The Prevalence of Gingivitis and Related Risk Factors in Schoolchildren Aged 6–12 Years Old

Xiaoyu Liu
The Second Affiliated Hospital of Jinzhou Medical University
Jianhui Xu
The Second Affiliated Hospital of Jinzhou Medical University
Siwei Li
The Second Affiliated Hospital of Jinzhou Medical University
Xueqin Wang
The Second Affiliated Hospital of Jinzhou Medical University
Jin Liu
The Second Affiliated Hospital of Jinzhou Medical University
Xin Li (**httplixin@163.com**)
The Second Affiliated Hospital of Jinzhou Medical University

Research Article

Keywords: Gingivitis, calculus, children, oral prevention, risk factors

Posted Date: May 20th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1658622/v1

Abstract

Background: Although epidemiological studies have consistently shown that gingivitis is a common disease, there is considerable variation between prevalence rates. This study aimed to understand the epidemiological characteristics of gingivitis, including prevalence, severity, intraoral distribution, and associated risk factors of each classification of gingivitis, in children aged 6–12 years in Jinzhou, China.

Methods: A multistage, whole-group, randomized sample of 2,880 children aged 6–12 years in Jinzhou City, China, was selected and clinically examined. Each selected child completed a questionnaire on sociodemographic factors and oral health behaviors associated with gingivitis in collaboration with the investigator and teacher. Bleeding gums were recorded using the gingival index, and bleeding gum was defined as gingivitis when the number of bleeding teeth was greater than or equal to 10% of the number of teeth examined. Gingivitis was further categorized into localized gingivitis (30%≥number of teeth positive for gingival bleeding≥10%) and generalized gingivitis (number of positive for gingival bleeding >30%).

Results: The prevalence of gingivitis in children aged 6–12 years in Jinzhou was 28.58%, including 701 cases of localized gingivitis (24.3%) and 122 cases of generalized gingivitis (4.2%). There were 429 cases (28.3%) of gingivitis in males and 394 cases (28.9%) in females, with no statistically significant difference in prevalence between males and females (P>0.05). Chi-square tests and binary logistic regression analysis showed that aging, tusk, plaque, and dental crowding were significantly associated with a high prevalence of gingivitis.

Conclusions: Our study showed that tartar, heavy plaque, poor oral health behavior, and oral health awareness are associated with the prevalence of gingivitis and maintaining children's oral health requires professional guidance and regular preventive care.

Background

Chronic gingivitis is the most common periodontal infection in children and adolescents and includes chronic gingivitis caused by plaque, steroid hormone-related gingivitis, and drug-influenced gingival overgrowth, and the most common is chronic gingivitis.[1] Plaque microorganisms can initiate periodontal diseases.[2] Gingivitis is of particular clinical significance as it is considered a pre-existing stage of periodontitis, the development of which occurs in only long-term gingivitis.[3] The initial symptoms of gingivitis are not obvious, and bleeding on probing and redness of the gums do not occur until early lesions of gingivitis are present. It is usually painless, rarely causes spontaneous bleeding, and its clinical symptoms are not obvious enough for most patients to recognize the disease.[4] A study showed that during adolescence, periodontal tissues become more sensitive to several irritants, such as plaque, calculus, and food debris collected in the gingival sulcus, owing to an increase in sex hormones (estrogen and progesterone).[5] It is therefore necessary to systematically examine children's oral hygiene and educate them about oral hygiene and preventive measures of oral diseases before they reach puberty.

Several studies have shown that effective long-term prevention of gingivitis can control the onset of attachment loss, making the long-term prevention essential for the primary prevention of periodontitis.[6] As mentioned above, maintaining good and healthy oral hygiene environment during childhood is beneficial for oral health in adulthood. In addition to a plaque, other factors including body mass index (BMI), sex, and parental education may directly or indirectly influence the development of gingivitis.[7] A survey in Sichuan province, China showed that children from urban households had a lower prevalence of gingivitis compared to that had by children from rural households and that higher levels of parenting had a positive impact on gingival status.[8] Therefore, our examination was not localized to periodontal tissues, but other aspects were also examined, and questionnaires on socio-demographic factors and gingivitis-related issues were distributed.

Although epidemiological studies have consistently shown that gingivitis is a common disease, there is considerable variation between prevalence rates, which can be explained by inter-population variability; however, the differences may also be due to the varying criteria used for diagnosis. The prevalence of periodontal disease (including gingivitis) was based on the Community Periodontal Index (CPITN).[9] However, the CPITN is not used to define the gingivitis grades. His scoring criteria were used to screen for periodontitis; therefore, the severity of the disease could not be defined. The joint EFP/AAP workshop defined gingivitis as children with a positive gingival bleeding score ≥ 10% and no AL or PD (≥ 4 mm), which in turn was categorized into localized and generalized gingivitis. Patients were considered to have healthy periodontal tissue if they presented with a positive gingival bleeding score of < 10% at probing and if the periodontal tissue was intact.[10] To grade the gingival status more clearly, we used the Gingival Index (GI) as a diagnostic criterion. This helped us to better observe and analyze the severity and distribution of gingivitis.

According to the results of an oral epidemiological survey, prevalence varies greatly from region to region. The prevalence of gingivitis in children aged 12 years was 46.63% in the southern Chinese province of Sichuan[8] and 29.1% in the central province of Shandong.[11] The prevalence also varies by ethnic group, with 93%, 61%, and 88% prevalence reported among the Dai, Hani, and Lisu ethnic groups in Yunnan Province, China, respectively.[12–14] No data are available for Jinzhou, which is a transportation hub in the north with a complex population comprising multiple ethnic groups. Therefore, the aim of this study was to investigate (1) the prevalence of gingivitis in children aged 6–12 years in Jinzhou, China, (2) the risk factors affecting the occurrence of gingivitis, and (3) the factors associated with the aggravation of gingivitis and also to use these findings as a reference for improving the direction of oral catharsis.

Table 1
Survey Population Composition

		N	%
Gender	Male	1516	52.64
	Female	1314	47.36
Age(year)	6	359	12.47
	7	416	14.44
	8	322	11.18
	9	583	20.24
	10	333	11.56
	11	416	14.44
	12	451	15.66
Area	Han	2004	69.58
	Man	728	25.28
	Other	148	5.14

Methods

A multi-stage, whole-group, random sampling method was used. Based on the Fourth National Oral Epidemiological Survey, the prevalence of gingivitis among 12-year-old children in Jinzhou, China is approximately 58%.[15] The sample size was increased by 10%, considering issues such as missed visits and individual samples that did not meet the inclusion criteria. A total of 2,880 children aged 6–12 years were sampled from all counties and districts in Jinzhou, China. The specific demographic characteristics are presented in Table 1. This epidemiological investigation was approved by the Ethics Committee of the Second Hospital of Jinzhou Medical University, China. A signed informed consent form was obtained from the family of the child before the children participated in the study.

The inclusion criteria were (1) age 6–12 years, (2) no other systemic diseases, (3) have been informed of the study details and have signed a consent form, (4) have lived in Jinzhou City for more than 6 months, and (5) eruption of the first molar.

The exclusion criteria were (1) people with congenital oral diseases, (2) people with incomplete or inaccurate oral examination data, (3) children who were unable to cooperate with the examination after behavioral and psychological induction, (4) children undergoing orthodontic treatment, and (5) children whose first molar had not yet erupted.

Inspection methods

On-site inspections occurred between September 2021 and 2021. Examination was performed in the sitting position under LED light. Intra-oral examination was performed using conventional oral examination instruments including plane mouth mirror, CPI probe, instrument cassette (one for sterilized instruments and the other for used instruments), disposable cap, mask, and gloves. The WHO Oral Health Assessment Form, which is a modified version of clinical examination, was used to obtain the clinical examination report. The oral cavity of each participant was assessed by a clinical examiner who was assisted by a recorder (the recorded the results of the examination results). The clinical examiner is a practicing dentist with at least 3 years of experience.

When the clinical examination was completed, teachers distributed the questionnaire to the parents with reference to the 4th National Oral Epidemiological Survey. The questionnaire covered general information about the respondents, their oral health behavior, dietary habits, poor oral habits, and family oral health awareness. The questionnaires were collected, quality checked, and filled in by the auditors. All examination and questionnaire results were inputted into an electronic computer to create a database for statistical processing and analysis of data, which was used to calculate the prevalence and risk factors of gingivitis, respectively, in children aged 6–12 years in Jinzhou, China.

Inspection criteria

Using the GI as a screening standard for gingivitis, a probe-based examination was combined with visual examination. The CPI probe was gently inserted into the gingival sulcus, and the entire area of the gingival sulcus was probed with the probe being parallel to the long axis of the tooth and close to the root, making short up and down quivering movements. In addition, we assessed for bleeding gums and scored the gum condition with not more than 20 g of force. Record the scores of all stages, including 1 score (red and swollen gums but no probing bleeding), where 2 and 3 are indicators of positive probing bleeding gingivitis (with probing bleeding). The fraction of each tooth in the mouth, the non-eruption of permanent teeth, and the fraction of milk teeth in the same position were recorded, and the second and third molars were not recorded. Gingivitis was defined as children with ≥ 10% positive teeth for gingival bleeding and with no AL or PD (≥ 4 mm), which was further categorized into localized gingivitis (30%number of teeth positive for gingival bleeding ≥ 10%) and generalized gingivitis (number of positive teeth for gingival bleeding > 30%).[10] No other diagnostic methods or equipment were used, including oral radiography. The Löe-Silness plaque index, a visual inspection standard, has also been chosen and used to classify plaques into four classes: none, light, medium, and heavy. Several risk factors that may affect gingivitis, including tartar, number of decayed fillings, BMI, deep coverage, and crowding, were also examined. In addition, to avoid examiner bias and training of six physicians who participated in the field survey, 20 children were selected for examination prior to the survey for standard consistency tests, and all the kappa values were greater than 0.87. To further reduce examiner bias, the examination was repeated in the groups by 2 physicians.

Statistical analysis

The data from this survey were double-entered using Epidata, and all statistical processing of the data was performed using SPSS 25.0. Percentages were used to describe categorical data, showing the prevalence of each factor. Two-factor analysis using Pearson's chi-square test was performed, and statistically significant variables were further included in the binary logistic regression analysis and in the calculation of dominance ratios (OR) and 95% confidence intervals (CI) to identify risk factors. The statistically significant level was $\alpha = 0.05$, *and* $P < 0.05$ was considered statistically significant.

Results

Of a total of 3,100 participants, 15 did not complete the questionnaire, the parents of 15 participants did not sign the informed consent form, and 90 were excluded as they did not meet the inclusion criteria, resulting in 2,880 participants receiving a complete clinical examination and completing the questionnaire (participation rate, 92.9%). Gingivitis was detected in 823 participants, with an overall prevalence of 28.58%. The prevalence of localized and generalized gingivitis was 24.34% and 4.24%, respectively. Of the 2,880 participants, 52.64% were males, and 47.36% were women. The prevalence of gingivitis in males was 28.3%, of which 23.28% was localized gingivitis and 5.01% was generalized gingivitis. The prevalence of gingivitis in females was 28.89%, of which 25.51% was localized gingivitis and 3.37% was generalized gingivitis. The prevalence of gingivitis tended to increase with age, and age had a statistically significant effect on the prevalence of gingivitis, with a statistically significant difference ($P < 0.05$). The prevalence of gingivitis was approximately the same among the different ethnic groups. In addition, there was no statistical difference in the prevalence of gingivitis between urban and rural populations ($P > 0.05$).

The chi-square test was used to analyze the relationship between demographic factors and gingivitis (Table 2). Age had a statistically significant effect on the prevalence of gingivitis, with a statistically significant difference ($P < 0.05$). Ethnicity did not affect the prevalence of gingivitis ($P > 0.05$).

Table 2
Relationship between demographics and prevalence of gingivitis in children aged 6–12 years in Jinzhou

Variable	*N*	Gingivitis			Normal	X^2	*P*
		Total (n = 823)	Localized gingivitis (n = 701)	Generalized Gingivitis (n = 122)	(n = 2057)		
		n(%)	n(%)	n(%)	n(%)		
Gender							
Male	1516	429(28.3)	353(23.28)	76(5.01)	1087(71.7)	0.121	0.728
Female	1364	394(28.89)	348(25.51)	46(3.37)	970(71.11)		
Age							
6	359	63(17.55)	58(16.16)	5(1.39)	296(82.45)	73.27	0.000
7	416	78(18.75)	66(15.86)	12(2.89)	338(81.25)		
8	322	102(31.68)	91(28.26)	11(3.42)	220(68.32)		
9	583	169(28.99)	149(25.56)	20(3.43)	414(71.01)		
10	333	99(29.73)	81(24.32)	18(5.41)	234(70.27)		
11	416	132(31.73)	110(26.44)	22(5.29)	284(68.27)		
12	451	180(21.87)	146(31.53)	34(7.34)	271(60.08)		
Ethnicity							
Han	2004	574(28.64)	489(24.4)	85(4.24)	1430(71.36)	1.481	0.477
Man	728	213(29.27)	180(24.73)	33(4.53)	515(70.74)		
Other	148	36(24.32)	32(21.62)	4(2.7)	112(75.68)		
Area							
Urban	2580	732(28.37)	623(24.15)	109(4.22)	1848(71.63)	0.506	0.477
Rural	300	91(30.33)	78(26)	13(4.33)	209(69.67)		

Figure 1 shows the characteristics of the intraoral distribution of the GI score for each tooth position, with the upper right lateral incisor having the highest number of prevalent teeth in the total tooth position in the full dental row. The first lower right molar was the most affected lower jaw teeth. Overall, the anterior teeth scored higher on the GI than that scored by the posterior teeth, and the right side scored higher than that scored on the left.

Relationship between each risk factor and gingivitis and between oral health behaviors and gingivitis are reported in Table 3. Plaque, tartar, crowding, and deep coverage was significantly related with the prevalence of gingivitis ($P < 0.05$). There was no statistically significant relationship between BMI and the prevalence of gingivitis. Among oral health behaviors (Table 4), the prevalence of gingivitis was significantly affected by bleeding from brushing, time spent brushing, flossing, and rinsing after meals ($P < 0.05$).

Table 3
Analysis of risk factors associated with gingivitis in children aged 6–12 years in Jinzhou

Variable	*N*	Gingivitis(n = 823)	Normal(n = 2057)	χ^2	*P*
		n(%)	n(%)		
Dental plaque					
No	414	42(10.15)	372(89.85)	818.32	0.000
Mild	1334	143(10.72)	1191(89.28)		
Moderate	996	528(53.01)	468(46.99)		
Severe	136	110(80.88)	26(19.12)		
Tusk					
No	1996	221(11.07)	1775(88.93)	976.199	0.000
Yes	884	602(68.09)	282(31.91)		
BMI					
Slim	104	33(31.73)	71(68.27)	0.528	0.913
Normal	1426	406(28.47)	1020(71.53)		
Obesity	824	234(28.4)	590(71.6)		
Overweight	526	150(28.52)	376(71.48)		
Crowded teeth					
No	2086	271(12.99)	1815(87.01)	900.434	0.000
Yes	794	552(69.52)	242(30.48)		
Deep Coverage					
NO	2621	646(23.5)	1975(76.5)	220.467	0.000
Yes	259	177(79.92)	82(20.08)		

Table 4
Relationship of oral health behaviors and health awareness with gingivitis

Variable	*N*	Gingivitis (N = 823)	Normal (N = 2057)	X^2	*P*
		n(%)	n(%)		
Bleeding from brushing teeth					
Never	2038	400(19.63)	1638(80.37)	325.874	0.00
Sometimes	762	355(46.58)	407(53.41)		
Frequently	80	68(85)	12(15)		
Daily brushing frequency					
Three or more times a day	48	13(27.08)	35(72.92)	0.24	0.887
Twice a day	2124	603(28.39)	1521(71.61)		
Once a day	708	207(29.24)	501(70.76)		
Brushing time					
>3min	542	139(25.65)	403(74.35)	6.223	0.045
2～3min	1542	432(28.02)	1110(71.98)		
<2min	796	252(31.66)	544(68.34)		
Flossed or not					
Yes	1153	243(21.08)	910(78.92)	53.004	0.000
No	1727	580(33.58)	1147(66.42)		
Whether to rinse your mouth after a meal					
Every time	505	143(28.32)	362(71.68)	0.449	0.799
Sometimes	1876	543(28.94)	1333(71.06)		
No mouthwash	499	137(27.45)	362(72.55)		
Have you seen a dentist in the past year					
Yes	2007	445(22.17)	1562(77.83)	133.039	0.000
No	873	378(43.3)	495(56.7)		
Brushing prevents bleeding gums					
Yes	2068	595(28.77)	1473(71.23)	0.252	0.882

Variable	*N*	Gingivitis (N = 823)	Normal (N = 2057)	X^2	*P*
		n(%)	n(%)		
No	428	118(27.57)	310(72.43)		
Unknown	384	110(28.65)	274(71.35)		
It is important to have regular dental check-ups					
Yes	2820	807(28.62)	2013(72.38)	10.576	0.005
No	17	7(41.18)	10(58.82)		
Unknown	43	9(20.93)	34(79.07)		
Causes of bleeding from brushing teeth					
Normal	72	25(34.72)	47(65.28)	4.205	0.24
Excessive force	566	175(30.92)	391(69.08)		
Inflammation of the gums	1569	444(28.3)	1125(71.7)		
Unknown	673	179(26.6)	494(73.4)		
Your parents will supervise your tooth brushing every day					
Yes	1425	396(27.79)	1029(72.21)	1.241	0.538
No	232	72(31.03)	160(68.97)		
Sometimes	1223	355(29.03)	868(70.97)		

Variables that were statistically significant ($P < 0.05$) in the chi-square test were included in the binary logistic regression analysis (Fig. 2). We used OR = 1 as the criterion for differentiating the risk factors. Age, tusk, moderate/severe dental plaque, crowded teeth, deep coverage, bleeding during brushing that was frequent or occurred sometimes, lack of flossing, and the visiting a dentist in a year were associated with the development of gingivitis.

The risk factors associated with gingivitis were then included in a binary logistic regression analysis with localized versus generalized gingivitis as the dependent variables (Fig. 3). The risk factors affecting the progression of localized gingivitis to generalized gingivitis were tusk, severe dental plaque, crowded teeth, bleeding teeth during brushing that occurred sometimes or was frequent, and severe dental plaque is a risk factor for generalized gingivitis.

Discussion

This study found a high prevalence of gingivitis in children aged 6–12 years in Jinzhou, China; however, in terms of severity, the prevalence of generalized gingivitis, which is less severe, was only 4.24%, with the majority of gingivitis being localized. This group of patients require more professional oral hygiene education. In a 2021 survey conducted in Guangdong Province, China, the prevalence rates of localized gingivitis and generalized gingivitis in 12-year-old children were 21.8% and 5.4%, respectively. Both studies used the same diagnostic criteria for gingivitis that was used in this study; however, the gingival bleeding index used for the examination of gingival bleeding was not the same as the examination criteria (GI) used in this study. Therefore, the findings cannot be compared. It is difficult to compare the results of various studies because there is no clear-cut method for gingivitis screening. To study the prevalence and severity of gingivitis in children more comprehensively and systematically, we examined all teeth in our survey and defined and graded gingivitis using the GI.

Regarding the distribution of gingivitis within the mouth, several studies have found that the gingiva of anterior teeth and their gingival papillae are more susceptible to the severity of gingivitis than that observed with the posterior teeth.[1] Addy et al. explained that the possible reason for this is that cuspids and premolars are easier to clean, which may also be the reason why lateral incisors and molars are more likely to suffer from gingivitis.[16] We found higher scores on the right side relative to the left side in all dental positions of the mouth, and similar results were obtained in a survey of gingivitis in primary school children in Bucharest, Romania, which suggested that gingivitis might be related to habitual hand brushing.[17] However, it has also been shown that there is no difference in the occurrence of gingivitis between left-handed and right-handed brushing.[18] Further longitudinal studies are required to confirm the association between handedness and gingivitis.

Some epidemiological reports have shown that gingivitis is more common in males than in females in the following two ways. Firstly, females have better oral hygiene than that of males. On the other hand, studies have shown that sex hormones play an important role in influencing the progression of periodontal tissue disease. In clinical trials, patients with adequate estrogen levels had more plaque and no increase in gingival inflammation compared to those had by patients with inadequate estrogen levels.[19] Some studies have suggested that sex is a risk factor for gingivitis[17,20]; however, this result was not found in our survey ($P > 0.05$). The *p*ossible causes are that peak gingivitis occurs in girls aged 11–13 years and in boys aged 13–14 years,[21] and the current survey recruited respondents from different age ranges. The present investigation found that the occurrence of gingivitis was associated with increasing age, which is consistent with other experimental findings. Therefore, compared to older children, younger children have better periodontal health.[20] The prevalence of generalized gingivitis increased slightly with age but did not differ significantly in the one-way logistic regression analysis.

Moderate and severe dental plaque and tusk are risk factors for the development of gingivitis, which is consistent with findings from national and international studies.[8,22,23] Bacterial biofilm that forms a dental plaque is an important factor for triggering gingivitis, while calculus exists in the form of calcified

biofilm and bacterial deposits in mineralized material.[24] Plaque accumulates more rapidly around inflamed gums than around gums without inflammation, and the plaque biofilm reacts immunologically with the host to produce an inflammatory infiltrate in the gingival tissue, leading to the development of gingivitis.[25] The extent of gingivitis increases as the amount and location of plaque buildup increase, further confirming the association of heavy plaque with generalized gingivitis. Once the plaque biofilm is removed, changes in periodontal tissue are completely reversible.[26] In addition, plaque is an indicator of poor oral hygiene; therefore, a good oral hygiene environment is important for the health of periodontal tissues.

Deep coverage and crowded teeth are the two risk factors associated with the development and severity of gingivitis. A previous study showed increased coverage and inflammation associated with lack of lip sealing, which causes dry environment and is detrimental to the health of gingival tissue.[27] Our study findings are consistent with that obtained in the previous study.[27] However, Thiam et al. showed that deep coverage was significantly associated with clinical attachment loss and the development of periodontal pockets but not with gingival inflammation and plaque accumulation.[28] Crowded teeth can damage the shape of the gums and alveolar bone and change the shape of the gingival papillae, further leading to thinning of the bone septum and reduction in blood vessels and cancellous bone, which makes the periodontal tissue less resistant to microbial attack.[29] There is evidence of a direct relationship between the number of contact areas overlapped by tooth displacement and the number of red, bleeding areas in the gums. There was also a significant correlation between dental crowding and the amount of plaque, with irregularities in tooth alignment, leading to an increase in plaque area on adjacent surfaces.[28,30] The correlation between dental crowding and generalized gingivitis was further examined. Dental crowding is a risk factor for the development of gingivitis, but plaque control is key to controlling the development of gingivitis.

In terms of oral health behaviors and health awareness, we found that poor cleaning habits and poor health awareness increased the prevalence of gingivitis. Higher prevalence of gingivitis was observed in patients who have not flossed or brushing time is less than three minutes. Regular interdental and frequent dental cleaning are effective in reducing plaque and tartar, thereby reducing the incidence and severity of gingivitis.[31] Although toothbrushes alone have less impact on reducing plaque tartar and gingivitis, its combination with interdental cleaning maximizes the oral environment.[32] Occasional or frequent bleeding from tooth brushing is an important risk factor for the development and severity of gingivitis, indicating that this group is not aware that bleeding gums are associated with gingivitis. Self-assessment of bleeding during teeth brushing is a valid method in the daily testing of gingival health,[33] raising periodontal awareness in the population and reducing the prevalence and severity of gingivitis through individual gingival health monitoring. Therefore, there is a need to further enhance oral hygiene awareness and education regarding periodontal tissue care. Unsurprisingly, not visiting a dentist within a year is a risk factor for the onset and exacerbation of gingivitis. Therefore, it is essential to receive professional oral hygiene advice and develop good awareness of health care to reduce the incidence of gingivitis. When personal oral hygiene skills are poor, receiving guidance from a professional dentist

before performing oral cleaning can complement the knowledge of oral health care and better improve oral hygiene.[34]

Conclusions

Our findings showed shown that tusk, severe dental plaque, poor oral health behavior, and oral health awareness are associated with the prevalence of gingivitis and that maintaining children's oral health requires professional guidance and regular preventive care.

Abbreviations

BMI: body mass index

CPITN: Community Periodontal Index

EFP/AAP: American Academy of Periodontology/European Federation of Periodontology

AL: attachment loss

PD periodontal probing depth

GI: Gingival index

WHO: World Health Organization

OR: odds ratio

CI: confidence intervals

Declarations

Ethics approval and consent to participate

This epidemiological investigation was approved by the Ethics Committee of the Second Hospital of Jinzhou Medical University, China. This epidemiological survey is in line with the Declaration of Helsinki.A signed informed consent form was obtained from the family of the child before the children participated in the study.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due [REASON WHY DATA ARE NOT PUBLIC] but are available from the corresponding author on reasonable request.

Competing interests

The author declares that there are no competing interests.

Funding

This research received no specific grant from any funding agency in the pub lic, commercial, or not for profit sectors.

Authors' contributions

XY L contributed in the design of the study wrote the first draft of the manuscript, revised the manuscript, participated in data interpretation. JH X, SW L and XQ W participated in acquisition of data. X L was major contributor in writing and revising of the manuscript, participated in data interpretation, and provided critical comments. J L participated in statistical analyses and interpretation. All authors read and approved the final manuscript.

Acknowledgments

Not applicable.

Consent for publication

Not applicable

References

1. Oh TJ, Eber R, Wang HL. Periodontal diseases in the child and adolescent. J Clin Periodontol. 2002;29:400–10.
2. Tatakis DN, Kumar PS. Etiology and pathogenesis of periodontal diseases. Dent Clin North Am. 2005;49:491–516, v.
3. Lang NP, Schätzle MA, Löe H. Gingivitis as a risk factor in periodontal disease. J Clin Periodontol. 2009;36 Suppl 10:S3-S8.
4. Blicher B, Joshipura K, Eke P. Validation of self-reported periodontal disease: a systematic review. J Dent Res. 2005;84:881–90.
5. Chaitra TR, Manuja N, Sinha AA, Kulkarni AU. Hormonal effect on gingiva: pubertal gingivitis. BMJ Case Rep. 2012;2012:bcr2012006193.
6. Ramseier CA, Anerud A, Dulac M, Lulic M, Cullinan MP, Seymour GJ, et al. Natural history of periodontitis: disease progression and tooth loss over 40 years. J Clin Periodontol. 2017;44:1182–91.
7. Lock NC, Susin C, Damé-Teixeira N, Maltz M, Alves LS. Sex differences in the association between obesity and gingivitis among 12-year-old South Brazilian schoolchildren. J Periodontal Res. 2020;55:559–66.

8. Chen H, Zhang R, Cheng R, Xu T, Zhang T, Hong X, et al. Gingival bleeding and calculus among 12-year-old Chinese adolescents: a multilevel analysis. BMC Oral Health. 2020;20:147.
9. Ainamo J, Barmes D, Beagrie G, Cutress T, Martin J, Sardo-Infirri J. Development of the World Health Organization (WHO) community periodontal index of treatment needs (CPITN). Int Dent J. 1982;32:281–91.
10. Trombelli L, Farina R, Silva C, Tatakis DN. Plaque-induced gingivitis: case definition and diagnostic considerations. J Clin Periodontol. 2018;45 Suppl 20:S44-S67.
11. Zhang M, Lan J, Zhang T, Sun W, Liu P, Wang Z. Oral health and caries/gingivitis-associated factors of adolescents aged 12–15 in Shandong province, China: a cross-sectional Oral Health Survey. BMC Oral Health. 2021;21:288.
12. Zhang S, Xu B, Liu J, Lo EC, Chu CH. Dental and periodontal status of 12-year-old Dai school children in Yunnan Province, China: a cross-sectional study. BMC oral health. 2015;15:117.
13. Chen J, Zhou N, Xu B, Li Y, Zhang S, Chu C. Oral health status of 12-year-old Hani children in the Yunnan Province of China: a cross-sectional study. Int J Environ Res Public Health. 2021;18:5294.
14. Chen KJ, Liu J, Xu B, Li Y, Li Y, Zhang S, et al. Oral health status of 12-year-old children in Lisu minority ethnic group in China: a cross-sectional study. BMC oral health. 2021;21:27.
15. Chen X, Ye W, Zhan JY, Wang X, Tai BJ, Hu Y, et al. Periodontal status of Chinese adolescents: findings from the 4th National Oral Health Survey. Chin J Dent Res. 2018;21:195–203.
16. Addy M, Griffiths G, Dummer P, Kingdom A, Shaw WC. The distribution of plaque and gingivitis and the influence of toothbrushing hand in a group of South Wales 11–12 year-old children. J Clin Periodontol. 1987;14:564–72.
17. unieru C, Klinger A, Băicuș C, Funieru E, Dumitriu HT, Dumitriu A. Epidemiology of gingivitis in schoolchildren in Bucharest, Romania: a cross-sectional study. J Periodontal Res. 2017;52:225–32.
18. Addy M, Dummer PM, Hunter ML, Kingdon A, Shaw WC. The effect of toothbrushing frequency, toothbrushing hand, sex and social class on the incidence of plaque, gingivitis and pocketing in adolescents: a longitudinal cohort study. Community Dent Health. 1990;7:237–47.
19. Mascarenhas P, Gapski R, Al-Shammari K, Wang HL. Influence of sex hormones on the periodontium. J Clin Periodontol. 2003;30:671–81.
20. Bashirian S, Seyedzadeh-Sabounchi S, Shirahmadi S, Soltanian AR, Karimi-Shahanjarini A, Vahdatinia F. Socio-demographic determinants as predictors of oral hygiene status and gingivitis in schoolchildren aged 7–12 years old: a cross-sectional study. PLoS one. 2018;13:e0208886.
21. Nakagawa S, Fujii H, Machida Y, Okuda K. A longitudinal study from prepuberty to puberty of gingivitis. Correlation between the occurrence of Prevotella intermedia and sex hormones. J Clin Periodontol. 1994;21:658–65.
22. Fan W, Liu C, Zhang Y, Yang Z, Li J, Huang S. Epidemiology and associated factors of gingivitis in adolescents in Guangdong Province, Southern China: a cross-sectional study. BMC Oral Health. 2021;21:311.

23. Sreenivasan PK, Prasad KVV. Distribution of dental plaque and gingivitis within the dental arches. J Int Med Res. 2017;45:1585–96.
24. Akcali A, Lang NP. Dental calculus: the calcified biofilm and its role in disease development. Periodontol 2000, 2018;76:109 – 15.
25. Murakami S, Mealey BL, Mariotti A, Chapple ILC. Dental plaque-induced gingival conditions. J Periodontol. 2018;89 Suppl 1:S17-S27.
26. Trombelli L, Farina R, Silva CO, Tatakis DN. Plaque-induced gingivitis: case definition and diagnostic considerations. J Clin Periodontol. 2018;45 Suppl 20:S46-S73.
27. Geiger AM, Wasserman BH, Turgeon LR. Relationship of occlusion and periodontal disease. VI. Relation of anterior overjet and overbite to periodontal destruction and gingival inflammation. J Periodontol. 1973;44:150–7.
28. Ngom PI, Diagne F, Benoist HM, Thiam F. Intraarch and interarch relationships of the anterior teeth and periodontal conditions. Angle Orthod. 2006;76:236–42.
29. Diedrich P. Periodontal relevance of anterior crowding. J Orofac Orthop. 2000;61:69–79.
30. Ashley FP, Usiskin LA, Wilson RF, Wagaiyu E. The relationship between irregularity of the incisor teeth, plaque, and gingivitis: a study in a group of schoolchildren aged 11–14 years. Eur J Orthod. 1998;20:65–72.
31. Crocombe LA, Brennan DS, Slade GD, Loc DO. Is self interdental cleaning associated with dental plaque levels, dental calculus, gingivitis and periodontal disease?. J Periodontal Res. 2012;47:188–97.
32. Gallie A. Home use of interdental cleaning devices and toothbrushing and their role in disease prevention. Evid Based Dent. 2019;20:103–4.
33. Kallio P. Self-assessed bleeding in monitoring gingival health among adolescents. Dent Oral Epidemiol. 1996;24:128–32.
34. Barbe AG, Al-Barwari A, Hamacher S, Deinzer R, Weik U, Noack MJ. Effectiveness of brushing teeth in patients with reduced oral hygiene by laypeople: a randomized, controlled study. BMC Oral Health. 2021;21:225.

Figures

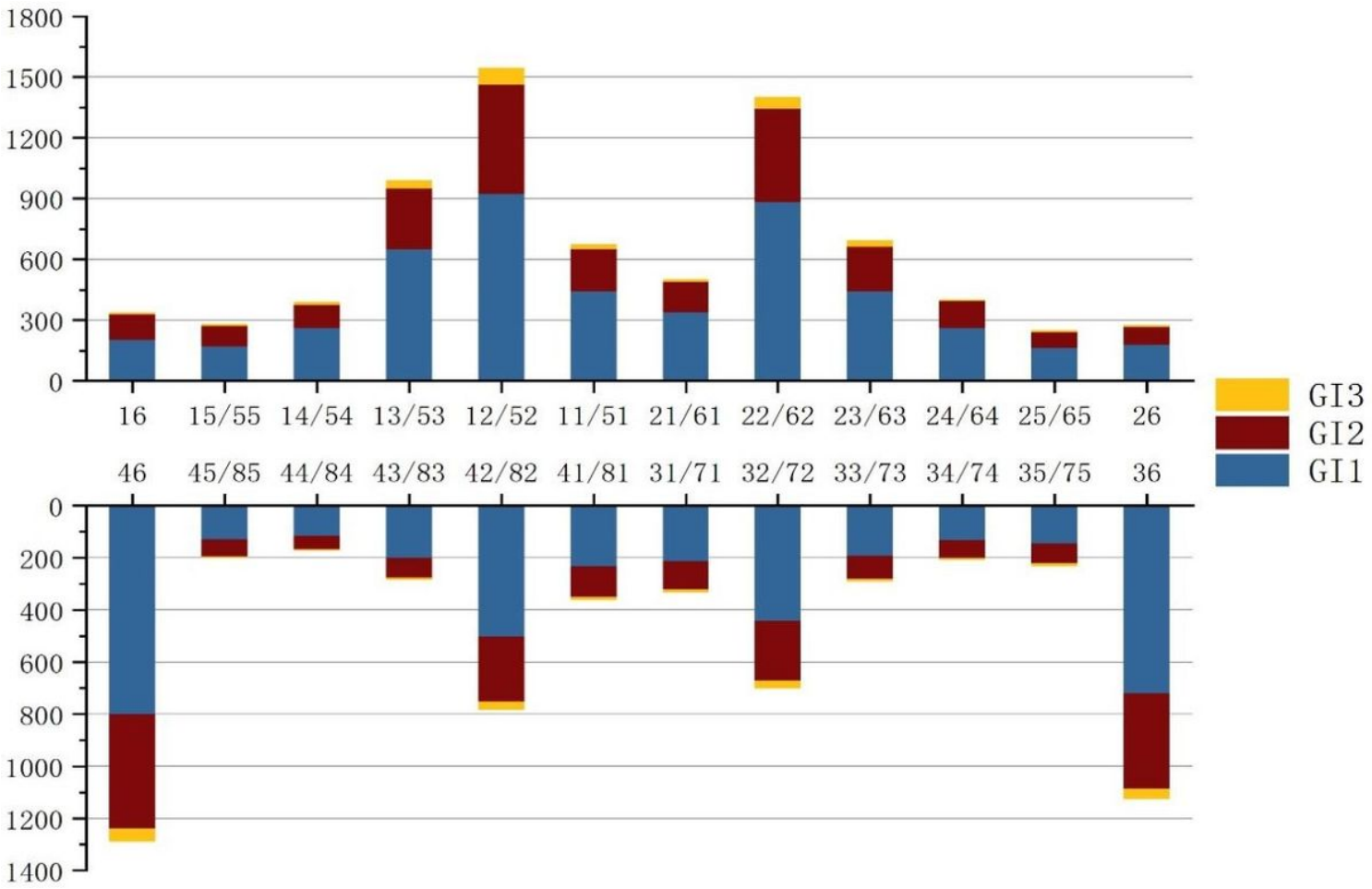

Figure 1

Distribution characteristics of gingival index scores for different tooth positions

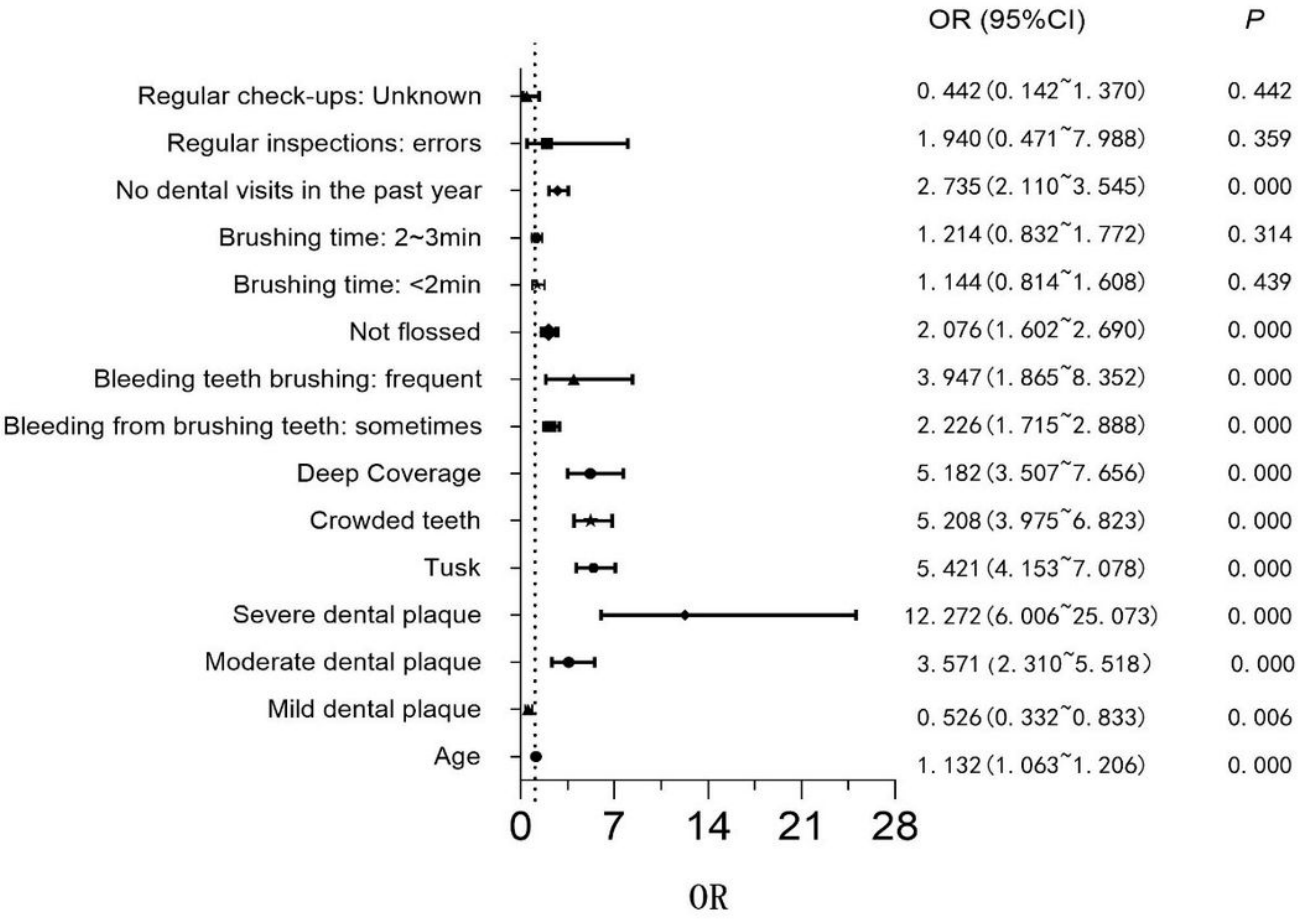

Figure 2

Binary logistic visual regression analysis of risk factors for gingivitis

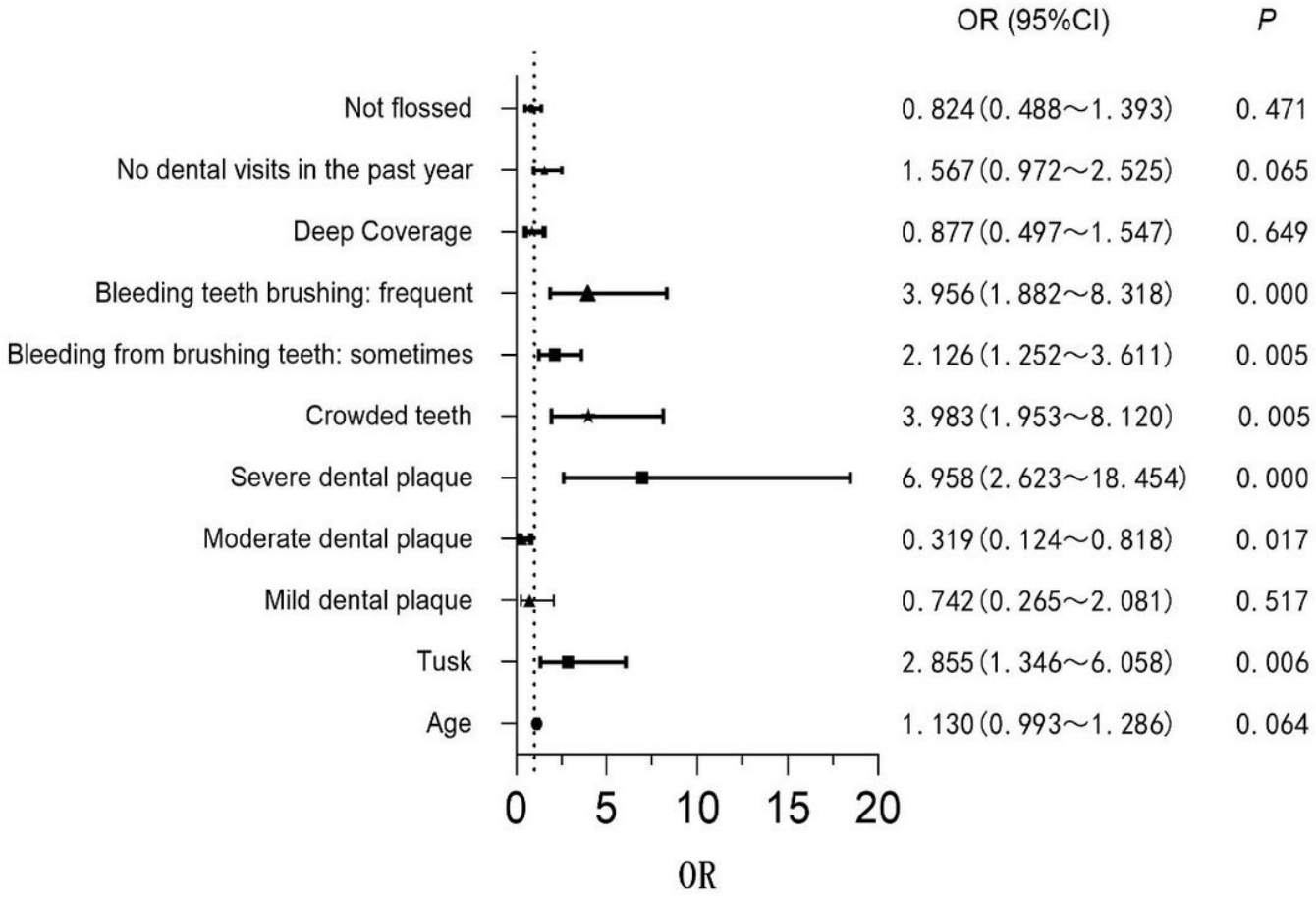

Figure 3

Binary logistic visual regression analysis of risk factors for localized versus generalized gingivitis