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ORIGINAL ARTICLE

Prevalence of gingivitis and associated factors in 13–16-year-old adolescents in Greece

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ABSTRACT

Background: The aim of this study was to estimate the prevalence of gingivitis and investigate possible associations among gingivitis and socioeconomic, demographic variables and oral hygiene habits in a sample of adolescents in Greece. **Materials and Methods:** The study sample consisted of 812 adolescents, 384 boys and 428 girls aged 13–16 years. All participants were clinically examined and answered questions regarding socioeconomic, demographic variables and oral hygiene habits. Statistical analysis of the questionnaire items was carried out by using a multiple logistic regression analysis models. **Results:** Five hundred and ninety-one adolescents were diagnosed as having gingivitis giving a prevalence rate 72.8%. Male gender ($P < 0.05$), lower parental educational ($P < 0.01$) and income level ($P = 0.001$), no regular dental follow-up ($P < 0.001$), no daily tooth-brushing ($P < 0.001$), no dental floss use ($P < 0.001$), presence of dental plaque ($P < 0.001$), and smoking ($P < 0.001$) were the most important associated factors of gingivitis. **Conclusion:** The study showed that gingivitis was associated with male gender, lower educational and income parental level, inadequate oral hygiene, the presence of dental plaque and smoking while the prevalence of this condition in the study sample was 72.8%.

Key words
Adolescents, gingivitis, prevalence, risk factors

INTRODUCTION

Dental caries and periodontal disease, regardless the progress of modern dentistry cause serious problems and dysfunction of the masticatory system and are considered as multi-complex problems for both clinical dentist and the patient.[1]

Children and adolescents are affected by various forms of periodontal disease, including gingivitis, localized or generalized aggressive periodontitis and periodontal disease associated with systemic disorders.[2]

Gingivitis has been defined as the reversible dental plaque-induced inflammation of the gingiva without detectable bone loss or clinical attachment loss. It is frequently encountered in dental practice, affected people of all ages and describes the condition of the dental soft tissue. It may also be associated with dental plaque only while gingival diseases modified by systemic factors associated with the endocrine system.[3]

Chronic gingivitis is the most common periodontal infection among children and adolescents and may include plaque-induced chronic gingivitis - the most prevalent form, steroid hormone-related gingivitis, drug-influenced gingival overgrowth and others.[4]

The etiology of gingivitis is multi-factorial and the result of more than one factor acting together. A wide range of factors has been identified as significantly associated

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with gingivitis including the presence of bacteria biofilm, genetic, socioeconomic, demographic, iatrogenic, and behavioral factors. These factors seem to influence the process, making it difficult to identify the risk factors.[5,6] The most important factor that has been associated with gingivitis is plaque accumulation on the dental surface, resulting in an inflammatory reaction, with clinical signs of redness, edema, gingival bleeding and sometimes pain, whereas as the condition persists that were initially edematous may become more fibrotic.[5] It is generally accepted that periodontal disease in children, adolescents, and adults begins as gingivitis, which progresses, only in some individuals, to periodontitis.[7]

Previous studies have recorded that the prevalence of gingivitis in children and adolescents over 80.0%[8,9] However, in general, the prevalence of gingivitis has shown a worldwide increase in contrast to the trends of dental caries.[10]

In addition, several forms of gingivitis in children and adolescents have been described, and several indices have been used in order to clinically characterize the degree of gingival inflammation. The most common indices that have been used to clinically characterize the degree of gingival inflammation are bleeding on probing, determined by gingival index (GI) and plaque index (PlI). However, it is unclear to what extent these parameters correlate to each other and to probing pocket depth that is a strong indicator of periodontitis.[11]

Similar epidemiological investigations have not been carried out in extent in Greece. Only one recent study[12] has examined the oral hygiene and periodontal status in adolescents. However, it has not recorded effective indicators that can evolve to the destructive periodontal diseases.

Therefore, it is important to collect detailed information of this condition to assess the epidemiology, identify the factors that could influence the presence of the early phases of gingivitis at younger ages to clarify the pathogenesis of this condition, distinguish the patients that require special dental treatment and establish preventive measures.

The present cross-sectional retrospective study was designed to assess the prevalence of gingivitis and the associations among socioeconomic, demographic variables and oral hygiene habits and gingivitis in a sample of adolescents in Greece.

MATERIALS AND METHODS

Subject population

The study population consisted of 812 adolescents, 384 boys and 428 girls, 13–16 years of age, who had reached the age of 13–16-year-old but had not attained their 17th birthday on the date of examination.

The Greek Ministry of Health and the Greek Dental Association organize dental surveys for school children and adults annually, to assess the prevalence of diseases such as dental caries and periodontitis, the oral hygiene level and the treatment needs of the Greek population. All the participants complete an oral health questionnaire and undergo an oral clinical examination in several private practices without charge. This precondition is an important motivation to create a representative random study sample.

As part of the mentioned National Oral Health Survey, the present study was carried out between November 2013 and May 2014. It is important to highlight that the topic of this study was included in the National Oral Health Survey. Therefore, the participants of thisstudy completed an additional questionnaire and underwent an oral clinical examination in a private dental practice.

Selection criteria

The selection criteria for the participants comprised adolescents without any orthodontic appliances, enamel defect accompanied by a loss of tooth substance, any multiple disabilities or individuals that were not be able to carry out effective tooth-brushing or had received medical treatment that causes gingiva enlargement.[13]

From the study design also excluded adolescents under current or previous periodontal treat ment, with diabetes mellitus or any syndromes, with any known/diagnosed form of immuno suppression or immunosuppressive medication. In addition, other forms of gingivitis such as eruption gingivitis, infective gingivitis, malnutrition-induced gingivitis, gingivitis associated with hormonal changes and gingivitis as a manifestation of systemic disease, for example, hematological or metabolic conditions that could lead to over- or underestimate the prevalence of gingivitis were also excluded. The study sample was consisted of adolescents with plaque-induced gingivitis.[13]

The participants were in good general health status as estimated by a general health questionnaire and confirmed by their parents/guardians.

Questionnaire

Before the clinical examination, all adolescents filled in a self-administered questionnaire that included variables such as age, gender, data regarding the general medical history of the sample and socioeconomic, demographic variables and oral hygiene habits. Based on the information provided in the questionnaire, the individuals were categorized in groups with the following coding:

a. Gender: (1) Males and (0) females
b. Smoking status: (0) Never smokers (former smokers included) and (1) current smokers

The individuals were regarded as smokers if they smoked more than 10 cigarettes daily. Occasional smokers were excluded from the study

c. Parental income level: (0) Low-income level, 0–1000 € a month and (1) high-income level, 1001 € a month and above
d. Parental educational level: (0) Low/medium educated individuals (elementary/high school) and (1) upper and supreme educated individuals (college/university)
e. Last dental follow-up: (0) <1 year and (1) more than 1 year
f. Daily tooth-brushing: (0) No daily tooth-brushing and (1) daily tooth-brushing
g. Frequency of tooth-brushing: (0) One or none times a day and (1) two or more times a day
h. Use of dental floss: (0) No use or sometimes and (1) use of dental floss daily
i. Bleeding during tooth-brushing: (0) No or sometimes and (1) yes.

Clinical examination

The clinical examinations were performed in a private dental practice, using a conventional dental unit and illumination, by a qualified in periodontology dentist.

The following indices were recorded in the subsequent order: GI by Loe and Silness[14] and PlI, by Silness and Loe.[15] The measurements were performed by means of a William's manual probe (PCP10-SE, Hu-Friedy Mfg. Co. Inc., Chicago, IL, USA).

The examination procedure includes the evaluation of four surfaces (buccal, lingual/palatal, mesial, and distal) of Ramfjord index teeth, such as 16, 21, 24, 36, 41, 44.[16]

The presence of gingivitis (GI) and dental plaque (PlI) was based on the examination of four surfaces of the mentioned index teeth to assess the presence/absence of the signs of the mentioned indices. The sites were probed, waiting 10 s to verify the presence or absence of gingival bleeding. Gingivitis was considered to be present when at least one site showed bleeding on probing (scores 2 and 3 according to GI), whereas the presence of dental plaque was determined if it was visualized with naked eye or existed abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin (score 2 and 3, respectively, according to PlI) and considered as present if at least one site showed the characteristic sign.

Ethical consideration

This study was not an experimental one. In Greece, only experimental studies must be reviewed and approved by Authorized Committees (Dental Schools, Greek Dental Association, Ministry of Health, etc.). An informed consent letter regarding the aim and importance of the study was signed by the adolescents and the parents/guardians before starting the survey, which assured that children participated in the study on their own accord.

Reproducibility

A randomly chosen sample of 80 (10%) adolescents was re-examined clinically by the same dentist in order to establish the intra-examiner variance. After consideration of the code numbers of the double examined adolescents, no differences were recorded between the 1st and the 2nd clinical assessment (Cohen's kappa: 0.94).

Statistical analysis

The individual was the statistical unit to assess the prevalence of gingivitis. Statistical analysis of questionnaire items was carried out by using a multiple logistic regression analysis model to identify which variables were best associated with gingivitis.

A stepwise selection procedure was used to investigate the influence of the possible risk factors to the outcome of gingivitis. A two-step approach was used for this aim. First, bivariate analysis was carried out to test the relationship between gingivitis and the associated factors. Thereby, the criterion for the independent variables to enter the model was set at 0.50. In addition, unadjusted odds ratios (OR's) with 95% confidence interval (95% CI) were estimated as well. Then, the mentioned model was used to analyze the factors that were in dependently related to the presence of gingivitis. The variables after the bivariate analysis were entered the model in a forward process and then in a backward fashion to evaluate which final variables could be considered as risk factors of gingivitis. Adjusted ORs with 95% CI were also assessed.

The data analysis was performed using the statistical package of SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). $P < 0.05$ was considered to be statistically significant.

RESULTS

The total number of the adolescents who visited the private practice during the determined period for their annual dental follow-up was 943; however, 812 of them met the mentioned selection criteria and accepted the invitation, giving a response rate 86.1%. The mean age of the study sample was 14.5 ± 1.6 years.

A total of 591 adolescents, 281 boys and 310 girls were diagnosed as having gingivitis (scores 2 and 3 according to GI), giving an overall prevalence of 72.8%, 73.1% in boys and 72.4% in girls, difference no statistically significant ($P = 0.096$), whereas the overall boys to girls ratio was 1:1.1. The prevalence of gingivitis according to the examined GI was 79.8%, 82.2% in boys and 79.5% in girls, difference statistically significant ($P = 0.042$).

The group without gingivitis was consisted of 103 boys and 118 girls (scores 0 and 1 according to GI).

The bivariate analysis model showed that all the examined factors except for gender were associated with gingivitis (GI) [Table 1].

Unadjusted and adjusted ORs and 95% CI are shown in Table 2.

The association between gingivitis and the possible risk factors was analysed by the multiple logistic regression analysis models. The final model (Wald method) showed that GI was associated with the examined variables except for bleeding during tooth-brushing [Table 3].

DISCUSSION

Gingivitis prevalence in the current study according to GI was assessed 72.8% higher than a recent study in 15-year-old adolescents in Greece[12] and other countries,[8,17] whereas was lower than other reports.[18,19] It is obvious that according to the available recent and previous reports the prevalence of gingivitis is ranging widely in children and adolescent samples in several countries. The variation in prevalence among those studies could be attributed to several factors. First, the different criteria used in various studies could be at least partly the reason for the observed difference. GI is the most extensively adopted index to measure gingivitis. However it could overestimate the prevalence of this condition because although it is considered as a specific index for gingivitis, it measures different forms of gingival inflammation. In addition, it is often difficult to distinguish the several forms of gingivitis, and it is likely that some forms of this condition, such as hormone-associated gingivitis may have been included in

Table 1: Associations between gingival index and the examined variables according to the bivariate analysis

Periodontal parameters variables	GI inflammation		
	No/mild 0-1 (%)	Moderate/severe 2-3 (%)	*P*
Gender			
Males	43.2	49.5	0.083
Females	56.8	50.5	
Smoking status			
Smokers	15.1	90.3	0.000*
Nonsmokers	84.9	9.7	
Family income			
Low	42.5	72.7	0.000*
High	57.5	27.3	
Educational level			
Low	35.8	74.2	0.000*
High	64.2	25.8	
Last dental follow-up			
>1/year	57.2	81.8	0.000*
<1/year	42.8	18.2	
Daily toothbrush			
No	52.3	79.7	0.000*
Yes	47.7	20.3	
Toothbrush frequency			
<2/day	53.3	78.4	0.000*
≥2/day	46.7	21.6	
Dental floss use			
No/sometimes	62.1	80.6	0.000*
Yes	37.9	19.4	
Bleeding during tooth-brushing			
Yes	42.8	75.1	0.000*
No/sometimes	57.2	24.9	

*P<0.05 statistically significant (Chi-square test). GI – Gingival index

Table 2: Odds ratios and 95% confidence interval of gingival index as dependent variable and the examined variables

Periodontal parameters variables	GI	
	OR-95% CI (unadjusted)	OR-95% CI (adjusted)
Gender		
Males	1.29 (0.97-1.72)	1.52 (1.01-2.27)
Females	1.00	1.00
Smoking status		
Smokers	1.66 (1.07-2.56)	1.14 (0.85-2.13)
Nonsmokers	1.00	1.00
Family income		
Low	3.57 (2.63-5.00)	2.08 (1.35-3.33)
High	1.00	1.00
Educational level		
Low	5.26 (3.85-7.14)	1.85 (1.22-2.86)
High	1.00	1.00
Last dental follow-up		
>1/year	3.33 (2.44-4.54)	2.86 (1.85-4.35)
<1/year	1.00	1.00
Daily toothbrush		
No	3.57 (2.63-4.35)	4.16 (2.56-6.67)
Yes	1.00	1.00
Toothbrush frequency		
<2/day	3.13 (2.33-4.35)	1.11 (0.70-1.75)
≥2/day	1.00	1.00
Dental floss use		
No/sometimes	6.67 (5.00-9.09)	2.50 (1.45-4.35)
Yes	1.00	1.00
Bleeding during tooth-brushing		
Yes	4.00 (2.94-5.55)	1.64 (1.02-2.63)
No/sometimes	1.00	1.00
PII		
2-3 (yes/visible)	7.14 (4.76-12.5)	11.11 (7.14-20.00)
0-1 (no/no visible)	1.00	1.00

OR – Odds ratio; CI – Confidence interval; GI – Gingival index; PII – Plaque index

Table 3: Results of the stepwise regression analysis model using gingival index as dependent variable

GI independent variable	Coefficient (*B*)	SE	*P*	OR	95% CI
Gender	0.413	0.203	0.042*	1.511	1.014-2.252
Income level	0.753	0.224	0.001*	2.123	1.368-3.300
Educational level	0.637	0.215	0.003*	1.890	2.421-2.881
Last dental follow-up	1.058	0.220	0.000*	2.781	1.873-4.424
Daily tooth-brushing	1.433	0.229	0.000*	4.202	2.674-6.579
Dental floss use	0.957	0.267	0.000*	2.604	1.543-4.386
Bleeding during tooth-brushing	−0.513	0.245	0.067	1.669	1.032-2.703
PII	2.314	0.214	0.000*	10.101	6.623-15.385
Smoking	1.623	0.288	0.000*	2.262	1.433-5.348
Constant	3.143	0.325	0.000	23.256	-

*Statistically significant. OR – Odds ratio; CI – Confidence interval; SE – Standard error; GI – Gingival index; PII – Plaque index

some of the cases examined in the current study, despite the mentioned exclusion criteria. Second, it is difficult to compare the results of prevalence studies when different teeth are included in the measurement method, for example, index teeth versus the total dentition or several and different indices are used, such as GI Community Periodontal Index. Consequently, differences regarding gingivitis prevalence could be observed after using different methodologies, for example, partial protocols of half-mouth quadrants, 1 and 3 or 2 and 4 or full protocols of full-mouth quadrants.

On the other hand, the permanent dentition analyzed in different investigations showed gingivitis at ages ranging from 3 to 65+ years and this finding may also influence the results through differences in the time of exposure to risk factors. Another important reason is that some investigators estimate the prevalence based on the proportion of the participants that show gingivitis on at least one tooth surface, whereas others estimate the prevalence of gingivitis according to GI or other indices based on three, four or six tooth surfaces examined. Differences in oral examination techniques and teeth or surfaces evaluated may also have produced variations in prevalence findings among comparable reports. Further more, socioeconomic, cultural, and geographical factors could influence the outcome of prevalence data. Standardization of the indices, ages, and the teeth examined would facilitate such comparisons.

A statistically significant difference was observed in gingivitis prevalence between boys and girls, finding that was in accordance with those from previous reports[12,20] in which boys showed higher gingivitis prevalence than girls, whereas in another report[19] was found that gingivitis prevalence was statistically significantly higher in girls than in boys. The mentioned difference in the current study may be explained by different patterns of exposure to risk factors in the study sample.

According to the literature, cigarette smoking could increase the risk for gingivitis and periodontitis not only in adults but also in younger ages, and it has been shown that it is an important risk factor for periodontal disease.[21,22] The current study showed that smoking was significantly associated with gingival inflammation. Smoking, in general, is uncommon in younger ages in other countries, however in Greece consists an important health problem, and this is the main reason that this variable was not included in similar reports in other countries.

When examining the relationship between socioeconomic indicators and gingivitis which determined based on parental educational level and family income, the results showed statistically significant associations between both variables and gingivitis, findings that were in agreement with those found in previous reports.[5,20] On the other hand, these observations were not in accordance with those observed in another similar study[23] in which the socio economic level showed no influence on gingival bleeding. It is important to highlight that few studies have investigated the influence of the mentioned factors on gingivitis in children and adolescents, whereas the majority of those have examined the possible associations in samples that consisted of 12-year-old school children or younger ages. Those reports have shown that school children with a lower parental educational and family income level had more periodontal problems than those with a higher socioeconomic level and had examined samples that come from urban or rural areas.[13]

Variables those are associated with adequate oral hygiene such as daily tooth-brushing, dental floss use and regular dental follow-up were shown to be strongly associated with a decreased frequency of gingival inflammation, findings that were in agreement with those from a previous report.[24] Similarly, few studies have examined the possible associations between the mentioned oral hygiene variables and gingivitis and most of them in ages lower than 13-year-old. According to the pathogenesis of gingivitis, it is known that inadequate oral hygiene leads to dental plaque accumulation and gingival inflammation. Despite the fact that previous reports have recorded significant associations between tooth-brushing frequency and of gingivitis[12,18] and showed that adolescents who brushed their teeth twice or more times daily had less gingival inflammation than those who brushed once daily or none, the current study recorded no association between the examined variables.

Those findings could be attributed to the study design and its limitations that are related to the part-mouth protocol and possible underestimation of gingival inflammation.

The presence of dental plaque estimated by PII was the most significantly associated factor of gingivitis according

to the results of the present study. Dental plaque is the principal etiological factor for plaque-induced gingivitis and other forms of periodontal disease. In addition, dental plaque and gingivitis are indicators of poor oral hygiene. This observation was in agreement with those from previous similar reports.[12,18]

The results also showed that the presence of bleeding during tooth-brushing was negatively and significantly associated with the occurrence of gingivitis. However, it is known that one of the principle signs of gingival inflammation is bleeding on probing. This observation could be attributed to the following limitations of the present study, which should be taken into account before any benchmarking with similar studies. First, in a retrospective study, like the present, the reliability is not as high as for prospective studies since the inter-examiner variability is most likely higher. Furthermore, the results were based on self-reported data regarding the oral hygiene habits parameters, systemic health conditions and other epidemiological aspects. The response outcomes to the questionnaire items may, therefore, suffer from inaccuracy. Respondents may under-report, over-report or choose not to report. In previous studies, the measurement of gingival inflammation was ranged from self-reported gingivitis, partial recording of gingival inflammation, etc., but few studies have been based on full-mouth registration of gingivitis to our knowledge. Another limitation is that partial protocols may over- or underestimate the prevalence, whereas validity depends on the age of the study population, with greater validity among adolescents and younger adults than older adults, because the number of available sites for examination in adolescents and younger adults is much higher than in older adults due to high rates of tooth loss. In addition, in the current study, GI was used for the definition of gingival inflammation, however, that index had not previously been used in epidemiological researches in similar age ranges.

Gingivitis is a multi-factorial condition, and there are many factors that could be associated with it and were not investigated in the present study and, such as the protective effect of saliva,[25] the association between gingivitis and dental crowding.[26] It could be also assumed that other factors such as cultural, social, occupational, and inter- and intra-individual host factors might be relevant in the occurrence of gingivitis.[5,6]

The identification of etiological factors of gingivitis is of vital importance for the establishment of preventive policies. Epidemiological, case–control and cohort studies have been carried out in the last years to elucidate possible causal determinants for gingivitis.

These studies could show associations and indicative risk factors, but they could not identify the etiological factors, as for this purpose only prospective studies could be necessary. Other studies are still necessary to explain the etiology of gingivitis, focusing in the biological and behavioral factors involved to implement adequate preventive measures.

CONCLUSION

The present investigation provided evidence that gingivitis consists a significant problem in Greek adolescents. Gingivitis should receive more attention that promotes awareness in dentists to make an early diagnosis and to identify the different forms and etiological factors of this condition. A strategy of offering preventive care including more campaigns promoting a healthier lifestyle for those at risk of gingivitis and a regular dental follow-up should be conducted for school children and adolescents.

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Conflicts of interest
There are no conflicts of interest.

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