Prevalence and factors associated with gummy smile in adolescents: a cross-sectional analysis

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Aim: To evaluate the prevalence and factors associated with gummy smiles in adolescents aged between 15 and 18 years attending high school. **Methods:** The cross-sectional and quantitative study was carried out during the Covid-19 pandemic, with 160 adolescents, from two public (A1) and two private (A2) schools chosen by lottery, divided into two groups: G1 (with gummy smile) and G2 (no gummy smile). A clinical examination was carried out on the adolescents, investigating the presence or absence of a gummy smile (GS), by analyzing the variables (interlabial distance at rest, upper incisor exposure at rest, smile arc, measurement from the subnasal to the upper lip philtrum, upper lip length, upper lip thickness, hypermobility and lower/middle third ratio). Means and dispersion were obtained, and the Chi-square association test was applied, to compare the results between A1 and A2 and between G1 and G2. **Results:** The prevalence of GS was 33.8% (=54). It was found that no statistically significant associations were found ($p > 0.05$), regarding the type of school and gender with the presence of GS in adolescents. There was no statistically significant difference ($\chi^2 = 1.82$; $p = 0.07$) between the groups and the age of adolescents. There was a significant association between the studied variables and GS ($p < 0.05$). **Conclusion:** The prevalence was high with a predominance of females. There were no statistically significant associations regarding the type of school and gender, but there was a significant association between gummy smile and lip dimensions.

Keywords: Esthetics, dental. Smiling. Orthodontics. Adolescent.

Introduction

An agreeable smile is considered a symbol of beauty and well-being, and depends not only on correct dental and skeletal configuration, but also on the structure and function of the lip muscles, as well as the amount of gingival exposure[1,2].

In a spontaneous smile, the smile arc is formed by the incisal edges of the canines and maxillary incisors and the lower lip. Ideally, the incisal edges are parallel to, and slightly apart from or lightly touching, the lower lip. This is only possible if the lower lip develops a natural curvature, with the corners of the mouth facing upward, and the incisal edges follow this curvature[3-5].

A smile with excessive exposure of the gingiva, known as gummy smile (GS), is characterized by gingival exposure of more than 3 millimeters and may negatively influence the aesthetics of the smile. This affects about 10% of the population[6], with a higher prevalence among women than men because of greater muscle flaccidity[6,7]. Other authors have highlighted that both sex and age are influencing factors, suggesting that women have higher smiles than men and that dentogingival exposure decreases with age[5-7].

Regarding etiological factors, bone, muscular, or dentogingival factors, or a combination of several factors, may play a role in GS. Concerning bone, excess vertical maxillary growth or excess vertical growth of the alveolar bone may be observed. With regard to muscular factors, there may be a short upper lip or lip hypermobility. Regarding dentogingival factors, the maxillary incisors may project excessively toward the buccal area, with a short clinical crown, which may be associated with gingival hyperplasia[8]. The smile is classified as high when there is the total exposure of the clinical crowns of the maxillary anterior teeth and excessive exposure of gingival tissue. A medium smile exposes most (75%) or all (100%) of the clinical crowns of the anterior maxillary teeth, but only the interdental or interproximal papillae are visible. A low smile shows less than 75% of the clinical crowns of these teeth, without showing gingival tissue[9,10]. A certain amount of exposed gingiva is aesthetically acceptable, being considered an important factor of joviality in interpersonal relationships. However, when more than 3 mm of gingiva is exposed, the smile becomes unsightly, inciting many patients to seek dental treatment[11-15].

Although GS can be found in individuals of any age, adolescents are one of the most psychologically affected groups as aesthetic standards have a direct influence on their self-esteem and on the way they relate and live in society[16-18]. The null hypothesis is that there is a low prevalence of GS in adolescents, with no association with being ashamed to smile and with total ignorance of the possible associated factors. Knowledge of the distribution and factors associated with GS in adolescents is of considerable importance for the design of treatment strategies and public policies aimed at improving oral health. Thus, it is justifiable to investigate the prevalence of GS among adolescents, taking into account that smile aesthetics may interfere with self-esteem. After diagnosis and identification of associated factors, treatment possibilities can be suggested early.

The objective of this research was to evaluate the prevalence and factors associated with GS in adolescents between 15 and 18 years of age in high school.

Materials and methods

Ethical aspects

After ethical approval of the Research Ethics Committee of the State University of Piauí (CEP/UESPI) had been obtained, with number: 3.289.714, a cross-sectional and quantitative study was carried out from November 2020 to July 2021.

Study population

The sample calculation was based on the target population—the number of people between 15 and 18 years of age enrolled in public and private schools in the city of Parnaíba in the state of Piauí, Brazil—which totaled 6209 students in 2020 according to a survey carried out by the Brazilian Institute of Geography and Statistics (IBGE)[18]. The required sample size was 362 participants. This minimum number of participants was considered sufficient for the proposed analyses, with a sampling error of 5% and 95% confidence level, indicating that the probability of the error made by the research did not exceed 5%[19]. Two researchers were provided with a letter of consent from the directors of two public (A1) and two private (A2) schools chosen by lot in the city of Parnaíba and that authorized the research. The schools were adopting the hybrid education system because of the current conditions of the Covid-19 pandemic. Students were chosen by lottery according to their schoolbook number.

Eligibility criteria

Although, according to the World Health Organization, adolescents are between 12 and 18 years of age, the inclusion criteria were those between 15 and 18 years of age who were attending high school in public and private schools, an age group that would present greater emotional maturity to analyze their own smile; having no harmful habits; with facial Pattern I (sagittal and vertical balance of the face in the frontal and lateral views); and who were not undergoing orthodontic treatment. Adolescents below the chosen age group and those unable to understand and answer the questionnaires, such as those with cognitive impairment syndromes or hearing and/or visual impairment, were excluded from the study.

Calibration

To standardize the diagnosis of GS, clinical training was carried out for examiners at the Clinic School of Dentistry (CSD) as calibration. Questionnaires were applied and 20 adolescents who did not participate in the study were examined to determine intra- and inter-examiner agreement, with kappa values of 0.83 and 0.82, respectively. These examinations were carried out twice, with an interval of 2 weeks.

Pilot study

Before data collection, a pilot study was carried out with 30 adolescents from municipal and private schools who were not part of the study sample, to evaluate the meth-

ods and verify if there was a need to make changes to the methodology initially proposed. No changes were required.

Data collection

Data collection was undertaken during the Covid-19 pandemic, when schools were adopting the hybrid teaching system. The research was carried out three times a week in both class shifts, with a small number of participants (2–5 adolescents).

Two researchers, wearing appropriate personal protective equipment (PPE), carried out the investigations. The questionnaire consisted of patient identification and related questions, and the epidemiological profile of the participant; type of school they belonged to; gender; age; and whether they were satisfied with their smile. Participants who were not satisfied with their smile were asked what made it unpleasant and the reason for not having treatment, using the questionnaire developed by Mokhtar et al.[8] (Figure 1). Simple and objective language was employed to explain to the adolescents how the research would be carried out.

At a subsequent time, in the school environment, participant smiles were examined under artificial light by the researchers, using a flat mouth mirror and a millimeter stainless steel ruler, previously sterilized in an autoclave and for individual use. The participants were seated in a school chair, with the head in the natural position. This position is standardized and easy to reproduce; the head is positioned vertically, with the patient looking at a distant point at eye level, which implies a horizontal visual axis[9]. In the clinical examination, the presence or absence of GS was investigated, and the variables (interlabial distance at rest, exposure of the maxillary incisors at rest, smile arc, philtrum measurement from the base of the nose to the upper lip, upper lip length, upper lip thickness, hypermobility, and lower/middle third ratio) were analyzed, based on a study previously carried out by Seixas et al.[5]. The results were recorded in the clinical file (Figure 2). Students who presented GS participated in Group 1 (G1), and those who did not were in Group 2 (G2), in both A1 and A2.

Gender: M ( ) F ( ) Age: _____ Race: White ( ) Black ( ) Brown( )

School: Public ( )   Private ( )
1- Are you satisfied with your smile?( ) Yes ( ) No

2- Are you embarrassed to smile at people you know?( )Yes ( )No

3- If so, what makes your smile unpleasant?( ) Diastema- "dental spaces"
 ( ) Gummy smile( ) Dental crowding   Another reason_____

4- Reason for not seeking orthodontic treatment:( ) disinterest
 ( ) Financial issues ( ) Lack of information ( ) Fear of treatment

 ( ) Family feature

Figure 1. Epidemiological questionnaire applied to research participants.

1. **Gingival exposure when smiling:** ( ) 0mm ( )1mm ( )2mm ( )3mm ( ) >3mm
2. **What is the interlabial distance at rest?:** ( ) 1-5mm(normal) ( ) > 5mm
3. **Upper incisor exposure at rest :** ( ) <1mm ( ) 1-4.5mm(normal)
                                                                        ( ) >4.5mm
4. **Smile arch :** ( ) Parallel to the curve of the lower lip (normal) ( )Plan
                             ( ) Reverse
5. **Measurement from the subnasal to the upper philtrum :** ( ) 12mm(normal) ( )
<12mm
6. **Upper lip length :** ( ) >18mm (normal) ( ) ≤ 18mm (short)
7. **Upper lip thickness :** ( ) ½ of the lower lip (normal)
                                          ( ) < ½ of the lower lip
8. **Hypermobility :** ( ) Yes ( )No
9. **Lower/middle third ratio :** ( ) Lower ≤ medium(normal) ( )Lower > medium

Figure 2. Clinical form for smile analysis

Statistical analysis

SPSS statistical software (version 25) was used to perform descriptive statistics, and then statistically analyzed. Means and dispersion were obtained and the chi-square association test was applied, with a statistical significance level of 5%, to compare the results between A1 and A2 and between G1 and G2.

Results

As the teaching adopted by the schools was hybrid, it was not possible to obtain the predicted sample. From November to December 2020, a sample of 40 students was obtained, 20 students per month. From January to July 2021, 140 students participated, 5 students per week, but 15 male students and 5 female students were excluded because they only answered the questionnaire. In total, the participation rate in the research was only 160 adolescents, including 90 Multiracial, 55 White, and 15 Black people. The prevalence of GS was 33.8%, representing 54 adolescents.

The distribution of the sample in relation to gender and school is shown in Figure 3. Chi-square statistical calculations revealed no statistically significant associations ($p > 0.05$) of the type of school and gender with the presence of GS. In addition, the t test was performed to compare the mean age between participants with and without GS, and there was no statistically significant difference ($\chi^2 = 1.82$; $p = 0.07$) between the age of adolescents in the groups with and without GS. The mean age was 15.7 (± 1.02), and the mean age for G1 was 15.5 (± 0.96) and for G2 was 15.8 (± 1.04).
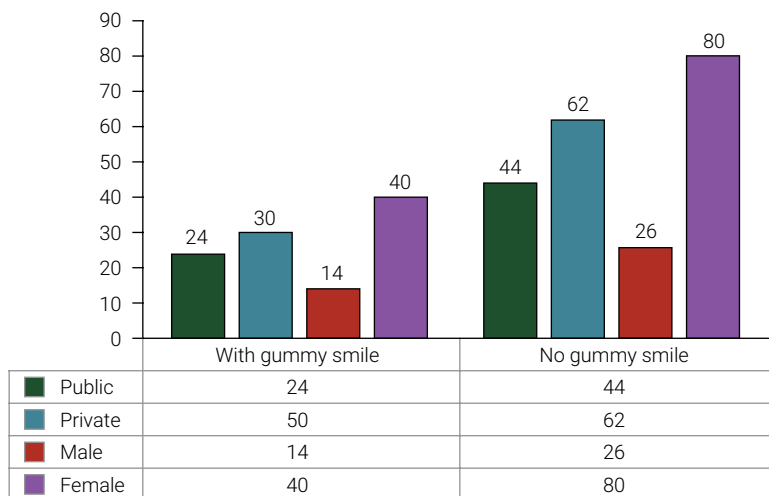
Figure 3. Prevalence of gummy smile according to gender and school of adolescents (15-18 years old)

All adolescents in G1 (n = 54) were satisfied with their smile, were not ashamed to smile, and did not seek orthodontic treatment out of disinterest. Only G2 students (n = 106) who had dental crowding (n = 39) and diastema between the incisors (n = 28) were embarrassed to smile and did not seek orthodontic treatment for financial reasons.

Table 1 shows the variables and their association with the presence or absence of GS. There was an association between the presence of GS and all the variables studied (p < 0.05). Adolescents who presented with an interlabial gap at rest of >5 mm (n = 28), maxillary incisor exposure of >4.5 mm (n = 28), or a flat smile arc (n = 16) had GS.

Table 1. Distribution of variables associated with gummy smile in adolescents (15 to 18 years old). Parnaíba-PI. 2021.

Variables		(with gummy smile)	(no gummy smile)	Total	χ^2 p value
Interlabial distance at rest	1-5mm (normal)	26	106	132	$\chi^2 = 66.62$ p = 0.001
	>5mm	28	0	28	
Upper incisor exposure at rest	<1mm	0	0	0	$\chi^2 = 60.94$ p = 0.001
	1 – 4.5 (normal)	26	106	132	
	> 4.5mm	28	0	28	
Smile arch	Parallel to the curve of the lip	--------	----------	------	$\chi^2 = 34.89$ p = 0.001
	Lower(normal)	38	106	144	
	Plan	16	0	16	
	Reverse	0	0	0	

Continuation

Measurement from the subnasal to the upper philtrum	12 mm (normal)	26	106	132	χ^2 = 66.62 p = 0.001
	<12mm	28	0	28	
Upper lip length	>18mm (normal)	26	106	132	χ^2 = 66.62 p = 0.001
	≤ 18mm (short)	28	0	28	
Upper lip thickness	½ of the lower lip (normal)	44	106	150	χ^2 = 20.94 p = 0.001
	< ½ do lower lip	10	0	10	
Hypermobility	Yes	50	106	156	χ^2 = 8.05 p = 0.001
	No	4	0	4	
Lower/ middle third ratio	Lower ≤ medium (normal)	24	106	130	χ^2 = 39.81 p = 0.001
	Lower >medium	30	0	30	

In adolescents with GS, the philtrum length from the base of the nose to the upper lip was <12 mm and the upper lip was short, with a length of ≤18 mm (n = 28); upper lip thickness was less than half that of the lower lip (n = 10); lip hypermobility was present and the lower third of the face was larger than the middle third (most of G1) (p = 0.01).

Discussion

Data collected with the participation of 160 adolescents revealed a prevalence of GS in adolescents of 33.8%. This is higher than in another study[7] that found a prevalence of 10% in the adult population. This may be due to greater hyperactivity of the upper lip elevator muscles and the nose wing in young people than in adults, especially in female individuals, as well as a short upper lip in most of the young population, which favors greater exposure of gingival tissue during smiling[5,12,13,19,20].

In the present study, there was a difference in terms of gender, with female participants having a higher prevalence of GS, corroborating the findings of other researchers that women have greater gingival exposure during smiling, with a significant influence on aesthetic perception[21]. It is worth mentioning that all subjects with GS were satisfied with their smile. Despite having GS, they were not ashamed to smile and therefore did not feel the need to go in search of dental treatment. These findings corroborate those of other authors who found that laypersons do not know how to assess how much gingival exposure is considered acceptable when smiling[22,23].

The majority of participants in G2 presented with dental crowding and diastema between the incisors, were ashamed to smile, and for financial reasons had not yet sought dental care. It was found that the adolescents considered dentoskeletal mal-occlusion to be more aesthetically relevant than an excessive amount of gingival exposure when smiling, probably because they considered this to be normal physiology in their age group, unlike other deviations from normal occlusion. A similar fact was observed by other authors who found that for most adolescents, malocclusion did not interfere with the level of self-esteem, although more than 90% of the par-

ticipants mentioned that they wanted to undergo orthodontic treatment to improve their appearance[18].

In this study, possible etiological factors in GS were disproportions of the lips and upper lip hypermobility, as observed in other studies[8,13,16]. If a patient with GS has an upper lip measurement that does not correspond to prescribed norms, the compromised smile aesthetics can be attributed, at least in part, to insufficient lip length. However, if face height, gingival levels, labial length, and central incisor length are all within acceptable limits in a patient with GS, the etiology of the smile is likely due to an overactive upper lip from excessive contraction of the upper lip elevator muscles[9,16,17,24,25]. Skeletal discrepancy due to excess vertical growth, as a possible etiological factor in GS, was not investigated because this measurement requires cephalometric analysis. This can be considered a limitation of this study.

This research was clinically relevant as it proved that the aesthetic issue of GS is not a worrying factor among adolescents. For them, the smile is unattractive if malocclusion is present. In this study, there were more female than male participants. This can be considered a limitation of this study. Another relevant factor limiting this study was that the sample number was less than the minimum value indicated by the sample calculation, with a different number of participants in the groups.

It is suggested that future studies be carried out with a greater number of Brazilian participants, addressing both the prevalence and possible etiological factors. In addition, variations in GS highlight the need to establish data from various geographic regions to examine the effect of genetics and environment on tooth development.

In conclusion the prevalence of GS was high in adolescents, with a predominance in female participants. There were no associations regarding the type of school and gender, but there was a significant association between GS and lip dimensions.

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Conflict of interest

None.

Data availability

Datasets related to this article will be available upon request to the corresponding author.

Author Contribution

Milena Lopes de Brito: Design, Literature Review;

Marcelo Lucio S. Silva Junior: Materials, Writer;

Breno Wesley Leal Carvalho: Data colletion and/or processing, critical review;

Elen Maria Carvalho da Silva: Interpretation and presentation of results;

Ana de Lourdes Sá de Lira: Conception, Critical Reviewing.

All authors actively participated in the manuscript's findings and revised and approved the final version of the manuscript.

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