Male	2 (2, 4)	5 (3, 6)	0.001**
100°	Male	3 (2, 3)	4 (2, 5)	0.019*
105°	Male	4 (2, 4)	4 (2, 5)	0.201
110°	Male	2 (2, 3)	3 (2, 5)	0.082
85°	Female	3 (2, 4)	5 (3, 6)	0.004*
90°	Female	4 (3, 5)	5 (4, 6)	0.052
95°	Female	4 (3, 5)	5 (5, 6)	0.002*
100°	Female	3 (2, 5)	5 (4, 6)	0.007*
105°	Female	3 (2, 3)	5 (4, 5)	0.002*
110°	Female	3 (1, 3)	4 (3, 5)	0.004*

*NL = Nasolabial angle, IQR = Interquartile range; *p ≤0.05, **p ≤0.001. Wilcoxon-signed rank test.*

Table IV: Gender wise comparison.

Variables NL	Gender	Male raters median (IQR)	Female raters median (IQR)	p-value
90°(Smile)	Male	6 (5, 6)	5 (4, 5)	0.002*
95°(Smile)	Male	6 (5, 6)	5 (4, 5)	0.002*
90° (Smile)	Female	6 (5, 7)	5 (4, 5)	0.006*
95° (Smile)	Female	6 (5, 7)	5 (4, 6)	0.009*
100° (Smile)	Female	6 (5, 7)	5 (4, 6)	0.030*
105° (Smile)	Female	5 (4, 7)	5 (3, 5)	0.029*

*NL = Nasolabial angle, IQR = Interquartile range; *p ≤0.05, **p ≤0.001. MannWhitney U test.*

Alharethy in his study found a mean ideal NL angle of 89.39 ± 3.66 (acute) for males and 90.62 ± 5.15 (normal) for females on profile photographs at rest.[16] In this study, a comparison was conducted between both rest and smile photographs of male and female subjects. It was found that LP preferred angles at 90° (p = 0.023) and 95° (p <0.001) for males, and at 90° (p = 0.011) for females for most attractive smile. GD and OD found 90° (p = 0.009) for males along with 90° (p = 0.014) and 95° (p = 0.002) for females to be attractive for smiling. Therefore, the results of this study showed that all three groups of raters preferred slightly acute or normal NL angle for male and female subjects which is similar to the findings of previous studies.[19,20] All those degrees of NL angles which were scored unattractive or slightly attractive at rest, improved on smile and were given highly attractive scores in this study. Throughout this study, OD gave less scores as compared to other raters due to more specific assessment of smile aesthetics, while LP gave highest scores due to lack of knowledge regarding dentistry and NL angle.

Results from the findings of De Freitas *et al*.[13] found an increase in NL angle during a smile, while in this study NL angle decreased on smile as compared to at rest. This can be due to the ethnic variability of their study population i.e., they included Brazilian subjects, whereas this study included Asians. NL is greatly influenced by the position of the upper lip so, in this study photographs having NL angles of 95°, 105°, and 110° were rated unattractive or slightly attractive at rest, however, on smiling, all these were found attractive or extremely attractive. This improvement in facial attractiveness can be due to the orbicularis oris muscle of the upper lip moves upward on smiling while the depressor septi nasi pulls the nasal tip downward converting the obtuse NL angle to a normal angle. Similar effect of the depressor septi nasi muscle was reported by Niechajev[21] in his study. In the present study, LP found 110° for males to be slightly unattractive at rest, whereas on smiling, they scored it to be attractive. GD found 85° for males and females to be neither unattractive nor attractive at rest, however, they scored it to be attractive on smiling. OD scored 95° for males to be very unattractive at rest and similarly attractive on smiling. All these findings depict the role of smile in masking the discrepancies of NL angle present in an individual at rest which can be due to the role of different soft tissue parameters such as upper lip and nose.

Yuksel *et al*.,[22] in their study, stated that increasing the NL angle decreases the facial profile attractiveness, which is in concordance with this study's findings. When assessing the differences in the perception of NL angles between male and female raters, significant differences were observed. The male raters preferred 90° and 95° for male subjects (p = 0.002) and 95° for females subjects (p = 0.009) to be attractive on smiling. Female raters preferred 90°, 95° for males (p = 0.002) along with 95° (p = 0.009) and 100° (p = 0.030) for female subjects to be attractive on smiling (Table IV). However, this does not match with previous studies, the results of which found no significant difference between male and female raters. This can be because they included only LP as raters while this study included LP, GD, and OD in which OD have different aesthetic preferences and knowledge regarding facial aesthetics and they might have paid attention to individual details rather than the entire facial complex.

To avoid the inculcation of bias by presenting these photographs in ascending sequence, all 24 photographs were presented to raters in a randomised order for more accurate results which is in conformity with the findings of Honn *et al*.[23] who stated that the order in which the photographs are shown can affect the judgement of raters.

To the best of this study's knowledge, this is the first study in which not only the preferred NL angles for male and female subjects were evaluated but also the influence of smile in increasing facial attractiveness and in masking the discrepancies which made the face unattractive at rest were assessed. This study had a limitation as only Asian subjects were selected for photographs. As Caucasians have more obtuse, Brazilians have more acute nasolabial angle, this study found a normal range of nasolabial angles for Asians. This limitation provides the clinical implication that in Asians, these norms should be considered during orthodontic treatment. Moreover, extreme modifications can lead to an unnatural distortion of the face, which is a limitation of the Photoshop software. Further studies, considering more factors such as the anteroposterior position of the maxilla, maxillary incisors, and thickness of the upper lip should be conducted to encompass all the variables that can assess the NL angle and facial attractiveness. The clinical implication of the study is that in Asians these norms should be considered during orthodontic treatment.

CONCLUSION

Smile significantly compensated nasolabial angle, enhancing the facial profile attractiveness. Male raters showed a preference for nasolabial angles of 90° and 95° for male subjects, and 95° for female subjects, while female raters favoured angles of 90° and 95° for male subjects and 95° and 100° for female subjects. Among the three groups of raters, LP preferred a nasolabial angle of 95° for both male and female subjects as the most attractive on smile. GD identified angles of 85°, 90°, and 95° as most attractive for both genders, whereas OD preferred angles of 90° and 95° for male subjects and 95° for female subjects. These findings illustrate the varying preferences across different evaluator groups regarding the nasolabial angle's impact on perceived attractiveness in smiling profiles.

ETHICAL APPROVAL:
The ethical approval was taken from the institutional Ethical Review Committee (ERC # 2021-6741-19751).

PATIENTS' CONSENT:
Informed consent was taken from subjects for the use of photographs and copies can be provided upon the journal's request.

COMPETING INTEREST*:*
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
AAB: Data collection, data analysis, interpretation of data, and writing of the manuscript.
KT: Data collection and data analysis.
RHS: Data interpretation and reviewing of the manuscript.
MF: Proofreading of the manuscript.
All authors approved the final version of the manuscript to be published.

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