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ORIGINAL ARTICLE

Caries risk profiles in Sardinian schoolchildren using Cariogram

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Abstract

Objective. The aim of our study was to assess the caries risk profile in a group of Sardinian schoolchildren and to compare the outcome with their history of caries. ***Material and methods.*** Using the computer-based program "Cariogram", 957 subjects aged 7, 8, and 9 years were enrolled in this cross-sectional study. The children were examined to evaluate dmfs/DMFS and gingival conditions. Data on dietary and oral hygiene habits were collected and saliva was analyzed, including levels of mutans streptococci (MS) and lactobacilli (Lb). Based on the Cariogram profiles, the children were divided into five risk groups in accordance with "chance of avoiding caries". ***Results.*** Almost 50% of the children had a low caries risk, while more than a quarter had less than 40% "chance of avoiding caries". A significant linear trend between the five Cariogram categories and dmfs/DMFS was observed in the three age groups ($p < 0.001$). ***Conclusions.*** The Cariogram risk profile showed strong correlations to the caries experience of Sardinian schoolchildren and that efforts to reduce caries risk are necessary.

Key Words: *Caries, caries risk, Cariogram, mutans streptococci, schoolchildren*

Introduction

It is important to identify individuals with higher caries risk in order to involve them in preventive programs and measures [1]. However, caries risk assessment is a complex matter. Risk variables such as epidemiology indexes (DMFS/T or Significant Caries index), level of associated caries bacteria, saliva setting, oral hygiene, and dietary habits have all to be evaluated [1,2]. In creating a risk profile to be able to predict the development of new caries in the future, it is important to analyze the combination and interaction of a large number of factors. Hausen [2] claims that it is difficult, almost impossible even, to identify risk patients, and concludes that it is subsequently hard to succeed with extra preventive approaches. It has been suggested, however, that similar measures be extended to the entire population regardless of risk level [3].

Cariogram is a caries risk predictor model that has been developed to describe and calculate the individual caries risk profile [4]. It is a computer-based program indicating the chance an individual has of avoiding caries in the near future and expressing this graphically. The program takes account of several of the risk factors involved in the caries etiology and depicts the strength of these background factors in a particular individual using an algorithm with a "weighted" analysis of the data entered [1]. Cariogram has been found favorable when used in the clinic, as it allows more objective handling during data interpretation and, as part of an educational program, in explaining the caries situation to patients and encouraging preventive action [1,5–7].

When validated in a 2-year prospective study on 446 schoolchildren, 10–11 years of age [6], Cariogram predicted caries increment more accurately than any single-factor model. Cariogram is considered particularly useful in a population with high disease prevalence [1,5–7].

In Italy, as in many Western European countries, a decline in childhood caries has been reported [8].

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Nevertheless, dental caries still constitutes a major problem for many individuals and affects about 50% of 12-year-olds and 22% of 4 to 5-year-olds [9,10]. No national data are available for Italian children aged 7–9 years; only in certain limited areas are data available [11,12].

The aim of this study was to assess the caries risk profile in a group of Sardinian schoolchildren aged 7–9 years using the Cariogram program and to compare the outcome with the history of caries in the same sample.

Material and methods

Study area

The survey was carried out as a cross-sectional study in the period January to June 2007. Data on the total number of residents in Sassari, derived from the National Statistics Institute [13], produced a total of 3241 children (1715 boys and 1526 girls) aged 7–9 years from primary school groups. Sassari is the largest district in northern Sardinia with 127,893 inhabitants [13]. The fluoride concentration in local tap water is low (0.3 mg/l) [14]. The study was approved by the Ethics Committee at the University of Sassari (no. 286SS/2006).

Sample

Sample size was calculated on the basis of previous studies on caries prevalence in Sardinia [10]. The theoretical sample size was set at 846 children (increased by 15%) to safeguard an optimal level of precision (5%) against possible disease reduction and number of non-responders. Schoolchildren were recruited using systematic cluster sampling, i.e. each class identified as a cluster and compiled in a list. The first cluster was chosen randomly, while the others were selected at the systematic interval of three classes. The number of subjects in each class was approximately the same. Altogether 1120 children were recruited to the study (Figure 1).

The protocol comprised a dental examination and a standardized questionnaire. Parents or guardians were issued with a leaflet explaining the aim of the study and requesting their child's participation, after which they were asked to sign consent. Only children with the questionnaire filled out and with signed consent from the parents were enrolled in the study (1073 subjects). The clinical examination took place during the school day with no adults present. Of the eligible children, 112 (10.4%) were absent on the school day of the clinical examination and another 4 (0.4%) refused to participate. The study therefore reported data on 957 subjects: 485 girls (50.6%) and 472 boys (49.4%).

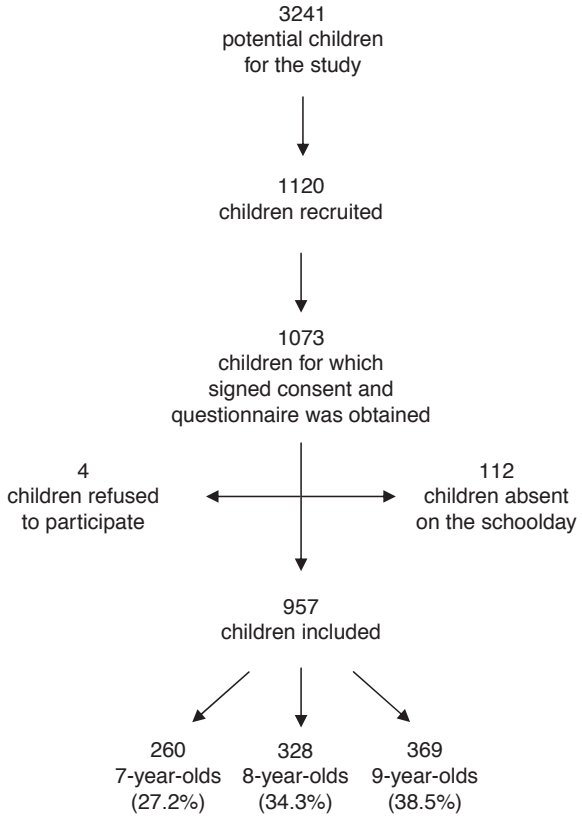

Figure 1. Flow diagram of the recruitment of children.

The subjects were categorized into three age groups: 7-year-old (260: 27.2%), 8-year-olds (328: 34.3%), and 9-year-olds (369: 38.5%).

Clinical examination and questionnaire

Clinical assessments were carried out by two examiners (G.S. and G.B.) under standardized conditions. Optimal artificial lighting, a drying tooth device, a plain mirror, and a WHO-CPI probe were used for the examination. Dental caries experience (dmfs/DMFS) and gingival status were recorded. Caries was diagnosed when there was a cavity at dentinal level [15]. Bitewing radiographs were not used for caries diagnosis [16]. Gingival status was scored as healthy or bleeding at probing. Presence of calculus was registered.

The two examiners received training, and intra- and inter-examiner reliability was assessed before the beginning of the survey. Forty-five subjects (15 from each age group) were re-examined after 72 h by the two examiners. Inter-examiner reliability was evaluated through analysis of variance for fixed effect [17,18], while intra-examiner reproducibility was assessed as percentage agreement and Cohen's Kappa statistics. Good inter-examiner reliability was found without significant differences ($p = 0.21$) and with a low mean squares for error value (0.44). The percentage agreement in regard to intra-examiner reproducibility was high (Cohen's Kappa 0.84).

The standardized questionnaire consisted of closed questions [9]. Filled out by parents or guardians at home and brought to school by the child, it contained questions related to medical status, consumption of sweets and soft drinks (mean intake frequency /day), frequency of toothbrushing and use of fluoride supplements apart from fluoride toothpaste.

Microbiological procedures

After clinical examination, each child chewed a piece of sterile paraffin wax for 60 s and a saliva sample was immediately collected. Mutans streptococci (MS) and lactobacilli (Lb) counts in saliva were assessed using the dip-slide technique (CTR bacteria, Ivoclar Vivadent, Germany) [19,20].

Risk assessment using Cariogram

The relationship between different caries risk factors and prediction of new caries was calculated using Cariogram [1]. For each subject, seven variables directly linked to caries, evaluated through the clinical examination and questionnaire, were scored and entered in the program (Table I).

Information about saliva secretion rate and buffer capacity was not included in the present analysis; hyposalivation is relatively uncommon in these young age groups and, if present, is often related to systemic diseases. All children were in good general health and no severe systemic diseases were reported. The most common disease reported was allergic respiratory problems in almost 10% of the sample.

Country/area was set at high risk and the group as standard for all children. Owing to the age range of the study group, both dmfs and DMFS were evaluated and scored from 0 (caries-free) to 3 [21]. Good general health and no severe systemic diseases were found in the case of all children, as reported above; thus, the factor "related diseases" was set to 0 for all children.

Dietary content was estimated using the Lb count as a measure of cariogenic diet [22,23] and data from the questionnaire on sugar content of the diet. Diet frequency was scored based on the number of intakes (including meals and snacks).

Bleeding on probing was used as a proxy of the presence of plaque, since there is a causal relationship between bleeding on probing and amount of plaque [24]. MS salivary class was scored in accordance with the manufacturer's instructions. Since none of the examined children were exposed to any fluoride source except fluoridated toothpaste, the fluoride variable was scored 2 for all children.

Finally, the caries risk profile for each subject was analyzed. The individuals were divided into five groups from the highest risk group (0–20% chance of avoiding caries) to the lowest predicted risk (81–100% chance of avoiding caries).

Statistical analysis

Both descriptive and analytic approaches were used for the data analysis. Caries distribution was calculated according to age and gender as mean and standard deviation (SD). Caries prevalence was calculated as the number of subjects with dmfs >0 and DMFS >0. Bivariate analyses by gender and age were tested by frequency distribution and chi-squared test. Odds ratio (OR) was calculated between the various Cariogram groups and gender. Means, standard deviation and 95% confidence interval (95% CI) were calculated; differences in mean values between the different Cariogram groups were tested with the Kruskal-Wallis test. A linear trend across the three groups and caries indices (dmfs/DMFS) were also calculated. Spearman's correlation coefficients were calculated for exploring associations among Cariogram groups and the individual variables. All the analyses were carried out using Stata SE® software v. 8.2 and a p-value <0.05 was considered statistically significant.

Results

Caries experience by gender and age group is displayed in Table II; 57.3% (CI 95% = 54.2–60.4%) had caries. Of caries-free children (dmfs/DMFS = 0), 48.8% were 7-year-olds, 36.0% were 8-year-olds, and 44.5% were 9-year-olds. Girls were less affected than boys, but a significant association was observed only for the oldest age group ($p = 0.01$). Mean (SD) dmfs were 1.5 (3.2), 2.7 (5.0), and 1.8 (3.5), and DMFS 1.3 (2.0), 1.0 (1.8), and 1.1 (2.0), in the respective age groups. dmfs/DMFS ranged from 0 to 38 and 0 to 12, respectively.

Caries experience was related to diet content (Lb count and data on sugar content), MS in saliva and gingival status (Table III). Significant linear trends ($p < 0.05$) of caries experience across categories of exposure were found for all three variables.

A score of 3 in diet content and presence of bleeding at probing and calculus were statistically associated with a dmfs/DMFS >0 (with an odds ratio of 2.1 and 3.0, respectively). Different results were found when comparing the relation between MS salivary concentration and caries status. A salivary MS score of 2 had a stronger association to dmfs/DMFS = 0 compared to dmfs/DMFS >0, while the OR for caries-free/affected was 1 for salivary MS score 0–2 and 7 for score 3.

The distribution of subjects according to categorization with Cariogram corresponds to the descriptive statistics of dmfs/DMFS (Table IV). A rise in mean dmfs was found in accord with a reduction in

Table I. Variables in Cariogram.

Sector	Variable	Data used	Score
Circumstances	Caries experience	dmfs/DMFS index	0: dmfs/DMFS = 0 1: dmfs >0, DMFS = 0 2: dmfs >0, DMFS = 1–3 3: dmfs >0, DMFS >3
Circumstances	Related diseases	General health information (questionnaire)	0: no systemic diseases
Diet	Diet content	*Lactobacillus* spp. count (CTR Bacteria) and data on sugar content of diet (questionnare)	0: first area of manufacturer's chart and very low sugar consumption 1: second area of manufacturer's chart and low sugar consumption 2: third area of manufacturer's chart and moderate sugar consumption 3: fourth area of manufacturer's chart and high sugar consumption
Diet	Diet frequency	Number of intakes per day (meals and snacks)	0: maximum 3 intakes per day 1: Maximum 5 intakes per day 2: maximum 7 intakes per day 3: more than 7 intakes per day
Bacteria	Plaque amount	Gingival status	0: healthy 1: bleeding at probing <50% of gingival sites 2: bleeding at probing >50% of gingival sites 3: bleeding at probing >50% of gingival sites and presence of calculus
Bacteria	Mutans streptococci count	CTR bacteria culture	0: first area of manufacturer's chart 1: second area of manufacturer's chart 2: third area of manufacturer's chart 3: fourth area of manufacturer's chart
Susceptibility	Fluoridation program	Oral health information (questionnaire)	2: fluoridated toothpaste only

Table II. Caries experience (number of subjects and percentage) by gender in the three age groups.

	Caries experience	
Gender	dmfs/DMFS = 0 no. (%)	dmfs/DMFS >0 no. (%)
7-year-olds		
Boys, no. 134	63(24.2)	71(27.4)
Girls, no. 126	64(24.6)	62(23.8)
$\chi^2 = 0.37$, $p = 0.51$		
8-year-olds		
Boys, no. 156	48(14.7)	108(32.9)
Girls, no. 172	70(21.3)	102(31.1)
$\chi^2 = 3.50$, $p = 0.06$		
9-year-olds		
Boys, no. 182	69(18.7)	113(30.6)
Girls, no. 187	95(25.8)	92(24.9)
$\chi^2 = 6.21$, $p = 0.01$		

the likelihood of new caries being avoided in the near future (from the lowest to the highest risk group). Furthermore, a significant linear trend among the five Cariogram categories – ranging from 81–100% respectively 0–20% chance of avoiding caries (very low risk to very high risk) and dmfs/DMFS – was observed in the three age groups ($p < 0.001$). At first, however, the mean DMFS rose from the lowest risk group to the medium risk group and than decreased from the medium to the highest risk group. One-third of the subjects exhibited a very low likelihood (very high risk) of avoiding caries in the near future (Figure 2). Caries risk profile was statistically associated with gender ($p < 0.001$), with an OR = 1.5 and a 95% CI 1.1–2.0 among boys with the highest risk level (0–20%). Significant correlation coefficients were observed between Cariogram score and dmfs, dmfs/DMFS, MS class, diet content, diet frequency and gingival status (Table V).

Table III. Caries experience by diet content (LB count and data on sugar content of diet), MS salivary concentration and gingival status as percent (count) and odds ratio (OR) for each category.

	dmfs/DMFS = 0	dmfs/DMFS > 0	OR	$CI_{95\%}$	*p*-value
Diet content					
Score 0–2	21.9(209)	12.4(119)	1	–	
Score 3	20.9(200)	44.8(429)	2.1	1.8–2.5	<0.001
MS salivary concentration					
Score 0–1	28.7(275)	27.1(259)	1	–	
Score 2	10.2(98)	2.9(28)	0.3	0.2–0.4	
Score 3	3.9(37)	27.2(260)	7.0	5.0–9.9	<0.001
Gingival status					
Healthy	29.9(286)	19.6(188)	1	–	
Bleeding at probing or calculus	12.8(122)	37.7(361)	3.0	2.4–3.6	<0.001

Table IV. Distribution of subjects according to categorization with Cariogram and corresponding descriptive statistics of dmfs/DMFS mean (SD).

		7-year-olds		8-year-olds		9-year-olds	
Chance of avoiding new caries (and caries risk level)	Subjects *n* (%)	dmfs Mean (SD)	DMFS Mean (SD)	dmfs Mean (SD)	DMFS Mean (SD)	dmfs Mean (SD)	DMFS mean ± SD ($_{95\%}$CI)
Total	957	1.5(3.2)	1.3(2.0)	2.7(5.0)	1.0(1.8)	1.8(3.5)	1.1(2.0)
81–100% (very low risk)	332(34.7)	0.03(0.2)	0.7(1.5)	0.2(1.0)	0.5(1.5)	0.04(1.2)	0.5(1.4)
61–80% (low risk)	155(16.2)	0.2(1.1)	1.5(2.0)	0.2(0.8)	1.8(2.0)	0.2(0.4)	1.2(1.9)
41–60% (medium risk)	195(20.4)	2.4(4.2)	3.4(2.5)	2.6(5.1)	3.3(2.6)	1.4(2.5)	3.3(2.9)
21–40% (high risk)	83(8.6)	4.3(2.5)	0.4 (1.2)	2.9(2.1)	0.1(0.3)	4.5(3.1)	0.3(1.2)
0–20% (very high risk)	192(20.1)	6.0(4.4)	0.07(0.3)	7.2(6.8)	0.2(0.6)	5.4(5.1)	0.5(1.2)
Kruskal-Wallis test		$p < 0.001$	$p < 0.01$	$p < 0.001$	$p < 0.05$	$p < 0.001$	$p < 0.05$

Discussion

Dental caries is a multifactorial disease with several well-known components teaming up in the disease process. Therefore, a caries risk evaluation method has to be based on as many of the involved factors as possible.

This article describes the caries risk profiles of Sardinian schoolchildren using the computer-based program Cariogram, which reflects strong correlations with caries experience in the deciduous teeth of children aged 7–9 years.

A positive aspect of using Cariogram to describe the risk profile of caries is that it includes a large number of the caries-related factors involved in the disease process. The various caries risk factors entered in the program have different weights and may influence the results differently (i.e. the chance of avoiding new caries). The weight of the different factors is based on the consensus of a large number of "caries experts" [4,25]. With Cariogram, factors such as microbial levels, gingival status, and diet seem to be more predictive of new caries than are socio-economic factors and previous caries experience. The difference among factors is that they participate either directly or indirectly in the development of caries.

Only in a few studies has the Cariogram program been used to assess caries risk in children [1,5–7]. Cariogram predicts caries development in a statistically significant way [6].

Since there have been no studies evaluating caries risk profile in the age range 7 to 9, the results of the present study are compared to previous epidemiological surveys in other older groups of children [26]. The present study shows that almost 50% of Sardinian schoolchildren have a low risk of caries, while more than a quarter have <40% "chance of avoiding caries" according to Cariogram. These data are quite different from those reported in the literature on 10–11 and 12–13 year-old Swedish children [26]. Slightly more than 14% and 30% of children in the respective studies had a medium or high caries risk, and around 10% and 13% had <40% "chance of avoiding caries". A possible explanation for the differences between the results of the present and the Swedish studies may be due to

Table V. Spearman correlation matrix among Cariogram scores and the individual variables.

	Cariogram score
Cariogram score	–
DMFS	0.06[#]
Dmfs	0.78[§]
Dmfs/DMFS	0.71[§]
MS class	0.59[§]
Diet content	0.81[§]
Diet frequency	0.70[§]
Gingival status	0.50[§]

[#]Not statistically significant.
[§]$p < 0.001$.

the age groups studied. It is also important to highlight the lack of community preventive programs in Italy.

Results from the present study show that some parameters seem more crucial to the prediction of the Cariogram than others are, and that the only factor not significantly correlated was DMFS. DMFS did not follow the pattern of dmfs. As the caries risk level increased and the likelihood of avoiding new cavities in the future decreased, dmfs rose. In contrast, DMFS reached its highest score for the medium caries risk group (41–60% chance of avoiding new caries according to Cariogram). Children experiencing high and very high levels of caries in deciduous teeth had higher "f" scores than others. Moreover, the different periods of time in which a deciduous versus permanent tooth was in the oral cavity should be considered when mixed dentition groups are studied. One may thus speculate whether less cariogenic bacteria could be present in the mouth when a high number of deciduous carious teeth are filled [27,28] and whether, consequently, this may lead to a higher chance of avoiding new cavities. Therefore, dmfs scores are considered more relevant compared to DMFS scores if caries risk is assessed in children with a mixed dentition. It is more likely that DMFS reflects actual caries activity.

On comparing caries experience and MS salivary counts, it was found that a MS score of 2 was associated with dmfs/DMFS = 0. It is clear that the higher the score, the higher the risk of caries. In order to explain this trend, one may speculate on whether lower MS scores compared to higher figures indicate a more positive picture of factors such as

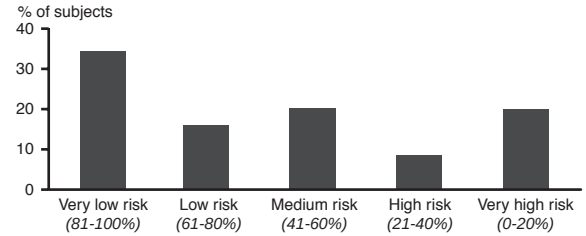

Figure 2. Distribution of the subjects into five groups according to Cariogram score ($n = 957$).

dietary habits and oral hygiene, which may influence the caries process and reduce the potential effect of cariogenic micro-organisms.

Caries experience could be considered a risk marker because it points to an increased probability of new caries [6], but it is questionable whether it may be considered a causal factor. With Cariogram, caries experience is considered but has lower weight compared to risk factors such as MS, diet and fluoride, which constitute important parts of the causal chain that leads to caries development. This is probably due to the fact that the Cariogram model was originally developed to predict future caries lesions, which could occur if etiological factors were not changed.

From a public health perspective, the results of this study support the recommendations suggested by Burt [29], i.e. preventive action, such as brushing with fluoridated toothpaste twice a day, should be the aim for the entire population. However, in selected geographic areas where caries is still at high levels, as in the Sardinia Region, additional preventive programs should be the target for all children; for example, on a classroom basis.

The Cariogram model successfully determines caries risk profiles for 7 to 9-year-old children and can be used in developing preventive strategies for reducing the risk of caries. The high percentage of medium or high risk shown by Cariogram could be due to the lack of a fluoride preventive program in the population studied.

Therefore, once the efficacy and costs of preventive programs have been established, it is recommended that these preventive measures concern the entire population of schoolchildren.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

[1] Bratthall D, Hänsel Petersson G. Cariogram – a multifactorial risk assessment model for a multifactorial disease. Commmunity Dent Oral Epidemiol 2005;33:256–64.
[2] Hausen H. Caries prediction – state of the art. Community Dent Oral Epidemiol 1997;25:87–96.
[3] Batchelor P, Sheiham A. The limitations of a "high-risk" approach for the prevention of dental caries. Community Dent Oral Epidemiol 2002;30:302–12.
[4] Bratthall D. Dental caries: intervened – interrupted – interpreted. Concluding remarks and Cariography. Eur J Oral Sci 1996;104:486–91.
[5] Hänsel Petersson G, Bratthall D. Caries risk assessment: a comparison between the computer program "Cariogram", dental hygienists and dentists. Swed Dent J 2000;24:129–37.
[6] Hänsel Petersson G, Twetman S, Bratthall D. Evaluation of a computer program for caries risk assessment in schoolchildren. Caries Res 2002;36:327–40.
[7] Stecksén-Blicks C, Holgerson PL, Twetman S. Caries risk profiles in two-year-old children from northern Sweden. Oral Health Prev Dent 2007;5:215–21.

[8] Campus G, Sacco G, Cagetti MG, Abati S. Changing trend of caries from 1989 to 2004 among 12-year-old Sardinian children. BMC Public Health 2007;7:28.
[9] Campus G, Solinas G, Cagetti MG, Senna A, Minelli L, Majori S, et al. National Pathfinder Survey of 12-year-old children's oral health in Italy. Caries Res 2007;41:512–7.
[10] Campus G, Lumbau A, Sanna AM, Solinas G, Luglie P, Castiglia P. Oral health condition in an Italian preschool population. Eur J Paediatr Dent 2004;5:86–91.
[11] Campus G, Lumbau A, Lai Bachisio S. Caries experience and streptococci and lactobacilli salivary levels in 6-8-years-old Sardinians. Int J Paed Dent 2000;10:306–12.
[12] Ferro R, Besostri A, Meneghetti B, Stellini E. Prevalence and severity of dental caries in 5- and 12-year old children in the Veneto Region (Italy). Community Dent Health 2007; 24:88–92.
[13] Italian National office of Statistics. ISTAT. Available at: http://www.demo.istat.it.
[14] Campus G, Solinas G, Sanna A, Maida C, Castiglia P. Determinants of ECC in Sardinian preschool children. Community Dent Health 2007;24:253–6.
[15] Pitts NB, Longbottom C. Preventive Care Advised (PCA)/ Operative Care Advised (OCA) – categorising caries by the management option. Community Dent Oral Epidemiol 1995;23:55–9.
[16] Bolin AK. Children's dental health in Europe. An epidemiological investigation of 5- and 12-year-old children from eight EU countries. Swed Dent J Suppl 1997;122:1–88.
[17] Castiglia P, Campus G, Solinas G, Maida C, Strohmenger L. Children's oral health in Italy: training and clinical calibration of examiners for the National Pathfinder about caries disease. Oral Health Prev Dent 2007;5:255–61.
[18] Fleiss JL. The design and analysis of clinical experiments. New York: John Wiley & Sons; 1986. p. 62–3.
[19] Köhler B, Bratthall D. Practical method to facilitate estimation of Streptococcus mutans levels in saliva. J Clin Microbiol 1997;9:584–8.
[20] Emilson CG. Prevalence of Streptococcus mutans with different colonial morphologies in human bleeding at probing and saliva. Scand J Dent Res 1983;91:26–32.
[21] Declerck D, Leroy R, Martens L, Lesaffre E, Garcia-Zattera M-J, Vanden Broucke S, et al. Factors associated with prevalence and severity of caries experience in preschool children. Community Dent Oral Epidemiol 2008;36: 168–78.
[22] Ccahuana-Vásquez RA, Tabchoury CP, Tenuta LM, Del Bel Cury AA, Vale GC, Cury JA. Effect of frequency of sucrose exposure on dental biofilm composition and enamel demineralization in the presence of fluoride. Caries Res 2007;41: 9–15.
[23] Beighton D, Manji F, Baelum V, Fejerskov O, Johnson NW, Wilton JM. Associations between salivary levels of Streptococcus mutans, Streptococcus sobrinus, lactobacilli, and caries experience in Kenyan adolescents. J Dent Res 1989; 68:1242–6.
[24] Müller HP, Stadermann S. Multivariate multilevel models for repeated measures in the study of smoking effects on the association between plaque and gingival bleeding. Clin Oral Investig 2006;10:311–6.
[25] Bratthall D, Hänsel Petersson G, Sundberg H. Reasons for the caries decline: what do the experts believe? Eur J Oral Sci 1996;104:416–22.
[26] Tayanin GL, Hänsel Petersson G, Bratthall D. Caries risk profile of 12-13-year-old children in Laos and Sweden. Oral Health Prev Dent 2005;3:15–23.
[27] Petti S, Pezzi R, Cattaruzza MS, Osborn JF, D'Arca AS. Restoration-related salivary Streptococcus mutans level: a dental caries risk factor? J Dent 1997;25:257–62.
[28] Morinushi T, Murayama M, Kinjyo S. Mutans streptococci, lactobacilli in saliva and acidity from organisms in dental bleeding at probing: changes after restorative treatment. J Clin Pediatr Dent 2004;28:327–32.
[29] Burt AB. How useful are cross-sectional data from surveys of dental caries? Community Dent Oral Epidemiol 1997;25: 36–41.