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**Abstract:** This study investigated the association between several demographic, socio-economic, behavioural and clinical variables on caries activity. One hundred and two patients were randomly retrieved from the files of the Operative Dentistry Clinic (UFPel-Brazil). The patients gave written consent to participate in the study. They were interviewed reporting demographic (sex and age), socio-economic data (income, educaional level) and oral health behaviours (tooth-brushing frequency, dental floss usage and snacks frequency). Intraoral examination was performed to investigate the clinical variables (presence and quality of biofilm, DMFT and modified DMFT index and bleeding points). Patients were divided between caries-active (n=51) and caries-inactive (n=51), according to the presence of white spot lesions and/or active cavity lesions. Statistical analysis was carried tout using Chi-square or Fischer's exact test, with the confidence level at 95%. Results demonstrated that several conditions (younger subjects, lower educational or income levels, lower tooth-brushing frequency, higher snacks frequency, adherent biofilm, presence of bleeding points and higher modified DMFT index) were associated with caries activity in the studied population. Within the limitations of the experimental design, and considering the population under investigation, it was verified that demographic (age), socio-economic (income and educational levels), behavioural (tooth brushing and snacks frequencies) and clinical (modified DMFT index, presence and quality of biofilm, and bleeding points) variables were associated with caries-active patients.

Key words: caries activity, clinical trials, dental biofilm, oral health

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n the Past few decades there has been a change in the management of dental caries. Nowadays, more attention is paid to preventive approaches, since caries activity has been positively associated with the frequency of sugar intake and poor oral hygiene level (Sayegh et al, 1997). Caries multifactorial etiology was early evidenced as being the main factor: microbial agents, tooth surface and substrate (sucrose) (Gustafson et al, 1954).

Different demographic conditions (age, gender), socio-economic conditions (educational level, income level) and behavioural factors (tooth- brushing frequency, dental floss usage) might influence caries development. (Forshee and Storey, 2004; Mascarenhas, 1998; Osterberg et al, 1998; Peres et al, 2005; Senna et al, 2005). Some clinical variables, such as DMFT and white spot lesion presence, could also be associated with caries occurrence (Nyvad at al, 1999; Powel, 1998). The clinical presence of an adherent cariogenic biofilm could influence the prevalence of unsatisfactory amalgam restorations, mainly due to secondary caries (Formolo et al, 2005). A biological approach to early lesions has reduced the traditional surgical approach, recognising that dental caries is an infectious disease. The control of caries disease is based on the reduction of the frequency of refined carbohydrate intake, optimum plaque control and normal salivary flow, with patient education as the first principle in minimal intervention dentistry (Eric-

**ORIGINAL ARTICLE** 

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Variables clinical independent	Category	Description
Dental	No visible	Patient without visible biofilm.
biofilm	biofilm	
	Visible biofilm	Patient with visible biofilm in proximal, oclusal
		and generalised teeth surfaces.
Quality of	Normal	Patient with detectable visual biofilm .
visible biofilm	Sticky	Patient with visible plaque and sticky in the
		explorer probe.
Bleeding	No bleeding points	Patient without gingival bleeding between
points		proximal surfaces when tested with dental floss.
	Bleeding points	Patient with gingival bleeding between proximal
		surfaces when tested with dental floss.
OMFT	2/15	Patients with DMFT index 2 to 15.
ndex	16/31	Patients with DMFT index 16 to 31.
Modified DMFT	7/21	Patients with index 7 to 21.
ndex*	22/31	Patients with index 22 to31.

son et al, 2003). This new philosophic concept aims at the least possible removal of enamel or dentin. A structured caries risk assessment should be carried out, based upon the concept of the caries balance (Featherstone, 2004). Unbalanced individuals leaning towards demineralisation instead of remineralisation are more prone to be caries-active subjects.

Clinical studies have disclosed that early diagnosis of caries activity (white spot lesions) could decrease the restorative treatment in young, adult and old patients (Maltz and Carvalho, 1997). In addition, caries-active patients have exhibited more amalgam restorations failures when compared to patients without activity (Formolo et al, 2005). Thus, the investigation of the factors that could be involved in caries activity is a relevant task.

The aim of this study was to investigate the association of demographic, socio-economic, behavioural and clinical variables on caries activity, testing the null hypothesis that these factors could not influence caries activity.

## **MATERIALS AND METHODS**

## **Patient Selection**

The inclusion criteria for patient selection was the participation in a study the authors were developing

to look at the longevity of composite restorations. The patients were randomly selected from those who had received composite restorations three years earlier by undergraduate students in the Operative Dentistry Clinics of the Federal University of Pelotas. One hundred and six patients were recalled. A randomisation table assured the correct randomisation, so that each patient was distributed into each group by chance. Before any procedure commenced patients were informed about the objectives and gave written consent to be included. Four patients refused to participatie. The study protocol had the approval of the Ethics Commitee (Federal University of Pelotas). One trained examiner (FRRM) carried out clinical evaluations and interviews. The examiner was calibrated with Cohen's Kappa higher than 0.85 for the variables investigated. The calibration procedure was undertaken in two stages with an interval of 30 days (Nyvad et al, 1999).

### Variables Definition

Demographic (age and sex), socio-economic (income and education), behavioural (dietary and oral hygiene habits) and clinical variables (presence and quality of biofilm and bleeding points) were considered the independent variables. The caries activity was considered the dependent variable. The descriptions of the variables are shown in Table 1.



## **Evaluation of the Demographic, Socio-economic and Behavioural Variables**

Information regarding gender, age, education level, income, sucrose intake and oral hygiene data were included in a personal questionnaire

Patients were divided into three groups according to age: between 16-25, 26-44 and 45-70 years old. For income level two categories were determined: up to three Brazilian minimal salaries (less than US\$300.00 per month) and four or more minimal salaries (above US\$300.00 per month) (Baldani et al, 2004). Regarding educational level, two categories were used: incomplete high school level or lower, and complete high school or upper. In relation to behavioural conditions, dietary habits were considered only as far as the frequency of snacks consumed was concerned (once a day or more than one a day); oral health hygiene was evaluated by both the tooth-brushing frequency (twice a day or three or more times a day) and dental floss usage. All of the patients were living in areas with fluoridated water supply with 0.58-0.83ppm F (Lima et al, 2004) and used fluoride-containing toothpaste with 1,000 ppm F (Lima and Cury, 2001).

## **Evaluation of the Clinical Variables**

Visual assessment of dental health was made using a dental mirror, probe and artificial light. The Gingival Bleeding Index (Ainamo and Bay, 1975) was performed by introducing a dental floss into the gingival sulcus. Biofilm was considered absent when not visually detected. Qualitatively, biofilm was considered normal, presenting a form of acquired pellicle and being adherent, when there was accumulation over the surface (Thylstrup and Fejerskov, 1995).

After prophylaxis, in a dry field and with adequate illumination, the caries experience was evaluated using the DMFT index (Caldas et al, 2000) and modified DMFT index (Nyvad et al, 1999; Formolo et al, 2005), where the white spot lesions were also included, in addition to DMFT.

## **Caries Activity Classification**

Patients were classified in two groups according to either the presence or absence of caries activity. To be classified in the caries-active group the patients showed present white spot lesions and/or active caries cavities (Nyvad et al, 1999), and this classification was performed combining visual and tactile criteria.

## RESULTS

**Statistical Analysis** 

#### **Description of the Results**

Among the examined patients, 51 (50%) were considered caries-active and 51 (50%) were considered without activity.

Data were submitted to statistical analysis using Chi-

square or Fischer's exact test, with a confidence

In the demographic aspects, approximately half of the patients (53%) were located in the group aged between 26-44 years. Twenty-four (23.5%) patients were found in the younger group (15-25 years) and 24 (23.5%) in the older group, with four individuals over 60 years old. The main age of the patients was  $36.5 (\pm 12.1)$ , and females composed 75.5% (77) of the studied population.

Fifty-seven patients (56%) received up to three minimal salaries per month, and completed high school or upper level was found in 33.3% (34) of the patients.

Approximately eighty percent (82) of the patients stated that they used fluoride-containing toothpaste to brush their teeth three or more times a day. Seventy-one (69.6%) patients reported dental floss use. Twen-ty-six patients (25.5%) reported snack ingestion more than once a day.

During the visual examination, biofilm was observed in 87.3% (89) of the patients. The biofilm accumulated over the tooth surface (adherent biofilm) was found in 46% (47) of the patients presenting biofilm.

When evaluating the experience of caries for the individuals, the DMFT index varied from two to 31. Forty-seven patients had a DMTF index between two and 15. In relation to the modified DMFT index, only 11 patients (10.8%) exhibited values of seven to 21, with the other patients exhibiting values of 22 to 31. The data from the periodontal evaluation revealed 84.3% had gingival bleeding.

## **Statistical Analysis**

As shown in Table 2, Chi-square or Fischer's exact test was performed to verify the association between demographic, socio-economic and behaviour al variables with caries activity. Several categories showed association with caries-active individuals: younger de Moura et al



Table 2 Demogr	aphic, socio-econo	mic and behavioural	variables associated v	with caries activity (p≤0	0.05)
Variables	Categories	No caries activity	Caries activity	RR	p
		% (n)	% (n)	(CI 95%)	
Sex	-Male	25.49 (13)	23.53 (12)	1	
	-Female	74.51 (38)	76.47(39)	0.94(0.59-1.50)	0.81
Age	16-25 years old	09.80 (05)	37.25 (19)	1	
	26-44 years old	54.90 (28)	50.98 (26)	0.53(0.37-0.75)	
	45-70 years old	35.29 (18)	11.76 (06)	0.33(0.14-0.77)	0.001*
Income					
(Brazilian					
minimal salary)	Up to 3	35.91 (20)	64.91 (37)	1	0.001*
	4 or more	68.89 (31)	31.11 (14)	0.47(0,29-0.77)	
Education level	Incomplete				
	high school	11 10 (00)	50.00 (10)		0.04
	level or lower	41.18 (28)	58.82 (40)	1	0.01*
	Complete				
	nign school		20.25 (11)		
	or upper	67.65 (23)	32.35 (11)	0.55(0.32-0.92)	
Tooth- brushing	Twice/daily	07.84 (04)	31.37 (16)	1	0.001*
frequency	Three or more				
	time /daily	92.16 (47)	68.63 (35)	0.53(0.38-0.74)	
Dental floss	Use	74.51 (38)	64.71 (33)	1	0.28
	No use	25.49 (13)	35.29 (18)	1.24(0.84-1.84)	
Snack frequency	Once a day	30.23 (13)	10.53 (04)	1	
	More than				
	once a day	69.77 (30)	89.47 (34)	2.52(1.02-5.32)	0.05*
* Statistically significar	1				

and older groups (p<0.001), income level up to three minimal salaries (p<0.001), lower level of education (p<0.01) and lower frequency of tooth brushing (p<0.001). Sex and dental floss variables did not demonstrate significant association (p>0.05).

In Table 3, the association between clinical variables and caries activity is demonstrated. Presence of biofilm and adherent biofilm, bleeding points and higher modified DMFT index disclosed association with caries-active patients (p<0.05). DMFT index was not positively associated with caries activity.

## DISCUSSION

Only one blinded experienced operator was responsible for the clinical evaluation of all patients. The examiner was calibrated with a Kappa Cohen score higher than 0.85.

In the present study, half of the patients (51) were classified as caries-active individuals, based on clinical evidence, considering the earliest manifestation of the disease (white spots) with a high reliability (Nyvad et al, 1999).

In relation to demographic and socio-economic aspects, several variables have shown to be related to caries activity (younger patients, lower income and ed-



patients% (n)		patients% (n)	ounce activity		P
Biofilm	No visible				
	biofilm	21.57 (11)	03.92 (02)	1	
	Visible biofilm	78.43 (40)	96.08 (49)	3.57(1.08-12.98)	0.001*
Quality of	Normal	64.71 (33)	43.14 (22)	1	
biofilm	Sticky				
	(Adherent)	35.29 (18)	56.86 (29)	0.51(0.37-0.72)	0.001*
Bleeding	No bleeding				
points	points	23.53 (12)	07.84 (04)	1	
	Bleeding points	76.47 (39)	92.16 (47)	2.18(1.11-5.19)	0.001*
DMFT	2/15	37.25 (19)	54.90 (28)	1	
Index	16/31	65.75 (32)	45.10 (23)	0.70(0.47-1.03)	0.07
Modified*	7/21	41.18 (21)	21.57 (11)	1	
DMFT	22/31	58.82 (30)	78.43 (40)	1.66(1.18-2.69)	0.03*
Index**					

ucational levels). In this study, caries activity was independent of gender, but the findings should be evaluated with caution due to non-equal distribution regarding gender. The gender distribution was not similar within the sample, and this reflects the population that attends the clinics of the Dental School, which is predominately composed of females. Regarding the influence of age, younger ages were associated with caries-active patients, while older individuals exhibited prevalence of caries inactivity. The occurrence of caries has been demonstrated to increase in adolescents. In this stage of their lifes self-care is usually neglected, including oral health habits (Knishkowy and Sgan-Cohen, 2005). Conversely, caries prevalence is reduced during adult life, and a new increase in caries prevalence is observed in older patients, mainly due to root caries (Forshee and Storey, 2004; Saunders Jr and Meyerowitz, 2005). However, in this study there was a decrease in caries activity in older patients, but it should be highlighted that only few patients were over 60 years old, when root caries is more likely to happen (Hamasha et al, 2005). No root caries was detected in the present study.

Lower income and educational levels were associated with dental caries in this study. In the adult population of Recife, Brazil, Caldas et al (2000) showed that more than 70% of lost teeth occurred in patients of lower income and education levels. A low educational level could also contribute to developing dental caries (Osterberg et al, 1998), and educational level influenced the experience of caries (DMFT) in young adults (Senna et al, 2005). In a recent study, Peres et al (2005) observed that employed fathers and mothers with more than eight years of study before a child s birth were associated with lower DMFT in children aged six years, while lower family income was associated with high DMFT. In Brazil, there is a correlation between higher income and higher educational levels and access to dental treatments (Baldani et al, 2004). More access to information, better understanding of the importance of dental health in the daily life and better oral hygiene could justify the findings in the population with more years of study.

Consumption of sticky sugar-containing products between meals can be associated with high caries activity (Birkhed, 1989). Such a finding was corrobo-

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rated for the results of this study, where patients with a snack frequency of more than once a day were associated with caries activity. Sweet consumption every day at least once was associated with an increased DMTF index in infants (Peres et al, 2005).

In the present study, patients with higher toothbrushing frequency were more prone to be classified as individuals without caries activity. Similarly, tooth brushing more than three time a day was associated with a lower prevalence of dental caries in children (Peres et al, 2005). The inverse relationship between brushing frequency and caries activity may be related to the more frequent fluoride contact when individuals brush their teeth (Leske et al, 1976). Poor oral cleanlinessess combined with higher snack frequency could increase caries activity. No association between dental floss usage and caries activity was detected in this study, which is reinforced by previous reports in the literature where the use of dental floss was not associated with the DMFT index (Peres et al, 2005). When clinical variables were analysed, the presence of biofilm and an adherent characteristic of this biofilm were strongly associated with caries activity as well the presence of gingival bleeding. Even though most of the patients reported tooth brushing more than three times a day, the brushing procedures were not likely to be well done, which was disclosed by the high level of gengival bleeding detected. Presence of bleeding points might be related to poor hygiene habits (Maltz et al, 2001). An adherent biofilm indicates a polysaccharide-rich layer, facilitating the adhesion of microorganisms (Thylstrup and Fejerskov, 1995). Cariogenic biofilm makes the environment acidic, facilitating tooth demineralisation. Frequent sucrose ingestion and microbial colonisation are two of the etiological factors implicated in caries disease (Thylstrup and Fejerskov, 1995). Therefore, the association observed in the present study between caries activity with gingival bleeding, tooth brushing and sugar intake could be easily justified.

The DMFT index has been frequently used in several studies (Caldas et al, 2000; Baldani et al, 2004; Senna et al, 2005) to evaluate dental status. Powell (1998) stated that caries experience is a factor that predicts the future development of the disease. However, in this study the DMFT index was not associated (p>0.05) with caries activity. The possible reason for such a finding is that DMFT is an index reporting past dental status and not the present oral condition. In addition, the index has limitations for determining the real status of the disease, since it is not able to measure the initial caries activity, such as white spots. When a



modified DMFT index including the white spot lesions was used a significant association was detected. The modified DMFT index demonstrates the diagnosis of oral health at present and determines the need to provide non-operative treatment (Formolo et al, 2005).

The manifestations and the treatment of caries are strongly dependent on caries risk and the severity of the attacking factors that determine the degree of caries activity, which can be minimised by effective preventive measures (Koning, 2004). This reinforces the importance of an educational approach in the prevention of caries activity, which is one of the bases of the minimally invasive dentistry (Ericson et al, 2003).

The findings of the present study should be analysed carefully. It is a cross-sectional study undertaken in a population attending for treatment in a dental school, and the sample comes from a relatively wealthy part of Brazil. Therefore, the inference of the study cannot easily be applied to another part of Brazil or to other countries. Multicentre studies should be performed to elucidate whether the same patterns would occur in other countries with different demographic, socio economic, oral health behavioural and clinical conditions.

The hypothesis tested in this study was rejected because most of the variables investigated have shown association with caries activity.

Based on the methodology and the population studied, it was possible to conclude that demographic (age), socio-economic (income and educational levels), behavioural (tooth brushing and snack frequencies) and clinical (modified DMFT index, presence and quality of biofilm, and bleeding points) variables were associated with caries-active patients.

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