Normative Evaluation of Smile Index and Buccal Corridor Space Among Gujarati Adults: A Cross-Sectional Study

Dr. Nipa Chauhan[1], Dr. Dolly Patel[2]
[1]*PhD Scholar (M.D.S, Orthodontics), Gujarat University*
[2]*PhD Guide (M.D.S, Orthodontics), Gujarat University*

Abstract—**Background: Smile aesthetics is an integral component of contemporary orthodontic diagnosis and treatment planning. Among various smile parameters, the Smile Index (SI) and Buccal Corridor Space (BCS) objectively assess the proportional relationship between the horizontal and vertical dimensions of the smile. Population-specific normative data are essential because smile characteristics vary according to ethnicity and gender, and limited information is available for the Gujarati population.**

Aim: To compare Smile Index and Buccal Corridor Space between Gujarati males and Gujarati females with well-balanced facial profiles.

Materials and Methods: A cross-sectional observational study was conducted among 507 Gujarati adults (241 males and 266 females) aged 18–35 years with clinically acceptable facial profiles and normal occlusion. Standardized posed smile photographs were obtained using a calibrated DSLR camera under controlled conditions. Smile Index was calculated as the ratio of inner intercommissural width to interlabial gap, while right and left Buccal Corridor Space were measured using calibrated digital photogrammetric analysis. Data were analyzed using descriptive statistics and the independent Student's t-test, with statistical significance set at $p < 0.05$.

Results: Female participants demonstrated a slightly higher mean Smile Index (6.14 ± 1.66) than males (5.92 ± 1.18); however, the difference was not statistically significant ($p = 0.082$). Similarly, right Buccal Corridor Space ($p = 0.696$) and left Buccal Corridor Space ($p = 0.780$) were comparable between genders, indicating similar transverse smile characteristics.

Conclusion: No statistically significant gender differences were observed in Smile Index or Buccal Corridor Space among Gujarati adults. The normative values established in this study provide population-specific reference data that may assist orthodontic diagnosis, esthetic treatment planning, prosthodontic rehabilitation, orthognathic surgery, and digital smile design.

Index Terms—**Buccal Corridor Space, Gujarati Population, Orthodontics, Photogrammetry, Smile Aesthetics, Smile Index.**

I. INTRODUCTION

Smile aesthetics is an important determinant of facial attractiveness and plays a significant role in social interaction, self-confidence, and overall facial harmony. In contemporary orthodontics, treatment objectives have evolved beyond achieving ideal occlusion to include the optimization of facial and smile aesthetics. Consequently, smile analysis has become an integral component of orthodontic diagnosis and treatment planning, incorporating macroesthetic, miniesthetic, and microesthetic principles to achieve balanced esthetic outcomes.

Among the objective parameters used in smile evaluation, the Smile Index (SI) and Buccal Corridor Space (BCS) are widely accepted quantitative indicators of smile morphology. The Smile Index, calculated as the ratio of inner intercommissural width to interlabial gap, reflects the proportional relationship between the horizontal and vertical dimensions of the smile. Buccal Corridor Space represents the negative space visible between the maxillary posterior teeth and the oral commissures during smiling and contributes to the perception of smile fullness and attractiveness.

Previous studies have demonstrated that smile characteristics may vary according to ethnicity, gender, age, and craniofacial morphology. Therefore, normative values established in one population may not be directly applicable to another, highlighting the

need for population-specific reference standards to support individualized orthodontic diagnosis and esthetic treatment planning. However, limited information is available regarding Smile Index and Buccal Corridor Space among Gujarati adults.

The present study was undertaken to compare Smile Index and Buccal Corridor Space between Gujarati males and Gujarati females with well-balanced facial profiles and to establish population-specific normative reference values. The findings are expected to contribute to evidence-based orthodontic diagnosis, prosthodontic rehabilitation, orthognathic surgical planning, facial esthetic evaluation, and digital smile design in the Gujarati population

Aim

To compare Smile Index and Buccal Corridor Space between Gujarati males and Gujarati females with well-balanced facial profiles.

Objectives

1. To determine Smile Index among Gujarati males.
2. To determine Smile Index among Gujarati females.
3. To compare Smile Index between genders.
4. To evaluate right Buccal Corridor Space.
5. To evaluate left Buccal Corridor Space.
6. To compare Buccal Corridor Space between genders.
7. To establish gender-specific normative values for Gujarati adults.
8. To evaluate the orthodontic significance of Smile Index and Buccal Corridor Space.

II. MATERIALS AND METHODS

Study Design

A cross-sectional observational study was conducted to compare the Smile Index and Buccal Corridor Space between Gujarati males and Gujarati females with well-balanced facial profiles. The study was designed to establish gender-specific normative values for smile aesthetics in the Gujarati population using standardized photographic smile analysis.

Study Setting

The study was carried out in the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad, Gujarat, India. Participants were enlisted from the Civil Hospital campus, including students, staff members, patients, and accompanying relatives who fulfilled the predetermined eligibility criteria. Ethical approval was obtained from the Institutional Ethics Committee before commencement of the study, and written informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

Study Population and Sample Size

A total of 507 Gujarati adults aged 18–35 years were included in the study following sample size estimation based on a pilot investigation with 80% statistical power and a 95% confidence interval. The study population comprised:

- Male participants: 241
- Female participants: 266

Only participants demonstrating clinically acceptable facial profiles and harmonious smile characteristics were included for analysis to establish normative smile parameters representative of the Gujarati population. The study sample was derived from approximately 600 screened individuals.

Inclusion Criteria

Participants fulfilling all of the following criteria were included:

- Age between 18 and 35 years.
- Gujarati ethnicity confirmed by Gujarati's mother tongue, native place, and parental domicile in Gujarat.
- Well-balanced facial profile with average facial growth pattern.
- Clinically normal occlusion with normal overjet and overbite.
- Complete permanent dentition extending from second molar to second molar.
- No anterior crowding or spacing.
- No previous orthodontic treatment.
- Acceptable facial esthetics without obvious facial asymmetry.
- Ability to provide written informed consent.

Exclusion Criteria

Participants were excluded if any of the following conditions were present:

- Craniofacial anomalies or facial deformities.
- Previous orthodontic or orthognathic treatment.

- Missing anterior or posterior teeth visible during smiling.
- Prosthodontic restorations involving visible teeth.
- Severe malocclusion.
- Active periodontal disease.
- Excessive dental attrition.
- Orofacial habits affecting dentofacial structures.
- History of facial or lip surgery.
- Congenital or acquired lip deformities.
- Systemic conditions affecting craniofacial growth or development.

Standardized Photographic Protocol

Standardized posed smile photographs were obtained using a Sony Digital Single Lens Reflex (DSLR) camera equipped with a 100-mm macro lens mounted on a tripod to minimize image distortion and improve measurement reproducibility shown in Fig-1. Camera settings were standardized throughout the study (aperture f/8–f/11, shutter speed 1/125 second, ISO 100–200) following recommendations for clinical smile photography.

Figure 1. Standardized photographic setup

Participants were positioned in a relaxed seated posture with the head maintained in Natural Head Position (NHP) while looking at the horizon. The camera lens was aligned perpendicular to the occlusal plane and positioned at the level of the oral commissures. A constant subject-to-camera distance of 152 cm (5 feet) was maintained using a calibrated measuring tape. Standardized diffuse lighting and a neutral non-reflective background were used to eliminate shadows and reflections. Five to seven posed smile photographs were recorded for each participant, and the most natural reproducible smile was selected for analysis.

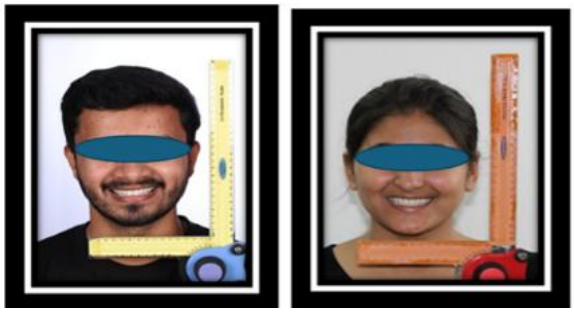

Figure 2. Standardized Photographs

Image Calibration and Digital Measurement

All photographs were transferred in high-resolution digital format and calibrated using a millimetre scale positioned in the same focal plane as the facial structures during image acquisition. Digital photogrammetric measurements were performed using calibrated image-analysis software to ensure life-size (1:1) measurements shown in Fig-2. Standardized soft tissue and dental landmarks including Subnasale (Sn), Stomion Superius (Stms), Stomion Inferius (Stmi), and bilateral Cheilion (Ch) were identified before linear measurements were obtained.

Smile Variables: The present investigation focused on three primary outcome variables:

Smile Index (Fig-3): Smile Index was calculated as the ratio of the inner intercommissural width to the interlabial gap during posed smiling.

$$\text{Smile Index} = \frac{\text{Inner Intercommissural Width}}{\text{Interlabial Gap}}$$

Smile Index provides an objective assessment of the proportional relationship between the transverse and vertical dimensions of the smile and has been recognized as a reliable indicator of smile harmony.

Figure 3. Measurement of Smile Index

In Fig-3, Horizontal black line depicts Inter commissural width and vertical line depicts interlabial gap.

Figure 4. Measurement of Buccal Corridor Space

In Fig-4, Right and left horizontal lines depict right and left buccal corridor space.

Buccal Corridor Space (Fig-4)

Right and left Buccal Corridor Spaces were measured as the perpendicular distance between the buccal surface of the most posterior visible maxillary tooth and the inner contour of the oral commissure during smiling. Measurements were recorded separately for both sides to evaluate transverse smile symmetry.

Reliability of Measurements

All photographic measurements were performed by a single calibrated investigator using standardized digital procedures. Image acquisition, landmark identification, and measurement protocols were maintained uniformly throughout the study to minimize observer-related variability and improve reproducibility.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics software (Version 26; IBM Corp., Armonk, NY, USA).

Descriptive statistics were expressed as mean ± standard deviation (SD) for continuous variables and frequencies with percentages for categorical variables. Comparison between Gujarati males and females was performed using the Independent Student's t-test for continuous variables and the Chi-square test for categorical variables.

A two-tailed p-value <0.05 was considered statistically significant for all analyses.

III. RESULTS

Table 1. Demographic Characteristics of the Study Population

Variable	Male (n = 241)	Female (n = 266)	Total (n = 507)
Sample size	241	266	507
Mean age (years), Mean ± SD	23.00 ± 3.53	22.38 ± 3.05	22.64 ± 3.40
Age range (years)	18–32	18–32	18–32

A total of 507 Gujarati adults were included in the study, comprising 241 males and 266 females. The overall mean age was 22.64 ± 3.40 years, with comparable age distribution between genders.

Table 2. Comparison of Smile Index Between Gujarati Males and Gujarati Females

Variable	Male (Mean ± SD)	Female (Mean ± SD)	Mean Difference	t-value	p-value
Smile Index	5.92 ± 1.18	6.14 ± 1.66	−0.22	−1.74	0.082

Female participants demonstrated a slightly higher Smile Index than males; however, the difference was not statistically significant (p = 0.082), indicating comparable proportional smile harmony between genders.

Table 3. Comparison of Right Buccal Corridor Space Between Gujarati Males and Gujarati Females

Variable	Male (Mean ± SD)	Female (Mean ± SD)	Mean Difference	t-value	p-value
Right Buccal Corridor Space (mm)	1.26 ± 1.16	1.30 ± 1.22	−0.04	−0.39	0.696

No statistically significant gender difference was observed in Right Buccal Corridor Space (p = 0.696).

Table 4. Comparison of Left Buccal Corridor Space Between Gujarati Males and Gujarati Females

Variable	Male (Mean ± SD)	Female (Mean ± SD)	Mean Difference	t-value	p-value
Left Buccal Corridor Space (mm)	1.42 ± 1.32	1.45 ± 1.27	−0.03	−0.28	0.780

Left Buccal Corridor Space was comparable between males and females with no statistically significant difference (p = 0.780).

Table 5. Comparison of Buccal Corridor Space Between Gujarati Males and Gujarati Females

Variable	Male (Mean ± SD)	Female (Mean ± SD)	Mean Difference	p-value
Right Buccal Corridor Space (mm)	1.26 ± 1.16	1.30 ± 1.22	−0.04	0.696
Left Buccal Corridor Space (mm)	1.42 ± 1.32	1.45 ± 1.27	−0.03	0.780

Both right and left Buccal Corridor Spaces remained statistically comparable between Gujarati males and females, suggesting similar transverse smile characteristics irrespective of gender.

IV. DISCUSSION

The present cross-sectional study evaluated Smile Index and Buccal Corridor Space among Gujarati adults with well-balanced facial profiles to establish population-specific normative values and assess possible gender-related differences. Smile aesthetics has become an essential component of contemporary orthodontic diagnosis because it integrates facial harmony, dental appearance, and soft-tissue dynamics into treatment planning. Objective assessment of smile characteristics enables clinicians to establish individualized treatment goals while respecting ethnic and population-specific facial features.

The present study demonstrated that female participants exhibited a slightly higher mean Smile Index (6.14 ± 1.66) than males (5.92 ± 1.18). However, the observed difference was not statistically significant (p = 0.082), indicating that both genders exhibited comparable horizontal-to-vertical smile proportions. Although a numerical trend towards a higher Smile Index was observed among females, the magnitude of the difference was insufficient to establish a true gender-related variation within the study population.

Similarly, the mean right Buccal Corridor Space was marginally higher in females (1.30 ± 1.22 mm) than in males (1.26 ± 1.16 mm), while the mean left Buccal Corridor Space measured 1.45 ± 1.27 mm in females and 1.42 ± 1.32 mm in males. Neither comparison reached statistical significance (p = 0.696 and p = 0.780, respectively). These findings suggest that transverse dental display and buccal corridor dimensions are generally comparable between Gujarati males and females with well-balanced facial profiles.

Previous investigations have reported that smile characteristics may vary according to ethnicity, gender, facial morphology, and craniofacial growth patterns. Studies by Ackerman and Ackerman, Sarver and Ackerman, Moore et al., Ioi et al., and Krishnan and Daniel emphasized the importance of objective smile analysis and demonstrated that esthetic smile parameters differ among populations.[7–12] However, the magnitude and direction of these differences have not been consistent across studies, possibly because of variations in ethnicity, sample characteristics, photographic protocols, landmark identification, and measurement techniques. Therefore, direct comparison between different populations should be interpreted with caution.

Although statistically significant gender differences were not observed in the present investigation, the establishment of normative values remains clinically important. Population-specific reference standards provide clinicians with objective data for evaluating smile characteristics rather than relying exclusively on values derived from Western or other ethnic populations. Such reference values may improve orthodontic diagnosis, prosthodontic rehabilitation, orthognathic surgical planning, facial esthetic evaluation, and Digital Smile Design by supporting individualized treatment planning based on the characteristics of the Gujarati population.

An important strength of the present study is the relatively large sample size of 507 Gujarati adults, which enhances the reliability of the estimated normative values. Furthermore, the use of standardized photographic protocols, controlled image acquisition, calibrated digital photogrammetric analysis, and uniform landmark identification minimized measurement variability and improved the reproducibility of the findings.

The present findings indicate that Smile Index and Buccal Corridor Space exhibit only minor numerical differences between Gujarati males and females and

that these differences are not statistically significant. Therefore, clinicians should consider individual facial characteristics, smile dynamics, and patient-specific esthetic expectations rather than gender alone when planning orthodontic or esthetic dental treatment.

V. CLINICAL IMPLICATIONS

The establishment of normative values for Smile Index and Buccal Corridor Space in the Gujarati population provides a valuable reference for evidence-based orthodontic diagnosis and individualized treatment planning. The findings can assist clinicians in achieving optimal smile aesthetics during orthodontic therapy by considering ethnic and gender-specific smile characteristics. These normative data are also useful in Digital Smile Design (DSD) for accurate esthetic smile planning and visualization. Furthermore, the results may aid prosthodontic rehabilitation by facilitating harmonious anterior tooth arrangement and smile reconstruction. In addition, they can support orthognathic surgical planning by providing objective soft-tissue smile parameters for facial esthetic assessment. Finally, the established normative values may serve as reference standards for AI-assisted smile analysis, automated facial esthetic evaluation, and digital treatment simulation, thereby improving the precision and predictability of esthetic outcomes.

Limitations

First, the cross-sectional design provides information at a single time point and does not permit evaluation of changes in smile characteristics over time.[13] Second, the study was limited to the Gujarati population; therefore, the findings may not be directly generalizable to other ethnic or regional populations with different craniofacial characteristics.[14] Third, smile assessment was performed using standardized static posed photographs, which may not completely represent the dynamic nature of spontaneous smiling observed during speech and social interaction.[15] Finally, dynamic video-based smile analysis and three-dimensional facial imaging were not incorporated, which could have provided a more comprehensive evaluation of smile esthetics.[16]

Future Recommendations

Future studies should incorporate three-dimensional facial imaging and dynamic video-based smile analysis to improve the accuracy and clinical relevance of smile assessment. The integration of artificial intelligence and automated facial recognition systems may further enhance objective smile evaluation, treatment planning, and digital smile simulation. Longitudinal investigations are recommended to evaluate changes in smile characteristics with age, orthodontic treatment, and facial growth. Furthermore, multicentric comparative studies involving different Indian ethnic populations would help establish comprehensive normative databases and improve population-specific orthodontic diagnosis and esthetic treatment planning.

VI. CONCLUSION

The present study found no statistically significant difference in Smile Index and right or left Buccal Corridor Space between Gujarati males and females. This indicates that both genders exhibit comparable smile proportions and transverse dental display. Therefore, similar normative values may be considered for smile assessment in the Gujarati population, while individual facial characteristics should remain the primary consideration during esthetic treatment planning.

Established Smile norms	Gujarati Male (Mean value)	Gujarati Female (Mean value)
Inter-labial Gap	10.07 mm	9.42 mm
Inner Intercommissural width	57.52 mm	55.25 mm
Buccal Corridor Space-Right	1.26 mm	1.30 mm
Buccal Corridor Space-Left	1.42 mm	1.45 mm
Smile Index	5.92	6.14

These findings establish population-specific normative values that can enhance orthodontic diagnosis, esthetic treatment planning, prosthodontic rehabilitation, orthognathic surgery, and digital smile design in Gujarati individuals.

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