

# Association of Normal Values of Nasolabial Angle and Lip Length with Incisal Display at Rest Position of Lips

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## Author's Contribution

<sup>1,3</sup>Substantial contributions to the conception or design of the work; or the acquisition, <sup>2,4</sup>Drafting the work or revising it critically for important intellectual content, <sup>2</sup>Final approval. <sup>5</sup>Literature review, <sup>6</sup>Active participation in active methodology, analysis, or interpretation of data for the work  
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## ABSTRACT

**Objective:** To determine correlation between values of nasolabial angle and lip length with incisal display at rest position of lips.

**Methodology:** This descriptive cross-sectional study was conducted at Institute of Dentistry LUMHS, Jamshoro from Jan-June 2023. Individuals aged between 18 to 40 years visiting for prosthesis of posterior teeth, both genders, with fully erupted anterior maxillary teeth and well aligned teeth and with intact upper central incisors, with no significant wear, fractures, or discoloration were included. A photogrammetric approach was employed to analyze the nasolabial angle, and two photographs with frontal and lateral views, with the camera placed 1.5 meters, which were digitally analyzed, with the nasolabial angle measured in degrees and the lip length and incisal display measured in millimeters. Vernier caliper was used for measurement of the lip length from the base of the nose to the lowest point of the upper lip, and these measurements were cross-referenced with digital measurements to ensure accuracy.

**Results:** Overall mean age of patients was  $28.4 \pm 6.7$  years. Overall mean nasolabial angle was  $93.38^\circ$ , total lip length average 20.02 mm, and incisal display average 2.09 mm, with the majority of the cases (60.3%) had minimal exposure of 0–2.0 mm. There was a weak negative association between nasolabial angle and incisal display at rest ( $r = -0.172$ ,  $R^2 = 0.030$ )  $p = 0.196$ . On the other most clinically meaningful association was observed between lip length and incisal display at rest ( $r = -0.555$ ,  $R^2 = 0.308$ ),  $p = 0.001$ : This moderate-to-strong negative correlation was significant in both males ( $r = -0.551$ ,  $p = 0.002$ ) and females ( $r = -0.477$ ,  $p = 0.008$ ), indicating lip length as the primary morphological determinant of incisal display at rest across both genders.

**Conclusion:** Nasolabial angle and lip length are significant independent determinants of incisal display at rest in the Pakistani population, with females exhibiting greater display values.

**Key words:** Nasolabial angle, lip length, incisal display, resting lip position, maxillary anterior teeth, dental esthetics

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## Introduction

An appealing and flawless smile is the top most priority of the patients as well as their treating prosthodontics.

This cosmetic priority makes the facial structures very important, which are involved in smiling process<sup>1,2</sup>. An attractive smile depends upon a balance between the surrounding facial structures to expose a controlled proportion of the incisal teeth and gingival tissue. So, it

can be stated that the most potent driving force for a patient, behind the consultation of a prosthodontics, is the aesthetic concerns. And the most reliable soft tissue parameters for incisal display are the nasolabial fold, both upper and lower lips (length and tissue appearance), gingival scaffold, and teeth alignment etc<sup>3</sup>. The prevalence of normal values of nasolabial angle (NLA) and lip length with incisal display (ID) at rest position of lips varies depending on the population studied. In general, a NLA of 90-110 degrees and an ID of 2-4 mm are considered to be within the normal range. However, there is a wide range of variation within these ranges, and what is considered to be "normal" may also vary depending on individual preferences and cultural norms<sup>4</sup>.

A study of 100 Caucasian adults in the United States found that the mean NLA was 97.5 degrees and the mean ID was 3.2 mm. However, there was a wide range of variation, with NLAs ranging from 85 to 110 degrees and IDs ranging from 1 to 6 mm<sup>4</sup>. Another study of 100 Asian adults in South Korea found that the mean NLA was 102.5 degrees and the mean ID was 2.8 mm. Again, there was a wide range of variation, with NLAs ranging from 90 to 115 degrees and IDs ranging from 1 to 4 mm<sup>5</sup>. The incisal display at smile depends upon the position and length of the lips (i.e maxillary and mandibular both), while at the resting position, it largely depends upon the underlying facial muscles (bulk and tone) around the lips. The maxillary lip length is in inverse relation with the display of teeth and gingival tissue i.e. smaller lip length leads to more incisal display and longer length is associated with smaller incisal structures display.

Similarly, this display is also dependent upon the nasolabial angle at resting as well as during smiling phase<sup>6-8</sup>. According to a study the mean vertical dimension for male was 64.48±4.67 mm while for female was 62.11±4.12 mm, the mean Lip Length for male was 19.17±3.04 mm while for female was 18.05±1.95 mm. In their study the correlation between variables in profile view was done with the help of Pearson correlation and they found the correlation coefficient value between incisal display and lip length was 0.436 and the correlation coefficient value between Nasolabial Angle and upper lip length was 0.214.<sup>9</sup> This study is designed to determine the correlation between the nasolabial angle, lip length, and incisal display, given their strong correlation with facial aesthetics, which is a significant concern for many patients seeking prosthodontic treatment. The nasolabial angle plays a crucial role in evaluating a patient's facial profile, and examining its

relationship with lip length and incisal display will expand the understanding of these aesthetic parameters. The findings from this study could help develop guidelines to enhance clinical practices when treating patients undergoing planned prosthetic procedures.

## Methodology

This cross-sectional study was conducted at Institute of Dentistry Liaquat University of Medical and Health Sciences, Jamshoro Jan-June 2023. Study was done after taking approval from CPSP and Institutional Ethical Review Committee of LUMHS/REC/03. The sample size of 58 cases was calculated using the correlation formula  $n = (Z\alpha/2 + Z\beta)^2 / (\text{Effect Size})^2$ , with  $Z\alpha/2 = 1.96$  ( $\alpha = 0.05$ ),  $Z\beta = 1.28$  (90% power), and an anticipated correlation coefficient of  $r = 0.4369$  derived from prior literature.<sup>9</sup> Non-probability consecutive sampling technique was used. All the individuals aged between 18 to 40 years, both genders, with fully erupted anterior maxillary teeth and well aligned teeth, with intact upper central incisors, with no significant wear, fractures, or discoloration and visiting for prosthesis of posterior teeth were including. On the other hand, individuals with history of facial or dental trauma, orthodontic treatment, or maxillofacial surgery, individuals with congenital craniofacial anomalies, missing upper central incisors, history of facial aesthetic treatments and cases with neuromuscular disorders were excluded. Written informed consent was obtained from all the cases and confidentiality of collected data was strictly maintained.

Demographic details, including name, age, gender, occupation, and address, was recorded for each participant. Subsequently a photogrammetric approach was employed to analyze the nasolabial angle, using standardized photographs taken with an iPhone camera set to its default settings. Two photographs (frontal and lateral views) were taken for each participant, with the camera placed 1.5 meters away at the participant's head height to ensure standardization. These photographs, captured in JPEG format, were digitally analyzed using ProVixwin software, with the nasolabial angle measured in degrees and the lip length and incisal display measured in millimeters. In addition to digital analysis, a Vernier caliper were used for manual measurement of the lip length from the base of the nose (subnasale) to the lowest point of the upper lip (stomion superius), and these measurements were cross-referenced with digital measurements to ensure accuracy. Nasolabial angle was measured in degrees using lateral cephalometric radiographs or standardized profile photographs, with

normal range typically between 90° and 110° for men and 95° to 115° for women. Lip Length was defined as the vertical distance from the base of the nose (subnasale) to the lowest point of the upper lip measured by using a digital caliper or image analysis software on standardized frontal facial photographs. Incisal display at rest was defined as the amount of maxillary incisor tooth visible below the upper lip in a relaxed, natural position of the lips, assessed in millimeters using a digital caliper or image analysis software on standardized frontal facial photographs taken while the participant's lips are at rest, with normal range of 2-4 mm of maxillary incisor display in a neutral lip position. All data was recorded in the study proforma. Correlation was assessed to assess the relationship of nasolabial angle and lip length, with incisal display. Data was entered and analyzed by using SPSS version 26. Mean and standard deviation were calculated for all quantitative variables like age, measurement of nasolabial angle, lip length and measurement of incisal display at rest. Frequency and percentage were calculated for all qualitative variables like gender. Pearson correlation was applied to correlate nasolabial angle and lip length with incisal at rest. Post stratification Pearson correlation was applied. P-value ≤ 0.05 was taken as significant.

## Results

This study enrolled the overall 58 cases with overall mean age of 29.78 ± 5.66 years, average number of

anterior teeth 5.91 ± 0.66, and the mean number of lost teeth 1.93 ± 0.88. overall mean nasolabial angle was 93.38 ± 14.14 degrees, mean lip length was 20.02 ± 2.45 mm, and mean incisal display at resting position was 2.09 ± 1.37 mm, as presented in table I.

The overall incisal display at resting position was ranged from 0-5 mm, with the majority of the cases (60.3%) falling within range from 0 to 2.0 mm, and progressively few cases had greater tooth display, indicating minimal incisal exposure at rest as the most common finding in the study population. Table II

**Table II: Incisal display at resting position categories. (n=58)**

| Incisal display at resting position (mm) | Frequency | Percent |
|--|-----------|---------|
| 0-1.0 mm                                 | 17        | 29.3%   |
| 1.1-2 mm                                 | 18        | 31.0%   |
| 2.1-3 mm                                 | 15        | 25.9%   |
| 3.1-4 mm                                 | 06        | 10.3%   |
| 4.1-5 mm                                 | 02        | 03.4%   |
| Total                                    | 58        | 100.0%  |

There was a weak significant positive association was found between lip length and nasolabial angle ( $r = +0.289$ ,  $R^2 = 0.084$ )  $p = 0.028$ , as lip length increases, the nasolabial angle increases slightly. Although weak and insignificant negative association was found between nasolabial angle and incisal display at rest ( $r = -0.172$ ,  $R^2 = 0.030$ )  $p = 0.196$ . On the other most clinically meaningful association was observed between lip length and incisal display at rest ( $r = -0.555$ ,  $R^2 = 0.308$ ),  $p = 0.001$ ): This moderate-to-strong negative correlation was

**Table I: Descriptive statistics of the study variable. (n=58)**

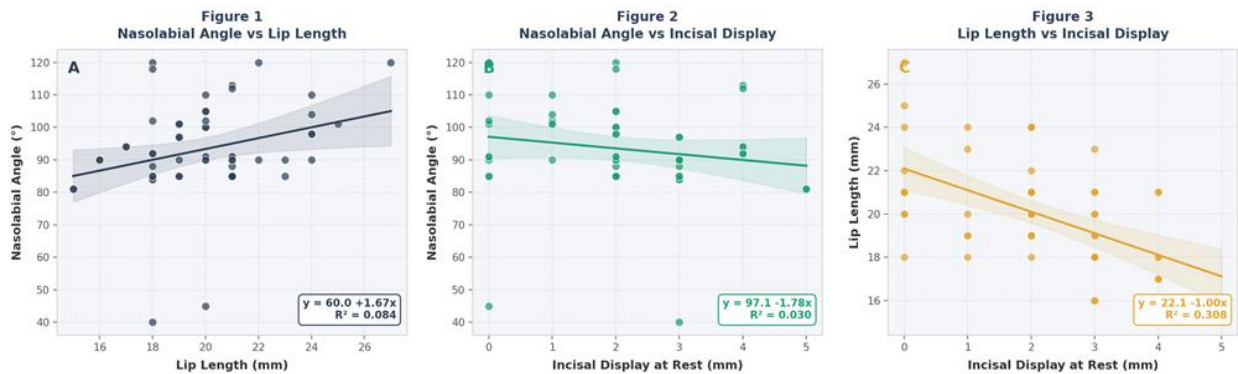
| Variables                                | Overall (n=58)             | Male (n=28) | Female (n=30) | p-value |
|--|----------------------------|-------------|---------------|---------|
| Mean age (years)                         | 29.78 ± 5.66               | 29.89±6.37  | 29.66±5.01    | 0.881   |
| Mean number of lost teeth                | 1.93 ± 0.88                | 1.78±0.73   | 2.06±0.98     | 0.225   |
| Mean nasolabial angle                    | 93.38 ± 14.14 <sup>0</sup> | 92.75±17.82 | 93.96±9.81    | 0.746   |
| Lip length (mm)                          | 20.02 ± 2.45               | 20.71±2.67  | 19.36±2.05    | 0.035   |
| Incisal display at resting position (mm) | 2.09 ± 1.37                | 1.75±1.55   | 2.40±1.10     | 0.070   |

**Table III: Mean lip length, NLA and incisional display as rest according to age and gender.**

| Variables                                | Gender | Mean  | SD    | p-value |
|--|--------|-------|-------|---------|
| <b>AGE GROUPS (YEARS)</b>                |        |       |       |         |
| Lip length (mm)                          | 18-30  | 19.41 | 2.25  | 0.024   |
|  | 31-40  | 20.87 | 2.50  |         |
| Nasolabial angle (degrees)               | 18-30  | 90.79 | 12.03 | 0.098   |
|  | 31-40  | 97.04 | 16.24 |         |
| Incisal display (mm) At resting position | 18-30  | 2.17  | 1.38  | 0.554   |
|  | 31-40  | 1.95  | 1.36  |         |
| <b>GENDER</b>                            |        |       |       |         |
| Lip length (mm)                          | Male   | 20.71 | 2.67  | 0.035   |
|  | Female | 19.36 | 2.05  |         |
| Nasolabial angle (degrees)               | Male   | 92.75 | 17.82 | 0.746   |
|  | Female | 93.96 | 9.81  |         |
| Incisal display (mm) At resting position | Male   | 1.75  | 1.55  | 0.070   |
|  | Female | 2.40  | 1.10  |         |

significant in both males ( $r = -0.551$ ,  $p = 0.002$ ) and females ( $r = -0.477$ ,  $p = 0.008$ ), indicating lip length as the primary morphological determinant of maxillary incisal display at rest across both genders. Figure 1.

at rest in females was  $20.59 \pm 2.46$  mm and in males was  $22.68 \pm 1.87$  mm, with males representing significantly greater lip length compared to females ( $p = 0.0059$ ). Moreover in the study by Gołębowski et al<sup>10</sup> reported



**Figure 1. Association between NLA and lip length.**

The lip length showed significant difference according age groups and genders, being raised in older participants (31–40 years) compared to younger cases (18–30 years;  $p = 0.024$ ), and was raised among males compared to the females  $p = 0.035$ . However, the in overall average of nasolabial angle and incisal display at rest showed insignificant differences according to age groups and genders, though females had a trend toward greater incisal display compared to males, and older cases tended toward a more obtuse nasolabial angle ( $p > 0.05$ ). Table III

## Discussion

Assessment of the facial balance and harmony relies on the interplay between the underlying skeletal framework and the overlying soft tissue covering. Dento-facial complex is comprehensively assessed in both the frontal and sagittal planes, including both static and dynamic muscular situations. At resting position, the degree of tooth exposure is managed by the static muscular position of the lips. This study has been conducted to establish normative values for nasolabial angle and lip length and determine their association with maxillary incisal display at rest, providing population-specific reference data applicable in orthodontic and aesthetic dental practice. In this study the overall mean nasolabial angle observed in the present study was  $93.38 \pm 14.14^\circ$ , with no statistically significant difference between males ( $92.75 \pm 17.83^\circ$ ) and females ( $93.97 \pm 9.81^\circ$ ) ( $p = 0.746$ ). In aligns to our findings Kolte AP et al<sup>1</sup> reported that, at lip resting position mean nasolabial angle was  $96.68 \pm 11.28^\circ$  among females and  $98.60 \pm 11.43^\circ$  in males, without significant difference ( $p = 0.3571$ ), while mean lip length

some increased mean of nasolabial length  $114.07^\circ \pm 10.81^\circ$ . The variation in the nasolabial angle also depends on gender and initial malocclusion. However, the Ballin et al<sup>11</sup> also evaluate the average values of NLA based on gender distribution as;  $107.75^\circ \pm 9.82^\circ$  for males and  $104.03^\circ \pm 10.65^\circ$  for females. In the study by Bergman et al,<sup>12</sup> reported mean value of NLA around  $102^\circ \pm 8^\circ$  and Fernandez-Riveiro et al<sup>13</sup> stated the mean of normal value around  $105^\circ \pm 13^\circ$  in females and  $107.6^\circ \pm 8.5^\circ$  in males. Although the average NLA of  $93.38^\circ$  observed in this study is comparable to that reported by Garg et al,<sup>14</sup> around  $1.38^\circ \pm 7.10^\circ$  in a North Indian population. In aligns to this series a systematic review by Quinzi et al<sup>14</sup> on nasolabial angle in orthodontic diagnosis stated the ideal nasolabial angle ranges from in males  $90^\circ$  to  $95^\circ$ , and in females from  $95^\circ$  to  $115^\circ$ , with the values varying among different ethnic and phenotypical groups. The differences in mean values reported across different studies may due to ethnic differences among study populations, as ethnicity is known to influence soft tissue morphological parameters. Moreover, methodological inconsistencies in the identification and marking may further contribute to the discrepancies observed in lip length measurements between studies.

In this study the overall mean incisal display at rest was  $2.09 \pm 1.37$  mm, specifically females with a trend toward greater display  $2.40 \pm 1.10$  mm compared to males  $1.75 \pm 1.55$  mm, without statistical significance  $p = 0.070$ , with most of the individuals 60.3% had minimal display within the 0–2.0 mm range, determining this as the normative pattern in the study population. The findings are consistent with the study by Awad MA et al<sup>17</sup> where mean tooth display at rest was  $2.40 \pm 0.79$  mm in females

and  $2.09 \pm 0.92$  mm in males, values that resemble remarkably closely to the present study, suggesting comparable lip-dental morphology between Pakistani and Saudi adult populations.

In this study there was a weak and insignificant negative association was found between nasolabial angle and incisal display at rest ( $r = -0.172$ ,  $R^2 = 0.030$ )  $p = 0.196$ . On the other most clinically meaningful association was observed between lip length and incisal display at rest ( $r = -0.555$ ,  $R^2 = 0.308$ ),  $p = 0.001$ ): This moderate-to-strong negative correlation was significant in both males ( $r = -0.551$ ,  $p = 0.002$ ) and females ( $r = -0.477$ ,  $p = 0.008$ , indicating lip length as the primary morphological determinant of maxillary incisal display at rest across both genders. In aligns to this study Sroka et al<sup>18</sup> reported that the changes in upper lip position were more closely associated to changes in the nasolabial angle than variation in nasal tip position ( $r > 0.5$ ), indicating that the labial component of NLA is the primary driver of its changes, rather than tooth display directly. However, in the study by Jeelani et al<sup>19</sup> demonstrated that the that upper lip length and thickness showed significant negative correlations with maxillary incisal display at rest, whereas multiple skeletal factors including mandibular plane angle and lower anterior facial height collectively contributed to the variation in incisal display, suggesting that NLA alone is an insufficient predictor of incisal display when considered in isolation. Yong et al<sup>20</sup> further demonstrated that the clinically recommended guide of 2 mm incisal show at rest is appropriate only for patients with a straight lip form, while patients with moderate or high lip forms aesthetically benefit from 4–5 mm of incisal display, underscoring that the length and form of the lip collectively modulate the perceived and actual degree of incisal exposure. The categorical findings of the present study reinforce this, with subjects having shorter lips ( $\leq 18$  mm) demonstrating the greatest mean incisal display (3.12 mm), declining progressively in those with longer lips (1.18 mm for  $> 21$  mm). Overall, the findings establish lip length as the primary morphological determinant of maxillary incisal display at rest, whereas nasolabial angle serves as a complementary but independent parameter, both of which should be routinely incorporated into prosthodontics and aesthetic dental evaluation and planning of treatment. However, this study possesses like very limited sample size from a single center, restricting final conclusive and several potentially influential variables such as interlabial gap, lip thickness, vertical facial pattern, and incisor inclination were not assessed. Hence further studies should recruit

larger, multicenter, and ethnically diverse samples with independent direct measurement of upper and lower lip length. Moreover, soft tissue and skeletal parameters should be involved for more inclusive analysis.

## Conclusion

Study revealed that the most of individuals observed with minimal incisal display at resting position, predominantly within the lower millimeter range, with incisal revealing decreasing as lip length raised and nasolabial angle became more obtuse. Moreover, the interlabial gap noted to be a most influential factor positively linked to the greater tooth display, whereas upper lip length exerted the highest limiting effect. Collectively the lip morphology plays a fundamental role in defining the degree of maxillary incisal exposure at rest position.

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