Dental Caries in 12-year-old Schoolchildren and its Relationship with Socioeconomic and Behavioural Variables

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Purpose: This study attempts to describe the caries experience in 12-year-old schoolchildren in Piracicaba, Brazil, and to verify the relationship between the disease and socioeconomic factors, and behavioural variables related to oral health.

Materials and Methods: The random sample consisted of 939 individuals from public and private schools in Piracicaba, São Paulo State, Brazil, in 2005. A calibrated dentist performed the examination in an outdoor setting, under natural light, using CPI probes and mirrors, following WHO recommendations. A questionnaire was sent to the parents to collect information on socioeconomic level and behavioural variables related to dental health. The mean number of decayed, missing and filled permanent teeth and surfaces (DMFT/DMFS), the Care Index and the SiC (Significant Caries Index) were determined. Multiple logistic regression analyses using the stepwise procedure were performed in order to identify the risk indicators for the DMFT and for the polarisation group.

Results: The DMFT and the SiC Index were 1.32 (SD = 1.92) and 3.52 (SD = 1.86), respectively, and the Care Index was 75.0%. The regression models showed that females and children with either low family income or low education level of the fathers were prone to have caries or take part in the polarisation group.

Conclusion: The 12-year-old individuals from Piracicaba presented a low prevalence of caries. Nevertheless, those high caries-level individuals showed moderate caries experience. The socioeconomic and the behavioural variables related to dental health were risk indicators of caries in permanent dentition not only for the entire sample, but also for the polarisation group.

Key words: dental caries, epidemiology, schoolchildren

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Dental caries is still the predominant cause of tooth loss around the world (Aoba and Fejerskov, 2002). For this reason, it is important to monitor the disease over time as well as to evaluate the influence of socioeconomic and behavioural variables on its epidemiology.

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Data concerning the dental health of 12-year-old individuals have been published elsewhere. Several studies have shown downward trends in caries experience throughout the world (Chawla et al, 2000; Irigoyen and Sánchez-Hinojosa, 2000; Bonecker and Cleaton-Jones, 2003; Marthaler, 2004; Pakshir, 2004; Pieper and Schulte, 2004; van Wyk and van Wyk, 2004), and in both fluoridated and non-fluoridated areas in Brazil (Pereira et al, 2000; Sales-Peres and Bastos, 2002; Bastos et al, 2004). This indicates that dental caries in 12-year-olds is becoming a less prevalent disease. In Brazil, the expansion of preventive programmes at schools, the water fluoridation and the fluoridated dentifrices, which have been available in Brazil since 1989, have been recognised as the main

factors that have contributed to caries decline (Pereira et al, 2001; Cury et al, 2004).

Another phenomenon that has also been observed is the caries polarisation in which a minority of individuals presents the highest caries scores (Burt, 1998; Powell, 1998; Tickle, 2002). In order to measure the caries experience in the high-caries-level individuals, Bratthall (2000) has proposed the Significant Caries Index (SiC), where the DMFT is calculated for the one-third of the entire sample that presents the highest caries levels.

Several surveys conducted in 12-year-olds during recent years have shown significant association between dental caries and socioeconomic (Campus et al, 2001; Baldani et al, 2004) or behavioural variables (Campus et al, 2001). However, only few studies have been carried out in order to clarify the factors associated with caries polarisation (Campus et al, 2003). Antunes et al (2004) found that the SiC Index was strongly correlated with socioeconomic level, dental health and fluoridated water supply accessibility. However, there is no recent data collected in Brazil on caries polarisation and its associated factors. Therefore, this study has attempted to describe the caries experience in 12-year-old schoolchildren in Piracicaba, Brazil, and to verify the relationship between the disease and socioeconomic factors, and behavioural variables related to oral health. Piracicaba is located in São Paulo State, has 329,158 inhabitants (IBGE – Brazilian Institute of Geography and Statistics, 2005), and has a Human Development Index of 0.81 (IBGE, 2005). Fluoride has been added to the water supply since 1971, when the first epidemiological survey on dental caries was conducted. Since then, caries decline has been verified (Pereira et al, 2001).

MATERIALS AND METHODS

Ethical aspects

The study was approved by the Research Ethics Committee of the Piracicaba Dental School, State University of Campinas, protocol number 148/2003. An Informed Consent Form containing information about the clinical examination that would be carried out as well as the benefits and possible risks for participants was obtained from parents prior to the survey.

Sample

The sample size was calculated based on caries experience reported in previous studies carried out in Piracicaba-SP, Brazil (Kozlowski, 2001). Considering a mean of 1.8 DMFT, standard deviation (SD) of 1.9, admitting a sampling error of 7%, and a confidence level of 95%, the sample size was defined in 939 individuals aged 12 years. Public and private schools were selected by the cluster sampling methods from the official records supplied by the Local Department of Education. The 12-year-old individuals were chosen at random in each school and only those who returned the informed consent form and also presented no systemic disease participated in the present study.

Methods

Prior to the examination, the dentist participated in the calibration process, which was divided into theoretical discussions on codes and criteria for the study, and practical activities. The dentist examined all individuals in 2005 in an outdoor setting, under natural light, with previous air-drying, using CPI probes ('ball point') and mirrors, following the World Health Organization (WHO) recommendations (WHO, 1997). Each child received a toothbrush with fluoridated dentifrice and performed toothbrushing supervised by a dental hygienist prior the examination. Dental caries was registered using the DMFT index according to WHO caries diagnostic criteria (WHO, 1997). In the calibration process and during the examination, when 10% of the sample was re-examined, good intra-examiner reproducibility (Kappa > 0.91) was reached.

Questionnaire

All children received a semi-structured questionnaire to be answered by their parents. This questionnaire was aimed at collecting information on socioeconomic level (monthly family income, number of people living in the household, parents' educational level, home ownership, householder's occupation, car ownership), and behavioural variables related to oral health (onset of toothbrushing).

To verify the clarity of the questionnaire, it was applied to a sample of ten subjects with an educational level equivalent to grade school, in order to verify whether there was any need to alter the text to make it more understandable. Due to the simplicity of the in-

Table 1 DMFT and SiC indices for 12-year-old schoolchildren, Piracicaba, Brazil, 2005

Index	Sample size	Interval of variation	Mean	Standard deviation	Coefficient of variation (%)
DMFT	939	0–14	1.32	1.92	145.4
SiC	311	2–14	3.52	1.86	52.8

strument, there was no need to change it as regards its semantic content.

The questionnaire was then applied to a sample of 939 families and its internal consistency was assessed by means of Intraclass Correlation. A very strong correlation was observed between the father's and mother's level of schooling (r = 0.9939) and the father's level of schooling and the number of cars in the family (r = 0.9878). There was strong correlation between the number of cars in the family and onset of toothbrushing (r = 0.7059); between the cars in the family and the mother's level of schooling (r = 0.6800); between the monthly family income and the father's level of schooling (r = 0.6958); and between income and the mother's level of schooling (r = 0.7166). There was median correlation between income and the type of housing (r = 0.4989); between income and onset of toothbrushing (r = 0.4299); between type of housing and number of residents (r = 0.4060); and between type of residence and number of cars (r = 0.4825). The weakest correlations were observed between the number of persons resident in the house and the number of cars in the family (r = 0.1044); number of persons resident in the house and the father's schooling (r = 0.1464); and between the number of persons resident in the house with the onset of toothbrushing (r = 0.1962). This study demonstrated that the instrument used is reliable and consistent, and shown to be very useful for collecting socio-economic data.

Statistical analysis

The mean number of decayed, missing and filled permanent teeth and surfaces (DMFT/DMFS) and percentage of caries-free children (DMFT = 0) were calculated for the entire sample. The Care Index was calculated in order to measure the health service accessibility by the equation as it follows: (FT/DMFT) x 100 (Pitts et al, 2002). The SiC Index was determined for the one-third of the children with the highest caries scores (Bratthall, 2000).

The dependent variable DMFT was dichotomised according to the median (Med = 0) whereas the variable 'taking part of the polarisation group' was dichotomised into yes or no. Univariate analyses were performed to test the influence of independent variables (socioeconomic characteristics and behavioural variables related to oral health) on dependent variables, using the Chi-square test (χ^2) at 5% significance level. Then multiple logistic regression analyses using the stepwise procedure were performed in order to identify the risk indicators for DMFT and for the polarisation group. Only the independent variables that showed significant association at $p < 0.15$ (Lucas et al, 2005) were selected for the regression analysis in order to eliminate variables that would make little contribution to the model. The logistic regression models were adjusted estimating the Odds Ratios (OR), their 95% confidence intervals (CI), and significance levels. All statistical tests were performed using the SAS software (SAS Institute Inc. 8.2, 2001) at 5% significance level.

RESULTS

The results of this study showed a mean DMFT of 1.32 (SD = 1.92; Table 1) and a DMFS of 2.00 (SD = 3.27) for 12-year-old schoolchildren. The most prevalent component of DMFT was the FT (78.42%), followed by the DT (19.72%) and the MT (1.86%) components. The Care Index was 75.0% with a confidence interval ranging from 71.0% to 78.3%. A total of 52% of the individuals were caries-free. The girls (DMFT=1.52; SD=2.14) showed statistically higher caries prevalence (p= 0.0184; Table 2) than the boys (DMFT=1.03; SD= 1.52).

The DMFT for the high caries-level individuals, or the polarisation group, was determined considering a cut-off point of 2.00. The polarisation group presented a SiC Index of 3.52 (Table 1). In addition, 89% of the disease was concentrated in 33.12% (or one third) of the sample. The Sic Index was 3.70 (SD = 2.08) for the girls and 3.16 (SD = 1.29) for the boys.

Table 2 Univariate analysis of the association between DMFT (dichotomisation by the median) and gender, socioeconomic characteristics and behavioural variables related to oral health

Variable	DMFT=0 n (%)	DMFT>0 n (%)	p-value
Gender			
Female	267 (48.72)	281 (51.28%)	0.0184
Male	221 (56.52%)	170(43.48%)	
Onset of toothbrushing			
≤ 1 year old	274 (51.99%)	253 (48.01%)	0.9086
> 1 year old	208 (51.61%)	195 (48.39%)	
Monthly family income			
up to 2 minimum wages*	175/375 (46.67%)	200/375 (53.33%)	0.0006
over 2 up to 6 minimum wages	228/440 (51.82%)	212/440 (48.18%)	
> 6 minimum wages	76/113 (67.26%)	37/113 (32.74%)	
Car ownership			
No car	200/422 (47.39%)	222/422 (52.61%)	0.0378
1 car	236/432 (54.63%)	196/432 (45.37%)	
≥ 2 cars	42/70 (60.00%)	28/70 (40.00%)	
Home ownership			
Yes	311/586 (53.07%)	275/586 (46.93%)	0.3413
No	174/349 (49.86%)	175/349 (50.14%)	
Number of people living in the household			
≤ 4 people	263/482 (54.56%)	219/482 (45.44%)	0.0894
> 4 people	220/449 (49.00%)	229/449 (51.00%)	
Father's education			
Incomplete middle-school	198/443 (44.70%)	245/443 (55.30%)	<0.0001
Incomplete high school	44/68 (64.71%)	24/68 (35.29%)	
Complete high school	85/153 (55.56%)	68/153 (44.44%)	
Incomplete undergraduate studies	26/35 (74.29%)	9/35 (25.71%)	
Complete undergraduate studies	36/57 (63.16%)	21/57 (36.84%)	
Mother's education			
Incomplete middle-school	282/593 (47.55%)	311/593 (52.45%)	0.0089
Incomplete high school	42/78 (53.85%)	36/78 (46.15%)	
Complete high school	105/174 (60.34%)	69/174 (39.66%)	
Incomplete undergraduate studies	25/40 (62.50%)	15/40 (37.50%)	
Complete undergraduate studies	30/48 (62.50%)	18/48 (37.50%)	

* Minimum wage at the time of the data collection, approximately US $101.02

Table 2 shows the association of independent variables with DMFT under the Chi-square test. Gender, monthly family income, car ownership, number of people living in the household and parents' educational level variables were significantly associated with the DMFT at $p < 0.15$. Fathers' educational level was the variable showing the highest association with caries experience in permanent dentition ($p < 0.0001$). On the other hand, the variables home ownership and onset of toothbrushing were not significantly associated with DMFT. Gender, monthly family income and fathers' educational level were considered risk indicators for caries in permanent dentition as shown by the logistic model (Table 3).

Table 4 shows the association of independent variables with caries polarisation under the Chi-square test. Gender, monthly family income and parents' educational level variables were significantly associated with the caries polarisation at $p < 0.15$. In the stepwise logistic regression, gender, monthly family income, and fathers' educational level variables were risk indicators for high caries levels (Table 5).

DISCUSSION

The 12-year-old schoolchildren from Piracicaba presented in 2005 an average of 1.32 DMFT (Table 1),

Table 3 Stepwise logistic regression with DMFT as dependent variable

Variable	DMFT > 0	Odds ratio	Odds ratio (95% Confidence interval)	p-value
Gender				
Female	281/548 (51.3%)	Reference		
Male	170/391 (43.5%)	0.679	0.488–0.945	0.0219
Monthly family income				
up to 2 minimum wages*	200/375 (53.3%)	Reference		
Over 2 up to 6 minimum wages	212/440 (48.2%)	0.831	0.578–1.198	0.3209
> 6 minimum wages	37/113 (32.7%)	0.347	0.170–0.708	0.0036
Father's education				
Incomplete middle-school	245/443 (55.3%)	Reference		
Incomplete high school	24/68 (35.3%)	0.509	0.268–0.965	0.0386
Complete high school	68/153 (44.4%)	0.194	0.437–1.123	0.1394
Incomplete undergraduate studies	9/35 (4.6%)	0.700	0.059–0.626	0.0061
Complete undergraduate studies	21/57 (36.8%)	0.463	0.206–1.042	0.0627

* Minimum wage at the time of the data collection, approximately US $101.02

which is lower than that presented by Brazilian individuals (2.78 DMFT) in the last national epidemiological survey carried out in 2002–2003 (Health Ministry of Brazil, 2004). Other studies conducted in Brazil during the last decade show that DMFT for this age group has ranged from 1.0 to 4.82 (Sales-Peres and Bastos, 2002; Tagliaferro et al, 2004; Bastos et al, 2005; Lucas et al, 2005), which indicates that Piracicaba presents similar or lower caries experience in comparison with national data. Recent international reported data have shown that the DMFT for 12-year-old children is also low, ranging from 1.5 in Iran to 2.33 in Cambodia (Pakshir, 2004; Pieper and Schulte, 2004; van Wyk and van Wyk, 2004).

Since 1971, when the first data on caries experience of children in Piracicaba were published (8.60 DMFT) (Moreira et al, 1983), a reduction of 85% in the DMFT can be observed. In addition, an important increase in the number of caries-free children can be detected since 1992, when only 25.3% of the children had no caries in permanent dentition (Pereira et al, 1995) in comparison with present data, which shows that 52% of the children present no caries. The preventive measures such as water fluoridation, the widespread use of fluoridated dentifrices and the preventive programmes including oral health education seem to be the main contributors for caries reduction in schoolchildren in Piracicaba (Pereira et al, 2001).

Regarding the Care Index, 75% of all affected teeth were filled, which suggests a good coverage of the oral health services available in Piracicaba. This result can also be supported by the finding that 78.42% of the DMFT index was composed by FT component.

The SiC Index is a good tool for measuring caries level among those individuals more affected by the disease. Considering those high-caries-level individuals examined in this study, the SiC index was 3.52. This value is more than two times higher than the mean DMFT for the entire sample. The present results are in line with some recently reported data, which demonstrates that caries experience of those high-caries-level individuals is not only higher (Tayanin et al, 2002; Antunes et al, 2004) but also more than two times higher (Nishi et al, 2002; Pieper and Schulte, 2004; Marthaler et al, 2005) than that shown by all the children examined. Bratthall (2000) has proposed a SiC Index less than 3.0 for the year 2015, which is lower than that determined in Piracicaba in 2005. Although the SiC Index in Piracicaba is still high, it has been demonstrating signs of decline: SiC Index = 4.15 in 2001 (Pereira et al, unpublished data). From 2001 to 2005 a reduction of 15.7% in the SiC index can be observed. Even so, children from the SiC group should continuously receive care on dental education and preventive measures.

In addition, the fact that 89% of the disease was concentrated in 33.12% of the sample clearly indicates the polarisation phenomenon in the 12-year-olds and the need for targeting specific oral health care at this group. The polarisation phenomenon has been

Table 4 Univariate analysis of the association between the dependent variable 'taking part of the polarisation group' and gender, socioeconomic characteristics and behavioural variables related to oral health

Variable	Polarisation group (SiC Group)		p-value
	No n (%)	Yes n (%)	
Gender			
Female	345/548 (63.0%)	203/548 (37.0%)	0.0025
Male	283/391 (72.4%)	108/391 (27.6%)	
Onset of toothbrushing			
≤ 1 year old	355/527 (67.4%)	172/527 (32.6%)	0.7217
> 1 year old	267/403 (66.3%)	136/403 (33.8%)	
Monthly family income			
up to 2 minimum wages*	234/375 (62.4%)	141/375 (37.6%)	0.0041
over 2 up to 6 minimum wages	293/440 (66.6%)	147/440 (33.4%)	
> 6 minimum wages	91/113 (80.5%)	22/113 (19.5%)	
Car ownership			
No car	275/422 (65.2%)	147/422 (34.8%)	0.2213
1 car	289/432 (66.9%)	143/432 (33.1%)	
≥ 2 cars	53/70 (75.7%)	17/70 (24.3%)	
Home ownership			
Yes	392/586 (66.9%)	194/586 (33.1%)	0.8955
No	232/349 (66.5%)	117/349 (33.5%)	
Number of people living in the household			
≤ 4 people	329/482 (68.3%)	153/482 (31.7%)	0.3312
> 4 people	293/449 (65.3%)	156/449 (34.7%)	
Father's education			
Incomplete middle-school	265/443 (59.8%)	178/443 (40.2%)	<0.0001
Incomplete high school	52/68 (76.5%)	16/68 (23.5%)	
Complete high school	109/153 (71.2%)	44/153 (28.8%)	
Incomplete undergraduate studies	31/35 (88.6%)	4/35 (11.4%)	
Complete undergraduate studies	46/57 (80.7%)	11/57 (19.3%)	
Mother's education			
Incomplete middle-school	378/593 (63.7%)	215/593 (36.3%)	0.1116
Incomplete high school	52/78 (66.7%)	26/78 (33.3%)	
Complete high school	127/174 (73.0%)	47/174 (27.0%)	
Incomplete undergraduate studies	30/40 (75.0%)	10/40 (25.0%)	
Complete undergraduate studies	35/48 (72.9%)	13/48 (27.1%)	

* Minimum wage at the time of the data collection, approximately US$101.02

verified around the world (Ellwood and O' Mullane, 1996; Powell, 1998; Tickle, 2002; Antunes et al, 2004) and in fluoridated and non-fluoridated Brazilian towns (Antunes et al, 2004; Bastos et al, 2005). In addition, dental literature has shown that caries polarisation has been associated with socioeconomic, dental health and fluoridated water supply (Antunes et al, 2004).

This study has also attempted to determine the association between caries experience among 12-year-old individuals and socioeconomic factors as well as behavioural variables related to oral health. According to the results, gender and socioeconomic (monthly family income, fathers' educational level) variables related to oral health were the risk indicators of dental caries in permanent dentition (Tables 3 and 5). Children with high family income or fathers' educational level were not as prone to caries or to being part of the polarisation group. Other oral health surveys conducted in 12-year-old individuals during recent years have also found significant association between dental caries and socioeconomic (Campus et al, 2001; Baldani et al, 2004) or behavioural variables related to dental health (Campus et al, 2001).

Table 5 Stepwise logistic regression with 'taking part of polarisation group' as dependent variable

Variable	Polarisation group	Odds ratio	95% Confidence interval	p-value
Gender				
Female	203/548 (37.04%)	Reference		
Male	108/391 (27.62%)	0.627	0.448–0.877	0.0064
Monthly family income				
up to 2 minimum wages*	141/375 (37.60%)	Reference		
Over 2 up to 6 minimum wages	147/440 (33.41%)	0.823	0.575–1.178	0.2876
> 6 minimum wages	22/113 (19.47%)	0.364	0.185–0.718	0.0035
Father's education				
Incomplete middle-school	178/443 (40.18%)	Reference		
Incomplete high school	16/68 (23.53%)	0.565	0.304–1.05	0.071
Complete high school	44/153 (28.76%)	0.610	0.393–0.947	0.028
Incomplete undergraduate studies	4/35 (11.43%)	0.222	0.075–0.659	0.007
Complete undergraduate studies	11/57 (19.30%)	0.469	0.218–1.01	0.053

* Minimum wage at the time of the data collection, approximately US$101.02

The regression analysis demonstrated that female individuals were more prone to caries or to 'taking part of the polarisation group'. As reported by some studies, females present higher caries experience than males (Alvarez-Arenal et al, 1998; Petersen and Kaka, 1999; Wu et al, 2003).

The results also indicated that children with low family income or low educational level of the fathers showed more risk of caries or being part of the polarisation group. Other national studies have also shown up the income as the main caries risk indicator (Peres et al, 2000; Baldani et al, 2004). As pointed out in a recent review on socioeconomic stratification for dental caries and periodontal disease studies, the family income has been considered as indicative of the access to oral health care, thus influencing many elements that act on the exposition to risks and protector factors of several diseases (Boing et al, 2005). Other researchers have claimed that educational level may bring a more complete socioeconomic evaluation, since individuals with greater educational level have better work conditions, greater income and access to health care (Gonçalves et al, 2002). Therefore, data from the present study suggest both low family income and/or educational level may be used to identify those individuals who are more prone to caries.

Piracicaba, an important city in the State of São Paulo, is located in the centre of the state and presents a Human Development Index of 0.836 and has an estimated population of 360,762 inhabitants, so that its data could be extrapolated to the majority of cities in the state.

In conclusion, the results of this study clearly indicate a low caries prevalence of 12-year-olds. In addition, gender and socioeconomic variables were risk indicators of caries in permanent dentition not only for the entire sample but also for the polarisation group.

Moreover, by means of sophisticated analyses, the data from this study corroborate what is already known about caries distribution profile around the world and are of great importance for evaluating, monitoring and planning oral health actions.

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