

ORIGINAL ARTICLE

Addressing children's oral health inequalities: caries experience before and after the implementation of an oral health promotion program

STEPHANIE TUBERT-JEANNIN^{1,2}, STEPHANIE LEGER³ & RACHEL MANEVY¹

¹CHU Clermont-Ferrand, Service d'Odontologie, Hôtel-Dieu, F-63001 Clermont-Ferrand, France, ²Université d'Auvergne, UFR d'Odontologie, EA 3847, F-63000 Clermont-Ferrand, France, and ³Université Blaise Pascal, Département de Mathématiques, F-63177 Aubiere, France

Abstract

Objective. (1) To evaluate the dental status of 5-year-old children in Clermont-Ferrand (France) in 2009; (2) To measure changes in children's dental status between 2003 and 2009; and (3) To estimate the impact of an Oral Health Promotion (OHP) program implemented in nine schools since 2005. **Materials and methods.** All 5-year-olds attending public schools in deprived areas ($n=15$) and six randomly selected other schools in Clermont-Ferrand were invited to participate. Dental status was recorded using d_3mft , as in 2003. Parents responded to questions about their child's oral hygiene and provided socio-demographic information. **Results.** Of children invited, 478 (77%) were examined. Mean $dmft$ was 1.18 (SD 2.61); 27.6% had at least one tooth affected. Caries experience varied significantly with deprivation status, oral hygiene and household SES indicators. The only difference observed between 2003 and 2009 was an increase in the 'f' component ($p<0.001$). Dental status had slightly deteriorated in areas characterized in 2003 by low caries levels ($p=0.07$). In deprived areas, mean $dmft$ increased in schools without the OHP program ($p=0.04$). Changes between 2003 and 2009 were studied at school level using Multiple Factorial Analysis; it tended to improve in four schools, which had the OHP program. Household indicators of SES changed little. Oral hygiene levels varied differently from one school to another. **Conclusions.** Caries experience was high, with large inequalities between children. No major differences were observed between 2003 and 2009. The OHP program has done little to reduce disparities in oral health, even if dental status improved in four schools.

Key Words: child–pre-school, dental caries, program evaluation, socioeconomic factors

Introduction

The levels of dental diseases in today's French children are low compared with earlier generations [1], but this improvement in dental health is not evenly distributed. In children from low SES (Socio-Economic Status) backgrounds, the prevalence of caries is higher than in other children and there is more untreated disease [2–4]. Such inequalities are particularly noticeable in countries like France, which lack a comprehensive dental service for children [5]. Dental services are provided by private dental practitioners and, while the cost of operative interventions is reimbursed by insurance funds, it has been shown that children who need most care avail of it least [3,4].

There is thus a need for strategies aimed at improving health and at reducing inequalities. It has been shown that oral health interventions that focus on

knowledge are ineffective and increase rather than reduce oral health inequalities [6]. An alternative approach is needed based on the principles of health promotion such as those developed in the WHO's Ottawa Charter [7]. The development of healthy environments and the adoption of health promoting behaviors would be particularly suited for schools, where children spend a significant proportion of their time. Schools can play an important role in promoting health and reducing inequalities. However, there is little guidance on effective interventions to tackle oral health inequalities, although it is widely accepted that interventions which involve greater availability of fluoride are more likely to provide benefits [8].

Within this context, an epidemiological study was conducted in 2003 in Clermont-Ferrand (pop. 150 000) and the dental status of 5-year-old schoolchildren was evaluated. The interrelation

Correspondence: Pr. Stéphanie Tubert-Jeannin, Faculté de Chirurgie Dentaire, 11 Boulevard Charles de Gaulle, 63000 Clermont-Ferrand, France.
Tel: +33 4 73 17 73 26. Fax: +33 4 73 17 73 09. E-mail: stephanie.tubert@u-clermont1.fr

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existing between household indicators of SES, an ecological measure of deprivation and dental status was examined. Deprived geographical areas and schools characterized by high dental needs were identified [9]. In 2005, a school-based oral health promotion (OHP) program was developed in this city. The program involved 3–5-year-old children attending nine schools with high-to-moderate caries levels and situated in deprived or semi-deprived areas of the city, as identified in the 2003 study. The aim of the program was to promote a supportive school environment for those children in order to reduce oral health inequalities [10–12]. The program focused on improvement of tooth brushing habits associated with the use of fluoridated toothpastes. Dental care was also encouraged for children with untreated carious lesions. The program included various educational activities conducted with the carers (parents, teachers, school nurses) of the children. Guidelines promoting oral health (oral hygiene, nutrition, dental care) were developed and circulated to carers. Dentists and members of an NGO (Non-Governmental Organization) that works in disadvantaged areas on housing issues organized these activities jointly. In 2006, an evaluation of the process and short-term outcomes of the program was conducted [13]. The program had some positive effects: A significant improvement in children's oral hygiene was obtained and the number of filled teeth increased slightly. Nevertheless, the care needs of the children were not totally covered and the feasibility of an extension of the program was questioned, as acceptance by and participation of the children's carers were difficult to obtain. After this first evaluation, the program was proposed each year on a voluntary basis to the nine targeted schools during the 2006–2009 period.

The objective of the present study was thus to evaluate the dental status of 5-year-old children in the city of Clermont-Ferrand in 2009. This survey also aimed to measure changes in children's dental status between 2003 and 2009 and to assess the impact of the OHP program after 5 years. An improvement of children's dental status in the schools targeted by the program was hypothesized.

Materials and methods

Study population

The schools selected for the present study were those studied in 2003 [9]. There are 35 public schools in Clermont-Ferrand. Fifteen of them are situated in socially-deprived or semi-deprived areas. The survey was conducted in all the deprived and semi-deprived schools ($n = 15$) and in six other schools randomly selected from the 20 non-deprived schools. Five-year-old children (born in 2004) were chosen so as to represent the oldest children attending kindergarten (schools for children aged 3–5 years). All the 5-year-

Table I. Schools involved in the 2003 and 2009 studies and targeted by the program.

School	Deprivation status	Caries levels 2003 study	2005–2009 period participation in the program (length)
1	Deprived	High	2 years
2	Deprived	High	4 years
3	Deprived	High	3 years ^a
4	Deprived	High	No ^b
5	Semi-deprived	High	4 years
6	Deprived	Moderate	3 years ^a
7	Semi-deprived	Moderate	4 years
8	Semi-deprived	Moderate	2 years
9	Deprived	Moderate	1 years
10	Deprived	Moderate	4 years
11	Deprived	Low	No
12	Semi-deprived	Low	No
13	Deprived	Low	No
14	Deprived	Low	No
15	Semi-deprived	Low	No
16	Non-deprived	Low	No
17	Non-deprived	Low	No
18	Non-deprived	Low	No
19	Non-deprived	Low	No
20	Non-deprived	Low	No
21	Non-deprived	Low	No

Caries levels: High; mean dmft >1 and more than 33% of the children with dmft ≠ 0 and more than 20% with dt >1. Moderate; mean dmft >1 or more than 33% of the children with dmft ≠ 0 or more than 20% with dt >1. Low; mean dmft <1 and less than 33% of the children with dmft ≠ 0 and less than 20% with dt >1.

Deprivation status: Deprived: Schools situated in deprived areas which receive additional educational resources from the Ministry of Education ('Zone d'Education Prioritaire'). Semi-deprived: Schools situated in deprived areas of the city, which receive municipal assistance ('Politique de la ville').

^aSchools 3 and 6 were combined in 2009.

^bThe program has not been offered to School 4 because this school was already participating in another oral health program in 2003. *n*, number of children examined.

olds attending the 21 selected schools ($n = 620$) were invited to participate in the survey (Table I). It must be noticed that the children examined in 2003 and in 2009 represent two different populations.

The study protocol was approved by the local primary education and health authorities. Each school was approached through the municipal school nurse system. Consent forms and explanatory letters were sent to parents. Only children whose parents returned the consent form were included in the study.

Data collection

Parents were asked to complete a questionnaire concerning the family and child demographic

background; family status (single/couple), number of children in the family, activity of the mother (work/does not work), immigrant background (French spoken at home/not) and extent of family health insurance (private complementary dental insurance or not). Information about income and level of education were not collected, to avoid discouraging parental participation. Some variables, which were not related to dental status in 2003, were not used in the present study; these included the child's place of birth, place of the child in the family and activity of the father [9].

Parents were also asked to answer questions relating to their child's use of fluoride, tooth-brushing frequency (once or less/twice a day), use of fluoride toothpaste (yes/no or unknown), supervision of tooth-brushing (child alone/supervised or done by the parents), use of fluoride supplement (used/never used) and use of fluoridated salt (yes/no or unknown). Those questions were not available in the 2003 study but were used in another study conducted in 2005, which evaluated the oral hygiene habits of the children from the nine schools targeted by the OHP program [14].

Carious lesions were diagnosed in deciduous teeth using standardized criteria at the surface level. Radiographs were not taken. Visual signs of dental caries were identified on clean and dry teeth. Carious lesions were not probed but debris was removed if necessary, using an explorer. Carious lesions were recorded at the enamel and dentine threshold using ICDAS criteria [15]. Enamel lesions at the surface level (d_{1-2S}) were not considered in the statistical analyses because those data were not available in the 2003 study [9]. The d_{3mft} index was thus calculated. Missing anterior teeth were not included in the calculation of the dmft. The dentist who examined the children in 2009 had participated previously in the 2003 study and was at that time a dental student. Examiner calibration exercises were carried out during two half-day sessions before the beginning of the present survey. The 2009 examiner did not know whether or not the school had benefited from the oral health promotion program. Intra-examiner variability was measured by re-examining 31 children. Weighted kappa coefficients >0.85 were found for the calculation of the dmft scores, which indicates good agreement.

Statistical analysis

As the dmft variable was not normally distributed, non-parametric tests were used to study the association between dental status and other study variables in 2009 (Mann-Whitney or Kruskal-Wallis). Comparisons between the dental status of 2003 and 2009 were also made using non-parametric tests (Mann-Whitney). The level of significance was arbitrarily set at 0.05.

Multiple Factor Analysis (MFA) analyzes observations described by several 'blocks' or sets of

variables. In our study, the two sets of variables described the same observations, the schools, in 2003 and in 2010 (temporal data). The analysis creates an integrated picture of the observations and of the relationships between the groups of variables. MFA is performed in two steps. Firstly, a principal component analysis (PCA) is performed on each data set, which is then 'normalized' by dividing all its elements by the square root of the first eigenvalue obtained from its PCA. Secondly, the normalized data sets are merged to form a unique matrix and a global PCA is performed on this matrix. The specificity of MFA compared with the classical methods (PCA, Multiple Correspondence Analysis) is to balance the influence of the different groups.

Those analyses led to the construction of three figures representing the evolution of the characteristics (1 = dental status, 2 = social status, 3 = oral hygiene practices) of the schools between 2003 and 2009 in three multidimensional spaces. For each figure, the multidimensional analysis reduces the number of axes in the space while retaining as much information as possible. Thus, the analysis calculates new coordinates for all values, reflecting the way they are located in a newly defined space. Those figures allow the observation of the relative situation of each school as well as their evolution between 2003 and 2009, in a two dimensional space. For instance, caries experience values (mean dmft, dt, mt and ft) were used in Figure 1 to create a new space. Each point corresponds to the 'average' value from the set of dental status variables for one school per year of study.

Results

Dental status

Of the children initially selected, 77% participated in the survey; 478 children were thus examined. Participation varied from a minimum of 51% in schools 1 and 17 to a maximum of 100% in schools 19 and 13. Non-participating children were those whose parents did not provide written consent or were absent from school the day of dental examination. Fifty-one per cent of the children were boys. The proportion of participating children in each area accorded with the initial distribution of the sample: 41.2% of children attended schools in deprived areas, 28.0% in semi-deprived and 30.8% in non-deprived areas.

The mean dmft of 5-year-old children was 1.18 and 27.6% of the children had at least one tooth affected (dmft >0). No major differences were observed between 2003 and 2009 except for the mean number of filled teeth ($p = 0.0005$) and the proportion of filled teeth ($p = 0.0003$) that increased (Table II).

Table II. Dental status of the children in 2003 and 2009.

Dental status	2003 (<i>n</i> = 453), Mean (SD)	2009 (<i>n</i> = 478), Mean (SD)
Number of primary teeth	19.34 (1.25)	19.29 (1.66)
d ₁ s	NA	2.27 (5.81)
ms	NA	0.31 (2.43)
fs	NA	0.67 (2.52)
d ₁ mfs	NA	3.24 (7.77)
d ₃ t	0.79 (1.99)	0.84 (2.06)
mt	0.01 (0.16)	0.06 (0.50)
ft	0.12 (0.64)	0.28 (0.90)
d ₃ mft	0.93 (2.26)	1.18 (2.61)
ft/d ₃ mft (dmft ≠ 0)	0.29 (0.39) (<i>n</i> = 120)	0.25 (0.35) (<i>n</i> = 132)
% dmft ≠ 0	26.5%	27.6%
% dt ≥ 2	15.4%	15.8%

Factors influencing dental status

The relationships between the children's dental status and the deprivation status of the area, baseline schools' caries level and school's participation in the program were examined (Table III). The differences in mean dmft values observed in 2003 were almost identical in 2009. The mean dmft of 5-year-

Table III. Dental status in 2003 and 2009 according to the deprivation status, 2003 caries level and participation in the program.

Variable	2003		2009	
	<i>n</i>	dmft	<i>n</i>	dmft
<i>Area deprivation</i>				
Deprived	192	1.42 (2.88)	205	1.44 (2.73)
Semi deprived	115	0.97 (2.09)	135	1.52 (2.92)
Non deprived	146	0.26 (0.94)	138	0.46 (1.90)
		<i>p</i> < 0.0001*		<i>p</i> < 0.0001
<i>Caries levels in 2003</i>				
High	124	1.81 (3.33)	121	1.24 (2.53)
Medium	84	1.04 (1.85)	90	1.54 (2.84)
Low	245	0.46 (1.46)	267	1.03 (2.56)
		<i>p</i> < 0.0001		<i>p</i> = 0.005
<i>OHP program</i>				
Non-deprived, no program	146	0.26 (0.94)	138	0.46 (1.90)
Deprived or semi-deprived, program	174	1.47 (2.75)	179	1.44 (2.78)
Deprived or semi-deprived, no program	133	0.97 (2.42)	161	1.52 (2.83)
		<i>p</i> < 0.0001		<i>p</i> < 0.0001

*Kruskall-Wallis test.

old children in the deprived schools was 3–5-times higher than in the non-deprived schools. Variations by school's baseline caries levels were lower in 2009. This can be explained by the fact that dmft values remained stable, except in areas with low caries levels where it increased slightly (*p* = 0.07). In deprived areas, the mean dmft was higher in schools without the OHP program (*p* = 0.04), while it did not change in schools with the program.

The relationships observed between household SES variables and dental health were consistent with those found in 2003. Parents' immigrant background, number of children in the family, activity of the mother and the extent of family health insurance were significantly related to the dental status (*p* < 0.0001). Significant relationships were also observed, as in 2005, between the dental status of the children and variables concerning their oral hygiene practices (supervision of tooth-brushing) or parental knowledge of fluoride in salt and toothpastes (*p* < 0.01).

Impact of the OHP program

In this study, there was a cluster effect related to the school considered (Table IV). Changes in dmft values between 2003 and 2009 varied depending on the school examined. The average mean dmft value in the schools that benefited from the program tended to decrease. Nevertheless, the situation differed from one school to another. In school 1, the mean dmft decreased from 2.40 (2003) to 1.31 (2009) while it increased from 0.93 (2003) to 1.93 (2009) in school 10. Those variations are not explained by differences in the length of participation nor in the level of involvement in the program of the educational team. As an example, school 10 had participated in the program during 4 years and the teachers had been very active within the OHP program.

We thus explored changes in dental status, household indicators of SES and oral hygiene factors between 2003 and 2009 by school using Multiple Factorial Analysis.

In Figure 1, schools situated in non-deprived areas are clearly situated on the left side of the figure while deprived schools are mainly on the right side. Some schools (namely schools 1, 2, 4, 5, 8, 12 and 16) have moved positively from the right to the left side. Four of those schools were situated in deprived areas and were exposed to the program. Some schools have moved negatively from the left to the right side (namely schools 10, 11, 14, 15, 18 and 20). All but one of those schools (school 10) were not exposed to the OHP program. For some schools (7, 9, 13, 17, 19 and 21) it is not possible to confirm any change in health status. Changes in schools 3 and 6 could not be studied because they were merged in 2009. It must be remembered that the initial dental status of the children in school 3 was particularly poor.

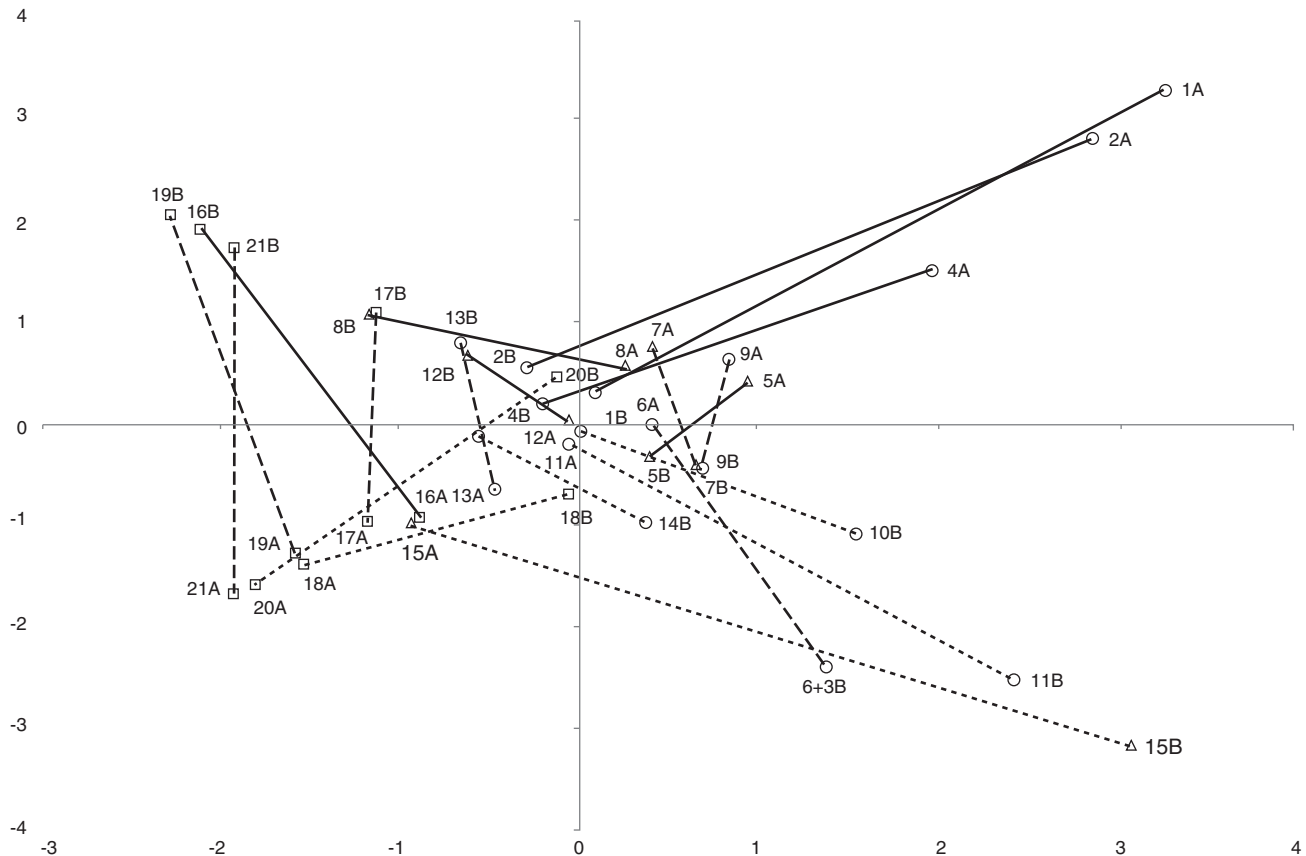


Figure 1. Multiple factorial analysis; change in dental status in the 21 schools between 2003 and 2009. Axis 1 is defined by caries experience indices (mean dmft, dt, mt and ft) with a satisfactory dental status on the left side and high levels of dental disease on the right side. Δ , semi-deprived schools; $\square$, non-deprived schools; $\circ$, deprived schools. (A) 2003 study, (B) 2009 study. Schools numbered from 1 to 21 (Table I). Continuous lines: improvement between 2003 and 2009. Large dotted lines: no particular variation between 2003 and 2009. Small dotted lines: deterioration between 2003 and 2009.

In Figure 2, schools situated in non-deprived areas are clearly situated on the left side of the figure, while deprived schools are mainly on the right side. Some schools (1, 5, 7, 11 and 21) have slightly moved from the right to the left side. Some schools have moved negatively from the left to the right side, particularly schools 8 and 9. Nevertheless, the social situation has changed little between 2003 and 2009. In school 10, there has been no worsening of the social situation of the children, which could explain the deterioration of dental indices in presence of the OHP program.

In Figure 3 good oral hygiene habits (tooth brushing: twice a day, supervised or done by the parents) and a high level of parental knowledge (related to the use of fluoridated toothpastes, salt or supplements) are on the left side and unfavorable practices are on the right side. In several schools (1, 5 and 9) oral hygiene habits improved between 2005 and 2009, while in some others the situation has worsened (2, 6, 7 and 10) or stayed the same (8). The negative change in oral hygiene in school 10 is associated with the deterioration of the dental status and, conversely, the improvement of oral hygiene in schools 1 and 5 is in accordance with the favorable

evolution of the dental status. In schools 1 and 5, social status and oral hygiene have improved concomitantly.

Discussion

Evaluation of an OHP program is important in order to make best use of limited resources, to provide feedbacks to staff, decision-makers and participants and to promote better practices. Oral health promotion evaluation is complicated because there are different types of interventions in an OHP program. This requires that, for each stage of the evaluation process, appropriate methods and measures be identified. Short-term evaluations are relatively easy to conduct and often lead to positive results on intermediate health outcomes [6,16]. OHP programs should also be long-term evaluated: maintaining the positive effects of the program on health and social outcomes is important [17,18].

The present results initially suggested that the OHP Program had done little to reduce disparities in the children's dental status. There were important variations regarding the time trend of dental status from one school to another during the study period. While

Table IV. Dental status in 2003 and in 2009 by school.

School	2009		2003		Variation Δ
	<i>n</i>	<i>M</i> dmft (SD)	<i>n</i>	<i>M</i> dmft (SD)	
<i>1</i>	13	1.31 (2.36)*	15	2.40 (3.75)	−1.09
<i>2</i>	23	1.09 (1.91)	30	2.00 (3.64)	−0.91
<i>4</i>	32	1.00 (1.92)	34	1.61 (3.37)	−0.61
<i>8</i>	8	0.50 (1.41)	14	1.00 (1.79)	−0.50
<i>16</i>	31	0.10 (0.40)	29	0.55 (1.82)	−0.45
<i>3</i>			16	2.00 (3.56)	−0.35
<i>19</i>	25	0 (0)	24	0.16 (0.48)	−0.16
<i>5</i>	31	1.33 (3.02)	29	1.41 (2.72)	−0.08
<i>12</i>	31	0.87 (1.59)	35	0.86 (2.39)	+0.01
<i>21</i>	25	0.16 (0.80)	21	0.05 (0.22)	+0.11
<i>13</i>	23	0.87 (1.98)	11	0.72 (1.85)	+0.15
<i>7</i>	29	1.45 (2.29)	15	1.07 (1.28)	+0.38
<i>6</i>	17	1.65 (3.39)	19	1.16 (2.36)	+0.49
<i>17</i>	14	0.57 (1.65)	33	0.36 (0.78)	+0.51
<i>9</i>	23	1.52 (2.45)	21	1.00 (1.70)	+0.52
<i>14</i>	21	1.29 (2.39)	18	0.72 (2.14)	+0.57
<i>18</i>	22	1.05 (3.12)	14	0.21 (0.43)	+0.84
<i>10</i>	30	1.93 (3.76)	15	0.93 (2.08)	+1
<i>20</i>	21	1.19 (3.19)	25	0.08 (0.27)	+1.11
<i>11</i>	23	2.35 (3.59)	13	0.93 (2.06)	+1.42
<i>15</i>	31	2.71 (4.17)	22	0.58 (1.01)	+2.13

$\Delta = \text{dmft}_{2009} - \text{dmft}_{2003}$, in italic: school which participated in the program.

not being able to attribute causation, the results also showed that dental health of 5-year-old children improved in four deprived schools benefiting from an OHP program compared with other schools with no program. The improvement of dental status in those schools was not directly related to the duration of participation in the OHP program. The implementation of the OHP program may partly explain the changes in dental status in some schools, but other independent variables related to the school environment and individual characteristics appear to be important factors associated with oral health.

Our results also indicate that dental status seemed to have worsened among pre-school children between 2003 and 2009, particularly in schools with no OHP program. Comparisons with other epidemiological studies need to be done with caution. Geographic variations in oral health are marked, but our results are consistent with other studies indicating that decline in caries prevalence seems to have halted in younger children in Europe [19–21].

In schools with the OHP program, dental status improved or stayed stable even if those schools were situated in the more deprived areas of the city. This trend shows that targeting OHP programs in deprived

areas may allow a reduction in oral health inequalities. Those results must be interpreted with caution because they came from two transversal ecological studies. Moreover, it should be noted that inequalities remained important in the study sample. This highlights the importance of the social and environmental determinants of oral health and the need for more comprehensive and effective OHP activities [10].

Previous studies have demonstrated positive effects of OHP programs in supportive schools where comprehensive health-promoting activities were developed [22]. Collaboration facilitates improvement in children's dental health and careful targeting of the policy to schools in poor areas may have the potential to narrow disparities [23]. OHP programs applied in deprived areas have positive effects on the dental health of pre-school children. OHP programs with culturally-relevant dental health promotion interventions and multidisciplinary collaborative networks seem to be more effective in improving oral health [24].

Multiple factorial analysis was used to describe the variations in dental, social and oral hygiene status between 2003 and 2009. The analyses were performed with the school as unit of analysis, given

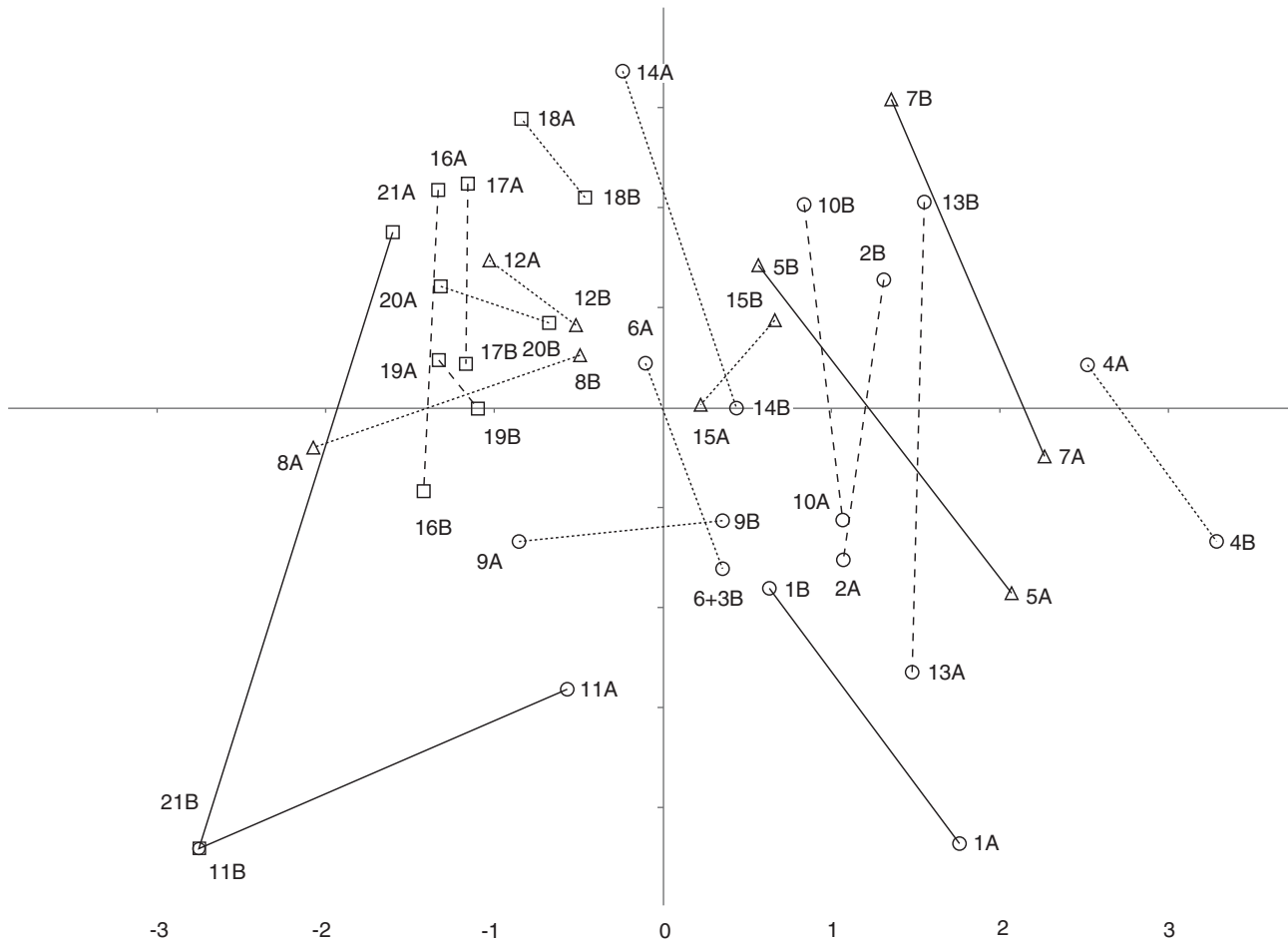


Figure 2. Multiple factorial analysis; change in social status in the 21 schools between 2003 and 2009. Axis 1 is defined by the social variables (family status, number of children in the family, activity of the mother, extent of family health insurance) with a high SES status on the left side and low SES status on the right side. The variable 'immigrant background' could not be used because the question changed slightly between 2003 and 2009. ▲, semi-deprived schools; ■, non-deprived schools; ●, deprived schools. (A) 2003 study, (B) 2009 study. Schools numbered from 1 to 21 (Table I). Continuous lines: improvement between 2003 and 2009. Large dotted lines: no particular variation between 2003 and 2009. Small dotted lines: deterioration between 2003 and 2009.

that there was an important cluster effect. Many factors, such as participation in the OHP program but also changes in social characteristics, might explain the variation of dental status in one school during the study period. Figures derived from the multiple factorial analyses were helpful in identifying factors, which might explain the changes in dental status within each school. Other studies evaluating OHP programs have also used multidimensional analyses to identify explanatory variables associated with children's caries experience. Social variables (family income, mother's education) as well as variables evaluating school support within the OHP program were independently associated with children's caries experience [22].

The present study had some limitations that should be discussed. The participation rate of the children in each school varied greatly. This might be a source of bias, as non-participating children could differ from participants. In some schools with low participation rates, dental status might have been under- or over-estimated. Many recall appointments were issued and

investigators visited the schools several times in order to improve the participation rate. They partly succeeded as they obtained a global participation rate of 77%. This rate was lower than that achieved in 2003 (84%), possibly explicable by the epidemic of H1N1 'flu in France, which occurred in 2009 at the time of the survey.

Schools represent a favored setting where public health programs or epidemiological studies of children are conducted, particularly in France. Educational teams and teachers are frequently called on to participate in health interventions. Some consider that health promotion activities interfere with educational activities and often view oral health as a separate entity to general health. School nurses in most schools have few or very limited links with local dental services (mainly private dentists). Knowledge of how to handle dental problems is limited [25]. This is particularly true in deprived areas where members of the educational team change every year and where teachers must manage social difficulties. In this context,

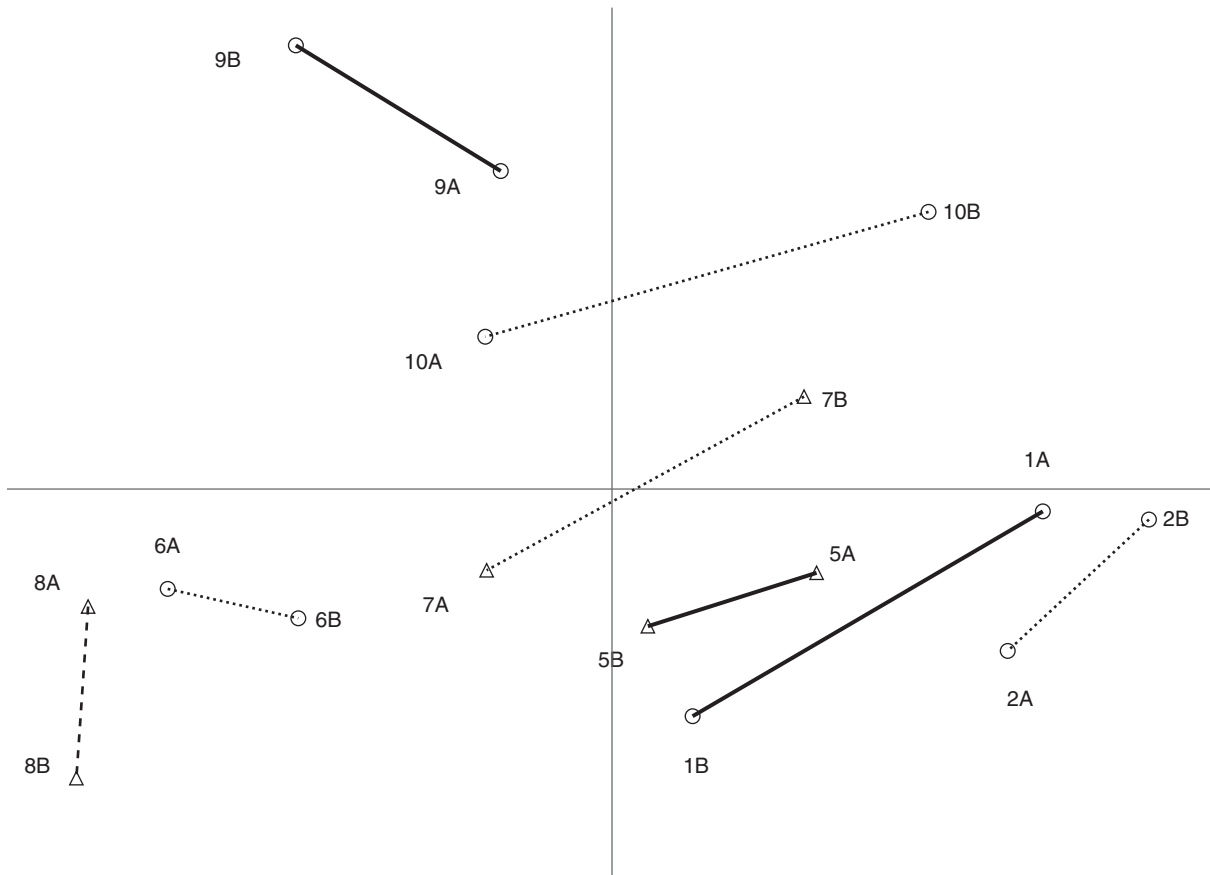


Figure 3. Multiple factorial analysis; change in oral hygiene practices in the nine schools with the OHP program between 2005 and 2009. Axis 1 is defined by oral hygiene variables (tooth-brushing frequency, use of fluoride toothpaste, supervision of tooth-brushing, use of fluoride supplement and use of fluoridated salt) for the nine schools which received the OHP program. Good oral hygiene practices are on the left side and unfavorable practices on the right side. Δ , semi-deprived schools; $\square$, non-deprived schools; $\circ$, deprived schools. (A) 2005 study, (B) 2009 study. Schools numbered from 1 to 21 (Table I). Continuous lines: improvement between 2005 and 2009. Large dotted lines: no particular variation between 2005 and 2009. Small dotted lines: deterioration between 2005 and 2009.

partnership working and multidisciplinary collaboration are needed to improve community empowerment and involvement. The success of OHP programs is heavily dependent on the commitment and attitudes of head teachers and school staff.

The OHP program was evaluated here using two cross-sectional epidemiological studies. No randomized clinical trial (RCT) was conducted. Schools participating in the OHP program were chosen in collaboration with local educational and health authorities. The emphasis was placed on schools with high dental needs, situated in disadvantaged areas. No longitudinal follow-up was conducted. It was not possible to follow the children during 5 years. Children move from kindergarten to primary school at age 6 and many migrate from one area or city to another each year. OHP programs are intended to change the environment of schools and to promote favorable health attitudes and practices. OHP programs may thus impact positively the oral health of the children in an area. Ecological studies monitoring dental health through cross-sectional epidemiological studies are not well suited to evaluating the impact of OHP programs. The nature of those

studies precludes any claims to be made with respect to causality of outcomes observed in areas where the program was implemented. It is nevertheless important that those data are reported in order to inform future strategy and research [24].

The choice of the outcomes used in this survey can also be discussed [17]. The impact of the OHP program on the children's dental status was evaluated directly using clinical or behavior variables. Dental status was appreciated using d_3mft , which gave a rough estimate of dental caries epidemiology. The appropriateness and the adequacy of caries indices for the evaluation of OHP programs have been questioned [18]. More emphasis should, thus, have been placed on other health outcomes, such as quality-of-life indicators. It also would have been useful to integrate more health promotion or intermediate health outcomes in the evaluation of this OHP program. Previous evaluations of the program, conducted 1 year after its start, have integrated variables such as the number of tooth-brushing sessions organized by the teachers, the participation rate of the parents in focus groups or plaque indices on the children's teeth. Acceptance and participation of the children's carers varied widely between schools and over time [13]. After

this first evaluation, the program was proposed each year on a voluntary basis to the schools. Three schools quickly decided to stop their participation in the OHP program. The management of the program and its evaluation was complicated due to frequent moves of the educational teams in the schools targeted by the program. Qualitative studies would be of interest to help understand what is happening in some schools. In school 10, social science analysis would be useful to understand why the OHP program seems to have no positive effect while children's carers participated actively in OHP interventions [26].

Our results indicate that caries experience was relatively high in the study sample. No major differences were observed between 2003 and 2009, except that the number of filled teeth had increased. Large inequalities in children's dental status were observed in 2009 and in 2003. The ecological measure of schools' deprivation and individual household indicators were strongly correlated with the children's oral health. There were also important variations regarding the time trend of dental status from one school to another during the study period. Results indicate that the OHP program has done little to reduce disparities, even if dental status improved in four schools. Multidisciplinary collaborative networks seem to be needed in order to improve the effectiveness of this OHP program. This study also reinforces the problem of achieving and evaluating community benefits from a health promotion program.

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