Trends in Caries Experience and Fluorosis Prevalence in 11- to 12-Year-Old Brazilian Children between 1991 and 2004

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Investigating dental caries and fluorosis prevalence over time is an important measure for monitoring trends in oral health.

Purpose: This work aimed to describe the prevalence of dental caries and dental fluorosis of 11- to 12-year-old schoolchildren from Iracemapolis, Brazil, in 2004 (n=236) and to compare the current prevalence rates with those from previous surveys carried out in 1991 (n=200), 1995 (n=160), 1997 (n=314) and 2001 (n=244).

Materials and Methods: The schoolchildren of both genders from all public schools were examined by two calibrated dentists (Kappa>0.81), using dental probes and buccal mirrors under natural light in an outdoor setting. Dental caries and fluorosis were measured using the DMFT and Thylstrup-Fejerskov (T-F) indexes, respectively. The variation of DMFT index over time was assessed by analysis of regression and the fluorosis prevalence (T-F>1) was compared over time by the Chi-square test at 5% significance level.

Results: In 2004, the mean value for DMFT was 1.2; 50% of the children were caries-free, and 15.7% presented dental fluorosis (T-F>1). A significant caries reduction (82.1%) and a significant increase (685%) of fluorosis prevalence have been observed from 1991 to 2004 ($p<0.01$).

Conclusion: The results suggest a continuous decrease of dental caries experience and an increase of dental fluorosis prevalence in 11- to 12-year-old schoolchildren from this Brazilian town as well as indicate that further epidemiological surveys should be carried out in order to monitor these trends.

Key words: dental caries, dental fluorosis, schoolchildren

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Epidemiological surveys in Brazil have demonstrated a decrease in dental caries experience (Brazil, 1988; 2004). The more recent national survey carried out in 2002-2003 showed that DMFT for 12-year-old schoolchildren was 2.78 (Brazil, 2004), which is much lower than earlier data collected in 1986 (DMFT=6.65; Brazil, 1988). According to several published studies, caries reduction has been observed in both fluoridated and non-fluoridated areas, mainly for schoolchildren in the south and southeast Brazilian regions (Freysleben et al, 2000; Narvai et al, 2000; Pereira et al, 2000; Bastos et al, 2004). Downward trends in caries experience have also been reported throughout the world (Loh, 1996; Sgan-Cohen et al, 1997; Chawla et al, 2000; Burt, 2002; Bonecker and Cleaton-Jones, 2003; Marthaler, 2004; Pakshir, 2004; van Wyk and van Wyk, 2004). Therefore, dental caries is becoming a less prevalent disease nowadays, at least in schoolchildren.

Fluoride has been recognised worldwide as the most effective agent for preventing and controlling dental caries, mainly when added to the water supply or to dentifrices because fluoride is available for all people, regardless of their socioeconomic level. Water fluoridation is a worthy method since an epidemiological survey conducted in the State of São Paulo, Brazil,

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showed that children from fluoridated communities presented on average one decayed tooth less than those from non-fluoridated areas (São Paulo, 1999). Besides, reduction in caries experience in fluoridated and non-fluoridated Brazilian areas (Pereira et al, 2001) suggests a key role of fluoridated dentifrices in the country, as pointed out by Cury et al (2004).
In fact, caries decline has been observed in both industrialised and developing countries since the discovery and use of diverse fluoride preventive methods such as fluoridated water, rinses, dentifrices and varnishes (Armonia et al, 1999; Irigoyen and Sánchez-Hinojosa, 2000).

On the other hand, an increase of fluorosis prevalence has also been detected worldwide (Browne et al, 2005) and a few Brazilian longitudinal studies focusing on the continuous monitoring of dental fluorosis have also demonstrated an increment on its prevalence over the recent years (Maltz et al, 2000; Pereira et al, 2000). It has generated discussions about the benefits - caries reduction - and risks - fluorosis increase - of fluoride exposure. According to some researchers, fluorosis increment is especially due to a greater exposure to fluoridated dentifrices (Wang et al, 1997; Pendrys, 2000). In addition, some studies suggest that the association of fluoridated dentifrices and diet may increase the risk of fluorosis in young children living in fluoridated areas (Armonia et al, 1999; Paiva et al, 2003).

In this context it is essential that studies can be carried out in order to monitor these tendencies and to give directions for oral health planning in public health. In Iracemapolis, a city located in São Paulo State, Brazil, fluoride was added to the water supply in 1997 but caries decline and fluorosis increase have been verified since 1991 (Pereira et al, 2000). In 2004, seven years after fluoridation, an epidemiological survey was carried out in order to follow-up these trends. This study aimed to describe data collected in 2004 on dental caries and fluorosis prevalence in 11- to 12-year-old schoolchildren and to compare these recent results with previous dental surveys, carried out in 1991, 1995, 1997, and 2001, which followed the same protocol.

MATERIALS AND METHODS

Ethical aspects

This study was approved by the Research Ethics Committee of the School of Dentistry of Piracicaba, State University of Campinas. Written authorisation was requested from head professors for performing the survey and from schoolchildren's parents for participating in clinical examination.

Town's characteristics

Iracemapolis has 17,506 inhabitants (IBGE, 2005) and is located in São Paulo State, Brazil. The town has presented improvements on the educational level in grade school, infant and perinatal mortality as well as longevity rates better than the average of São Paulo State. Although the city has lost position in the Human Development Index in the Social Responsibility Index of São Paulo State and is characterised by low income level, Iracemapolis has been presenting good social indicators (IBGE, 2002). Fluoride has been added to the water supply since 1997 (0.7 ppm F) and, like other Brazilian cities, Iracemapolis has had commercially acquired fluoridated dentifrices since 1989. Regarding other preventive measures, there is no oral health programme based on fluoride therapy. Children from all public schools perform tooth-brushing at school supervised by their respective teachers and are instructed to brush their teeth at least twice a day.

Study population

All schoolchildren from all public schools in Iracemapolis were invited to participate in the epidemiological surveys. A response rate higher than 90% could be achieved in all the surveys. The individuals who were born in the town or lived there since the age of two, did not use fixed orthodontic appliances, did not present severe dental hypoplasia, as well as those whose parents had given consent for participation were included in the studies. A total of 236 11- and 12-year-old schoolchildren participated in the epidemiological survey carried out in 2004. The sample size for the 1991, 1995, 1997 and 2001 surveys was 200, 160, 314 and 244, respectively.

Examination methodology

All epidemiological surveys were conducted following the same protocol. The DMFT index was used for caries examination following the World Health Organization criteria (WHO 1987, 1997), and the T-F index (Thylstrup and Fejerskov, 1978) was used for fluorosis examination with the highest score being registered for each child.

Table 1 Mean DMFT and reduction (%) of caries experience for schoolchildren aged 11 and 12 years in Iracemapolis, Brazil, according to year of survey

Year of survey and Authors	Sample	Mean DMFT	% Reduction in relation to 1991	% Reduction in consecutive surveys
1991 – Pereira et al, 2000	200	6.7	-	-
1995 – Pereira et al, 2000	160	3.9	41.8	41.8
1997 – Pereira et al, 2000	314	2.9	56.7	25.7
2001 – Kozlowski, 2001	244	2.1	68.7	27.6
2004 – present study	236	1.2	82.1	42.9

Table 2 Percentage of individuals with TF>1 and increase (%) of fluorosis prevalence for schoolchildren aged 11 and 12 years in Iracemapolis, Brazil, according to year of survey

Year of survey and authors	Sample	Fluorosis prevalence (% TF>1)	% Increase in relation to 1991	% Increase in consecutive surveys
1991 – Pereira et al, 2000	200	2.0	-	-
1995 – Pereira et al, 2000	160	4.4	120	120
1997 – Pereira et al, 2000	314	10.2	410	132
2001 – Kozlowski, 2001	244	12.7	535	25
2004 – present study	236	15.7	685	24

Before each survey calibration processes with theoretical discussions about codes and criteria and practical activities with clinical examinations were carried out. Two dentists, helped by two recorders, performed the clinical examination in all the surveys. One of them examined dental caries and the other dental fluorosis. Duplicate examinations were conducted by each dentist in 10% of the sample in order to assess the consistency intra-examiner (WHO, 1997), with Kappa values (Landis and Koch, 1977) higher than 0.81 for both examiners in all the surveys.

Prior to the examination, each individual received a toothbrush with fluoridated dentifrice and performed tooth-brushing supervised by a dental hygienist. The dentists examined all schoolchildren under natural light in an outdoor setting, using a dental probe, buccal mirror and air-drying. No radiographs were taken during the surveys. For the DMFT index all permanent teeth were examined and for the T-F index all the buccal surfaces of all permanent teeth that showed more than two-thirds of errupted crown, and no fillings, were examined. The differential diagnosis between very mild signs of dental fluorosis and nonfluorotic enamel opacities followed the Russel's criteria (Russel, 1961).

Statistical analysis

The data analysis consisted of descriptive statistics such as mean number of decayed, missing and filled permanent teeth (DMFT), the percentage of children with dental fluorosis as well as caries-free children (DMFT=0). The variation of the DMFT index over time (1991 to 2004) was assessed by the analysis of regression at 1% significance level. Comparison of fluorosis prevalence (T-F>1) according to the year of survey was performed by the Chi-square test (a=0.05).

RESULTS

Table 1 summarises the results of dental caries experience obtained in all surveys carried out between 1991 and 2004. In 2004, 50% of schoolchildren were caries-free. The mean value for DMFT was 1.2, 82.1% lower than the results obtained in 1991 (mean DMFT=6.7). Seven years after fluoridation of the water supply (2004), the DMFT for the schoolchildren was 58.6% lower, while in the 1991-1997-period, with no fluoride in drinking water, the percentage of caries reduction was 56.7%. A significant decrease of DMFT

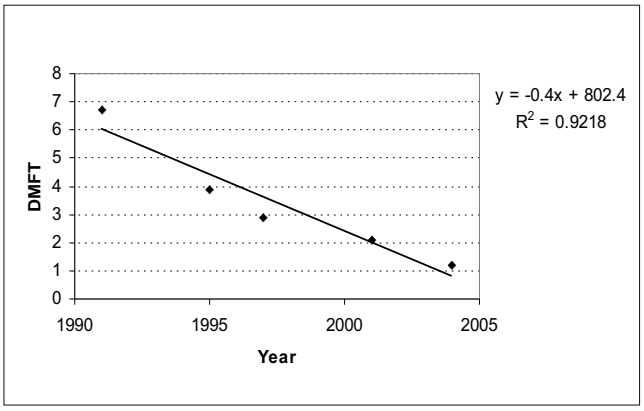

Fig 1 DMFT variation for 11- to 12-year-old schoolchildren in function of time.

over time for 12-year-old schoolchildren could be demonstrated by analysis of regression that showed a linear effect for DMFT and year of survey (Fig 1).

Table 2 shows the prevalence of fluorosis (T-F>1) recorded in 1991, 1995, 1997, 2001 and 2004. Statistically significant differences ($p<0.01$) were found for fluorosis prevalence between 1991 and 1997 as well as 1997 and 2004. In 2004, 15.7% of the individuals presented the disturbance classified as T-F>1. A total of 59.7%, 24.6%, 10.6% and 5.1% of the children were scored as T-F=0, T-F=1, T-F=2 and T-F≥3, respectively.

DISCUSSION

The results showed that the mean value for DMFT was 1.2 for 11- to 12-year-old schoolchildren from Iracemapolis in 2004 (Table 1). This index for 12-year-old individuals is 2.78 for Brazil and 2.30 for the southeast region, where Iracemapolis is located, according to the last national epidemiological survey carried out in 2002-2003 (Brazil, 2004). Other Brazilian studies conducted in the past decade show that DMFT for this age group has ranged from 2.6 to 4.82 (Sales-Peres and Bastos, 2002; Cypriano et al, 2003; Tagliaferro et al, 2004). Iracemapolis therefore presents a low caries experience.

In addition, a reduction of 82.1% in the DMFT index from 1991 (DMFT=6.7) to 2004 (DMFT=1.2) could be observed in caries experience for the schoolchildren in Iracemapolis (Table 1). According to Cury et al (2004), the expansion of preventive programmes at schools, the presence of fluoride in the water supply and the fluoridated dentifrices, which have been available in Brazil since 1989, have been recognised as the main factors for caries decline in Brazil.

The beneficial effect of fluoride added to water supply or to dentifrices has led to important consequences that may reflect in clinical practice, such as an increasing number of caries-free children (DMFT=0), the development of the polarisation group, which shows a concentration of the highest disease prevalence in a small number of individuals, and an increasing prevalence of non-cavitated lesions (Pitts, 2004), which may make correct diagnosis difficult, mainly during surveys. The 11- to 12-year-old children from Iracemapolis have been considered a low caries experience population since 2001 (Table 1), with 50% of individuals with no caries experience in 2004. It could be suggested that groups with low caries experience demand a new or a better oral health diagnosis and planning, which could require more detailed examinations, with the inclusion of plaque index and the diagnosis of initial lesions, both not contemplated by the current WHO criteria, and the provision of non-invasive procedures targeted to caries-risk individuals (e.g. fluoride application in gel, solution or varnish). Therefore, further prospective studies with the inclusion of better approaches of diagnosis and prevention/treatment are needed for this age group in Iracemapolis.

Regarding fluorosis prevalence, reports in the scientific literature have demonstrated an increase of the disease, which could be confirmed in this work by comparing data from 2004 with those from studies conducted in 1991, 1995, 1997 and 2001 (Table 2). In 1991, 2% of the schoolchildren in Iracemapolis had fluorosis with T-F>1, while in 2004, 15.7% of them presented T-F>1 (Table 2). It is important to mention that the authors considered the grade T-F>1 because previous studies on dental fluorosis in Iracemapolis reported the prevalence rates in such way (Pereira et al, 2000; Kozlowski, 2001). These results lead to two questions at present: a) what is the impact of caries preventive methods using fluoride on the fluorosis prevalence? And b) is dental fluorosis becoming a public health problem?

Water fluoridation is one of the main public health measures and reaches all people regardless of socioeconomic population status, in spite of having a decreased preventive power of 20%, due to the influence of other fluoridated methods for caries control (Kozlowski, 2001). In the present study, children examined in 2004 were four to five years old in 1997, which does not make water fluoridation an important factor for fluorosis prevalence increase in permanent teeth. In fact, after seven years of water fluoridation one cannot claim for certain that this method was responsible

for the increment in fluorosis prevalence observed from 1997 to 2004. Considering that dental fluorosis is a specific disturbance caused by excessive and chronic intake of fluoride during tooth mineralisation (Lesan, 1987), the critical period for developing manifest fluorosis in the upper central incisors is from two to three years of age if one takes in fluoride doses higher than therapeutic levels (Ishii and Suckling, 1991). In addition it is well known that children older than eight years run no risk of fluorosis whatever the fluoride level in drinking water (Buendia and Zaina, 1997).

Tooth-brushing with fluoridated dentifrice is an equally powerful community method, since it removes dental biofilm and provides topical application of fluoride, contributing to decreased caries prevalence, even in areas where there is no fluoride in the water supply (Tenuta and Cury, 2005). Considering that some researchers have demonstrated that an individual living in fluoridated areas is exposed nowadays to a daily intake of about 0.09 mg F/Kg provided by the association of diet and fluoridated dentifrice, risk of dental fluorosis would increase (Paiva et al, 2003). In a review of literature on risk factors of dental fluorosis, Mascarenhas (2000) pointed out as the major risk factors of fluorosis the use of fluoridated drinking water, fluoride supplements, fluoridated dentifrices and infant formulas before the age of six years. In this context, the authors believe that the significant increase in fluorosis prevalence has possibly been due to the inadequate use of fluoridated dentifrices by young children.

In this context, should one be worried about the significant increase in flurorosis prevalence detected in the period 1991-2004 (Table 2)? One might suppose not, since fluorosis in its mild form, which is not of aesthetical concern, was detected in the majority of individuals who presented the disturbance in 2004. Dental fluorosis in this condition, therefore, does not fill the criteria to be considered as a public health problem (Alcântara, 1998; Marcelino et al, 1999; Kozlowski, 2004). Moreover, the current fluorosis prevalence rate observed in Iracemapolis is similar to or lower than that found in low fluoridated areas (Mascarenhas, 2000). Even so, education on the rational use of fluoridated dentifrices and control of optimal fluoride levels in drinking water should be encouraged.

CONCLUSION

According to the five epidemiological surveys discussed in this study, a significant decrease in dental caries experience and a significant increase in dental fluorosis prevalence could be verified from 1991 to 2004. Although fluorosis prevalence increased a lot from 1991 to 2004, most part of the individuals presented T-F=1 and T-F=2 scores, which does not affect aesthetics and function. Future epidemiological surveys should be carried out in order to monitor dental caries and fluorosis trends over time.

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