Behavioural and socioeconomic factors associated with the simultaneous occurrence of periodontal disease and dental caries

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ABSTRACT

Objective: The aim was to evaluate the association of behavioural and socioeconomic factors with the occurrence of periodontal disease and dental caries, paying special attention to the simultaneous occurrence of these diseases.

Materials and methods: The study population consisted of 5255 dentate persons aged ≥30 years from a nationally representative survey. Caries and probing pocket depth were recorded by tooth and calculated in relation to the number of existing teeth. The groups were: non-affected (A), the two most affected quintiles for periodontal disease with little or no dental caries (B), the two most affected quintiles for dental caries with little or no periodontal disease (C), and the two most affected quintiles for both periodontal disease and dental caries (D). Presence of dental plaque was determined, and behavioural and socioeconomic factors were established.

Results: Dental plaque, smoking, lack of regular dental check-ups, older age, and a basic level of education were strongly associated with the simultaneous occurrence of periodontal disease and dental caries.

Conclusion: There are many behavioural and socioeconomic factors that associate with the occurrence of both periodontal disease and dental caries. These factors also increase the risk of individuals having these diseases simultaneously.

Key words: periodontal diseases; dental caries; health surveys; health behaviour

Introduction

Our previous study showed that periodontal disease and dental caries tend to accumulate in the same individuals [1]. This is in accordance with findings of a large survey of an adult population in the United States [2] and has also been detected relating to root caries and periodontal diseases [3].

There are numerous studies that identify background factors for either periodontal disease or dental caries. Results from these studies show that both diseases have a multifactorial aetiology, also including many social and behavioural factors. Background factors related to periodontal disease include for example age, gender, educational level, oral hygiene habits, smoking, marital status, and living habits [4-6]. Background factors related to dental caries include for example age, gender, race, sociodemographic status, frequency of dental visits, educational level, poor oral hygiene, and poor dietary habits. [7-9].

Although knowledge about background variables related to either periodontal disease or dental caries is comprehensive, only few studies have analysed these two simultaneously in the same study population. There is evidence in the Health 2000 study population that a higher socioeconomic status is associated with lower prevalence of both dental caries and periodontal disease [10]. Tervonen et al. [11] concluded that periodontitis and dental caries share many social and behavioural background variables in common. In contrast, Kinane et al. [12] concluded that periodontal disease and dental caries do not share the same major risk factors. Sewon et al. [13] determined that there is not necessarily a common aetiology underlying periodontitis and dental caries.

Jepsen et al. [14] observed that there are surprisingly few studies analysing the co-occurrence of dental caries and periodontitis, and that no attempts have been made to explore to what extent this association is explained by common risk factors. The aim of the present study was to evaluate the differences in behavioural and socioeconomic factors between non-affected persons and those with dental caries or periodontal disease, paying special attention to the association of these factors with the simultaneous occurrence of periodontal disease and dental caries in a Finnish population aged 30 yr and older. The data were obtained from the nationally representative Health 2000 survey carried out in 2000-2001 in Finland.

Materials and methods

The data were obtained from the nationally representative Health 2000 survey carried out by the National Institute for Health and Welfare in 2000-2001 in Finland. 16 clusters (health centres) were selected from each of the five university hospital districts covering the whole country. The 15

largest towns were all included and 65 other health centres were added according to the probability in proportion to their size. The persons in these 80 health centres were selected using systematic random sampling. The survey used a stratified two-stage cluster sampling of 8028 persons aged 30 ys and older [15]. A total of 6335 of these filled in postal questionnaires, were interviewed, and participated in the clinical oral health examination conducted by five field teams, each including a dentist and a dental nurse. The teeth identification and clinical examination complied with the WHO [16] recommendations, and followed the protocol developed for and used in the previous Finnish population survey [17]. A reference dentist made parallel measurements (n=269) on several visits to each field team [18]. The present study included 5255 dentate persons with complete recordings for their dental and periodontal status. Additional information about the Health 2000 study is available at http://www.terveys2000.fi/indexe.html.

Dental caries was determined on every surface of each tooth and diagnosed as a detectably softened lesion reaching the dentine. The findings were recorded by tooth. Probing pocket depth was measured for all teeth, except the third molars, using a ball-ended WHO periodontal probe at four points (distobuccal, mid-buccal, mid-oral and mesio-oral) by a standardised force of 20 grams. The findings were recorded by tooth according to the deepest probing pocket depth (PPD) as no deep periodontal pockets, a pocket depth of 4-5 mm, or a pocket depth of 6 mm or more. Periodontal disease was diagnosed as a pocket 4 mm deep or deeper. Presence of dental plaque was determined on three selected teeth: the buccal surface of the most posterior tooth in the upper right quadrant, the lingual surface of the most posterior tooth in the lower left quadrant, and the labial surface of the lower canine tooth. The amount of visible plaque was recorded using a scale modified from an index developed by Silness & Löe [19]: no plaque, plaque on the gingival margin only, and plaque elsewhere. The highest figure indicated each person's overall dental plaque status. In the parallel examinations, the agreement of the recordings by tooth was 93% (κ 0.87) for caries status, 77% (κ 0.41) for periodontal status, and 58% (κ 0.36) for plaque recordings [18].

We calculated the relative number of teeth with untreated dental caries and the number of teeth with deepened probing pocket depths (4 mm deep or deeper) in proportion to the number of teeth present in each person. These proportional indicators were cross-tabulated using 6 categories in both. Table 1 presents the number of persons in each cell, and shows the cells belonging to the 4 selected groups with different levels of disease. Persons in group A were non-affected, having no caries and no deep periodontal pockets. Persons in group B belonged to the two most affected quintiles for periodontal disease (PPD 4 mm or more in ≥ 45.4% of their teeth), while having little or no caries (dental caries in ≤ 6.7% of their teeth). Persons in group C belonged to the two most

affected quintiles for caries (dental caries in $\geq$ 11.2% of their teeth), while having little or no periodontal disease (PPD 4 mm or more in $\leq$ 27.3% of their teeth). Persons in group D belonged to the two most affected quintiles for both periodontal disease (PPD 4 mm or more in $\geq$ 45.4% of their teeth) and caries (dental caries in $\geq$ 11.2% of their teeth). The mean number of teeth and the mean number of teeth with dental caries and with PPD 4 mm or more in these four groups are shown in Table 2.

Oral self-care habits, smoking habits, use of dental services, level of education, marital status, and living environment were recorded in the health interview [20]. For the oral self-care habits, the respondents were asked how often they brush their teeth. We classified the responses into three groups: at least twice a day, once a day, and less than once a day. Smoking habits were identified using a series of questions recommended by the WHO [21]. We classified these responses into three groups: never, occasionally or daily, and quit smoking. Those belonging to the occasional or daily smoking groups were classified as smokers. To assess the use of dental care services, the persons were asked whether they were in the habit of going to see a dentist for check-ups and if so, how often ("once a year", "every other year", "less often"). The level of education was classified into three groups: basic, intermediate and higher education [15]. Those with no vocational training beyond a vocational course or on-the-job training and who had not taken the matriculation examination were classified as having a basic level of education. Completion of vocational school or passing the matriculation examination were defined as intermediate education. Higher education comprised degrees from higher vocational institutions, polytechnics and universities. The marital status of the persons was classified into two groups: married or living with a partner, and single, divorced or widowed. In terms of the living environment, the persons were divided into two groups: urban versus non-urban. Urban areas were defined as cities, urban centres, or urban municipalities, and non-urban areas were defined as rural areas.

Eating of sweets, consumption of sweetened drinks, and dietary habits were queried using a questionnaire [20]. The respondents were asked how often they usually drink their coffee or tea with sugar, consume other sweet beverages, chocolate or biscuits with filling, toffee, liquorice or dried fruit, and lozenges, or chewing gum without xylitol. We classified these into three groups: less than once a day, once or twice a day, and more than twice a day.

The STATA statistical package was used to take into account the two-stage cluster sampling. The design effects were taken into account using the SVY-TAB and SVY-MEANS procedures. The effect of non-response was corrected by corresponding weights. The calibration of original design weights was carried out using SAS macro CALMAR [22]. The data were analysed using STATA

version 8.0 (Stata Corp, College Station, TX). The differences in characteristic factors between non-affected persons (group A), and the three affected groups B, C, and D were calculated using logistic regression models. Two separate models were constructed. The first model used behavioural factors and the second one socioeconomic factors as independent variables. Of the sociodemographic factors, age and gender were used in both models. Multivariable logistic regression analysis was conducted using STATA survey commands and the population weights provided by the sampling design. A p-value of < 0.05 was considered to be statistically significant.

Results

Weighted population estimates for behavioural and socioeconomic factors in the four study groups are presented in Table 3. The most evident differences related to the determined factors were observed between the non-affected persons (group A) and those in the two most affected quintiles for both periodontal disease and dental caries (group D) (Table 3). Women presented 65% of the nonaffected but only 29% of those in group D. The youngest persons (aged 30-40 years) made up 40% of the nonaffected but only 7% of those in group D. In the category of behavioural factors, 69% of the non-affected but only 37% of those in group D brushed their teeth at least twice a day. Sixty-nine percent of the non-affected but only 17% of those in group D had regular dental check-ups. No visible dental plaque was detected in 53% of the non-affected but in only 13% of those in group D. Fifty-four percent of the persons in group D and 20% of those in group A were smokers. Most persons in group D belonged to those with a basic level of education level (59%) while those in the non-affected group most frequently (40%) had higher level of education. Forty-five percent of those in group D were living alone compared with 24% living alone in the group of non-affected. In terms of the living environment, the largest differences were found between groups B and C. Altogether 61% of those belonging to the two most affected quintiles for periodontal disease, while having little or no caries (group B), were living in an urban environment. Correspondingly, 61% of those belonging to the two most affected quintiles for dental caries, while having little or no periodontal disease (group C), were living in a nonurban environment.

Associations of behavioural and socioeconomic factors in the three groups of persons with dental diseases as compared to the non-affected were analysed using logistic regression models. The most significant associations were observed in group D. Concerning behavioural factors (Table 4), 'Having dental plaque also elsewhere than on the gingival margin', being a smoker, and 'Having dental checkups only when symptoms occur', were strongly associated with the simultaneous occurrence of periodontal disease and dental caries. They were also significantly associated with

both groups B and C. Among these, smoking and dental plaque were associated more significantly with group B than with group C. Correspondingly, irregular dental checkups were more significantly associated with group C than with group B. Tooth-brushing frequency was associated with groups C and D. The consumption of sugary products did not significantly differentiate groups B, C or D from the non-affected.

Concerning socioeconomic factors (Table 5), older age and a basic level of education were strongly associated with the simultaneous occurrence of periodontal disease and dental caries. They were also significantly associated with both groups B and C. In terms of higher age, the association was more linear in group B than in group C. The factors of living environment or marital status did not significantly differentiate groups B, C or D from the non-affected. Significant interaction terms were detected between older age groups and basic level of education, especially in groups C and D.

Discussion

To our knowledge, this is the first study to explore the association of common risk factors with the simultaneous occurrence of periodontal disease and dental caries in a large population survey. Our previous study [1] showed that periodontal disease and dental caries tend to accumulate in the same individuals, leading us to evaluate the association of behavioural and socioeconomic factors with the occurrence of periodontal disease and dental caries, paying special attention to the simultaneous occurrence of these diseases. We formed four groups according to the levels of periodontal disease and dental caries, using criteria giving a basis for statistical analyses that would achieve confidential estimates of associations. The size of the reference group (A) was large enough in relation to the other groups, whose sizes were also large enough for constructing models that would fit the data well. As no reasonable cut-off points for the proportional numbers of teeth with caries or periodontal disease were found, it was decided that the use of quintiles would be an applicable basis for categorization. We found it important to include in our analyses those who were really affected by these diseases. Groups B and C were formed to represent persons who are highly affected by one of the two dental diseases while showing little or no signs of the other disease. In contrast, persons in group D were the most affected by both of these diseases.

Due to the associations found between the behavioural and the socioeconomic variables in the pre-testing stage, we decided to use two separate models. This was done so that a more confident interpretation of the results could be reached, and to avoid difficulties related to complicated interactions. Significant interaction terms were found for age and the level of education. A significantly larger proportion of those in the older age groups had no more than a basic level of

education [15].

Properly designed studies using large representative surveys can provide valuable information on the association between variables and the occurrence of disease. The effects assessed in cross-sectional studies are referred as associations [4]. The present study was based on a representative population sample of Finnish adults aged 30 years and older, and thus formed a reliable basis for this kind of deduction. The data used in this study were collected during 2000-2001. The Health 2011 Survey was conducted on a similar basis later, although due to limited resources, only two out of a total of five university hospital districts were covered in the said survey. The findings on dental and periodontal health were in line in both these studies [23]. As our previous study, which showed a significant association between dental caries and periodontal disease, was made using data from the Healthy 2000 Survey, and as it also has a more representative population outcome, we decided to use the data obtained from the Healthy 2000 Survey in this study.

The agreement of measurements was described in terms of kappa values. On the basis of these data, it seems that the quality assurance of the clinical measurements was successful [20]. Overall, the level of agreement between the measurements was high, particularly so in the measurements of caries. Levels of agreement were somewhat lower in areas that are more difficult to measure, such as dental plaque, but that is consistent with earlier experiences from similar surveys [20,24]. As dental plaque is an essential measure of oral health behaviour affecting both dental caries and periodontal health, we decided to include it in our analyses. Furthermore, dental plaque and tooth brushing frequency together give a more comprehensive view of oral hygiene behaviour than either of them alone.

The most evident differences were observed between healthy persons (group A) and those most affected by both periodontal disease and dental caries (group D). The strongest associations were found for factors that were also significantly associated with a major occurrence of periodontal disease and dental caries, respectively (groups B and C). Dental plaque, smoking, irregular dental check-ups, older age, male gender and a basic level of education were significantly associated with the occurrence of both dental caries and periodontal disease and were strongly associated with the simultaneous occurrence of these diseases. As these factors associate with both of these most common dental diseases, they can be more widely seen as associative factors for oral health disorders.

The association of smoking and dental plaque was somewhat weaker with the occurrence of dental caries than with the occurrence of periodontal disease or with the simultaneous occurrence of these diseases. This emphasizes the role of these factors in the pathophysiology of periodontal

diseases. On the other hand, the association of irregular dental check-ups was stronger with the occurrence of dental caries. This is probably due to the fact that those who have regular check-ups also have their caries lesions treated by dental fillings more often.

Infrequent brushing of teeth was associated with the occurrence of dental caries, and with the simultaneous occurrence of periodontal disease and dental caries. In practice, infrequent brushing of teeth also means infrequent use of fluoride toothpaste, especially as the amount of dental plaque was recorded in the same model. This most likely also caused the lack of association between tooth-brushing frequency and periodontal disease.

We found that many behavioural and socioeconomic factors are related to both periodontal diseases and dental caries. This is in accordance with the findings of Tervonen et al. [11] and Bernabe et al. [10]. We also found that these same factors substantially increase the risk of individuals having these diseases simultaneously (logistic model D vs. A compared to logistic models B vs. A, and C vs. A).

Earlier studies have concluded that socioeconomic factors are good risk indicators for periodontal diseases [25-27]. The increased risk level seems to be attributed to behavioural and environmental factors [4]. Psychosocial factors can promote periodontal diseases by behavioural mechanisms. This means that a specific behavioural factor, such as neglect of oral hygiene or smoking, exacerbates lifestyles that are known to potentiate periodontal disease [28]. This is in accordance with the findings of the present study, and may also suggest that, while periodontal disease and dental caries tend to accumulate in the same individuals, these background factors can have a crucial role in the progression of these dental diseases in susceptible individuals.

As dental diseases seem to have many risk factors in common, we should consider oral health and oral diseases more as a whole. This should be taken into account in prevention, diagnostics and treatment of these diseases. It should also be kept in mind while studying these diseases.

In conclusion, to our knowledge, this is the first study to explore the association of common risk factors with the simultaneous occurrence of periodontal disease and dental caries in a large population survey. Dental plaque, smoking, lack of regular dental check-ups, older age and a basic level of education were strongly associated with the simultaneous occurrence of periodontal disease and dental caries.

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Table 1. Distribution of the proportional number of teeth with dental caries and with a probing pocket depth (PPD) 4 mm or more in the four study groups.

Proportional number of teeth with caries (%)	Proportional number of teeth with PPD 4 mm or more (%)						
	0	0.1-12.0	12.1-27.3	24.4-45.3	45.4-72.0	72.1-	Total
0	A 1498	842	613	374	B 246	174	3747
0.1–3.8	122	73	58	62	31	20	366
3.9-6.7	74	56	43	39	36	23	271
6.8-11.1	68	43	52	42	34	34	273
11.2-24.0	C 66	35	35	44	D 58	42	280
24.1-	80	14	27	36	63	98	318
Total	1908	1063	828	597	468	391	5255

Groups (marked with bolded borderlines):

A = no caries, PPD < 4 mm

B = proportional number of teeth with caries 0 – 6.7%, and with PPD 4 mm or more ≥45.4%

C = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more 0-27.3%

D = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more ≥ 45.4%

Table 2. Number of teeth and number of teeth with dental caries, and with probing pocket depth (PPD) 4 mm or more in the four study groups.

Group	A (healthy)	B (perio high caries low)	C (caries high perio low)	D (perio high caries high)	Total
Number of persons (n)	1498	530	257	261	2546
Number of teeth (mean±sd)	23 ± 8	21 ± 8	15 ± 9	15 ± 8	21 ±9
Number of teeth with dental caries (mean±sd)	0	0.2 ± 0.4	3.3 ± 2.2	4.0 ± 2.6	0.8 ± 1.8
Number of teeth with PPD 4 mm or more (mean+sd)	0	14 ± 6	1 ± 2	10 ± 6	4 ± 7

A = no caries, probing pocket depth (PPD) < 4 mm
B = proportional number of teeth with caries 0–6.7%, and with PPD 4 mm or more ≥45.4%
C = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more 0-27.3%
D = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more ≥ 45.4%

Table 3. Weighted population estimates (%) for behavioural and socioeconomic factors in the four study groups.

Group	A (healthy)	B (perio high caries low)	C (caries high perio low)	D (perio high caries high)
Number of persons (n)	1498	530	257	261
Gender				
Male	35	61	58	71
Female	65	39	42	29
Age				
30-40	40	11	16	7
41-50	27	28	34	30
51-60	20	35	27	32
61-74	13	26	23	32
75+	3	6	9	10
Tooth-brushing frequency				
At least twice a day	69	60	41	37
Once a day	28	31	41	39
Less than once a day	3	9	18	24
Reason for seeing a dentist				
Regular check-ups	69	49	19	17
Only when symptoms occur	31	51	81	83
Smoking				
Never	58	33	4	24
Occasionally/daily	20	45	36	54
Quit	22	22	22	22
Consumption of sugary products				
< 1 times a day	45	40	39	34
1-2 times a day	30	33	27	32
3 or more times a day	25	27	34	34
Dental plaque				
No visible plaque	53	20	31	13
Plaque on gingival margin only	4	55	47	39
Plaque elsewhere	5	25	22	48
Level of education				
Basic	28	43	51	59
Intermediate	32	35	35	30
High	40	22	14	11
Living environment				
Urban	49	61	39	50
Non-urban	51	39	61	50
Marital status				
Married/Living with a partner	76	71	68	55
Single/Divorced/ Widowed	24	29	32	45

A = no caries, probing pocket depth (PPD) < 4 mm
B = proportional number of teeth with caries 0–6.7%, and with PPD 4 mm or more ≥45.4%
C = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more 0-27.3%
D = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more ≥ 45.4%

Table 4. Gender and age-adjusted associations of behavioural factors in groups *B (perio high, caries low), C (caries high, perio low),* and *D (perio high, caries high)* as compared to the non-affected (*A*)

Groups	B vs A	C vs A	D vs A
	β coeff (SE) p	β coeff (SE) p	β coeff (SE) p
Tooth-brushing frequency			
At least twice a day	-	-	-
Once a day	-0.26 (0.16) ns	0.54 (0.20) **	0.57 (0.23) *
Less than once a day	-0.08 (0.30) ns	1.22 (0.35) ***	1.01 (0.37) **
Reason for seeing a dentist			
Regular check-ups	-	-	-
Only when symptoms occur	0.50 (0.13) ***	2.03 (0.19) ***	1.96 (0.21) ***
Dental plaque			
No visible plaque	-	-	-
Plaque on gingival margin only	1.20 (0.15) ***	0.55 (0.19) **	1.19 (0.28) ***
Plaque elsewhere	2.33 (0.22) ***	1.50 (0.28) ***	2.94 (0.34) ***
Smoking			
Never	-	-	-
Occasionally/daily	1.58 (0.16) ***	0.82 (0.21) ***	1.87 (0.26) ***
Quit	0.31 (0.17) ns	-0.05 (0.24) ns	0.24 (0.29) ns
Consumption of sugary products			
< 1 time a day	-	-	-
1-2 times a day	0.12 (0.15) ns	-0.01 (0.22) ns	0.04 (0.30) ns
3 or more times a day	-0.17 (0.17) ns	0.05 (0.19) ns	-0.08 (0.29) ns

A = no caries, probing pocket depth (PPD) < 4 mm

B = proportional number of teeth with caries 0 – 6.7%, and with PPD 4 mm or more ≥45.4%

C = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more 0-27.3%

D = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more ≥ 45.4%

No significant interaction terms were detected

Statistically significant differences were defined by logistic regression models

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5. Associations of socioeconomic factors in the three groups *B (perio high, caries low), C (caries high, perio low), and D (perio high, caries high)* as compared to the non-affected (*A*)

Groups	B vs A β coeff (SE) p	C vs A β coeff (SE) p	D vs A β coeff (SE) p
Gender			
Female	-	-	-
Male	1.18 (0.13) ***	1.01 (0.15) ***	1.77 (0.17) ***
Age			
30-40	-	-	-
41-50	1.74 (0.50) ***	1.32 (0.58) ***	2.93 (1.15) ***
51-60	2.81 (0.45) ***	2.24 (0.60) ***	3.97 (1.16) ***
61-74	3.21 (0.51) ***	1.78 (0.76) ***	4.48 (1.17) ***
75+	3.61 (0.71) ***	3.05 (1.03) ***	5.46 (1.22) ***
Level of education			
Basic	2.19 (0.52) ***	2.23 (0.59) ***	3.67 (1.10) ***
Intermediate	1.73 (0.40) ***	1.24 (0.44) **	2.53 (1.06) *
High	-	-	-
Living environment			
Urban	0.45 (0.29) ns	0.19 (0.39) ns	0.37 (0.54) ns
Non-urban	-	-	-
Marital status			
Married/Living with a partner	-	-	-
Single/Divorced/Widowed	-0.30 (0.34) ns	0.56 (0.42) ns	0.94 (0.58) ns
Interaction terms			
Age 41-50 : Level of education. Basic	-0.81 (0.6) ns	-0.36 (0.72) ns	-1.65 (1.19) ns
51-60 : Level of education. Basic	-2.24 (0.56) ***	-2.01 (0.65) **	-2.71 (1.17) *
61-74 : Level of education. Basic	-2.46 (0.60) ***	-1.23 (0.85) ns	-3.24 (1.22) **
75+ : Level of education. Basic	-3.05 (0.81) ***	-2.06 (1.27) ns	-4.51 (1.28) ***
Age 41-50 : Level of education. Intermediate	-1.04 (0.92) *	-0.04 (0.60) ns	-0.89 (1.15) ns
51-60 : Level of education. Intermediate	-1.82 (0.48) ***	-0.99 (0.58) ns	-2.29 (1.17) ns
61-74 : Level of education. Intermediate	-1.41 (0.56) *	-0.32 (0.90) ns	-2.17 (1.20) ns
75+ : Level of education. Intermediate	-1.64 (0.81) *	-0.13 (1.25) ns	-2.83 (1.31) *
Age : Living environment	ns	ns	ns
Age : Marital status	ns	ns	ns

A = no caries, probing pocket depth (PPD) < 4 mm

B = proportional number of teeth with caries 0 – 6.7%, and with PPD 4 mm or more ≥45.4%

C = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more 0-27.3%

D = proportional number of teeth with caries ≥11.2%, and with PPD 4 mm or more ≥ 45.4%

Statistically significant differences were defined by logistic regression models

* p < 0.05, ** p < 0.01, *** p < 0.001