Dental erosion amongst 13- and 14-year-old Brazilian schoolchildren

Sheyla M Auad*, Paula J Waterhouse, June H Nunn, Nick Steen and Paula J Moynihan**
Newcastle upon Tyne

* **and Belo Horizonte, Brazil**
** **and Dublin, Ireland**

Objectives: To assess the prevalence of dental erosion in a sample of 13- and 14-year-old Brazilian schoolchildren and to assess the relationship of dental erosion and socio-demographic characteristics. **Methods:** A convenience sample of 458 children (190 boys and 268 girls) from 14 schools in Três Corações, south east Brazil, was examined. Socio-demographic data were collected by self-completion questionnaires. **Results:** Dental erosion was observed in 34.1% of subjects, involving enamel only and showing a symmetrical distribution. The palatal surfaces of the upper incisors were the most commonly affected surfaces. Erosion experience was higher in boys; pupils from Government funded schools; those resident in rural areas and those from the high economic class, but none of these were statistically significant. **Conclusion:** These data are the first to show that in a cohort of 13-14-year old Brazilian schoolchildren, approximately one third of those examined showed mild erosion, requiring clinical preventive counselling. No statistically significant association was observed between erosion, gender and socioeconomic factors.

Key words: Erosion, prevalence, socio-economic demographics

There is growing concern that the prevalence of dental erosion is increasing, especially amongst children and adolescents. In 1993, the first National Survey to include the assessment of dental erosion in children was developed in the UK. This showed over 30% of the 14-year-olds examined had erosion affecting the palatal surfaces of the upper incisors[1]. Data from epidemiological studies in several countries and other UK National Surveys show wide-ranging prevalence figures[2-12]. A probable reason contributing to this is the absence of a unified approach to assessment of dental erosion. Different indices and criteria have been used to assess the non-carious loss of dental tissue, with some workers reporting the assessment of dental erosion[7,11] whilst others assessed tooth wear[13,14].

To achieve a better understanding about the erosive process, it is important to have information about its occurrence worldwide. However, most of the prevalence data come from European countries with only one study reporting prevalence data (in 12-year-old children) for dental erosion in Brazil[10]. In addition to the paucity of world-wide data on the prevalence of erosion, it is unclear how erosion may vary according to socio-demographic factors.

In view of this, the aims of the study were to determine the point prevalence of dental erosion in a sample of 13-14-year-old Brazilian schoolchildren and assess the relationship of dental erosion to socio-demographic characteristics. The objectives were to undertake a clinical study, using standardised criteria, of a group of 13-14-year-olds and gather information, by means of a questionnaire on socio-demographic factors thought likely to affect dental erosion.

Materials and methods

Ethical approval was obtained from the Ethics Committee of the Federal University of Minas Gerais

in Brazil. This cross-sectional observational study was conducted in the city of Três Corações, south east Brazil. The city has a population of 65,291 inhabitants and the majority (58,419) live in urban areas[15]. All 14 (12 public and 2 private) schools with children in the target age agreed to participate. In Brazil, private schools require the payment of fees, whilst Government-funded schools do not. Of the 12 Government-funded schools, two were located rurally, and the remainder located in an urban environment.

Consent and inclusion criteria

Explanatory information letters and consent forms were sent to all prospective subjects and their parents/guardians. Schoolchildren were included in the study if they were aged 13 and 14 years, but not yet 15 years of age and registered at a public or private school, if they were present on the day of the proposed dental examination and provided written consent from their parents/guardians to participate. This provided a non-randomised convenience sample.

Sample size

The sample size calculation was based on a 52% prevalence of dental erosion among 11-14-year-olds in the United Kingdom[11] because no Brazilian data were available at the time of the study design. It was estimated that a sample size of 500 students would give 80% power to the study, with a standard error of 2.24 (95% CI 45.6-54.4) in estimating a 50% prevalence of erosion amongst Brazilian children.

Data collection

The socio-demographic characteristics of the study sample were collected through two questionnaires which were completed by the schoolchildren and their parents/guardians. Standard instructions were given to all subjects before they responded to the questionnaire, which they undertook in school during the school-day. The questionnaire completed by the parents/guardians provided information about the parents' educational level and families' economic profile. This was sent to the homes of all prospective subjects and was returned to school by the child. The Brazilian Association of Research Institutes[16] has stratified the categories of the education system[17] within the Brazilian Economic Classification Criteria (CCEB).

In relation to the economic status and according to CCEB criteria, the families were categorised using Brazilian criteria for assessing economic status[16]. This uses seven economic classes: A1, A2, B1, B2, C, D, and E (from the highest to the lowest respectively). For the purpose of this study, classes A1 to B2 inclusively were combined to represent 'high' economic class, class C was defined as 'middle' class and classes D and E were combined to represent the 'low' economic class[18].

Oral examinations

Dental examinations were undertaken between October and December 2003 by one examiner (SMA), calibrated previously by an experienced examiner (JHN) and were performed at participating schools in a room whilst seated in front of the examiner who wore a head-mounted light. To facilitate this, the relevant tooth surfaces were dried using sterile gauze and cotton wool and examination was accomplished using sterile plain dental mirrors and a sterile probe, which was used to remove food debris only.

Data were recorded by a trained assistant. As seen in *Figure 1*, the prevalence of dental erosion was determined using a previously validated index from the oral health component of the National Diet and Nutrition Survey (NDNS)[11]. This index assessed the labial and palatal surfaces of the upper incisors and the occlusal surfaces of the first permanent molars (*Table 1*).

Reproducibility

To assess intra-examiner agreement, 49 (10%) randomly selected children were examined both at the start and the end of the examination session, with an interval of at least two hours between the examinations. The examiner was blind to subjects to be examined in duplicate. Additionally, to assess inter-examiner agreement, clinical intra-oral photographs were obtained from 66 (14%) randomly selected subjects. These were scored for erosion by the principal researcher (SMA) and also by a second more experienced examiner (JHN). The level of both intra- and inter-examiner agreement was measured using the Cohen's Kappa statistic[19].

Statistical analysis

The prevalence of erosion was calculated as the proportion of subjects, dental surfaces, groups of teeth, depth and area affected. Associations between dental erosion and socio-demographic variables were tested through a process of bivariate analysis, using the exact versions of the non-parametric tests Chi-square, Fisher's and Linear Association. Odds ratio (OR) and 95% Confidence Intervals (CI) were calculated for 2x2 tables. Only two-sided statistical tests were used. The statistical significance level was set at 5%.

Results

Response rate

Written consents were obtained from 547 out of 1,120 pupils (48.8%). Of these, two had left school, 15 de-

Code	Depth	Area of Surface Affected
0	Normal	Normal
1	Enamel only	Less than one third of surface involved
2	Enamel and dentine	One third up to two thirds of surface involved
3	Enamel, dentine and pulp	Two thirds or more of surface involved
9	Assessment cannot be made	Assessment cannot be made

Figure 1. The criteria used to assess dental erosion[11]

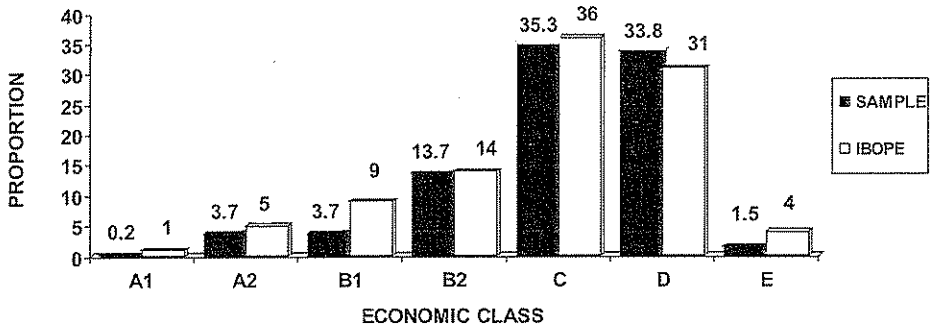

Figure 2. The proportion of subjects categorised by the economic class compared to the Brazilian National Data (IBOPE), according to the CCEB (Brazilian Economic Classification Criteria)

Table 1 The number of examined labial and palatal surfaces and number and (%) of surfaces with erosion affecting the upper permanent incisors.

Upper Incisor (tooth number)	Tooth Surfaces					
	Labial			Palatal		
	Number examined	Number with erosion	% with erosion	Number examined	Number with erosion	% with erosion
Left lateral (22)	409	12	2.9	454	103	22.7
Left central (21)	406	52	12.8	453	150	33.1
Right central (11)	405	51	12.6	451	148	32.8
Right lateral (12)	408	14	3.4	455	105	23.1
TOTAL	1628	129	7.9	1813	506	27.9

clined to participate and 25 were absent from school on the days their school was visited. This resulted in an initial sample of 501 students. However, 43 pupils were absent from school on the days when dental examinations took place. Therefore, 458 pupils were examined and represented the final study sample. This represents 40.9% of the original population and 91.6% of the estimated sample size. From the study sample, 452 (90.2%) out of a 501 questionnaires were returned.

Socio-demographic characteristics

The mean age of the 458 subjects examined was 13.8 (SD 0.39) years, ranging from 13 to 14 years. There were 190 boys (41.5%) and 268 girls (58.8%). Four hundred and eight subjects (89.1%) lived in urban areas and 40 subjects (8.7%) lived in rural areas. Information about the area of residence was unavailable for 10 subjects (2.2%). Four hundred and forty two subjects (95.5%) attended a Government-funded school and 16 (3.5%) private schools.

Complete information on the economic status was obtained from 91.9% (375) of the 408 subjects living in urban areas, with the majority of the families categorised into economic classes C and D (*Figure 2*).

Results pertaining to the educational level of both parents were available for 89.1% (408) mothers and 86.5% (396) fathers. The majority of mothers and

fathers in rural areas were illiterate or had up to three years of school education, whilst all the parents with fifteen or more years of school education (corresponding to a university degree or beyond) were resident in urban areas.

Prevalence of dental erosion and reproducibility of the oral examination

The intra-examiner reliability for dental erosion, assessed by Cohen's Kappa statistic on a surface by surface basis was 0.825, indicating a good level of agreement[19]. The inter-examiner reliability of the assessment of clinical photographs, assessed by the same statistical method was 0.745, indicating a substantial level of agreement[19].

Of the 458 children examined 156 (34.1%) exhibited signs of erosive tooth surface loss, which was confined to enamel, and mainly sited on the upper incisor teeth. There was no evidence of erosion affecting dentine. Where a subject showed erosion affecting the upper incisors, a symmetrical pattern of distribution was observed (*Tables 1* and *2*). The palatal surfaces (33.6%) of the upper incisors were more affected than the labial surfaces (12.4%). Only 23 subjects (5%) exhibited erosion of the first permanent molars, extending up to two thirds of the occlusal surfaces, but only involving enamel.

Dental erosion and socio-demographic characteristics

Eighty-six (32.1%) girls and 70 (36.8%) boys had dental erosion, however, as seen in *Table 3*, the higher experience reported in boys was not statistically significant (p=0.317). A higher proportion of children from Government-funded schools had erosion (34.4%) when compared with those from private schools (25%). Children from rural areas were more affected (45%) than those from urban areas (32.9%). However, no meaningful analyses were possible due to the small numbers attending private schools or living in a rural location. In relation to economic status, 39.1% of the children from the high economic class had erosion, compared with 31.1% and 30.6% of children with erosion in the middle and low economic classes, respectively. Erosion was also more prevalent among those whose mothers had a university degree or beyond (42.9%), than in children whose mothers were illiterate or had not completed

Table 2 The number (N) and (%) of subjects with erosion affecting labial and palatal surfaces categorised by the number of upper central and lateral incisors affected.

Groups of teeth	Number of teeth with erosion	Number of subjects			
		Labial erosion		Palatal erosion	
		N	%	N	%
Central incisors	0*	406	88.6	308	67.2
	1	1	0.2	2	0.4
	2	51	11.1	148	32.3
Lateral incisors	0*	444	96.9	351	76.6
	1	2	0.4	6	1.3
	2	12	2.6	101	22.1

* Includes subjects whose incisors did not have erosion and subjects for whom at least one incisor was not assessed

Table 3 The significance of the association between the number (N) and proportion (%) of subjects with or without experience of erosion and gender.

Gender	Experience of erosion	Subjects		p *(Fisher's Exact test)*	OR (Odds ratio)	95% Confidence Interval	
		N	%			Lower	Upper
				0.317	1.234	0.835	1.825
Boys	Yes	70	36.8				
	No	120	63.2				
	Total	190	100.0				
Girls	Yes	86	32.1				
	No	182	67.9				
	Total	268	100.0				

more than three years of primary education (34%). Conversely, only 28.6% of children whose fathers had at least a university degree had erosion compared with the 37.3% of affected subjects with fathers who were illiterate or had not completed more than three years of primary education. However, despite these apparent differences, the univariate analysis did not show any statistically significant association between the experience of dental erosion and school type (p=0.594), place of residence (p=0.160) economic class (p=0.466), nor mothers' (p=0.505) and fathers' (p=0.78) educational levels (*Table 4*).

Discussion

The prevalence of dental erosion as well as general tooth wear in the permanent dentition has been assessed in children, adolescents and adults. The published data for children shows wide-ranging prevalence figures of 3-100% [2,4,13,14,20]. The majority of studies are European, but there appears to be an increasing worldwide awareness of dental erosion, with data from non-European countries reported recently[21,22]. Comparisons between studies are problematic not only because different indices and criteria have been used to assess erosion, but also differing age ranges, groups of teeth and tooth surfaces have been assessed.

In the present study the criteria used in the NDNS were applied. The results showed that 34% of subjects had clinical signs of dental erosion, with no evidence of dentine involvement. This figure is higher than that reported for Brazilian 12-year-olds, where 13% of subjects had erosion[10]. Direct comparison of data between the two studies is difficult as different indices, criteria and age groups were used.

The criteria used in the present study were validated previously in a UK National Survey[11] and employed in subsequent prevalence studies[3,7] which reported a higher prevalence of dental erosion than 34% seen here. Despite this, the present finding of a third of 14-year-olds with signs of enamel erosion is clinically relevant, particularly from the perspective of prevention and counselling. It has been suggested that tooth wear progresses rapidly in adolescents[13]. This is substantiated by a case control study of 1,308 subjects examined at both 12 and 14 years of age. An incidence of erosion of almost 8% was observed, along with a significant increase in the severity of the condition[24]. Despite the differences in methodology between the findings of Peres *et al.*[10] and the present study, the prevalence of dental erosion appears to increase with increasing age of the subjects with 12% prevalence in 12-year-old schoolchildren[10] rising to 30% in 13-14 year-olds reported in this study. A similar trend was observed in a study reporting on changes in

Table 4 The significance of the association between the number (N) and (%) of subjects with experience of erosion and economic class, and number of years of parental education.

Variable	Total Number of Subjects	Subjects with experience of erosion		p *(Linear Association exact test)*
		N	%	
Economic class				0.226
High (classes A1, A2, B1, B2)	87	34	39.1	
Middle (class C)	144	45	31.3	
Low (classes D, E)	144	44	30.6	
Total 375		123	32.8	
Mothers number of years of school education				0.524
0-3 years	150	51	34.0	
4-7 years	125	42	33.6	
8-10 years	45	15	33.3	
11-14 years	53	18	34.0	
≥ 15 years	35	15	42.9	
Total 408		141	34.6	
Fathers number of years of school education				0.802
0-3 years	142	53	37.3	
4-7 years	141	44	31.2	
8-10 years	44	18	40.9	
11-14 years	34	14	41.2	
≥ 15 years	35	10	28.6	
Total	396	139	35.1	

dental erosion prevalence from studies conducted as part of the NDNS and National Child Dental Health Surveys in the UK, between 1993 and 1996[25].

The symmetrical distribution of erosion observed has been documented previously[3,7]. The palatal surfaces of the upper incisors were most commonly affected, confirming the findings of two UK National Surveys[5,11]. It has been suggested that the abrasive effect of the tongue on softened, demineralised enamel may contribute to a greater loss of tooth surface palatally[26]. The central incisors were more affected than the lateral incisors for both labial and palatal erosion. As the lateral incisors erupt later than central incisors, any exposure to potential erosive risk factors would be comparatively shorter.

The finding that only 5% of subjects had molar erosion should be viewed in the context that literature reporting this shows wide variation. Higher proportions of children with erosion or tooth wear affecting the first permanent molars have been reported previously[3,5,11,27,28]. Other studies have shown contrasting results, with a lower proportion of molar teeth being affected[2,4,13]. In the present study almost half of the children examined had large restorations, extensive decay or fissure sealants on the occlusal surfaces of at least one first permanent molar, and so could not be assessed for erosion. Similarly, the low prevalence may be explained partly by early signs of tooth surface loss on occlusal surfaces being less perceptible than those affecting smooth surfaces and less likely to be attributed solely to erosion[29].

In the present study, boys had a higher experience of erosion than girls. Although the difference was not statistically significant, it is in agreement with previous studies[6,11] but contrary to others[2,4,7,14,20,24,28]. It has been postulated that the higher proportion of boys with erosion affecting dentine may be due to differences in the strength of musculature, biting forces and consumption of carbonated drinks between boys and girls[29].

It is well accepted that socio-demographic characteristics impact upon health. The access to health services and knowledge and attitudes regarding health may be influenced by cultural and socio-economic factors[11,30,31]. Although in this study, erosion was not significantly associated with economic status or parental educational level, there was a trend showing that a higher experience of erosion was seen in subjects from the higher economic groups. Similar results were reported by researchers in England and The Netherlands[7,28]. Again, comparing results of studies from different countries is problematic as the social structures may differ. Brazil has enormous social inequalities[32]. Whether the experience of erosion in young people is associated with the families' economic status is equivocal. Some studies found an increased prevalence of tooth surface loss with increasing affluence[9,20,27,29], whilst others found the converse[2,11,14,33,34].

Children whose mothers had a university degree or beyond had a higher experience of erosion than those whose mothers were less well educated, but this was not statistically significant. These results are similar to those observed in the UK-based NDNS[11] and a Chinese study[9]. However, in the present study when the level of the fathers' education was explored, the opposite was found. It has been suggested that mothers are the main carer and have a stronger influence upon a child's behaviour pattern. Educational level is an important indicator of socio-economic status and the results from this study may suggest that children appear to experience more erosion if they are from a high economic background and their mothers have a higher level of educational attainment. However, from the literature the relationship between socio-demographic factors and dental erosion is equivocal.

Conclusions

Approximately one third of the present study sample had experience of erosion. Although comparisons are difficult, the prevalence of erosion amongst Brazilian schoolchildren appears to be lower than that of European countries. The erosive lesions were most commonly identified on the palatal surfaces of the upper incisor teeth in a symmetrical pattern. Few subjects were identified as experiencing erosion involving the first permanent molar teeth.

In this study erosion affected enamel only. This is an important finding because, from a clinical perspective, it is essential to instigate monitoring and preventive counselling for such patients. This will prevent further progression of the condition and help to avoid more invasive, costly restorative interventions. Whilst there were both positive and negative correlations noted between dental erosion and the various socio-demographic variables recorded, none of these relationships were statistically significant.

Acknowledgements

This study was supported by the grant 1367/01-2 from CAPES (Brazilian Coordination for the Improvement of Higher Education Personnel), Brazil. The authors would like to thank all the children, parents, schools staff and local authorities for their willing cooperation with the study.

References

1. O'Brien M. Children's Dental Health in the United Kingdom 1993. London: Her Majesty's Stationery Office 1994.
2. Al-Dlaigan YH, Shaw L, Smith A. Dental erosion in a group of British 14-year-old, schoolchildren. Part I: prevalence and influence of differing socioeconomic backgrounds. *Br Dent J* 2001 **190**: 145-149.

3. Al-Majed I, Maguire A, Murray JJ. Risk factors for dental erosion in 5-6 year old and 12-14 year old boys in Saudi Arabia. *Community Dent Oral Epidemiol* 2002 **30:** 38-46.
4. Arnadottir IB, Saemundsson SR, Holbrook WP. Dental erosion in Icelandic teenagers in relation to dietary and lifestyle factors. *Acta Odontologica Scandinavica* 2003 **61:** 25-28.
5. Chadwick B, Pendry L. Non-carious dental conditions. Children's Dental Health in the United Kingdom, 2003. London: Office for National Statistics 2004.
6. Deery C, Wagner ML, Longbottom C *et al.* The prevalence of dental erosion in a United States and a United Kingdom sample of adolescents. *Paediatric Dent* 2000 **22:** 505-510.
7. Dugmore CR, Rock WP . The prevalence of tooth erosion in 12-year-old children. *Br Dent J* 2004 **196:** 279-282.
8. Kunzel W, Cruz MS, Fischer T. Dental erosion in Cuban children associated with excessive consumption of oranges. *Euro J Oral Sci* 2000 **108:** 104-109.
9. Luo Y, Zeng XJ, Du MQ *et al.* The prevalence of dental erosion in preschool children in China. *J Dent* 2005 **33:** 115-121.
10. Peres KG, Armenio MF, Peres MA *et al.* Dental erosion in 12-year-old schoolchildren: a cross-sectional study in Southern Brazil. *Int J Paediatric Dent* 2005 **15:** 249-255.
11. Walker A, Gregory J, Bradnock G *et al.* National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 2: Report of the oral health survey 2000. London: The Stationery Office.
12. Williams D, Croucher R, Marcenes W *et al.* The prevalence of dental erosion in the maxillary incisors of 14-year-old schoolchildren living in Tower Hamlets and Hackney, London, UK. *Int Dent J* 1999 **49:** 211-216.
13. Bartlett DW, Coward PY, Nikkah C *et al.* The prevalence of tooth wear in a cluster sample of adolescent schoolchildren and its relationship with potential explanatory factors. *Br Dent J* 1998 **184:** 125-129.
14. Milosevic A, Young PJ, Lennon MA. The prevalence of tooth wear in 14-year-old school children in Liverpool. *Community Dent Health* 1994 **11:** 83-86.
15. IBGE, 2000. Banco de Dados – Cidades@. http://www.ibge.gov.br/cidadesat/default.php. Access date 23/02/05
16. ABEP (2000). Criterios de Classificacao Economica Brasil: Associacao Brasileira de Empresas de Pesquisa. http://www.abrp.org.br/Arquivos/CCEB/pdf. Access date: 30/03/03
17. IBGE teen, 2000. O Sistema Educacional Brasileiro. http://www.ibge.gov.br/ibgeteen/pesquisas/educacao.html. Access date: 18/10/05
18. Marques LS, Barbosa CC, Ramos-Jorge ML *et al.* Prevalencia da maloclusao e necessidade de tratamento ortodontico em escolares de 10 a 14 anos de idade em Belo Horizonte, Minas Gerais, Brasil; enfoque psicossocial. *Cadernos de Saude Publica* 2005 **21:** 1099-1106.
19. WHO, 1997. Oral Health Surveys – Basic Methods. 4 ed. Geneva: WHO Library Cataloguing in Publication Data. 66p.
20. van Rijkom HM, Truin GJ, Frencken JEFM *et al.* Prevalence, distribution and background variables of smooth-bordered tooth wear in teenagers in The Hague, The Netherlands. *Caries Res* 2002 **36:** 147-154.
21. Ogunyinka A, Dosumu OO, Otuyemi OD. The pattern of tooth wear amongst 12-18-year-old students in a Nigerian population. *J Oral Rehabil* 2001 **28:** 601-605.
22. Esber C, Betul K, Ilknur T *et al.* Dental erosion among children in an Istanbul public school. *J Dent Children* 2005 **72:** 5-9.
23. O'Sullivan EA. A new index for measurement of erosion in children. *Euro J Paediatric Dent* 2000 **2:** 69-74.
24. Dugmore CR, Rock WP. The progression of tooth erosion in a cohort of adolescents of mixed ethnicity. *Int J Paediatric Dent* 2003 **13:** 295- 303.
25. Nunn JH, Gordon PH, Morris AJ *et al.* Dental erosion – chamging prevalence. Review of British National Studies. *Int J Paediatric Dent* 2003 **13:** 98-105.
26. Gregg T, Mace S, West NX, Addy M. A study *in vitro* of the abrasive effect of the tongue on enamel and dentine softened by acid erosion. *Caries Res* 2004 **38:** 557-560.
27. Milward A, Shaw L, Smith A *et al.* The distribution and severity of tooth wear and the relationship between erosion and dietary constituents in a group of children. *Int J Paediatric Dent* 1994 **4:** 151-157.
28. Truin GJ, van Rijkom HM, Mulder J *et al.*Caries trends 1996-2002 among 6- and 12-year-old children and erosive wear prevalence among 12-year-old children in The Hague. *Caries Res* 2005 **39:** 2-8.
29. Bardsley PF, Taylor S, Milosevic A. Epidemiological studies of tooth wear and dental erosion in 14-year-old children in North West England. Part 1: The relationship with water fluoridation and social deprivation. *Br Dent J* 2004 **197:** 413-416.
30. Hoffmann RHS, Cypriano S, Sousa MLR *et al.* Experiencia de carie dentaria em criancas de escolas publicas e privadas de um municipio com agua fluoretada. *Cadernos de Saude Publica* **20:** 522-528.
31. Irigoyen ME, Maupome G, Mejia AM. Caries experience and treatment needs in a 6- to 12-year-old urban population in relation to socio-economic status. *Community Dent Health* 1999 **16:** 245-249.
32. IBGE (2002). Sintese de Indicadores Sociais 2002. http://www.ibge.gov.br/home/presidencia/noticias/12062003indic2002.shtm. Access date: 26/10/05.
33. Harding MA, Whelton H, O'Mullane DM *et al.* Dental erosion in 5-year-old Irish school children and associated factors: A pilot study. *Community Dent Health* 2003 **20:** 165-170.
34. Steele J, Lader D. Social factors and oral health in children. Children's Dental Health in the United Kingdom, 2003. London: Office for National Statistics 2004.

Correspondence to: Dr Paula Jane Waterhouse, The School of Dental Sciences, Framlington Place, Newcastle upon Tyne, NE2 4BW, UK.
Email: p.j.waterhouse@ncl.ac.uk