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Original Article

Quantitative evaluation of gummy smile in north Indian young population: A clinical study

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ABSTRACT

Objectives: The objective is to clinically evaluate the prevalence, extent, and etiological factors of gummy smile (GS) in young north Indian individuals, with a specific focus on the association of gingival display (GD) with upper lip length and lip mobility.

Material and Methods: A total of 205 participants (aged 18–30 years) were enrolled. Gingival display (GD) was measured over six maxillary anterior teeth during posed smiles. Upper lip length at rest and during smiling was recorded, and lip mobility was calculated using the formula ([A–S]/A) × 100. All measurements were done clinically using a millimeter ruler. Data were analyzed using Statistical Package for the Social Sciences v26.0, with significance set at $P < 0.05$.

Results: The mean age of participants was 23.83 ± 3.4 years, where the GD was highest at the right maxillary lateral incisor. Female participants showed significantly greater GD from canine to canine (19.78 ± 6.41 mm) compared to males (12.28 ± 4.11 mm) ($P = 0.001$). Of 205 cases, 148 were with mild and 57 with moderate GS. A significant association was observed between short upper lip and GD severity ($P = 0.012$), while lip mobility showed no significant correlation ($P = 0.581$).

Conclusion: GS was more common in females and showed a significant association with short upper lip length. This study highlights the importance of assessing soft-tissue factors, especially lip length, in the diagnosis and treatment planning of GS.

Keywords: Gingival display, Gummy smile, Lip length, Lip mobility, Smile esthetics

INTRODUCTION

A beautiful smile is one of the primary reasons individuals seek orthodontic treatment.[1] Hence, achieving a harmonious and symmetrical smile becomes one of the main goals of orthodontic therapy.[1] Normal GD ranges from 1 mm to 4 mm.[1] Based on the extent of GD, GS can be classified as mild (2–4 mm), moderate (4–8 mm), and severe (>8 mm).[1] During a normal smile, the upper lip elevates to the gingival margin of the maxillary central incisor, exposing little or no gingival display (GD).[2] Excessive GD while smiling is widely considered unesthetic and is referred to as a gummy smile (GS).[3] The causes of GS are multifactorial and may include a short upper lip, hyperactive perioral musculature, gingival overgrowth, dentoalveolar extrusion, infra- or supra-eruption of maxillary anterior teeth, and skeletal sagittal and/or vertical maxillary excess.[3]

GS has been largely defined as a non-pathological condition causing esthetic disharmony, in which more than 3–4 mm of gingival tissue is exposed while smiling.[4] It is characterized by excessive exposure of the periodontium and is generally viewed as unattractive by orthodontists and surgeons.[5,6]

The prevalence of GS is approximately 10% in individuals aged between 20 and 30 years, and it is more commonly observed in females than males.[7] Gingivectomy (clinical crown lengthening) is indicated when gingival remodeling is required. However, if the bone level is close to or covers the cementoenamel junction, osteotomy is performed in combination with gingivectomy. Other treatment options include apically positioned flaps, orthognathic surgery, and the use of botulinum toxin.[7]

MATERIALS AND METHODS

This cross-sectional observational study was conducted after obtaining approval from the Institutional Health Ethics Committee (SDC/IHEC/2023/MDS/#SG3OR18042023D) and the Institutional Research and Development Committee (SDC/IRDC/2023/MDS/#SG3OR18042023D).

The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

A total of 205 participants (145 females and 60 males), aged between 18 and 30 years, were selected from the outpatient department of the Department of Orthodontics and Dentofacial Orthopedics. All participants were North Indian individuals. The study was conducted from June 2023 to August 2024. Informed written consent was obtained from all participants before their inclusion in the study. Individuals were included if they were between 18 and 30 years of age, had good oral health, and were willing to participate. Participants were excluded if they had missing teeth, tooth anomalies or malformations, any dental restorations, a history of facial trauma, orthodontic treatment, or cosmetic facial/dental procedures. Individuals with facial asymmetry, systemic disorders, or those undergoing prolonged medication were also excluded.

The sample size for this clinical study was determined to ensure sufficient statistical power to detect differences in GD among young individuals aged 18–30 years seeking orthodontic treatment. Using the formula $n = Z^2 \times p\ (1\text{-}p)/d^2$, the minimum required sample size was calculated to be 186 participants. In this formula, Z corresponds to the Z-value for a 95% confidence level (1.96), p represents the estimated population proportion (0.14), and d denotes the absolute precision (0.05). The study enrolled 205 participants, surpassing the calculated minimum sample size, thereby providing adequate power to analyze the correlations between GD, upper lip length at rest, upper lip length during a posed smile, and percentile lip mobility.

The assessment focused on GD, and upper lip length was measured using a millimeter ruler during rest and a posed smile. Participants were instructed to say the word "cheese" to induce a posed smile. The amount of GD (in mm) was measured clinically, over six maxillary anterior teeth, using a millimetric ruler during a posed smile (assess the extent of GS) [Figure 1]. It was done from the zenith point of each tooth to the lower border of the upper lip (The lower border of the upper lip was marked with a lip liner pencil). The upper lip length at rest (A) [Figure 2] and posed smile (S) [Figure 1] was measured from the base of the nose (subnasale) to the inferior border of the upper lip (stomium). Percentile lip mobility was calculated using a specific formula (A-S/A × 100) that incorporates both the upper lip length at rest and the upper lip length during the posed smile.[1] All measurements were recorded on a pre-customized manual data sheet with the help of a data recording chart, which is intended for data collection. All the data thus obtained were digitized, and statistical analyses were performed using Statistical Package for the Social Sciences (SPSS). All measurements were conducted by a single trained examiner to maintain consistency.

The reproducibility of measurements and statistical consistency were ensured by assessing the reliability of the collected data. Participants were instructed to maintain a posed smile during measurements, which were repeated 2 weeks after the initial measurements to ensure consistency and minimize errors.

Statistical analysis

Statistical analysis was performed using SPSS software, version 20.0 (SPSS Inc., Chicago, IL, USA). Data were compiled in Microsoft Excel with no missing values. Quantitative variables, including GD, upper lip length at rest and during a posed smile, and percentile lip mobility, were expressed as mean ± standard deviation. Comparisons

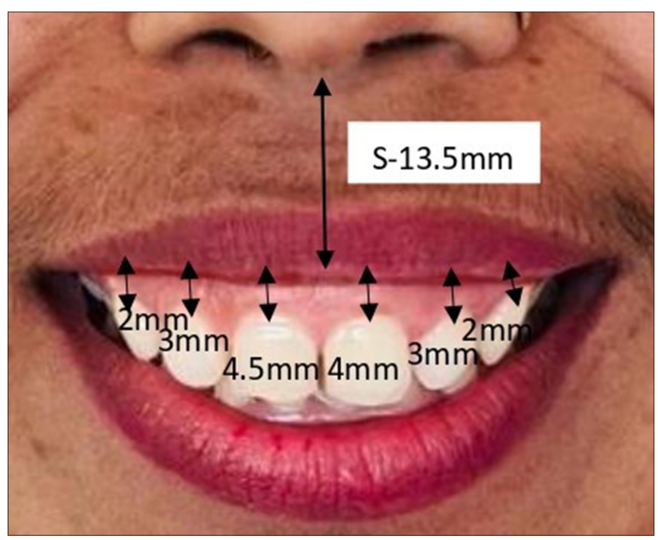

Figure 1: Measurement of gingival display and upper lip length (in mm) during posed smile (S).

Figure 2: Upper lip length at rest (A).

between mild, moderate, and severe GD groups and gender were conducted using Chi-square tests for categorical data, Student's *t*-test for two-group mean comparisons, and one-way Analysis of Variance with Tukey's *post hoc* tests for multiple groups. Reliability was assessed via Cronbach's Alpha and ICC, with measurements repeated after 2 weeks. Statistical significance was set at $P < 0.05$.

Table 1: Comparative evaluation of GS (GD in mm) between 6 maxillary anterior teeth (n=205).

Maxillary anterior teeth	GS (GD in mm)		Minimum	Maximum
	Mean	SD		
Right maxillary canine (13)	2.89	1.16	0.5	6.0
Right maxillary lateral incisor (12)	3.01	1.28	0.5	6.5
Right maxillary central incisor (11)	2.99	1.28	0.5	7.0
Left maxillary central incisor (21)	2.96	1.25	1.0	6.5
Left maxillary lateral incisor (22)	2.94	1.28	0.5	6.5
Left maxillary canine (23)	2.77	1.19	0.5	6.5
Canine to canine total gummy smile	17.58	6.7	5.5	38.0
ANOVA "F" value	1.015			
Significance "*P*" value	0.407 (NS)			

GS: Gummy smile, GD: Gingival display, ANOVA: Analysis of variance, SD: Standard deviation, NS: Non-significant

RESULTS

The study included 205 north Indian individuals (145 females, 60 males) with a mean age of 23.83 ± 3.4 years. GD was measured across six maxillary anterior teeth, with the highest mean GD at the right maxillary lateral incisor (3.01 ± 1.28 mm) and the lowest at the left maxillary canine (2.77 ± 1.19 mm), though no significant differences were found among teeth from canine to canine ($P = 0.407$) [Table 1].

Females exhibited significantly higher mean GD from canine to canine (19.78 ± 6.41 mm) compared to males (12.28 ± 4.11 mm) ($P = 0.001$) [Table 2].

Of the 205 participants, 148 were classified with mild GS (2–4 mm) and 57 with moderate GS (4–8 mm); no severe cases (>8 mm) were reported. A significant association was found between short upper lip length and GS ($P = 0.012$), while lip mobility showed no significant correlation ($P = 0.581$). These findings indicate that upper lip length is a key etiological factor for GS, particularly in females, with no notable differences in GD across anterior teeth [Table 3].

DISCUSSION

This cross-sectional clinical study aimed to assess the prevalence, extent, and etiology of GS among young adults in the North Indian population, focusing specifically on soft-tissue determinants such as upper lip length and mobility. A total of 205 participants between the ages of 18 and 30 years were included, with 145 females and 60 males. The absence of a statistically significant difference in mean age between male and female participants supports the comparability of the groups. It aligns with previous findings by Kapagiannidis *et al.*, who reported minimal age-related variation in GD among young adults.[8]

When assessing GD across six maxillary anterior teeth, the highest average display was observed at the right maxillary lateral incisor (3.01 ± 1.28 mm), whereas the lowest was recorded at the left maxillary canine (2.77 ± 1.19 mm). These findings corroborate the conclusions of McNamara *et al.*, who reported that GD variations across anterior teeth are primarily influenced by lip mobility rather than tooth position alone.[9] Although these differences were not statistically significant ($P = 0.407$), the pattern of slightly higher GD on the right side may suggest functional or muscular dominance, a factor that has been relatively underexplored in GS literature. Such asymmetry could be influenced by habitual facial expressions, smile muscle activation patterns, or even handedness, indicating a need for future investigations involving neuromuscular studies or three-dimensional facial analysis to determine the underlying cause of this lateral variation.

A significant gender-based difference in GD was noted, with females exhibiting substantially higher GD across all six teeth. The mean GD from canine to canine was 19.78 ± 6.41 mm in females, compared to 12.28 ± 4.11 mm

Table 2: Comparative evaluation of gummy smile (gingival display mm) for 6 maxillary anterior teeth between male and female participants.

Maxillary anterior teeth	Male		Female		Student "t" test value	"*P*"-value
	Mean	SD	Mean	SD		
13	2.108	0.8391	3.217	1.1208	6.901	0.001 (HS)
12	2.100	0.9469	3.393	1.2207	7.339	0.001 (HS)
11	2.025	0.7942	3.390	1.2339	7.910	0.001 (HS)
21	2.025	0.6406	3.355	1.2373	7.893	0.001 (HS)
22	2.058	0.9210	3.314	1.2317	7.111	0.001 (HS)
23	1.967	0.8530	3.114	1.1498	6.971	0.001 (HS)
Canine to canine total gummy smile	12.283	4.1111	19.783	6.4177	8.363	0.001 (HS)

SD: Standard deviation, HS: Highly significant

Table 3: Etiology of GS.

GS	Liplength(in mm)		Lip mobility (in %)	
	Short	Normal	Hypermobile	Normal
Mild *n*=148	26	122	19	129
Moderate *n*=57	40	17	9	48
Chi-square value	52.17		0.304	
Significance "*P*" value	0.012 (S)		0.581 (NS)	

GS: Gummy smile, S: Significant, NS: Non-significant

in males (P = 0.001). These findings corroborate earlier studies by Kapagiannidis *et al.* and McNamara *et al.*, which also identified gender as a major determinant of GD.[8,9] Anatomical factors such as shorter upper lips and greater lip mobility in females are commonly attributed to this difference. Furthermore, social and psychological factors may also contribute, as females are more likely to display broader, expressive smiles in social interactions, increasing gingival exposure during smile assessment.[3] Several other studies have also confirmed that gender plays a crucial role in determining smile esthetics. Geron and Atalia analyzed gender differences in the perception of smile esthetics and found that females were more frequently associated with high smile lines and greater GD, whereas males typically had lower smile lines with minimal gingival exposure. These findings suggest that esthetic standards for males and females differ significantly, influencing treatment approaches for GS correction. We found that canine-to-canine total maximum GS was 21 mm and the minimum was 5.5 mm in males. In females, canine to canine maximum GD was 38 mm and minimum 6.5 mm.[5] A study done by El-Bokle and Ghany found that significantly more women displayed gingiva when smiling, with a 2:1 female–male ratio.[1]

In evaluating the etiology of GS, the present study found that short upper lip length had a statistically significant association with the presence of GS (P = 0.012), particularly in moderate cases. In contrast, lip mobility did not show a statistically significant correlation (P = 0.581), indicating that anatomical lip length has a more direct impact on GD than dynamic lip movement. These findings are supported by the work of Peck *et al.*, who also identified a short upper lip as a key contributor to excessive GD.[3] This has important diagnostic and therapeutic implications, as it highlights the relevance of soft-tissue evaluation, particularly upper lip length, as a non-invasive and clinically practical method for assessing GS. It also supports a more conservative treatment approach for cases of GS linked to lip length, such as lip repositioning surgery or injectable treatments, as opposed to more invasive orthognathic procedures reserved for skeletal etiologies.[9]

From a clinical perspective, the findings emphasize the importance of incorporating soft-tissue evaluation into routine orthodontic assessment. Measurement of upper lip length can be performed easily in a clinical setting without specialized equipment and offers critical insights into the likely cause of GS. Recognizing gender differences in GD and anatomical variations aids in setting realistic expectations and planning individualized esthetic interventions. Understanding that lip length is a more influential factor than lip mobility in this context can help clinicians better identify patients who are suitable candidates for minimally invasive procedures.

However, this study has certain limitations. One of the main concerns is the unequal gender distribution, with a higher proportion of females, which could skew gender-based comparisons and reduce the generalizability of results. Furthermore, the study did not include radiographic or cephalometric assessment of skeletal or dentoalveolar structures, such as vertical maxillary excess or incisor inclination, which are well-established etiological contributors to GS. Their omission limits the scope of the current findings to soft-tissue parameters alone. In addition, facial growth patterns-vertical and horizontal-were not evaluated, even though such patterns significantly influence smile characteristics and lip posture, as demonstrated in previous studies. Another limitation lies in the lack of assessment of muscular activity or facial symmetry, which could have provided a better understanding of the slight asymmetry observed in GD across the arch. Finally, as the participants were exclusively from a North Indian background, the applicability of the findings to other ethnic or regional populations is limited, given known differences in craniofacial morphology and esthetic norms.

Future research should aim for a more balanced gender sample and include cephalometric or three-dimensional evaluations to assess skeletal contributions alongside soft-tissue variables. In addition, the role of facial musculature, growth patterns, and functional asymmetry in GD should be further explored using advanced imaging and muscle-tracking technologies. These additions would enable a more holistic and accurate understanding of the complex etiology of GS and facilitate the development of more personalized and effective treatment strategies.

CONCLUSION

The present study highlights that GS is more prevalent among females and is primarily influenced by soft-tissue factors, particularly short upper lip length, rather than hyperactive lip mobility. Although GD was slightly higher on the right side, no significant asymmetry was found. These findings emphasize the clinical importance of assessing upper lip length during diagnosis, which can assist in selecting minimally invasive and individualized treatment approaches. A better understanding of gender-based patterns and soft-tissue contributions can enhance smile esthetics and guide orthodontic planning. Future research integrating skeletal and muscular evaluations is recommended for a comprehensive understanding of GS etiology.

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