Gingival biotypes in Mexican students aged 17-19 years old and their associated anatomic structures, socio-demographic and dietary factors

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Abstract: This was a cross-sectional study with 550 students aged 17-19 years old. Gingival biotype (GB) was classified as thin, thick, and mixed based on visual inspection. Biotypes were associated with anatomical parameters from the anterior teeth, including probing depth, keratinized gingiva (KG), and gingival attachment (GA). Upper lip distance, facial thirds, tooth shape, gingival recessions, and gummy smile (GS) were also measured. Other variables included sex, age, dietary intake, and oral hygiene habits. Prevalence of thin, thick, and mixed biotypes was 68.4%, 19%, and 12.5%, respectively. Recessions occurred most often in those with thin biotypes. GS was more often seen in men with thin biotypes and in women with thick biotypes. There was a relationship between thin biotypes and oval teeth, and between thick biotypes and square teeth. The lower facial third was larger in thin biotypes. Thin biotypes were also related to larger canines, larger lateral and central incisors, and less KG and GA. Conversely, thick biotypes were associated with shorter teeth and with more KG and GA. Dietary intake and dental hygiene were not significantly associated with GB. Morphologic and phenotypic characterization of GBs can be relevant when planning and performing common dental procedures (e.g., prosthetics, implants, and orthodontics).

Keywords: biotype; gingiva; gum; Mexico; periodontal; students.

Introduction

A healthy gingival complex is essential to protect teeth and maintain correct positioning. Anatomically, the gum is divided into the gingival attachment (GA) and the keratinized gingiva (KG) (1). The length, width, and shape of these two components comprise the gingival biotype (GB), leading to specific functional and esthetic features for an individual. GB can be assessed by its morphotype and thickness (2). Based on visual inspection, GB was initially dichotomized into thin and thick types, but other authors recently categorized biotypes into three thickness groups: thin, thick, and mixed (3,4). While other methods for evaluating the GB exist, they may be expensive or require a traumatic approach (2,5-7). For example, the method proposed by Müller et al. entails the use of a specialized ultrasonic measuring device (2), and the one reported by Vandana et al. can be considered traumatic, as the gum needs to be perforated to determine the biotype (5).

Until now, there has been limited information concerning the relationship between GB and other anatomical characteristics of the mouth and face, such as the size and shape of the teeth or lips (8). There is even
less research associating sociodemographic factors and dietary habits with specific GBs. Yet, the identification of such factors could be relevant to promote periodontal health and to maintain the placement of dental implants and other prosthetic and orthodontic treatments. Therefore, this study was undertaken to characterize GBs among Mexican adolescents and to identify associated anatomical, demographic, and dietary factors.

### Materials and Methods

#### Study design

This was a cross-sectional study conducted at San Luis Potosi Autonomous University (UASLP) in central Mexico. Data was collected from student candidates who were required to undergo a routine dental exam to apply for university studies.

An Ethics and Research Committee at UASLP revised and approved the study proposal (No. GVII-02-2012). Written informed consent was obtained from each student prior to the clinical examination. Those who participated were provided basic periodontal prophylaxis.

#### Sampling strategy

From the nearly ten thousand potential candidates, a sample of 550 individuals was selected between June 2013 and March 2014. The sample size was computed based on an estimated prevalence of 50% for thin GB, assuming a finite population of 7,000 students aged 17-19 years old with a confidence level of 95% and 4% absolute precision.

Pregnant women and individuals with prosthetic crowns, periodontal illness, and poorly controlled systemic diseases were excluded, as were those under medical treatment (e.g., phenytoin, hormones, or cyclosporine), active anticoagulant therapy, orthodontic treatment, or treated with mucogingival or periodontal surgery.

#### Data collection and measurements

Prophylactic non-curate management was provided one month prior to measurements to ensure healthy gums and prevent any potential factor from affecting the assessment, such as the presence of dental plaque that could lead to inflammation and inaccurate measurements.

GBs were visually assessed based on probe transparency in the six upper frontal teeth using the three-group classification initially proposed (3,8,9) and subsequently modified (4), as illustrated in Fig. 1. The individual’s biotype was categorized as thin when the gingiva was delicate, friable, and translucent during probing in all the six assessed teeth, and as thick when it was fibrotic and rigid with no probe transparency in the six teeth. It was classified as mixed when there was an uneven pattern across teeth.

To assess the anatomical and clinical parameters, a North Carolina periodontal probe (Hu-Friedy-CPUNC15, Chicago, IL, USA) and a 30-mm flexible plastic ruler (Petigón Corp., Mexico City, Mexico) were used to perform the visual inspection of the gums and the facial measures, respectively. A trained periodontist made all the measurements in the mid-facial site of each tooth.

The periodontal probe was used to determine the following anatomic measures (in mm): probing depth (PD), measured in the mid-facial site of the tooth; keratinized gingiva (KG), measured from the middle of the gingival margin to the mucogingival line of the tooth; crown length (CL), measured in the middle of the incisal edge of each tooth zenith; crown width (CW), measured in the widest section of the tooth; and tooth cervical...
(TC) distance, corresponding to the width at the level of the margin of the tooth with the gingiva (10). From the anatomical measures, the following two dimensions were computed: 1) GA from the end of the marginal gingiva to the mucogingival line (PD-KG) (11); and 2) tooth ratio (CL/CW). The flexible plastic ruler was used to determine the upper lip distance, measured from the anterior nasal spine to the lower edge of the vermillion at rest; the facial thirds, divided into upper (from the frontal hair implantation to the anterior nasal depression), middle (from the nasal depression to the anterior nasal spine), and lower third (from the anterior nasal spine to the lower edge of the chin).

Visual inspection of the teeth included the following measures: tooth shape, classified as oval, triangular, or square (12); gummy smile (GS), present when more than 3 mm of gingiva were exposed when smiling; recessions, classified as present or absent; and malocclusion, classified as maxillary, mandible, both, or neither.

The assessment of demographic factors included sex, age, and smoking habits. Dietary items potentially related to the periodontal health status included the intake of spicy foods, chocolate, yogurt, coffee, and alcohol. Consumption was categorized as less than once per month, once per month, once per week, or more than once per week (13,14). Oral hygiene was assessed by measuring the frequency of tooth brushing and the use of oral rinse and dental floss (15).

Statistical analyses

Graphic inspection (Q-Q plots) and Shapiro-Wilk test were used to assess normality of continuous data. Overall, continuous variables showed normal distributions; thus, parametric statistics were used. Means and standard deviations were computed. Pearson Chi-square tests were used to identify differences between proportions of GBs by selected sociodemographic factors, dental characteristics, dental hygiene habits, and dietary intake patterns.

ANOVA and Bonferroni tests were used to compare mean differences in GBs by facial appearance features, and to compare the GA, KG, and LT means across GBs for upper frontal teeth. Levene’s test was used to assess the homogeneity of variance across groups (i.e., homoscedasticity). Since variances were homogeneous ($P > 0.05$), the F-statistic was used.

A reliability analysis for the GBs and the anatomical measures (i.e., 18 measurements, three for each of the six assessed teeth) was carried out in a subsample of 20 students using inter-observer kappa coefficients and the percentage of agreement. Discrete measures (in mm) were treated as categorical data with up to four groups. The GB classifications and anatomical measures produced by the trained periodontist who assessed the whole sample of students were compared with those made by a senior expert periodontist in the subsample.

Data was entered and analyzed using SPSS v.20 (IBM Corp., Armonk, NY, USA).

Results

There was 90% agreement for the GB classification between the two periodontists leading to a Kappa coefficient of 0.84. Agreement also reached 90% for GS; however, the Kappa coefficient was slightly lower at 0.73. For the 18 anatomical measures of the six assessed teeth, coefficients and percentages of agreement averaged 0.71 and 78.9%, respectively. Medial and distal measures tended to produce better coefficient and agreement values. Central incisors also tended to show better estimates.

While the distribution of thick GB was relatively similar by sex, women accounted for 60.2% of the thin biotype ($P < 0.001$). No clear patterns were seen by age, but thin biotypes were slightly more common in 19-year-old individuals; whereas, thick GBs were more frequent among those aged 17 and 18 years old. The majority (85%) of the recessions were associated with thin biotypes. Thick biotypes were associated with GS more often than thin ones (33.3% vs. 15.5%; $P < 0.001$), with an even larger differential among men (57.7% vs. 18%; $P = 0.01$). Malocclusion and smoking were not significantly associated with GB, although smokers tended to have slightly thicker biotypes than nonsmokers did (17.9% vs. 12.1%; $P = 0.53$) (Table 1).

Most individuals with oval or triangular/narrow teeth showed thin GB (73%). A thick biotype was more common among persons with square teeth (39.4%) compared to the other shapes ($P < 0.001$), especially among males, where a thick gingiva was present in 52.4% of those with square teeth. Dental hygienic habits, including tooth brushing, oral rinsing, and dental flossing were not significantly associated with either biotype ($P > 0.10$). Additionally, coffee and alcohol intake showed no relationship with GB in this sample (Table 2). The intake of probiotic foods such as yogurt and chocolate, as well as the consumption of spicy foods or candy, were not related to GB (Table 2).

No statistical differences in the mean upper lip distance were found between individuals who had thin and thick biotypes for both men and women. For facial distance, significant differences were observed only for
the lower third of the face, especially for men with thin biotypes who showed larger distance compared with thick biotypes (6.58 vs. 6.24 cm; *P* < 0.05) (Table 3).

Those with thick GB consistently showed longer mean GA and KG but smaller LT, compared with those having thin GBs in all the measured upper frontal teeth (*P* < 0.05) (Table 4).

Table 5 presents the mean tooth width, mean ratio, TC distance, and PD measured in the mid-facial site of upper frontal teeth stratifying by GBs. Relevant differ-

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**Table 1** Gingival biotypes by selected sociodemographic and dental characteristics

| Characteristic       | Category | Gingival biotype*, n (%) | P-value** |
|----------------------|----------|--------------------------|-----------|
|                      |          | thin (73.0) | thick (61.2) | mixed (67.5) |
| age                  | 17       | 128 (64.6) | 41 (20.7) | 29 (14.6) | 0.24 |
|                      | 18       | 176 (69.8) | 49 (19.4) | 27 (10.7) |
|                      | 19       | 45 (75.0)  | 7 (11.7)  | 8 (13.3)  |
| recession            | Yes      | 17 (85.0)  | 1 (5.0)   | 2 (10.0)  | 0.21 |
|                      | No       | 331 (67.8) | 95 (19.5) | 62 (12.7) |
| gummy smile          | yes      | 51 (53.1)  | 32 (33.3) | 13 (13.5) | <0.01 |
|                      | no       | 297 (72.1) | 64 (15.5) | 51 (12.4) |
| male                 | yes      | 8 (30.8)   | 15 (57.7) | 3 (11.5)  | 0.01 |
|                      | no       | 131 (65.5) | 36 (18.0) | 33 (16.5) |
| female               | yes      | 43 (61.4)  | 17 (24.3) | 10 (14.3) | <0.01 |
|                      | no       | 166 (78.3) | 28 (13.2) | 18 (8.5)  |
| malocclusion         | no       | 193 (68.4) | 57 (20.2) | 32 (11.3) | 0.91 |
| maxillary            | yes      | 12 (63.2)  | 4 (21.1)  | 3 (15.8)  |
|                      | no       | 50 (71.4)  | 10 (14.3) | 10 (14.3) |
| jaw                  | yes      | 94 (67.6)  | 26 (18.7) | 19 (13.7) |
|                      | no       | 287 (74.9) | 73 (19.1) | 10 (2.5)  |
| smoking              | yes      | 246 (69.9) | 63 (17.9) | 43 (12.2) | 0.53 |
|                      | no       | 37 (75.5)  | 6 (12.2)  | 6 (12.2)  |

*Thin: delicate, friable, translucent. Thick: fibrotic, rigid, non-translucent. Mixed: characteristics differ across the examined teeth.

**Table 2** Tooth shape, oral hygiene habits, and intake of coffee/alcohol by gingival biotype

| Variable              | Category | Gingival biotype*, n (%) | P-value** |
|-----------------------|----------|--------------------------|-----------|
| tooth shape           | oval     | 268 (73.0) | 48 (13.1) | 51 (13.9) | <0.01 |
|                       | square   | 56 (51.4)  | 43 (39.4) | 10 (9.2)  |
|                       | triangular/narrow | 25 (73.5) | 6 (17.6) | 3 (8.8)  |
| male                  | oval     | 110 (67.9) | 23 (14.2) | 29 (17.9) | <0.01 |
|                       | square   | 15 (55.7)  | 22 (52.4) | 5 (19.1)  |
|                       | triangular/narrow | 14 (63.3) | 6 (27.3) | 2 (9.1)  |
| female                | oval     | 158 (77.1) | 25 (12.2) | 22 (10.7) | <0.01 |
|                       | square   | 41 (61.2)  | 21 (31.3) | 5 (7.5)  |
|                       | triangular/narrow | 11 (91.7) | 0 (0)   | 1 (8.3)  |
| tooth brushing        | never    | 2 (50.0)   | 0 (0)    | 2 (50.0)  | 0.19 |
|                       | 1/day    | 33 (62.3)  | 12 (22.6) | 8 (15.1)  |
|                       | 2/day    | 152 (69.4) | 40 (18.3) | 27 (12.3) |
|                       | 3/day    | 99 (77.3)  | 18 (14.1) | 11 (8.6)  |
| oral rinse            | never    | 140 (66.7) | 37 (17.6) | 33 (15.7) | 0.17 |
|                       | 1/month  | 15 (93.8)  | 0 (0)    | 1 (6.2)   |
|                       | 1/week   | 91 (74.0)  | 24 (19.5) | 8 (6.5)   |
|                       | >1/week  | 40 (72.7)  | 9 (16.4)  | 6 (10.9)  |
| dental flossing       | never    | 213 (69.8) | 58 (19.0) | 34 (11.1) | 0.53 |
|                       | 1/month  | 2 (100.0)  | 0 (0)    | 0 (0)     |
|                       | 1/week   | 63 (75.9)  | 9 (10.8)  | 11 (13.3) |
|                       | >1/week  | 9 (60.0)   | 3 (20.0)  | 3 (20.0)  |
| coffee intake         | yes      | 238 (70.4) | 61 (18.0) | 39 (11.5) | 0.63 |
|                       | no       | 49 (73.1)  | 9 (13.4)  | 9 (13.4)  |
| alcohol intake        | yes      | 198 (71.7) | 51 (18.4) | 27 (9.8)  | 0.56 |
|                       | no       | 88 (68.8)  | 19 (14.8) | 21 (16.4) |

*Thin: delicate, friable, translucent. Thick: fibrotic, rigid, non-translucent. Mixed: characteristics differ across the examined teeth.

**Pearson chi-square tests were used to identify differences in proportions.**
ences were observed in the canines. Individuals with thin biotypes had larger width and smaller ratio and PD compared with those with thick GB. In the lateral and central incisors, except for probing where persons with thin GB had smaller mean depth, no major differences were seen for the other three measures between the thin and thick biotypes (Table 5).

**Discussion**

This study aimed to characterize GBs among Mexican students aged 17-19 years old, including their association with various anatomic structures of the mouth and face. The relatively large sample used here contrasts with the considerably smaller samples surveyed previously. Together with the assessment of various sociodemographic and dietary factors potentially associated with GBs, sample size constitutes an important strength of this work. Conversely, the main drawback relates to the cross-sectional design of this study, which along with the small number and partial assessment of dietary and lifestyle factors, limits the value of the investigated associations.

In terms of the prevalence of biotypes, 68.4%, 19.0%, and 12.5% of the students had a thin, thick, and mixed GB, respectively, like that reported in a small sample of 42 German men aged 20-25 years (77.0%, 21.0%, and 12%, respectively) (13). When using cluster definitions
considering both thickness and tooth form, the same authors reported relatively similar prevalence of thin gingiva (15,16).

The prevalence of GB types reported in a recently published review of seven studies is difficult to directly compare with the current study due to variations in assessment methods. Nonetheless, when using the two-group classification (thick and thin based on gingival thickness), the authors of the review reported that the thick biotype was more prevalent than the thin biotype (51.9% vs. 42.3%), which is in contrast with the findings of the current study. Yet, the authors also reported a wide range of thin GB (12-81%) depending on the method of measurement and definition (7,17).

In this study, 4% of the students had recessions in the upper frontal teeth. Of these, 85% were seen in those with a thin GB. This result replicates what other authors have reported, namely, that recessions are more prevalent in people with a thin biotype. This is expected, as thick biotypes seem to better cover recessions. Apparently, persons with thin GBs have reduced GA and KG, leaving these subjects at higher risk of recessions (15,16,18-22).

Thick GBs were present in 19% of the students, like the 22% prevalence reported in Jordanian adults (24). The differential seen in GS by sex (men 11%; women 24%) corresponded to the 2:1 ratio reported earlier (23,24). However, there is no published study associating GBs with GS. In the current study, the association between GS and GB varied by sex. GS was more frequent in men with thick biotypes and in women with thin biotypes.

As others have noted, tooth shape is also associated with GB (2,11,15). Those with thin and thick biotypes tend to have oval and square teeth, respectively. The relationship between tooth shape and ethnic morphogenetic dental variations (9,25) needs to be explored.

There is some evidence that certain mouth rinse solutions can cause cell damage, and some drinks such as coffee may be protective against periodontal bone loss, potentially modifying the gingival tissue (26-28). However, no significant associations between dietary and dental hygiene factors and GB were found. The cross-sectional nature of this study makes it difficult to determine whether these factors preceded the changes in gingival anatomy.

This is also the first study relating GB to facial characteristics. However, except for the lower facial third in which those with thin GB had larger distance compared with thick GB, no relevant anatomical differences were identified in terms of upper lip and the upper and middle facial distance between the thin and thick biotypes.

Concerning tooth size, the results show mean width and length of central and lateral incisors similar to Asian individuals (25,29). However, as reported previously, canines had larger variability. Apparently, some dental features vary more than others depending on the type of teeth and ethnicity (25,30). Anatomical and clinical characteristics of the structures surrounding the gingiva, including the PD, GA, and KG, were also similar to those reported in other populations in canines and central and lateral incisors (10,21). Thin GB was associated with larger canines and lateral and central incisors, and with less KG and GA. Conversely, thick GB was associated with shorter teeth but more KG and GA. These results are like previous studies where thick biotypes were
commonly found in short and quadratic teeth compared with longer teeth, in which thin GBs with less KG and GA were more common (16,29). Thin biotypes also had slightly wider teeth compared with thick GB in this sample, and the PD was deeper in the thick biotype in contrast with the lack of association reported previously between PD and GBs (11).

Gingival recessions, triangular shape of teeth, and facial distance in the lower third of face were associated with thin GB. It is suggested that these findings need to be considered when planning clinical treatment. Additionally, exploring factors that could affect the gingival structures is also important for preventive purposes.

Finally, other study limitations need to be mentioned. Participants were close to their final growth stage (adolescence ends at 19 years old), and a minimal biotype change could still be seen; however, the potential variation would be negligible in terms of misclassification bias. Another limitation relates to the relatively subjective assessment of GB. Nontraumatic visual classification was used due to costs and logistic feasibility, and this modified classification has been used and well referenced by several authors. On the other hand, while the validity of the anatomical and morphological measures may not be certain, the relatively good reliability of the measures found in the subsample points to a consistent assessment.

In conclusion, characterizing the morphologic and phenotypic features of GB in relation to other oral and facial structures is relevant when planning and performing dental procedures in the fields of prosthetics, occlusion, implants, and orthodontics (31-34). Developing new economical and nontraumatic methods to accurately identifying GB and correlating GB with associated factors such as the occurrence of malocclusion (35-37) should be part of future research efforts about preventable conditions.

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Conflict of interest
The authors have no conflict of interest to declare.

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