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Gingival health and oral hygiene practices among high school children in Saudi Arabia

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BACKGROUND: Gingivitis is a site-specific inflammatory condition initiated by dental biofilm accumulation. The accumulation of dental plaque on the gingival margin triggers inflammatory effects that can become chronic. In addition to its local effect, gingival inflammation has recently been suggested to have an impact on general health.

OBJECTIVE: Determine the prevalence of gingivitis and its relationship to oral hygiene practices in high school children in Saudi Arabia.

DESIGN: Cross-sectional.

SETTING: High schools from different regions in Saudi Arabia.

PATIENTS AND METHODS: Periodontal examinations were conducted on a randomly selected sample of high school children between the ages of 15 and 19 years. Gingival and plaque indices, probing depth, clinical attachment level, oral hygiene practices and sociodemographic characteristics were recorded. Data were analyzed using descriptive statistics, chi-square and the independent *t* test.

MAIN OUTCOME MEASURE: Prevalence of gingivitis as defined by mean gingival index.

SAMPLE SIZE: 2435 high school students.

RESULTS: Twenty-one percent of the sample had slight gingivitis, 42.3% had moderate, and 1.8% had severe. Gender, toothbrushing, tongue brushing, plaque index, and the percentage of pocket depth (PD) ≥4 mm showed a significant relationship with the severity of gingivitis. Almost 39.3% of females had a healthy periodontal status when compared to males (30.7%). Thirty-five percent (35.5%) of students who brushed their teeth had a healthy periodontium compared to 26.9% who did not brush. The mean plaque index was significantly higher in students with severe gingivitis when compared to students with healthy periodontium (2.4 vs. 0.79, respectively).

CONCLUSION: Gingivitis prevalence was high compared with Western countries in a nationally representative sample of high school students in Saudi Arabia and was influenced by oral hygiene practices.

LIMITATIONS: The half-mouth study design may underestimate disease prevalence. Data on oral hygiene practices was self-reported and may thus have been affected by social desirability bias.

CONFLICT OF INTEREST: None.

Periodontal diseases have major public health importance due to the high prevalence rates and remarkable social impact. Recently, periodontal diseases have been linked to population general health.[1] Dental plaque is considered to be a risk factor for the initiation and progression of periodontal diseases.[2] A wide variety of organisms comprise the dental plaque biofilm collected from oral surfaces. Accumulation of plaque on the gingival margin initiates gingival inflammation that can become chronic.[3,4] This inflammatory condition called gingivitis is characterized by gingival redness, edema and bleeding on probing without detectable alveolar bone loss or tooth supporting structures.[5,6] Gingivitis is reversible without permanent damage if properly treated. However, if left untreated, it can progress to periodontitis leading to destruction of alveolar bone and subsequently may lead to tooth loss. Based on epidemiological and experimental studies, dentists recommend effective oral hygiene to control the dental plaque for maintaining optimal oral health.[2,7,8] Therefore, gingivitis management is a crucial strategy to prevent the development of advanced periodontal disease.[9] Furthermore, gingival inflammation leads to the release of inflammatory mediators into the circulatory system, which may have a negative impact on overall health.[10,11]

Gingivitis prevalence was 100% in a sample of adults aged between 18 and 40 years from a private college in Riyadh city[12] and in a sample of 272 of children aged 5–12-years old.[13] In another study, severity varied but was nearly universal in adolescents and children; in children older than 7 years, gingivitis affected almost 70%.[14] However, a cross-sectional study that included a sample of Saudi males (n=685) aged 13-15 years in 2016 concluded that the severity of gingivitis was not associated with toothbrushing, but significantly increased in smokers and people who consumed a sugary diet, which indicates the effect of lifestyle on gingival health status and the need to encourage a healthy lifestyle in the population.[15] Another study also indicated that periodontal disease prevalence is lower in young subjects than in adults and the incidence increases in adolescents aged 12 to 17 when compared to children aged 5 to 11.[16]

The role of plaque control, which includes but is not limited to tooth and tongue brushing and flossing, and its association with gingivitis, has been widely studied. It has been globally agreed that dental floss has a positive effect on plaque removal.[17] Eighty percent of plaque deposits can be removed by flossing as reported by the American Dental Association (ADA).[18] It is also universally accepted that oral health status is closely linked to socioeconomic status, which is closely associated with oral health knowledge, attitudes and behaviors.[19,20] A study that analyzed data on self-reported oral hygiene measures showed that some increased risk of gingivitis related to oral hygiene. These findings may be related to the population studied and the impact of regular preventative dental care. In randomly selected sample in Nigeria, toothbrushing once daily was the most common practice, and the authors concluded that gingival health was influenced by socioeconomic status, oral hygiene frequency and toothbrush texture.[21] Early diagnosis and treatment of periodontal diseases in children and adolescents are important for better oral health in adults. Early periodontal diseases in children may develop into advanced periodontal diseases in adults, which may increase susceptibility to certain systemic diseases and conditions.[6,22] Prevention and treatment of most periodontal diseases are very effective and provide lifetime benefits. Patients, families, or populations at risk may be identified and included in special prevention or treatment programs.[23] The significance of implementing dental services should be emphasized through different channels, including schools, social media and oral health professionals.[24]

There is a need to form baseline information about oral health in the Saudi population to understand the prevalence of periodontal diseases in Saudi Arabia. Accordingly, our study evaluated the prevalence of gingivitis and its correlation with oral hygiene practices in a nationally representative sample of Saudi school children.

SUBJECTS AND METHODS

This cross-sectional descriptive study to assess the prevalence of gingivitis and its correlation with oral hygiene practices among school children in Saudi Arabia took place from September 2012 to January 2016. The study was approved by the Research Ethics Committee of Faculty of Dentistry, King Abdulaziz University (073-09-12) The study included a random sample of healthy school children grades 10 to 12 (15-18 years old) of both genders. Students or parents who refused to provide consent or rejected the periodontal examination, and students with medical conditions related to periodontitis were excluded from the study. No children were admitted to the study without their parents' approval. Subject name, gender, age, marital status, address, contact information, and socioeconomic status were recorded on the consent form, which was signed by the parent.

A detailed sampling design was reported in an earlier study.[25] We followed a multistage clustered sam-

pling design to guarantee an adequate representation of all children in the country within the specified school grades. The study focused mainly on large cities in each region. The relative number of subjects from each city was based on the population in the region where the city is located. Within each chosen city a group of schools were randomly selected from various geographic regions to guarantee a mixture of various social and economic backgrounds. Within each selected school all children grades 10th to 12th were included in the sample. A detailed multilevel quality control procedure was used in this survey. A reference examiner trained the survey examiners and monitored them throughout the survey period. The examiners were evaluated before the survey began and were monitored during the survey period. At the examination visit, the examiners reviewed the medical history with the subjects and recorded the information. A dental history questionnaire was completed by each subject and revised with the examiner. The dental history included reference to the patient's oral hygiene regimen, including toothbrushing, brushing frequency, flossing and tongue brushing.

All clinical examinations were performed by four dentists, who were calibrated to the exact procedures for disease diagnosis, the proper use of Williams probes, probe angulation, force and position for each tooth, and other examination criteria was prepared and made available to each in a diagnostic manual. Adequate training and evaluation of the examiners was conducted to document that the examiners were scoring diseases accurately and consistently. Examiners were given didactic sessions to explain the proper use of periodontal probe including force, site and angulation of the probe. After the didactic sessions, all examiners were given hands-on physical training sessions to fill the examination forms accurately. The intra and inter-examiner reliabilities of gingival index, probing depth and clinical attachment level were tested using intra-class correlation coefficients (ICC). The value of the ICC's were >0.7 for all variables, which corresponded to an excellent reliability as reported by Landis and Koch.[26]

The gingival and periodontal examination consisted of measurement of the gingival and periodontal supporting tissue including gingivitis, attachment loss, and probing pocket depth. Probing depth and attachment loss were measured at six sites for each examined tooth (using a Williams probe). We randomly selected one maxillary and one mandibular quadrant using simple random sampling. The disease was evaluated at mesiobuccal, mid-buccal and distolingual (MB-B-DL) of all teeth excluding third molars following the partial mouth 3 protocol.[27] For oral hygiene evaluation, we used the Silness and Loe plaque index.[28] For severity of gingival inflammation, we used the Loe and Silness gingival index.[29] The mean gingival index was used for the assessment of severity of gingival inflammation in the study sample. Slight gingivitis was defined as gingival index 0.1-1, moderate gingivitis as gingival index 1.1-2.0, and severe gingivitis as gingival index 2.1-3.0.[30]

The data were analyzed using IBM SPSS version 22.0.0 (IBM SPSS, Armonk, NY: IBM Corp). Simple descriptive statistics were used to define the characteristics of the study variables by counts and percentages for the categorical and nominal variables while continuous variables are presented as mean and standard deviation. To test for a relationship between gingivitis and categorical and continuous variables, we used the chi-square and independent t test, respectively. These tests were done under the assumption of a normal distribution. Statistical significance was set at $P<.05$

RESULTS

Prevalence of gingivitis

The sample consisted of 2435 subjects (**Table 1**) with a mean (SD) age of 17.3 (1.0) and mean percentage of pockets >4 mm in depth of 1.85 (range, 0 to 66.7) (**Figure 1**). Of the 2435 study subjects, 209 (8.6%) had periodontitis as reported earlier.[25] **Table 2** shows the the prevalence of slight, moderate, and severe gingivitis and the relationships of other variables to severity of gingivitis in 2226 subjects. The remaining subjects who had periodontitis, another form of periodontal diseases, were excluded and reported in an earlier study.[24] Gender, toothbrushing, tongue brushing, plaque index, and the percentage of PD ≥4 mm showed significant relationships with the severity of gingivitis. For instance, 39.3% of females had a healthy periodontal status when compared to males (30.7%).

Oral hygiene practices

Table 3 shows that females (96%) brush their teeth more than males (82.3%). Flossing (95.7%), tongue brushing (99.7%), plaque index (1.23 [0.8]), and gingival index (1.00 [0.8]) had statistically significant relationships to toothbrushing. Ninety-nine percent of students who brushed their tongue also brushed their teeth while only 40% of students practice the opposite. **Table 4** shows that the majority(83.5%) brushed their teeth once or twice while only 16.5% brushed their teeth more than two times per day. Female gender (21.1%), flossing (27.5%), tongue brushing (20.3%) plaque and gingival indices had significant relationships to tooth-

Table 1a. Demographic and clinical characteristics of participant population (continuous variables).

Age (years)	17.3 (1.0), 15-19
Mean PD (mm)	0.59 (0.17), 0-1.80
PD ≥4 mm (%)	1.85, 0-66.7
Mean CAL (mm)	0.1 (0.2), 0-2.2
CAL ≥1 mm (%)	2.54, 0-100
Plaque index	1.3 (0.8), 0-3
Gingival index	1.0 (0.8), 0-3

Data are mean (SD) and/or range. PD: probing depth, CAL: clinical attachment loss.

Table 1b. Demographic and clinical characteristics of participant population (categorical variables).

Nationality	
Non-Saudi	196 (8.0)
Saudi	2239 (92.0)
Gender	
Male	1329 (54.6)
Female	1106 (45.4)
Do you smoke?	
Yes	201 (8.3)
No	2234 (91.7)
Medical history	
No	2022 (83)
Yes	413 (17)
Do you visit a dentist regularly?	
Yes	455 (18.7)
No	1980 (81.3)
Do you brush your teeth?	
Yes	2156 (88.5)
No	279 (11.5)
Brushing frequency	
Once	922 (42.8)
Twice	922 (42.8)
More than 2 times	356 (16.5)
Missing	279

Data are number (%).

Table 1b. (cont.) Demographic and clinical characteristics of participant population (categorical variables).

Do you floss your teeth?	
Yes	255 (10.5)
No	2180 (89.5)
Do you brush your tongue?	
Yes	871 (35.8)
No	1564 (64.2)
Previous dental treatment	
Yes	1657 (68.0)
No	778 (32.0)
Previous permanent teeth extracted	
Yes	585 (24.0)
No	1850 (76.0)

Data are number (%).

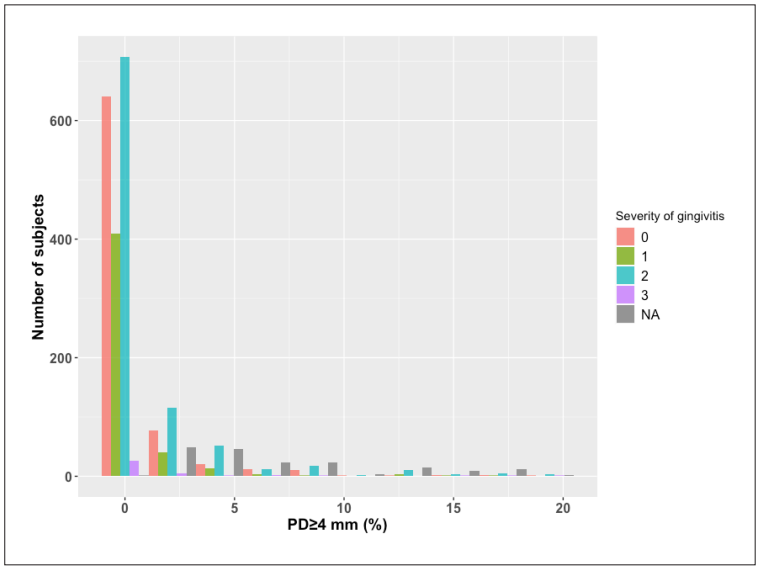

Figure 1. Distribution of percentage of sites per patient with probing depth ≥4 mm by severity of gingivitis for subjects with PD ≥4 mm less than or equal to 20% (NA: not available) (n=2392).

brushing frequency. **Table 5** shows that 89.5% of the students did not floss their teeth and that subjects who use dental floss tend to brush their tongue (16.2%) and brush their teeth more than two times per day (18.8%). Females (13.7%) flossed more than males (7.8%), and

Table 2. Characteristics of study population in relation to severity of gingivitis (n=2226).

Variables	Severity of Gingivitis				*P* value
	Healthy	Slight Gingivitis	Moderate Gingivitis	Severe Gingivitis	
Total	769 (34.5)	475 (21.3)	941 (42.3)	41 (1.8)	N/A
Age (years)	17.28 (1.0)	17.30 (1.0)	17.22 (1.0)	17.21 (1.0)	.418
Nationality					
Non-Saudi	61 (36.3)	28 (16.7)	76 (45.2)	3 (1.8)	.493
Saudi	708 (34.4)	447 (21.7)	865 (42.0)	38 (1.8)	
Gender					
Male	374 (30.7)	297 (24.3)	527 (43.2)	22 (1.8)	**<.001**
Female	395 (39.3)	178 (17.7)	414 (41.2)	19 (1.9)	
Smoker					
Yes	66 (36.9)	40 (22.3)	71 (39.7)	2 (1.1)	.737
No	703 (34.3)	435 (21.3)	870 (42.5)	39 (1.9)	
Regular dental visits					
Yes	135 (32.8)	93 (22.6)	176 (42.8)	7 (1.7)	.825
No	634 (34.9)	382 (21.0)	765 (42.1)	34 (1.9)	
Tooth brushing					
Yes	704 (35.5)	415 (20.9)	833 (42.0)	32 (1.6)	**.008**
No	65 (26.9)	60 (24.8)	108 (44.6)	9 (3.7)	
Brushing frequency					
Once	262 (32.2)	173 (21.3)	366 (45.0)	13 (1.6)	.244
Twice	318 (37.6)	180 (21.3)	334 (39.5)	14 (1.7)	
More than 2 times	124 (38.3)	62 (19.1)	133 (41.0)	5 (1.5)	
Flossing					
Yes	94 (39.5)	44 (18.5)	98 (41.2)	2 (0.8)	.218
No	675 (34.0)	431 (21.7)	843 (42.4)	39 (2.0)	
Tongue brushing					
Yes	328 (40.6)	169 (20.9)	301 (37.3)	10 (1.2)	**<.001**
No	441 (31.1)	306 (21.6)	640 (45.1)	31 (2.2)	
Previous dental treatment					
Yes	524 (34.8)	308 (20.5)	648 (43.1)	24 (1.6)	.265
No	245 (33.9)	167 (23.1)	293 (40.6)	17 (2.4)	
Previous permanent teeth extracted					
Yes	173 (33.1)	109 (20.9)	232 (44.4)	8 (1.5)	.666
No	596 (35.0)	366 (21.5)	709 (41.6)	33 (1.9)	
Plaque index	0.79 (0.7)	1.17 (0.6)	1.58 (0.7)	2.41 (0.6)	**<.001**
Missing teeth	0.38 (1.0)	0.29 (0.8)	0.43 (1.0)	0.39 (0.9)	.063
Mean PD	0.58 (0.2)	0.57 (0.2)	0.58 (0.2)	0.61 (0.3)	.275
PD (%) ≥4 mm	0.75 (2.2)	0.57 (1.9)	1.57 (4.5)	4.54 (9.1)	**<.001**

Data are number (%) or mean (standard deviation).

Table 3. Characteristics of study population in relation to tooth brushing (n=2435).

Variables	Brushing		*P* value
	Yes (%)	No (%)	
Total	2156 (88.5)	279 (11.5)	N/A
Age (years)	17.25 (1.0)	17.35 (1.0)	.135
Nationality			
Non-Saudi	171 (87.2)	25 (12.8)	.552
Saudi	1985 (88.7)	254 (11.3)	
Gender			
Male	1094 (82.3)	235 (17.7)	**<.001**
Female	1062 (96.0)	44 (4.0)	
Flossing			
Yes	244 (95.7)	11 (4.3)	**<.001**
No	1912 (87.7)	268 (12.3)	
Tongue brushing			
Yes	868 (99.7)	3 (0.3)	**<.001**
No	1288 (82.4)	276 (17.6)	
Plaque index	1.23 (0.8)	1.59 (0.8)	**<.001**
Gingival index	1.00 (0.8)	1.21 (0.8)	**<.001**
Missing teeth	0.42 (1.0)	0.25 (0.7)	**<.001**
Mean PD	0.59 (0.2)	0.61 (0.2)	.171
PD (%) ≥4 mm	1.81 (4.8)	2.23 (5.1)	.166

Data are number (%) or mean (standard deviation).Note: Number do not add up in some cells due to missing data.

Table 4. Characteristics of study population in relation to Tooth Brushing Frequency (n=2435).

Variables	Brushing frequency			*P* value
	Once	Twice	More than 2 times	
Total	878 (40.7)	922 (42.8)	356 (16.5)	N/A
Age (years)	17.22 (1.0)	17.27 (1.0)	17.27 (1.0)	.485
Nationality				
Non-Saudi	73 (42.7)	72 (42.1)	26 (15.2)	.824
Saudi	805 (40.6)	850 (42.8)	330 (16.6)	
Gender				
Male	573 (52.4)	389 (35.6)	132 (12.1)	**<.001**
Female	305 (28.7)	533 (50.2)	224 (21.1)	
Flossing				
Yes	72 (29.5)	105 (43.0)	67 (27.5)	**<.001**
No	806 (42.2)	817 (42.7)	289 (15.1)	
Tongue brushing				
Yes	265 (30.5)	427 (49.2)	176 (20.3)	**<.001**
No	613 (47.6)	495 (38.4)	180 (14.0)	
Plaque index	1.30 (0.7)	1.17 (0.8)	1.20 (0.8)	**.002**
Gingival index	1.05 (0.8)	0.97 (0.8)	0.96 (0.7)	**.047**
Missing teeth	0.37 (0.9)	0.45 (1.0)	0.47 (1.0)	.155
Mean PD	0.59 (0.2)	0.59 (0.2)	0.60 (0.2)	.212
PD (%) ≥4 mm	1.79 (5.0)	1.87 (4.8)	1.68 (4.2)	.802

Data are number (%) or mean (standard deviation).Note: Number do not add up in some cells due to missing data.

gingival indices had a significant relationship with flossing. **Table 6** shows that gender, regular dental visit, toothbrushing, brushing frequency, flossing, previous dental treatment, plaque and gingival Indices and missing teeth had a significant relationship with tongue brushing. For instance, 80% of male students did not brush their tongue compared to 50% of females. **Table 7** shows that females (23.7%), students who brush their teeth (20%) and their tongues (23.8%) visit the dentist regularly.

DISCUSSION

Gingivitis, the most common form of periodontal disease, is characterized by inflammation of the soft tissue without evident clinical attachment loss.[31] Studies on gingivitis have been conducted in many parts of the world with people of different ethnic and cultural backgrounds, but periodic evaluation of data is very much required. Presence of gingivitis in the school children can be due to different food habits, the presence of

Table 5. Characteristics of study population in relation to dental flossing (n=2435).

Variables	Brushing frequency		*P* value
	Yes	No	
Total	255 (10.5)	2180 (89.5)	N/A
Age (years)	17.29 (1.0)	17.26 (1.0)	.652
Nationality			
Non-Saudi	22 (11.2)	174 (88.8)	.720
Saudi	233 (10.4)	2006 (89.6)	
Gender			
Male	103 (7.8)	1226 (92.2)	**<.001**
Female	152 (13.7)	954 (86.3)	
Tooth brushing			
Yes	244 (11.3)	1912 (88.7)	**<.001**
No	11 (3.9)	268 (96.1)	
Brushing frequency			
Once	72 (8.2)	806 (91.8)	**<.001**
Twice	105 (11.4)	817 (88.6)	
More than 2 times	67 (18.8)	289 (81.2)	
Tongue brushing			
Yes	141 (16.2)	730 (83.8)	**<.001**
No	114 (7.3)	1450 (92.7)	
Plaque index	1.17 (0.8)	1.28 (0.8)	**.035**
Gingival index	0.93 (0.8)	1.04 (0.8)	**.046**
Mean PD	0.57 (0.2)	0.59 (0.2)	.076
PD (%) ≥4 mm	1.60 (4.6)	1.89 (4.9)	.368

Data are number (%) or mean (standard deviation). Note: Number do not add up in some cells due to missing data.

Table 6. Characteristics of study population in relation to tongue brushing (n=2435).

Variables	Tongue Brushing		*P* value
	Yes	No	
Total	871 (40)	1564 (60)	N/A
Age (years)	17.28 (1.0)	17.25 (1.0)	.512
Nationality			
Non-Saudi	72 (40)	124 (60)	.769
Saudi	799 (40)	1440 (60)	
Gender			
Male	321 (20)	1008 (80)	**<.001**
Female	550 (50)	556 (50)	
Tooth brushing			
Yes	868 (40)	1288 (60)	**<.001**
No	3 (0.0)	276 (100)	
Brushing frequency			
Once	265 (30)	613 (70)	**<.001**
Twice	427 (50)	495 (50)	
More than 2 times	176 (50)	180 (50)	
Flossing			
Yes	141 (60)	114 (40)	**<.001**
No	730 (30)	1450 (70)	
Plaque index	1.08 (0.8)	1.37 (0.8)	**<.001**
Gingival index	0.90 (0.7)	1.10 (0.8)	**<.001**
Mean PD	0.59 (0.2)	0.59 (0.2)	.746
PD (%) ≥4 mm	1.69 (4.4)	1.95 (5.1)	.219

Data are number (%) or mean (standard deviation). Note: Number do not add up in some cells due to missing data.

mixed dentition, improper and unsupervised oral hygiene practices, and malocclusion.[16,32] Based on our knowledge, the present study is the first study reporting the prevalence of gingivitis and its correlation with oral hygiene practices in a representative sample from different regions in Saudi Arabia. The prevalence of gingivitis varies between studies which could be due to dissimilarities in age groups, study populations, and the case definition of gingivitis. In general, gingivitis starts in early childhood, and becomes more prevalent and severe with age. In the present population, 21.3% had slight gingivitis, 42.3% had moderate gingivitis and 1.8% had severe gingivitis with a total of 65.4% having some severity of gingivitis, which is consistent with most studies. In a study that described periodontal health in 14- to 17-year-old children who participated in the National Survey of Oral Health in US schoolchildren, during 1986-87, prevalence of gingivitis was approximately 60%, which is consistent with our data.[33] In contrast, the prevalence of gingivitis was higher in another study from Saudi Arabia in which prevalence of gingivitis was 100% in a sample of 385 adult subjects 18-40

years of age.[34] A study from Iran reported a gingivitis prevalence of 97.9%.[35] Theses inconsistencies among various studies could be attributed to age group differences, dietary habits, oral hygiene practices and/or demographic backgrounds. In our study, the severity of gingivitis was significantly related to toothbrushing, tongue brushing, plaque index, and the percentage of PD ≥4 mm. Subjects who brush their teeth and tongue were less likely to have gingivitis. As is to be expected, subjects who do not brush had a higher plaque index and percentage of PD ≥4 mm compared to those who do brush. It has been shown that abstaining from oral hygiene measures for 21 days will result in the initiation of gingival inflammation.[36] This correlates well with the results of this study, specifically that 11.5% reported that they do not brush their teeth and 40.7% brush only once a day. Our study indicated that there is a significant relationship between the severity of gingivitis and gender. Males were more likely to have gingivitis compared to females and this is consistent with several other studies.[24,37] One explanation, which is consistent with our data, is that males have poorer hygiene practices and worse attitudes to oral health and visiting the dental office. In our study population, more males did not brush their teeth, floss, or attended regular dental visits compared to females. A higher rate of oral hygiene practices (tooth and tongue brushing, frequency of brushing and flossing) were observed among females than males in our study sample. This translated to a higher plaque index in the male population compared to the female population. Another study similarly reported that 82% of boys and 76% of girls were affected with gingivitis, and they attributed this discrepancy to the greater cleanliness of the girls.[15] A study on the prevalence of periodontal disease in 19-year-old individuals in Sweden in relation to gender revealed that gender (males) and the particular county region were significant factors associated with high plaque and gingivitis score.[38] Our data indicates that age and nationality (Saudis vs. non-Saudis) were not significantly associated with the severity of gingivitis, which is inconsistent with other studies[39,40] that showed worse oral hygiene status among older children. The inconsistency could be due to the older age group in the present study (15-19 years) while in the aforementioned studies the ages were 7-15 years, and the sample size of the non-Saudi students was small. In the present study, the mean plaque index was higher in those who reported not brushing their teeth (plaque index=1.59) than in those who did (plaque index=1.23). The same pattern was observed with the gingival index. The mean gingival index was 1.21 in those who did not brush their teeth and 1.00 in those who did. These parameters were also significantly related to the frequency of toothbrushing, tongue brushing and flossing. Plaque index was significantly associated with the severity of gingivitis, meaning that the higher the plaque index the more severe the gingival inflammation. However, in a 3-5 year-old Flemish population,

Table 7. Characteristics of study population in relation to regular dentist visits (n=2435).

Variables	Regular dental visits		*P* value
	Yes	No	
Total	455 (18.7)	1980 (81.3)	N/A
Age (years)	17.26 (1.0)	17.26 (1.0)	.936
Nationality			
Non Saudi	33 (16.8)	163 (83.2)	.489
Saudi	422 (18.8)	1817 (81.2)	
Gender			
Male	193 (14.5)	1136 (85.5)	<.001
Female	262 (23.7)	844 (76.3)	
Brushing			
Yes	436 (20.2)	1720 (79.8)	<.001
No	19 (6.8)	260 (93.2)	
Brushing frequency			
Once	116 (13.2)	762 (86.8)	<.001
Twice	201 (21.8)	721 (78.2)	
More than 2 times	119 (33.4)	237 (66.6)	
Flossing			
Yes	57 (22.4)	198 (77.6)	.112
No	398 (18.3)	1782 (81.7)	
Tongue brushing			
Yes	207 (23.8)	664 (76.2)	<.001
No	248 (15.9)	1316 (84.1)	
Plaque index	1.31 (0.8)	1.26 (0.8)	.193
Gingival index	1.03 (0.7)	1.02 (0.8)	.785
Missing teeth	0.76 (1.3)	0.32 (0.8)	<.001
Mean PD	0.62 (0.2)	0.59 (0.2)	.004
PD (%) ≥4 mm	2.17 (5.6)	1.78 (4.6)	.175

Data are number (%) or mean (standard deviation).Note: Number do not add up in some cells due to missing data.

almost 30% to 40% of the children presented with noticeable plaque accumulation and only 3% to 4% of the population presented with clinical signs of gingival inflammation.[41] The differences may be due to the different age groups. Gingivitis in younger age groups usually tends to be plaque independent. The major contributing factors of increased gingival and plaque indices were incompliance with oral hygiene measures and lack of regular dental visits, which is consistent with a study of 3090 Saudi students, where 22.6% had never visited the dentist. That study showed a correlation between the use of dental services and periodontal health status, especially if the services were suggested by the dentist or the patient was given oral hygiene instructions (i.e. taught how to brush by the dentist).[24] Toothbrushing is the most prevalent method of plaque control at home. Lack of plaque reduction despite satisfactory brushing frequency seems to be attributed to a lack of oral hygiene practices and skills, which also influences the efficiency of self-performed mechanical plaque removal in adults.[42] Therefore, studies on oral hygiene techniques indicate that appropriate techniques in use for a long time (modified Bass technique, modified Stillmann technique, Charter technique) are significant in the prevention of periodontal diseases.[43] Our study indicated that almost all students who brush their tongue brush their teeth. However, only 40% of students who brush their teeth brush their tongue. One study showed significant reductions in plaque levels after 10 and 21 days of tongue brushing.[44] It also showed that tongue brushing was equally effective in reducing plaque deposits in children. Therefore, all the other oral hygiene practices should be stressed out as an adjunctive to toothbrushing during the educational programs to maximize the effect of plaque control measures.

Although oral hygiene instructions have been considerably researched, most of the studies suffer from methodological deficiencies, such as missing control groups.[45,46] The importance of education was demonstrated in a study in Edinburgh. School children who received 20 minutes information sessions and take-home educational material had statistically significant improvements in plaque scores and gingival health compared to those who did not.[47] The present study used the half-mouth study design, which may underestimate the disease prevalence. The data on oral hygiene practices was self-reported and may thus have been affected by social desirability bias.

In conclusion, there was a high prevalence of gingivitis among the study sample and it was related to oral hygiene practices. Therefore, emphasis on the importance of tooth and tongue brushing, flossing and regular dental visits is recommended to prevent gingivitis. Moreover, community instructive and preventative programs should be contemplated and re-implemented on a larger scale—to a larger study population, in both urban and suburban areas, with a larger population size and clearer instructive programs. Although there is good evidence to support toothbrushing only for children, flossing is recommended to develop the necessary skills and establish a habit. Further research on the application of oral health educational and preventive methods is required to improve the oral health status of Saudi population. There is also good evidence to recommend the use of chlorhexidine oral rinse to help prevent gingivitis.[48]

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