Caries reduction in Belgian 12-year-old children related to socioeconomic status

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This study compares dental caries reduction in Belgian 12-year-old children of different socioeconomic status in 1983 and 1998. Moreover, the relative effect of dental health factors on caries reduction is estimated. In the region of Brussels, children in the 7th grade at the same schools participated in cohort 1983 ($n = 533$) and in cohort 1998 ($n = 496$). DMFT, DMFS, and dental fluorosis were clinically recorded. The socioeconomic status of the children was established on the basis of their parents' education and profession. Data on children's home-based and professional dental health care habits were registered. Caries reduction was observed in both privileged and non-privileged children. However, non-privileged children, in cohort 1983 and cohort 1998, had significantly higher DMF scores than privileged children ($P < 0.01$). Dental fluorosis was more often identified in privileged children than in non-privileged ones. Most of the dental factors relating to children's home based and professional care were associated with caries reduction. Caries reduction was strongly related to socioeconomic status; non-privileged children registered lower than their counterparts. □ *Dental caries; epidemiology; socioeconomic status; trends*

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In contrast to many other Western European countries, the prevalence of dental caries in Belgian schoolchildren was still high in the early eighties (1–3). Data on dental caries in Belgian children over the past 15 years was recently brought up to date; the caries reduction in 12-year-olds from 1983 to 1998 was investigated cross-sectionally. A reduction of the mean number of teeth affected by dental caries from 7.5 to 1.6 and of tooth surfaces from 11.5 to 2.5 was observed. In addition, the percentage of caries-free children rose from 4% to 50% (4). However, as the pattern of dental disease is influenced by social factors (5–7), it was considered important to carry out further analyses on this matter. In particular, we wanted improved information on caries reduction in children with less favorable socioeconomic status and with access to private dental care only, as is essentially the case in Belgium.

In Belgium there are no public preventive dental procedures for children or adolescents. There is some public subsidy for health care; the National Institute of Health Insurance and Invalidity reimburses private health insurance companies that partially refund dental and medical expenses included in a list of selected treatments. Low levels of fluoride in drinking water, 0.1–0.2 ppm F, have been measured during the study period in the region of Brussels, where the study was carried out (8).

The present study was undertaken to compare caries reduction in Belgian 12-year-old children of different socioeconomic status in 1983 and 1998. Moreover, the relative effect of dental health factors on caries reduction was estimated.

Materials and methods

Cohorts

The national composition of the Belgian population of 12-year-olds did not undergo important changes between 1983 and 1998. Non-Belgian children represented 30% of the Brussels population in 1983 and 27% in 1998 (9), whereas the corresponding values for the cohorts were 32% in 1983 and 29% in 1998. Thus, the cohorts in terms of non-Belgian and Belgian nationals reflected the real population. The region of Brussels has a population of 10,000 12-year-old children attending the 7th grade in 120 secondary schools (9). The two cohorts were drawn in connection with children's obligatory medical check-up at the University School Health Center in Brussels, which is responsible for 17 secondary schools. These schools—catholic, municipal, and independent—were located in and around the region of Brussels. Eight of these 17 schools were randomly selected to participate in the sample in 1983 ($n = 533$). Children from the same schools were included in 1998 ($n = 496$). The number of children in each cohort represented 5% of the age-specific population in the region of Brussels.

Data collection

The examinations were performed under standardized conditions in the same room equipped with dental chair and dental lamp. Cohort 1983 was examined by one examiner (JPVN), and duplicate records for caries assessment were made in 10% of the sample. Two

examiners (JPVN and JCC) carried out the examination in cohort 1998. The examiners were calibrated, and duplicate records were made of 10% of the sample with an interval of at least 4 h between the examinations. The children had their teeth cleaned and dried with gauze compress in cohort 1983. The children's teeth were professionally brushed, flossed, and dried with gauze compress in cohort 1998. The examiners carried out these procedures before the clinical examination for dental caries and fluorosis.

Dental caries was visually diagnosed by using a plane mouth mirror. A dental probe was used to identify whether cavitated lesions were of soft or hard consistency. Bitewing radiographs were not taken, in accordance with a recommendation made by the ethical committee from the University of Louvain. Dental caries was assessed in accordance with Møller & Poulsen (10) and summarized as DMFT and DMFS index. Thus, a surface was classified as sound when it showed normal enamel translucency without any previous or present signs of caries. A surface was defined as carious when it showed 1) a lesion with discontinuity in the enamel and loss of substance without dentin involvement; 2) a lesion as a definite cavity with dentin involvement; or 3) a lesion with probable pulp complication. In the case of missing teeth/surfaces, only those due to caries were included. Such inclusion was based on the criterion that in young individuals the type of tooth missing indicates the reason for extraction. Caries treated by fillings were recorded as such when the presence of a permanent filling was identified on one or more surfaces without the presence of any caries. Additionally, in 1998, a surface showing an opaque area with a dull-whitish surface was recorded as a non-cavitated active lesion (11).

The maxillary central incisors were examined for dental fluorosis on the basis of the TF index (12) as follows: 0 = normal enamel translucency remains after wiping and drying of the surface; 1 = thin white opaque lines across the enamel surface, and, in some cases, the presence of slight 'snowcapping' of cusp/incisal edges may also be seen after air drying; 2 = lines are more pronounced and frequently merge to form small cloudy areas; these changes may be recorded without drying the teeth. 'Snowcapping' is common; and 3 = the surface shows distinct, opaque, or cloudy white areas, clinically giving the impression of a cervical enamel more opaque with a relatively constant width on each tooth. Only scores less than or equal to 3 were found in the present study; for this reason the fluorosis scores from 4 to 9 were not recorded. The results of the clinical examination were recorded in the child's file by dental students. The data were computerized from written record forms.

Interview

To investigate some factors that might be related to dental caries, the examiners (JPVN and JCC) interviewed each child with regard to his/her nationality, socio-economic status, and dental health factors related to home-based and professional care. The questions were standardized, and the interview was individualized. The answers were noted on record forms. To determine the reliability of the personal interview about oral habits in 12-year-olds, the answers of 25 children were compared with the answers of their parents. The children and their parents were interviewed separately to prevent any influence on their individual answers.

Belgian children were natives, with at least one of the parents being Belgian. Non-Belgian children were children of immigrants mainly from Italy, Spain, Portugal, Republic of Congo, Morocco, and Turkey.

The socioeconomic status of the children was determined in accordance with their parents' education and profession (13). When a child's parents were both working, the socioeconomic status was determined in as the parent having the highest status. The parents' education and profession were described in the following categories: 1) without any profession or with non-established profession; 2) unskilled manual workers; 3) farm workers; 4) shop-keepers and office employees; 5) middle or senior managers; 6) teaching staff; and 7) self-employed. This classification was used in cohort 1983 (1), and it was observed that the children whose parents belonged to the categories from 1 to 4 did not differ significantly in caries prevalence and therefore could be considered as one group of non-privileged children. Similarly, the children whose parents belonged to the categories from 5 to 7 did not differ significantly in caries prevalence and could be grouped as privileged children. The same criteria were applied in cohort 1998.

Some dental health factors related to home-based and professional care were studied. Toothbrushing habits included: A) use of fluoridated toothpaste: 1) yes, 2) do not know, 3) no; and B) frequency of brushing: 1) never brush, 2) brush two to three times per week, 3) brush four to five times per week, 4) brush once per day, 5) brush twice per day, 6) brush three times per day. The practice of flossing teeth was answered: 1) never, 2) not regularly practiced, and 3) regularly practiced. The intake of fluoride tablets was determined as follows: 1) never, 2) during a short period of time, 3) regularly. With regard to the children's professional dental health care they were classified on the basis of the reason and frequency for making dental appointment: 1) has never been to the dentist, 2) only goes to the dentist in case of discomfort or pain, 3) goes to regular control visits at least once per year.

Statistical analysis

The reliability of both the clinical scores for caries and the interview data was assessed by means of the kappa coefficient. The Wilcoxon test for two independent samples was used to examine the statistical significance of differences between means (14). Multiple logistic regression analyses were used to evaluate the predictive values of the independent variables for caries-free children. Linear hierarchical regression analyses with DMFS scores

Table 1. Mean number of decayed (DS), missing (MS), and filled (FS) tooth surfaces (DMFS) and teeth (DMFT) in Belgian 12-year-olds in relation to socioeconomic status

	DS (s.e.)	MS (s.e.)	FS (s.e.)	DMFS (s.e.)	DMFT (s.e.)
1983					
Non-privileged, $n = 197$	8.78 (0.42)	1.59 (0.27)	3.22 (0.34)	13.60 (0.61)	8.61 (0.31)
Privileged, $n = 336$	6.15 (0.27)	0.34 (0.09)	3.68 (0.25)	10.20 (0.38)	6.86 (0.22)
P	***	***	NS	***	***
1998					
Non-privileged, $n = 163$	0.81 (0.17)	0.18 (0.10)	2.44 (0.33)	3.44 (0.41) 4.61 (0.48)‡	2.08 (0.23) 2.88 (0.24)‡
Privileged, $n = 333$	0.37 (0.08)	0.04 (0.03)	1.47 (0.14)	1.89 (0.17) 3.38 (0.24)‡	1.31 (0.11) 2.32 (0.14)‡
P	**	NS	NS	**	**

Wilcoxon two-sample test: NS = not significant; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$; s.e. = standard error of the mean.
‡ DMFS/DMFT scores including non-cavitated lesions.

as dependent variable were run to investigated a possible association with the following independent variables: cohort (1983 and 1998), sex (male and female), nationality (Belgian and non-Belgian), age (12 years and 13 years), dental health care (toothbrushing from 1 to 6; fluoride tablets from 1 to 3; dental appointments from 1 to 3), and socioeconomic status (privileged and non-privileged). The hierarchical (nested) model consisted of four levels, taking initially the cohort as independent variable followed by the addition of sex, nationality, and age at the second level, by the addition of dental health care at the third level, and finally by the addition of socioeconomic status at the fourth level (15). The data were analyzed by using the Statistical Analysis System (SAS) software.

Results

In cohort 1983 the intra-examiner reliability for caries assessment showed a kappa coefficient of agreement of 0.92 (1). In cohort 1998 the inter-examiner reliability for caries diagnosis showed a kappa of 0.93, and the corresponding values for the intra-examiner reliability were 0.94 (JPVN) and 0.96 (JCC). A kappa coefficient of 0.72 was obtained from the interview data, which tested the reliability of the children's answers against those from their parents.

During the past 15 years caries reduction was observed in both privileged and non-privileged Belgian 12-year-old children. Non-privileged children represented 36.9% of the sample in 1983 and 32.8% in 1998. The percentages of caries-free subjects increased in both non-privileged and privileged children, from 2.0% in 1983 to 46.0% in 1998 and from 4.5% in 1983 to 52.0% in 1998 ($P < 0.001$). The percentage of privileged children who were caries-free was higher than that of non-privileged ones, but the difference was not significant either in cohort 1983 ($P = 0.15$) or in cohort 1998 ($P = 0.21$). Nevertheless, non-privileged children had significantly higher caries experience than privileged children, as can be seen in Tables 1 and 2. Data on DMF scores, including non-cavitated lesions in cohort 1998, are presented in Table 1. Non-cavitated lesions increased markedly the DMF scores in both categories of children.

In cohort 1983, two thirds of the DMFS scores represented the decayed component (D) in both categories of children, but this pattern changed in cohort 1998, with the filling component (F) contributing to most of the DMFS scores. Further, in cohort 1983 the values of the decayed and missing components differed significantly between non-privileged and privileged children, whereas in cohort 1998 such a difference was only observed for the decayed component. Occlusal surfaces were responsible for most caries experience in both cohorts and in both socioeconomic groups. In cohort 1998 occlusal surfaces represented about half of all surfaces with caries

Table 2. Mean number of tooth surfaces with caries experience in Belgian 12-year-olds in relation to socioeconomic status

	Occlusal surfaces	Smooth, free surfaces	Approximal surfaces	All surfaces
1983				
Non-privileged, $n = 197$	7.88 (0.27)	3.44 (0.21)	2.28 (0.22)	13.60 (0.61)
Privileged, $n = 336$	6.27 (0.19)	2.52 (0.14)	1.38 (0.12)	10.20 (0.38)
P	***	***	***	***
1998				
Non-privileged, $n = 163$	1.67 (0.18)	1.06 (0.16)	0.70 (0.11)	3.44 (0.41)
Privileged, $n = 333$	1.06 (0.09)	0.61 (0.07)	0.20 (0.03)	1.89 (0.17)
P	**	NS	***	***

Wilcoxon two-sample test: NS= not significant; * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$.
Values in parentheses are standard error of the mean.

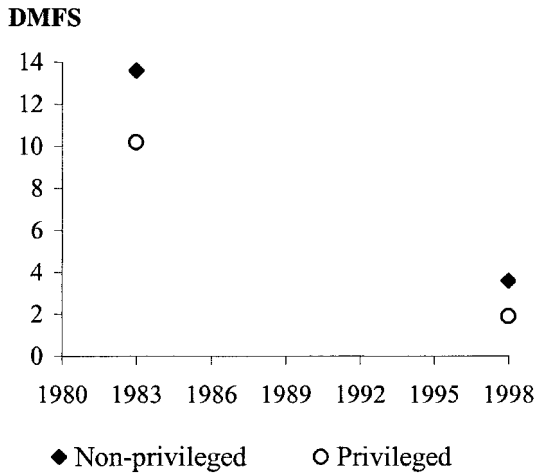

Fig. 1. DMFS scores within socioeconomic status groups during the study period.

experience. Data on inter-proximal surfaces may be underestimated, since no bitewing radiographs were taken.

Fig. 1 illustrates DMFS scores within groups of socioeconomic status during the study period. The linear regression analyses showed that the interaction between socioeconomic status and cohorts was not significant ($P = 0.08$). It indicates that social inequalities in dental caries were reduced over time, but not significantly.

In cohort 1983 dental fluorosis (scores ≤ 3) was more frequent in privileged children (5.6%) than in the non-privileged (4%), but the difference was not significant ($P = 0.30$). After 15 years dental fluorosis was identified in 26% of the non-privileged children and in 32% of the privileged children ($P = 0.30$).

Non-Belgian children represented about one third of the studied population in both cohorts. In cohort 1983 their DMFT/S scores (s.e.) were 8.62 (0.32) and 13.38 (0.60), respectively. In cohort 1998 the DMFT scores were equal to 2.01 (0.35), and the DMFS scores equal to 3.20 (0.59). Non-Belgian children showed significantly higher caries experience than Belgians in cohort 1983 ($P = 0.0001$). However, the difference became non-significant in cohort 1998 ($P = 0.20$).

The use of fluoridated toothpaste did not differ in accordance with socioeconomic status, since 90% of the interviewed children in 1983 and 95% in 1998 had claimed to use it. Non-privileged children brushed their teeth less frequently than privileged children (groups 1–6), but the observed differences were not significant either in cohort 1983 ($P = 0.7$) or in cohort 1998 ($P = 0.6$). The percentage of children brushing twice per day increased from 36% to 49% in non-privileged children and from 39% to 53% in the privileged ones. Few children used dental floss in both categories of children in both cohorts. In 1983 the regular use of fluoride tablets by privileged children was not significantly higher than by non-privileged children ($P = 0.06$), but it was significant in cohort 1998 ($P = 0.001$). The privileged children in both cohorts had much higher frequency of dental appointments to prevent dental disease than did non-privileged children ($P < 0.001$).

Table 3 shows the results of the multiple logistic regression analyses with caries-free children as dependent variable. The cohort effect, the frequency of toothbrushing once or twice per day, the use of fluoride tablets, and regular dental appointments as independent variables were significantly associated with the percentage of caries-free children ($P \leq 0.01$). On the other hand, in Table 4, the regression analysis with DMFS scores as dependent variable showed that most of the independent variables were significantly related to caries reduction during the study period ($P \leq 0.05$).

Discussion

As the children sampled for this study came from schools located in and around the region of Brussels, our results are only considered representative for this part of Belgium. For practical reasons the samples were drawn on the basis of selection of schools rather than of individuals, as would normally be done to prevent any bias.

Table 3. Multiple logistic regression for predicting caries-free Belgian 12-year-old children

Variables	Odds ratio	95% Confidence intervals	*P*
Cohort	32.02	12.37–109.72	***
Age	0.68	0.49–0.95	*
Sex	1.42	0.99–2.04	NS
Nationality	0.75	0.50–1.13	NS
Appointment on pain	0.21	0.09–0.49	**
Regular appointment	0.46	0.22–0.97	*
Tooth brushing once a day	6.10	1.65–39.58	**
Tooth brushing twice a day	7.51	2.04–48.63	**
Tooth brushing three times a day	7.38	0.64–85.59	NS
Fluorosis	1.15	0.77–1.72	NS
Regular use of F tablets	1.55	1.03–2.32	*
Socioeconomic status	1.59	0.55–5.72	NS
Interaction socioeconomic status and cohort	0.63	0.17–1.93	NS

−2 log likelihood = 380.1 ($P = 0.0001$; 13DF); −2 log likelihood no variable = 1174.9.

Table 4. Multiple linear regression model with DMFS scores as dependent variable

Independent variables		1983, *n*	1998, *n*	Parameter estimate	Standard error	*P* value
Intercept				−2.09	4.85	0.6661
Cohort		533	496	−8.81	0.67	0.0001
1983 = 0; 1998 = 1						
Age	12 years	364	358	1.31	0.37	0.0004
12 years = 0; 13 years = 1	13 years	169	138			
Sex	Boys	196	180	0.88	0.40	0.0285
Boys = 0; girls = 1	Girls	337	316			
Nationality	Belgian	358	353	0.96	0.44	0.0308
Belgian = 0; non-Belgian = 1	Non-Belgian	175	143			
Appointment on pain		218	99	3.34	0.79	0.0001
No = 0; yes = 1						
Regular appointment		272	372	1.52	0.77	0.0486
No = 0; yes = 1						
Toothbrushing once a day		313	191	−3.36	1.08	0.0020
No = 0; yes = 1						
Toothbrushing twice a day		194	258	−3.57	1.09	0.0011
No = 0; yes = 1						
Toothbrushing three times a day		12	3	−4.20	1.87	0.0252
No = 0; yes = 1						
Fluorosis		27	150	−1.32	0.54	0.0147
No = 0; yes = 1						
Regular use of F tablets		27	154	−1.02	0.54	0.0610
No = 0; yes = 1						
Socioeconomic status						
Non-privileged = 0; privileged = 1	Non-privileged	197	163	−2.13	0.57	0.0002
	Privileged	336	333			
Interaction socioeconomic status and cohort				1.38	0.79	0.0835

F (13/1013) = 55.4; $P = 0.0001$; $R^2 = 0.41$.

There is general agreement that socioeconomic status is an important factor for dental caries (5, 6, 16). The results of the present study showed that caries reduction in privileged Belgian 12-year-olds was significantly higher than in non-privileged children, as also observed in other studies (5, 7, 16). Even though the diagnostic criteria used in this study were more detailed than those recommended by the WHO (17), comparisons with other studies are possible because the results are presented with and without the inclusion of non-cavitated lesions.

An interesting point to discuss is the impact of social inequalities in caries reduction from 1983 to 1998. As seen in Fig. 1, the absolute difference in DMFS scores between privileged and non-privileged children decreased from cohort 1983 to cohort 1998. However, in relative terms, the DMFS scores of privileged children were reduced by 82%, whereas those of non-privileged children were reduced by 75%. This pattern of caries reduction in children from different socioeconomic status was recently documented (18). In cohort 1998 non-cavitated lesions indicated that children's caries experience was largely underestimated if only cavitated lesions were taken into account. Non-Belgian children presented DMF scores very similar to those recorded for non-privileged children, as shown in Table 1. This observation suggests that even though many non-Belgian children were non-privileged, socioeconomic status was a stronger factor than the national origin. One may question whether the parents' length of residence in Belgium and their process of integration have contributed to a better dental health of their children in 1998, but this was not investigated in our study.

Social inequalities in dental caries reduction may be related to distinct dental health factors, such as use of fluoridated toothpaste, frequency of tooth brushing, and access to dental care, whereas changes in sugar consumption are currently considered of very little importance (19, 20). Scientists worldwide agree on the importance of the regular use of fluoridated toothpaste to control dental caries (21). In the present study the use of fluoridated toothpaste did not differ in accordance with socioeconomic status, in agreement with the high market share of sales of fluoridated toothpaste in Belgium. It is known that children from less favorable socioeconomic status and from ethnic minorities brush their teeth less frequently than do children with more favorable socioeconomic status (7). We also found that non-privileged children brushed their teeth less often than privileged children did, but the difference was significant neither in cohort 1983 ($P = 0.7$) (22) nor in cohort 1998 ($P = 0.6$). In this context more regular plaque removal and topical fluoride application should also be considered to explain the detected differences in caries reduction.

On the other hand, previous studies on the prevalence of dental fluorosis in low-fluoridated areas have shown that 20%–24% of the children presented TF index scores from 1 to 3 (23, 24). In the present study the prevalence of dental fluorosis increased fivefold during he study period; in cohort 1998 it was 26% in non-privileged children and

32% in privileged children. The increase in dental fluorosis occurred simultaneously with a significant increase in the regular use of fluoride tablets, which were still normally prescribed and used in the '90s. It is known that the very initial changes induced by fluoride in the enamel may not be immediately visible without air-drying. Since in this investigation the children's teeth were dried with gauze compresses, it is reasonable to believe that the prevalence of fluorosis was related to scores 2 and 3. Additionally, it should be stressed that only maxillary incisors were examined, and for this reason an underestimation of the prevalence and severity of dental fluorosis is to be expected.

In a country with essentially private dental care, the reasons for and the frequency with which dental appointments are made are likely to be influenced by socioeconomic aspects (22, 25). Accordingly, our findings showed that most of the privileged children, in contrast their counterparts, had made dental appointments for caries prevention once or twice per year. Finally, the relative effect of the cohort and of the dental health factors on caries reduction was estimated in both caries-free children and in children with dental caries. The condition of being caries-free was significantly associated with few independent variables—that is, cohort, toothbrushing, intake of fluoride tablets, and regular dental appointments. However, in children with dental caries both the cohort and most of the independent variables were significantly associated with the observed caries reduction.

In conclusion, caries reduction during the past 15 years in Belgian children from the region of Brussels was strongly associated with socioeconomic status; lower caries reduction levels were registered for non-privileged children than for their counterparts. Therefore, continuous efforts should be made towards a dental health policy that increases benefits to children with less favorable socioeconomic background.

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