

Use of occlusal sealant in a community program and caries incidence in high- and low-risk children

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ABSTRACT

Objective: The aims of this study were to investigate the effectiveness of sealant placement under the guidelines of the Oral Health Promotion Program for Children and Adolescents (Portugal), and to test the influence of clinical and socioeconomic variables on the DMFT increment in 277 children, born in 1997. Material and Methods: A dental hygienist performed the initial examinations and sealant placement (Helioseal, Vivadent) on the permanent first molars in 2005. These activities were registered in dental records that were assessed in 2007. Children were classified according to caries risk at baseline [high (HR: DMFT+dmft>0); low (LR: DMFT+dmft=0) risk] and sealant placement as follows: HR-S and LR-S Groups (with sealant placement); HR-NS and LR-NS Groups (without sealant placement). A calibrated dentist performed the final examination in 2007 at school, based on the World Health Organization recommendations. The variables collected were: dental caries, visible dental plaque, malocclusions, and socioeconomic level (questionnaire sent to children's parents). For univariate (Chi-square or Fisher tests) and multivariate (Multiple logistic regression) analyses the DMFT increment >0 was selected as dependent variable. Results: Approximately 17.0% of the children showed DMFT increment>0 (mean=0.25). High-risk children presented a significant increase in the number of decayed and/or filled teeth. These children had 7.94 more chance of developing caries. Children who did not receive sealant were 1.8 more prone to have DMFT increment >0. Conclusion: It appears that sealant placement was effective in preventing dental caries development. Moreover, the variables "risk" and "sealant placement" were predictors for DMFT increment in the studied children.

Key words: Dental caries. Fissure sealants. Preventive dentistry. Risk.

INTRODUCTION

In recent decades, decreasing prevalence in dental caries has been observed worldwide^{9,19,32}. The slower progression of lesions²², the unequal distribution of disease², with about 80% of caries experience is concentrated in 20-30% of the population^{10,25,31}, and the concentration of new lesions on occlusal surfaces of permanent molars^{8,12,26} have also been noted.

Indeed, several studies have shown that occlusal caries account for the majority of the total caries

experience in children and adolescents^{8,11,12,21,24,25}. An effective procedure for protecting the occlusal surfaces of permanent molars is the application of pit-and-fissure sealants^{1,5,14,28}, the resin-based type being the most commonly used^{3,13}.

In Portugal, from 1999 to 2005, the Oral Health Promotion Program for Children and Adolescents (PPSOCA - *Programa de Promoção da Saúde Oral em Crianças e Adolescentes*) included: a) diet and oral hygiene instructions, fluoride mouthrinse fortnightly for all children and adolescents (Basic Oral Health Program); b) sealant placement on all

permanent first molars in children aged up to 7 years, in premolars and second permanent molars in those aged up to 13 years, under a population strategy, attending the maximum number of children according to the financial and human resources available (specific program of sealant placement); and c) restorative care (intervention program).

Since 2005, some modifications have been made and the PPSOCA was re-named as the National Oral Health Program (PNPSO - *Programa Nacional de Saúde Oral*). The most important changes were: toothbrushing in the school environment, individual and community risk assessment for dental caries and specific measures for individuals at high caries risk, such as sealant placement, use of fluoride varnish or chlorhexidine.

The aims of this study were to investigate the effectiveness of a resin-based sealant placement following the PPSOCA guidelines and to test the influence of clinical and socioeconomic variables on caries incidence after 2 years of follow-up.

MATERIAL AND METHODS

Ethical aspects

The study was approved by the Research Ethics Committee of the School of Dental Medicine, University of Lisboa (Protocol number 6/2006). An informed consent form was signed by the parents/guardians before starting the survey.

Study location

In the Sintra region (Portugal), the PPSOCA/PNPSO has been developed by a dental hygienist, which differs from other regions of the country where the first was carried out by nurseries. One out of 5 Health Centers in the Sintra region (Cacem Health Center) assisted the largest number of children, with organized dental records and was thus selected for the study.

Sample

This study was conducted from 2005 to 2007. The dental records of 854 children who were born in 1997 and attended the PPSOCA at the Cacem Health Center were tracked. Among them, some did not have all their permanent first molars in 2005 ($n=71$) and others were not available for examination ($n=157$). Therefore, the final population included 626 children. As much as 349 parents/guardians did not return the informed consent form in 2007, thus 277 children (44.3% response rate) were reexamined in 2007. The sample size was calculated considering the significance level of 5%, $DMFT=0.17$, standard deviation= 0.46 , both of them obtained in a pilot study, and power of the test= 0.80 .

Children's allocation

The dental records completed in 2005 were evaluated. The DMFT/dmft were calculated and the status of the permanent first molars was recorded. Considering that past caries experience has been an excellent predictor, as shown in several studies^{16,18,29,30,33}, and has also proved to be a practical and effective predictor for use in community health⁶, the children were classified according to caries risk [HR=high caries risk when $DMFT+dmft>0$; LR=low caries risk when $DMFT+dmft=0$] and sealant placement on the permanent first molars, as follows:

HR-S Group: children with $DMFT+dmft>0$ submitted to sealant placement

LR-S Group: children with $DMFT+dmft=0$ submitted to sealant placement

HR-NS Group: children with $DMFT+dmft>0$

LR-NS Group: children with $DMFT+dmft=0$

Calibration process, dental examination and sealant placement

A dental hygienist performed the baseline examinations and sealant placement in 2005, and these activities were registered in dental records.

Prior to sealant placement, the permanent first molars were cleaned using a brush attached to a rotary instrument with pumice slurry and washed. The teeth were etched with 37% phosphoric acid for 30 s, washed for 15 s and air-dried. The light-curing fissure sealant Helioseal (Ivoclar, Vivadent, Schaan, Liechtenstein) was then applied directly to the pits and fissures according to the manufacturer's instructions, under isolation with cotton rolls.

In 2007, a dentist evaluated the 2005 dental records and performed the final examination of the sealants after being calibrated and trained in theoretical and practical exercises by two experienced professionals of the School of Dental Medicine, who used the World Health Organization criteria³⁵ and the Assaf, et al.⁴ (2006) criteria. To assess the examiner's consistency, duplicate examinations were conducted in 20 children in a 7-day-interval, reaching a kappa value higher than 0.85. Dental examinations were performed at school in well-lit classrooms, using natural light, dental mirrors and CPI probes with the children seated in front of the examiner. The clinical variables collected were: dental caries, dentofacial anomalies (open bite, cross bite, edge-to-edge bite, overbite, crowding)³⁵ and visible dental plaque (labial surface of teeth 16, 26, 41, and 21; lingual surface of teeth 36 and 46)¹⁵.

Questionnaire

A socioeconomic questionnaire based on that of Meneghim, et al.²⁰ (2007) with some adjustments for spelling, income and education was sent to

Table 1- Univariate analysis for association between DMFT increment and independent variables

Variable	DMFT increment>0		p-value*
	Yes n (%)	No n (%)	
Group**			
HR-S	20 (22.2)	70 (77.8)	0.0001
LR-S	1 (1.6)	63 (98.4)	
HR-NS	22 (31.0)	49 (69.0)	
LR-NS	4 (7.8)	47 (92.2)	
First permanent molars sealed			
Yes	21 (13.6)	133 (86.4)	0.0921
No	26 (21.3)	96 (78.7)	
Risk			
High	42 (26.1)	119 (73.9)	<0.0001
Low	5 (4.4)	110 (95.6)	
Dental plaque			
<2	4 (19.0)	17 (81.0)	0.592
2	28 (15.4)	154 (84.6)	
>2	15 (20.6)	58 (79.4)	
Spacing			
Yes	10 (20.4)	39 (79.6)	0.4877
No	37 (16.3)	190 (83.7)	
Crowding			
Yes	9 (18.4)	40 (81.6)	0.4459
No	32 (14.1)	195 (85.9)	
Overjet			
Yes	3 (10.7)	25 (89.3)	0.4365
No	44 (17.7)	204 (82.3)	
Overbite			
Yes	0 (0.0)	14 (100.0)	0.1376
No	47 (17.9)	215 (82.1)	
Crossbite			
Yes	4 (20.0)	16 (80.0)	0.7568
No	43 (16.8)	213 (83.2)	
Open bite			
Yes	5 (23.8)	16 (76.2)	0.3898
No	42 (16.5)	213 (83.5)	
Edge-to-edge bite			
Yes	0 (0.0)	8 (100.0)	0.3587
No	47 (17.5)	221 (82.5)	
Home ownership			
Yes	39 (17.6)	182 (82.4)	0.3175
No	8 (25.0)	24 (75.0)	
Number of people living in the household			
≤4 people	36 (17.1)	174 (82.9)	0.5397
>4 people	11 (20.8)	42 (79.2)	
Mother's education			
≤9 years of schooling	28 (19.4)	116 (80.6)	0.2875
>9 years of schooling	15 (14.3)	90 (85.7)	
Monthly family income			
Up to 2 minimum wages***	15 (16.3)	77 (83.7)	0.8791
2-6 minimum wages	23 (18.7)	100 (81.3)	
>6 minimum wages	6 (19.4)	25 (80.6)	

*Chi-square or Fisher's Exact tests ($\alpha=0.05$)

**HR: high caries risk; LR: low caries risk; S: sealed permanent first molars; NS: not sealed permanent first molars

***Minimum wage at the time of the data collection=€ 403.00

children's parents. In order to classify the children's socioeconomic level, the following variables were collected: home ownership, number of people living in the household, mother's education, monthly family income, and parents' occupation.

Data analysis

For univariate and multivariate analyses the DMFT increment >0 was selected as dependent variable. In the univariate analysis (Chi-square or Fisher tests) variables related to treatment group, dental plaque, malocclusion, and socioeconomic level were tested with the dependent variable. Those with $p < 0.15$ were selected for the multiple logistic regression. After adjusting the regression model, the values of Odds Ratio, their 95% confidence interval and p-values were estimated. The Kruskal-Wallis and Dunn tests, at a 5% level of significance, were used to compare differences between the study groups as regards the increase in the number of decayed and filled teeth after 2 years. The Mann-Whitney test was used to compare differences between the HR-S and HR-NS groups in relation to DMFT at baseline. All statistical tests were performed using the SPSS (version 13.0) and Statistic (version 6.0) programs.

RESULTS

The mean DMFT values at baseline/final examination were 0.40/0.73, 0.00/0.02, 0.46/0.89 and 0.00/0.16 for the HR-S, LR-S, HR-NS and LR-NS groups, respectively. There was no statistically significant difference between HR-S and HR-NS in relation to DMFT at baseline ($p > 0.05$). Approximately 17.0% ($n=47$) of the children showed a DMFT increment >0 after 2 years (mean DMFT

increment=0.25). Among them, 44.7% ($n=21$) participated and 55.3% ($n=26$) did not participate in the specific sealant placement program.

Table 1 shows the univariate analysis for association between DMFT increment >0 and independent variables. Only the variables "group" and "risk" showed statistically significant association with DMFT increment >0 . Data distribution showed that among those with DMFT increment the majority (31%) belonged to the HR-NS group. However, when testing the participation in the Sealant Program with DMFT increment, no statistical difference was observed ($p > 0.05$).

Table 2 shows the results of the logistic regression analysis. The children who were not submitted to sealant placement were 1.8 more prone to have DMFT increment >0 . The high-risk children had 7.94 more chance of developing caries, irrespective of whether or not they had received a sealant in the studied period.

Table 3 shows the increase in the number of decayed and/or filled teeth after 2 years from baseline in the different groups. High-risk children not submitted to sealant placement showed the highest increase in the number of decayed teeth. However, they did not differ from high-risk children submitted to sealant placement. Significant differences ($p < 0.05$) were also found between high- and low-risk individuals, irrespective of participation in the sealant program.

Table 4 shows the status of the permanent first molars at baseline and final examinations. There was a clear increase in the number of first molars sealed/restored in the sealant program participants. Moreover, the highest percentage of decayed teeth was observed in high-risk children not submitted to a sealant placement.

Table 2- Multiple logistic regression with DMFT increment >0 as dependent variable

Variable	Estimate	Standard error	Wald chi-square	DMFT increment >0 n (%)	Odds Ratio	95% Confidence Interval	p-value
Intercept	2.06	0.25	69.86				<0.0001
First permanent molars sealed							
Yes				21 (13.6)	1		
No	0.3	0.17	3.09	26 (21.3)	1.81	0.93-3.50	0.0767
Risk							
Low				5 (4.4)	1		
High	-1.03	0.25	17.63	42 (26.1)	7.94	3.01-20.80	<0.0001

AIC (Akaike Information Criteria)=228.83 -2LogL=222.83

Table 3- Increase in the number of decayed and filled teeth after 2 years from baseline, according to the groups

Teeth status	Group*	Mean**	Standard Deviation	Median	Minimum	Maximum
Decayed Teeth	HR-S	0.09 ^{ab}	0.32	0	0	2
	LR-S	0.02 ^c	0.12	0	0	1
	HR-NS	0.14 ^a	0.35	0	0	1
	LR-NS	0.04 ^{bc}	0.2	0	0	1
Filled Teeth	HR-S	0.24 ^a	0.32	0	0	2
	LR-S	0.00 ^b	0	0	0	0
	HR-NS	0.28 ^a	0.7	0	0	3
	LR-NS	0.12 ^b	0.2	0	0	1
Decayed + Filled Teeth	HR-S	0.33 ^a	0.69	0	0	3
	LR-S	0.02 ^b	0.12	0	0	1
	HR-NS	0.42 ^a	0.74	0	0	3
	LR-NS	0.16 ^b	0.64	0	0	4

*HR: high caries risk; LR: low caries risk; S: sealed permanent first molars; NS: not sealed permanent first molars

**Means followed by distinct letters are statistically different by the Kruskal-Wallis and Dunn tests ($p < 0.05$)

Table 4- Status (Sound: code 0; decayed: codes 1 and 2; filled: code 3; sealed: code 6 of DMFT index according to the WHO recommendations) for the permanent first molars at baseline and final examinations, according to the groups

Group*	Tooth	Tooth status n (%)							
		Sound at BL**	Sound at FE**	Decayed at BL	Decayed at FE	Filled at BL	Filled at FE	Sealed at BL	Sealed at FE
HR-S	16	85 (94.4)	24 (26.7)	4 (4.4)	4 (4.4)	0 (0.0)	7 (7.8)	1 (1.1)	55 (61.1)
	26	80 (88.9)	15 (16.7)	8 (8.9)	4 (4.4)	0 (0.0)	11 (12.2)	2 (2.2)	60 (66.7)
	36	77 (85.6)	11 (12.2)	13 (14.4)	5 (5.6)	0 (0.0)	17 (18.9)	0 (0.0)	57 (63.3)
	46	79 (87.8)	11 (12.2)	9 (10.0)	6 (6.7)	1 (1.1)	12 (13.3)	1 (1.1)	61 (67.8)
LR-S	16	64 (100.0)	10 (15.6)	0 (0.0)	1 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	53 (82.8)
	26	64 (100.0)	8 (12.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	56 (87.5)
	36	64 (100.0)	6 (9.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	58 (90.6)
	46	64 (100.0)	7 (10.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	57 (89.1)
HR-NS	16	59 (91.1)	47 (66.2)	6 (8.4)	7 (9.9)	3 (4.2)	7 (9.9)	3 (4.2)	10 (14.1)
	26	62 (87.3)	45 (63.4)	3 (4.2)	9 (12.7)	1 (1.4)	5 (7.0)	5 (7.0)	12 (16.9)
	36	58 (81.7)	45 (63.4)	9 (12.7)	6 (8.4)	1 (1.4)	7 (9.9)	3 (4.2)	13 (18.3)
	46	56 (87.5)	40 (56.3)	11 (8.3)	9 (12.7)	2 (2.8)	13 (18.3)	5 (7.0)	9 (12.7)
LR-NS	16	46 (90.2)	40 (78.4)	0 (0.0)	1 (2.0)	0 (0.0)	1 (2.0)	5 (9.8)	9 (17.6)
	26	46 (90.2)	39 (76.5)	0 (0.0)	1 (2.0)	0 (0.0)	1 (2.0)	5 (9.8)	10 (19.6)
	36	43 (84.3)	40 (78.4)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.9)	8 (15.7)	9 (17.6)
	46	45 (88.2)	41 (80.4)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.9)	6 (11.8)	8 (15.7)

*HR: high caries risk; LR: low caries risk; S: sealed permanent first molars; NS: not sealed permanent first molars

**BL: baseline; FE: final examination

DISCUSSION

The results showed that the DMFT increment found in 17% of the children was statistically associated with risk, as shown in Table 1. Moreover,

those classified as high-risk children at baseline (DMFT+dmft>0) were about 8 times more likely to have DMFT increment compared with caries-free children (Table 2). These results confirm previous studies that showed past caries experience to be a

strong predictor of future caries^{16-18,29,30} and confirm the importance of using the correct risk assessment to identify the most caries-susceptible individuals, thus targeting them for preventive care.

The results also showed a trend towards better results for those submitted to sealant placement (Table 1), which is in line with other studies that demonstrate the effectiveness of sealants in high-risk groups³⁴. On the other hand, the DMFT increment in 31% of children without sealant placement (HR-NS group) demonstrates that there is a real need for specific measures for this group and that the population strategy alone (oral health education + fluoride mouthrinse) was not sufficient (Table 1).

As regards low-risk children only 1 child submitted to sealant placement (1.6%) developed caries, while among those without sealant, 4 children (7.8%) developed caries. This difference, however, was not statistically significant ($p > 0.05$; Table 3). Therefore, one must calculate the cost-effectiveness of applying sealants in low-risk groups because there may be other preventive measures such as the use of fluoride, toothbrushing instructions, capable of achieving the same results.

This study also assessed the influence of clinical and socioeconomic variables on caries incidence. The presence of plaque is usually linked to high rates of dental caries¹⁷. This study showed different results (Table 1), probably due to the use of the Simplified Oral Hygiene index without dye. This was done in order to not disturb the school class routines. Variables related to malocclusions were also not statistically associated with DMFT increment (Table 1).

The socioeconomic level has been strongly associated with caries prevalence²⁷. Our results differed from published data, possibly because this study was designed to measure caries incidence. However, most children who lived in their own house, with fewer than 4 persons, parents with over 9 years of schooling and families with a monthly income of over 6 minimum wages, showed no increment in DMFT (Table 1), indicating the important role of socioeconomic characteristics in caries development.

The significant increase in the number of decayed and/or filled teeth after 2 years in high-risk individuals (Table 3), with or without sealed permanent molars, demonstrated that these children need specific preventive care, in addition to care targeting all the children. Oulis and Berdouses²³ (2009) evaluated the effectiveness of fissure sealants applied to permanent first molars on caries reduction, in a sample of children with low, moderate and high caries risk. The results demonstrated that the highest percentage of teeth that developed caries was found in the high risk

group. The findings indicate that high risk children may demand a great attention from the oral health team, who should bear in mind that high risk and population strategy should be taken together in order to improve the children's overall health⁷.

An increase in the number of sealed/filled first molars could be detected in children who had been submitted to the sealant placement (Table 4). The fact that the majority of permanent molars were healthy at baseline demonstrated that this was an excellent time to take preventive measures. At final examination, the HR-NS group showed a higher percentage of decayed permanent molars, demonstrating the importance of having a good team of professionals working on preventive care.

It is important to emphasize that this study was developed within an oral health program targeting Portuguese children from Sintra region. The Cacem Health Center was selected because the largest number of children was treated there and it presented organized dental records, while other health centers in the same region had some problems about that. Though this study had been carried out in a bounded area, probably the results can be inferred for whole region because children live in the same socioeconomic conditions. A limitation that should be mentioned is the difficulty in controlling the dental treatments that each child received besides the PPSOCA protocol, such as sealants placed by other dentists.

In conclusion, it appears that sealant placement was effective in preventing dental caries development. Moreover, the variables "risk" and "sealant placement" were predictors of DMFT increment in the studied children. Therefore, children initially classified as high risk and not submitted to sealant placement presented higher risk of developing caries lesions within a 2 year-period. Finally, the past caries experience was an excellent predictor of future caries and can easily be used in oral health programs.

REFERENCES

- 1- Ahovuo-Saloranta A, Hiiri A, Nordblad A, Mäkelä M, Worthington HV. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. *Cochrane Database Syst Rev.* 2008;4:CD001830.
- 2- Antunes JLF, Narvai PC, Nugent ZJ. Measuring inequalities in the distribution of dental caries. *Community Dent Oral Epidemiol.* 2004;32:41-8.
- 3- Armfield JM, Spencer AJ. Community effectiveness of fissure sealants and the effect of fluoridated water consumption. *Community Dent Health.* 2007;24:4-11.
- 4- Assaf AV, Castro Meneghim M, Zanin L, Tengan C, Pereira AC. Effect of different diagnostic thresholds of dental caries calibration - a 12-month evaluation. *Community Dent Oral Epidemiol.* 2006;34:213-9.
- 5- Azarpazhooh A, Main PA. Pit and fissure sealants in the prevention of dental caries in children and adolescents: a systematic review. *J Can Dent Assoc.* 2008;74:171-7.

- 6- Badovinac RL, Morgan KE, Lefreve J, Wadhawan S, Mucci L, Schoeff L, et al. Risk assessment criteria applied to a screening exam: implications for improving the efficiency of a sealant program. *J Public Health Dent.* 2005;65:203-8.
- 7- Batchelor PA, Sheiham A. The distribution of burden of dental caries in schoolchildren: a critique of the high risk caries prevention strategy for populations. *BMC Oral Health.* 2006;31;6:3.
- 8- Batchelor PA, Sheiham A. Grouping of tooth surfaces by susceptibility to caries: a study in 5-16 year-old children. *BMC Oral Health.* 2004;4:2.
- 9- Bönecker M, Cleaton-Jones P. Trends in dental caries in Latin American and Caribbean 5-6- and 11-13 year-old children: a systematic review. *Community Dent Oral Epidemiol.* 2003;31:152-7.
- 10- Bratthall D. Introducing the Significant Caries Index together with a proposal for a new global oral health goal for 12-year-olds. *Int Dent J.* 2000;50:378-84.
- 11- Campain AC, Morgan MV, Evans RW, Ugoni A, Adams GG, Conn JA, et al. Sugar-starch combinations in food and the relationship to dental caries in low-risk adolescents. *Eur J Oral Sci.* 2003;111:316-25.
- 12- David J, Raadal M, Wang NJ, Strand GV. Caries increment and prediction from 12 to 18 years of age: a follow-up study. *Eur Arch Paediatr Dent.* 2006;7:31-7.
- 13- Dorantes C, Childers NK, Makhija SK, Elliott R, Chafin T, Desanayake AP. Assessment of retention rates and clinical benefits of a community sealant program. *Pediatr Dent.* 2005;27:212-6.
- 14- Francis R, Mascarenhas AK, Soparkar P, Al-Mutawaa S. Retention and effectiveness of fissure sealants in Kuwaiti school children. *Community Dent Health.* 2008;25:211-5.
- 15- Greene JC, Vermillion JR. The simplified oral hygiene index. *J Am Dent Assoc.* 1964;68:7-13.
- 16- Kassawara ABC, Tagliaferro EPS, Cortellazzi KL, Ambrosano GMB, Assaf AV, Meneghim MC, et al. Epidemiological assessment of predictors of caries increment in 7-10-year-olds: a 2-year cohort study. *J Appl Oral Sci.* 2010;18:116-20.
- 17- Leroy R, Bogaerts K, Lesaffre E, Declerck D. Multivariate survival analysis for the identification of factors associated with cavity formation in permanent first molars. *Eur J Oral Sci.* 2005;113:145-52.
- 18- Li Y, Wang W. Predicting caries in permanent teeth from caries in primary teeth: an eight-year cohort study. *J Dent Res.* 2002;81:561-6.
- 19- Marthaler TM. Changes in dental caries 1953-2003. *Caries Res.* 2004;38:173-81.
- 20- Meneghim MC, Kozłowski FC, Pereira AC, Ambrosano GMB, Meneghim ZMAP. A socioeconomic classification and the discussion related to prevalence of dental caries and dental fluorosis. *Ciênc Saúde Coletiva.* 2007;12:523-9.
- 21- Meneghim MC, Saliba NA, Pereira AC. The importance of first permanent molar in determining the DMFT index. *J Bras Odontopediatr Odontol Bebe.* 1999;2:37-41.
- 22- Moberg Sköld U, Birkhed D, Borg E, Peterson LG. Approximal caries development in adolescents with low to moderate caries risk after different 3-year school-based supervised fluoride mouth rising programs. *Caries Res.* 2005;39:529-35.
- 23- Oulis CJ, Berdouses ED. Fissure sealant retention and caries development after resealing on first permanent molars of children with low, moderate and high caries risk. *Eur Arch Paediatr Dent.* 2009;10:211-7.
- 24- Pardi V, Pereira AC, Ambrosano GMB, Meneghim MC. Clinical evaluation of three different materials used as pit and fissure sealant: 24-months results. *J Clin Pediatr Dent.* 2005;29:133-7.
- 25- Pereira SM, Tagliaferro EPS, Ambrosano GMB, Cortellazzi KL, Meneghim MC, Pereira AC. Dental caries in 12-year-old schoolchildren and its relationship with socioeconomic and behavioral variables. *Oral Health Prev Dent.* 2007;5:299-306.
- 26- Pereira SM, Tagliaferro EPS, Cortellazzi KL, Ambrosano GMB, Mialhe FL, Meneghim MC, et al. An estimate of DMFT using teeth most affected by dental caries in twelve-year-old children. *Rev Saude Publica.* 2009;43:179-82.
- 27- Peres KGA, Bastos JRM, Latorre MRDO. Severity of dental caries in children and relationship with social and behavioral aspects. *Rev Saude Publica.* 2000;34:402-8.
- 28- Splieth CH, Ekstrand KR, Alkilzy M, Clarkson J, Meyer-Lueckel H, Martignon S, et al. Sealants in dentistry: outcomes of the ORCA Saturday Afternoon Symposium 2007. *Caries Res.* 2010;44:3-13.
- 29- Tagliaferro EPS, Ambrosano GMB, Meneghim MC, Pereira AC. Risk indicators and risk predictors of dental caries in schoolchildren. *J Appl Oral Sci.* 2008;16:408-13.
- 30- Tagliaferro EPS, Pereira AC, Meneghim MC, Ambrosano GMB. Assessment of dental caries predictors in a seven-year longitudinal study. *J Public Health Dent.* 2006;66:169-73.
- 31- Tickle M. The 80:20 phenomenon: help or hindrance to planning caries programmes? *Community Dent Health.* 2002;19:39-42.
- 32- Van Wyk PJ, Van Wyk C. Oral health in South Africa. *Int Dent J.* 2004;54:373-7.
- 33- Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. Assessing risk indicators for dental caries in the primary dentition. *Community Dent Oral Epidemiol.* 2001;29:424-34.
- 34- Weintraub JA. Pit and fissure sealants in high-caries-risk individuals. *J Dent Educ.* 2001;65:1084-90.
- 35- World Health Organization. Oral health surveys - basic methods. 4th ed. Geneva: World Health Organization; 1997.