Distribution of Plaque and Gingivitis and Associated Factors in 3- to 5-Year-Old Brazilian Children

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ABSTRACT

This cross-sectional study investigated the distribution of plaque and gingivitis and its association with demographic, socioeconomic, and orthodontic variables (spacing in anterior teeth, anterior open bite, and crossbite), and visible plaque level (low, medium, high) in Brazilian preschoolers. The sample comprised 490 3- to 5-year-old children from nursery schools in Canoas, a city in southern Brazil. One single, trained observer examined children's oral cavities and determined visible plaque index (VPI) and gingival bleeding index (GBI). Results showed that 99% of the children had visible plaque and 77% had gingivitis (GBI>0). A positive (r_S=0.32) and significant correlation was found between VPI and GBI. VPI and GBI were significantly higher in posterior teeth and buccal and lingual surfaces. VPI was significantly higher in boys, children of low-income families, and without spacing in maxillary anterior teeth. Gingivitis was associated with absence of spacing in maxillary anterior teeth and plaque level. The most prevalent areas of plaque and gingivitis identified in this study should be taken in consideration during oral hygiene instructions, which should be given to children and mothers—particularly those with a low socioeconomic status—to motivate self-care and prevent gingivitis. (J Dent Child 2006;23:4-10)

KEYWORDS: GINGIVITIS, PLAQUE, RISK FACTORS, PEDIATRIC DENTISTRY

Periodontal disease, one of the most prevalent pathologies of the oral cavity, is found in all age groups.[1-4] The predominant form of periodontal disease in children and adolescents is gingivitis induced by supragingival plaque, which initiates in primary dentition and reaches its peak in adolescence.[2,5-9] Epidemiological studies have demonstrated a great variation in the prevalence of gingivitis in children and adolescents in different populations, with rates ranging from 35% to 100%.[8,10,11]

The accumulation of bacterial plaque on teeth and gingiva is the primary etiological factor of inflammatory periodontal disease. This association was clearly established by a classical experimental study about gingivitis, which demonstrated that plaque is a fundamental prerequisite for the development of gingival inflammation.[12] Several studies have shown, however, that the degree of gingival inflammation is lower in children than in adults exposed to similar amounts of plaque.[13,14] Moreover, no correlation was found between the amount of plaque and the intensity of inflammation of gingival tissues in primary dentition.[14-16] Other factors may affect the occurrence and severity of gingivitis in children, such as immunological, microbiological, and anatomic characteristics.[13,14,17] Also, the effect of demographic and socioeconomic factors on gingivitis has not yet been defined.[18,19]

The gingivitis pattern seen at a young age may, with time, reflect the eventual distribution of attachment loss.[20] Therefore, preventive strategies should be introduced at the time of primary dentition. Preventive programs should be based on the knowledge of the network of multiple causes of gingivitis in this age group, such as the distribution of bacterial plaque in primary dentition and the identification of associated factors.

The purpose of this study was to evaluate the prevalence and distribution of visible plaque and gingivitis, as well as to investigate factors associated with the occurrence of gingivitis in 3- to 5-year-old children.

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METHODS

This cross-sectional study comprised 490 3- to 5-year-old children of both sexes attending 14 public school nurseries randomly selected from a total of 28 nurseries maintained by the municipal government of Canoas, a city in southern Brazil. Children of public schools in Brazil are typically of low socioeconomic level. Exclusion criteria were: (1) systemic disease; (2) chronic use of medication; and (3) presence of permanent teeth. A questionnaire and clinical examinations were used to collect data.

QUESTIONNAIRE

Demographic and socioeconomic data were collected by means of a self-applied questionnaire sent to children's parents. The following data were collected: (1) sex; (2) age; (3) maternal education level; (4) family income; and (5) general health conditions. The number of children classified in relation to family income (N=453) and mother's education (N=323) was smaller due to incomplete data.

CLINICAL EXAMINATION

Dental clinical examination was conducted by a single examiner trained to evaluate visible plaque and gingival bleeding and calibrated for orthodontic variables (κ=0.8). All primary teeth were examined; teeth with less than two thirds of the crown erupted or with coronal destruction were excluded. First, orthodontic characteristics were evaluated:

1. spacing in maxillary and mandibular anterior teeth, considered when the child had spacing between all teeth in anterior segments;
2. anterior open bite; and
3. posterior crossbite.

Children with missing teeth or extensive coronal destruction (N=41) were excluded from orthodontic analysis to avoid misclassification.

After that, the visible plaque index (VPI) was calculated according to a simplified version of the Silness and Löe[21] procedure, which recorded only the presence or absence of visible plaque. The examination consisted of assessment of 4 surfaces on each tooth: (1) mesial; (2) buccal; (3) distal; and (4) lingual. The plaque to be scored had to be visible beyond doubt. For distal and mesial surfaces of teeth that were in contact, plaque scores were determined assessing visible areas of each surface: distobuccal and distolingual areas for distal surfaces and mesiobuccal and mesiolingual areas for mesial surfaces, around the approximal contact points or surfaces. The mean plaque index values for each subject were calculated, representing the percentage of surfaces with visible plaque.

The gingiva's condition was assessed using the Ainamo and Bay[22] gingival bleeding index (GBI), which evaluates bleeding on probing. A Williams periodontal probe was used to obtain the GBI. The probe was smoothly introduced about 0.5 mm into the gingival sulcus and moved along all its extension. All surfaces with marginal bleeding were recorded. The mean gingival index values for each subject were calculated as the percentage of surfaces with gingival bleeding. Gingivitis was defined when a child had at least one surface with bleeding on probing. All examinations were conducted in the morning, and the data were recorded on a standardized clinical form used for statistical analysis.

STATISTICAL ANALYSIS

Data were statistically analyzed with the SPSS for Windows 8.0 software (Statistical Package for the Social Sciences, SPSS, Chicago, Ill). A paired t test was used to test intraindividual differences in VPI. Because of the positively skewed distribution of GBI, means and medians with the 25% and 75% quartiles (Q1 and Q3) were reported in the descriptive analysis of this variable, and the Wilcoxon test was used to test intraindividual differences. The Spearman correlation coefficient was used to define the correlation between VPI and GBI. A *t* test or an analysis of variance (ANOVA) test was used to test differences in VPI between groups.

Statistical significance for the association between gingivitis and demographic variables (sex, age), orthodontic variables (spacing, open bite, and crossbite), socioeconomic variables (maternal education level, family income), and plaque level was determined using simple and multiple logistic regression (adjusted for age and sex). Statistical level of significance was set at $P<.05$.

ETHICAL ASPECTS

This study was approved by the Ethics in Research Committee of Lutheran University of Brazil (ULBRA), Canoas, Brazil. The procedures, possible discomforts, and risks were fully explained to the children and their parents or guardians, and informed consent was obtained prior to the investigation.

RESULTS

The study sample comprised 490 children, 260 (53%) of whom were boys. The sample was evenly distributed by age: 155 3-year-olds (32%), 189 4-year-olds (38%), and 146 5-year-olds (30%) children.

Of the 490 children, 486 (99%) had visible plaque. VPI ranged from 0 to 82.50, and the distribution of this variable was close to normal. Mean VPI (±SD) was 28.42 (±16.56), and median (Q1-Q3) was 25.00 (±16.25-37.50).

Of the children examined, 377 had gingival bleeding, with a gingivitis prevalence rate of 77%. GBI ranged from 0 to 38%, with an asymmetric distribution (skewness=2.07). Mean GBI was 5% (±5.7) and median (Q1-Q3) was 3% (±1.25-6.25); 16% (76/490) of the children in this study had a GBI higher than 10% and accounted for over 50% of all surfaces with gingival bleeding.

The analysis of intraoral distribution showed that VPI was higher on the maxillary arch, in the posterior segment, and in the buccal and lingual surfaces, and these differences were statistically significant ($P<.001$; Table 1). The highest visible plaque rates (93% and 94%) were found in the left and right lower second molars, respectively.

GBI was significantly higher ($P<.001$) in lower teeth, in the posterior segment, and on lingual and buccal surfaces

(Table 1). Left (75) and right (85) lower second molars were also the teeth with the highest GBI rates, which ranged from 45% to 48%.

A positive (r_S=0.32) and significant (*P*<.01) correlation was found between VPI and GBI. The scatter diagram of VPI and GBI (not included) showed that many children, although with an elevated VPI, did not have gingival bleeding.

Table 2 shows VPI according to the exposure variables evaluated. VPI was higher for boys than for girls, and this difference was statistically significant (*P*<.01). No significant difference was found between the different age groups. A higher VPI (*P*=.039) was found for children without spacing in the maxillary anterior teeth. The VPI difference between the groups of variables spacing in mandibular anterior teeth, open bite and crossbite was not statistically significant.

No significant difference was found for maternal level of education. There was a statistically significant difference (*P*=.016), however, between the family income groups—children whose family income was lower than 2 Brazilian minimum wages (approximately US $200/month) had a higher VPI.

Table 3 shows crude and adjusted odds ratios after multivariate analysis. No significant difference in gingivitis prevalence between sexes was found in the crude or adjusted model. The crude model revealed higher odds in the group of 4-year-old children. After adjustment, the association of this variable with outcome was not observed.

Children without spacing in maxillary anterior teeth had a 90% higher probability of having gingivitis in both the crude and the adjusted models. The variables spacing in mandibular anterior teeth, open bite, and crossbite, however, were not associated with gingivitis. No socioeconomic variable was associated with gingivitis in the crude or adjusted model.

To investigate the association between gingivitis and plaque index, the VPI variable was classified in terciles: (1) low index (VPI<20%); (2) medium index (IPV=20%-35%); or (3) high index (IPV>35%). The crude model revealed higher odds of gingivitis in children with a high plaque index than in children with a low index, and no difference was observed between children with low and medium indices. After adjusting for sex and age, however, a difference between the 3 groups was found. Children with a medium plaque index had 60% higher odds of gingivitis than children with a low plaque

Table 1. VPI and GBI Distribution in Relation to Arch, Segment, and Surfaces

Variables	VPI (%) Mean (±SD)	P value*	GBI (%) Mean (±SD)	Median (Q25-Q75)	P value†
Total (n=490)	28.42 (±16.56)		4.82 (±5.73)	2.50 (1.25-6.25)	
Arch					
Maxillary	29.95 (±18.95)	.000	4.23 (±7.58)	0.00 (0.00-5.00)	.000
Mandibular	26.87 (±17.20)		5.41 (±6.00)	5.00 (0.00-7.50)	
Segment					
Anterior teeth	22.14 (18.81)	.000	2.34 (±4.68)	0.00 (0.00-2.08)	.000
Posterior teeth	37.86 (16.99)		8.56 (±9.31)	6.25 (0.00-12.50)	
Surfaces					
Buccal/lingual	38.47 (16.04)	.000	7.85 (±8.78)	5.00 (2.50-10.53)	.000
Proximal	18.37 (19.38)		1.78 (±3.79)	0.00 (0.00-2.50)	

*Paired t test.
†Wilcoxon test.

Table 2. VPI Distribution in Relation to Demographic, Orthodontic, and Socioeconomic Variables

Variables	n	VPI (%) Mean (±SD)	P value*
Sex			
Male	260	30.55 (±17.69)	.002
Female	230	26.02 (±14.85)	
Age (ys)			
3	155	28.78 (±16.35)	.575
4	189	29.05 (±17.15)	
5	146	27.22 (±16.04)	
Maxillary anterior teeth†			.039
With spacing	183	26.16 (±16.01)	
Without spacing	266	29.44 (±16.88)	
Mandibular anterior teeth†			.604
With spacing	202	27.66 (±16.23)	
Without spacing	247	28.47 (±16.90)	
Anterior open bite†			.581
Yes	187	28.62 (±15.85)	
No	262	27.74 (±17.12)	
Posterior crossbite†			.222
Yes	71	25.90 (±12.64)	
No	378	28.52 (±17.21)	
Family income†			.016
<2 minimum wages	152	31.17 (±18.74)	
≥2 minimum wages	301	27.21 (±15.17)	
Mother's education (ys)†			.389
<4	163	30.22 (±17.99)	
4-8	78	27.28 (±15.67)	
>8	82	30.62 (±17.37)	

*t test or ANOVA test.
†The total was smaller than the effective sample (n=490) due to missing information (family income: n=453; mother's education: n=323) or children excluded (n=41) from orthodontic analysis (n=449).

index. Children with a high plaque index had 3 times higher odds of gingivitis than children with a low plaque index.

DISCUSSION

Prevalence of gingivitis in this study (77%) was similar to that found for 5-year-old Swedish children[8] and 6-year-old Icelandic children.[23] Other studies, however, reported gingivitis prevalence rates ranging from 91% to 100%.[10,11,24,25] This variation may reflect criteria to define outcomes rather than differences in populations. Such differences, particularly in gingivitis, affect results and comparisons between studies.[2,9,16] The diagnosis of gingivitis, according to clinical signs such as redness and edema, is subject to interpretation and, particularly, to bias.[11] Therefore, diagnostic criteria should be simplified by using gingival bleeding to evaluate gingival conditions.[26-28] Also, this study was conducted with only one trained examiner, which decreased the possibility of bias.

Visible plaque was found in almost all children. This is similar to previously reported findings,[24,28] which demonstrated that visible plaque is not a variable with appropriate specificity to estimate the risk of gingivitis. VPI, which varied greatly in the children evaluated, is a direct measure of the quality of dental health behavior and is a better criterion to identify children that should be targeted for dental hygiene instruction.[29] Mean VPI found in this study (28%) was similar between the age groups and higher than the VPI values ranging from 8% to 23% at 3 and 5 years of age, as reported by Hugoson and Koch.[30]

Mean GBI found in this study (5%) was the same found by Hugoson and Koch[30] at 3 years of age and lower than that reported by Poulsen and Möller[10] and Carvalho et al.[31] GBI reflects the severity of gingivitis in children. An analysis of measures of dispersion in this study showed that 75% of the children had a GBI lower than or equal to 6%, which indicated low severity in most of the sample. The fact that 16% of the children had more than half of the bleeding surfaces, however, indicated a highly skewed distribution of gingivitis in primary dentition.

The higher incidence of plaque in the maxillary arch and posterior segment has already been reported for pri-

Table 3. Logistic Regression: Odds Ratios (Crude and Adjusted for Age and Sex) and 95% Confidence Intervals (95% CI) for the Association Between Demographic, Orthodontic, and Socioeconomic Variables With Gingivitis

		With gingivitis (GBI>0)		OR for gingivitis (95% CI)				
Variables	n*	n	(%)	Crude		Adjusted		P value
Total	490	377	(77)					
Sex†								.420
Male	260	196	(75)	1.00		1.00		
Female	230	181	(79)	1.21	(0.79-1.84)	1.19	(0.78-1.82)	
Age (ys)‡								.160
3	155	127	(82)	1.00		1.00		
4	189	136	(72)	0.57	(0.34-0.95)	0.65	(0.35-1.22)	
5	146	114	(78)	0.78	(0.45-1.38)	1.17	(0.60-2.31)	
Maxillary anterior teeth§								.003
With spacing	183	127	(69)	1.00		1.00		
Without spacing	266	216	(81)	1.90	(1.23-2.96)	1.93	(1.24-3.00)	
Mandibular anterior teeth§								.101
With spacing	202	148	(73)	1.00		1.00		
Without spacing	247	195	(79)	1.37	(0.88-2.18)	1.45	(0.93-2.26)	
Anterior open bite§								.833
Yes	187	145	(78)	1.12	(0.72-1.74)	1.05	(0.67-1.65)	
No	262	198	(76)	1.00		1.00		
Posterior crossbite§								.543
Yes	71	53	(75)	0.89	(0.50-1.60)	0.83	(0.46-1.51)	
No	378	290	(77)	1.00		1.00		
Family income§								.420
<2 minimum wages	152	114	(75)	1.00		1.00		
≥2 minimum wages	301	236	(78)	1.21	(0.76-1.91)	1.24	(0.73-2.12)	
Mother's education (ys)§								.339
<4	163	117	(72)	0.62	(0.32-1.17)	0.62	(0.32-1.18)	
4-8	78	58	(74)	0.70	(0.33-1.48)	0.68	(0.32-1.45)	
>8	82	66	(81)	1.00		1.00		
Plaque level§								.000
Low	169	115	(68)	1.00		1.00		
Medium	172	133	(77)	1.60	(0.99-2.59)	1.64	(1.01-2.66)	
High	149	129	(87)	3.03	(1.71-5.36)	3.31	(1.85-5.93)	

*The total (n=490) was smaller for orthodontic variables (n=449), family income (n=453), and mother's education (n=323).
†Odds ratios adjusted for sex.
‡Odds ratios adjusted for age.
§Odds ratios adjusted for age and sex.

mary dentition,[32,33] and may be justified by the difficulty to access these regions, especially by preschoolers. Different from findings for permanent teeth,[34] the higher frequency of plaque on buccal and lingual than on proximal surfaces has already been reported for children in the same age group.[30] Plaque on the proximal surfaces seems to increase with age[12] due to anatomic differences between primary and permanent teeth and changes in the morphology of periodontal tissues.[30]

The fact that gingival bleeding was also more prevalent on buccal and lingual surfaces and on posterior teeth showed that such regions should receive special attention when preschoolers receive individualized dental hygiene instructions to control plaque and prevent gingivitis. The predominance of gingival bleeding in the mandibular arch, however, where plaque was less prevalent, points to a possible effect of other factors not evaluated in this study, such as the duration of the microbial challenge.[5] The induction period, defined as the period of time from causal action to disease initiation,[35] may not be completed in the maxillary arch, which may explain, at least in part, why a higher number of surfaces with plaque does not necessarily lead to more surfaces with gingivitis. Bacterial plaque on some regions in the mandibular arch, even when found on fewer surfaces, may remain for a longer time, particularly on lingual surfaces of lower molars, and, thus, cause more gingivitis. Similarly to this study's results, other studies have identified lower primary second molars as the teeth with the highest prevalence of plaque and gingivitis.[8,36]

The positive and significant correlation found between VPI and GBI has already been reported for primary dentition.[1] VPI offered little explanation for the variation in GBI, however, which confirmed that the association between plaque accumulation and gingival inflammation in children is weaker than the association found in adults.[1] In this study, many children did not have gingival bleeding, although their mean visible plaque percentages were elevated. Several studies[13,14,17,36,37] suggest that the degree of gingivitis in children is not directly associated with the amount of plaque, but rather with other factors, such as microbial composition of plaque, differences in immune system, and anatomy of primary teeth.

The strength of association and the biological gradient (presence of a dose-response curve) between the amount of plaque and gingivitis, however, characterize 2 important causality principles[35] and confirm the need to control plaque to prevent gingivitis in primary dentition.

Few studies have evaluated the effect of orthodontic characteristics on plaque accumulation and periodontal disease in children. Silness and Roynstrand[38] found that, among adolescents, surfaces without interdental contact had a more favorable periodontal condition than surfaces with contact. This study revealed that the lack of spacing between maxillary anterior teeth is a risk factor for plaque and gingivitis in primary dentition, which demonstrated the effect of anatomic characteristics on these outcomes. Moreover, this study's results point to the need of individualized instruction for children with such characteristics.

The association between family income and VPI, previously reported for 13- and 14-year-old adolescents,[39] confirms the association between socioeconomic status and health outcomes,[40,41] How socioeconomic status (SES) operates to affect disease is poorly understood.[42] Since plaque is a direct measure of the quality of dental health behavior, however, it is possible that such behavior could moderate or mediate the association between socioeconomic status and plaque. Although this study's results did not find an effect of SES on gingivitis, dental plaque, which plays an important role in the etiology of periodontal disease and caries, was associated with a lower SES. Dental plaque is another effect of socioeconomic adversity, and children of low SES—even at age 3 to 5 years—should be protected. Therefore, these children should receive special attention at a relatively early age to try to change this behavior.[29] Motivational factors are one of the greatest problems in the control and treatment of behavioral diseases,[43,44] and the control of the periodontal health-disease process should start as early as possible so that children learn and form appropriate, lifelong habits. Children with better oral health behaviors have a higher chance of periodontal health in adulthood.[29] Moreover, hygiene habits of preschool children are modeled by family behaviors,[29] particularly maternal behavior.[44,47] Such factors should be considered when implementing oral health programs.

CONCLUSIONS

This study's results found that:

1. plaque was significantly associated with gingival bleeding;
2. gingival bleeding was worse in posterior teeth; and
3. children without spacing in maxillary anterior teeth are at a higher risk of gingivitis.

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