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An ecological study of caries experience, school performance and material deprivation in 5-year-old state primary school children

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Abstract – *Aim:* To investigate whether measures of school performance and socioeconomic circumstances could be used as indicators of caries experience in 5-year-old Wandsworth state primary schoolchildren. *Design:* An ecological study using aggregated caries data collected in the British Association for the Study of Community Dentistry (BASCD) Oral Health Survey of 5-year-old children (2001), Jarman scores generated from national census data and matched by school postcodes (1991), school performance results in English, mathematics and Linguistic Awareness of Reading Readiness test (LARR; literacy) and free school meals recipient data from the Local Education Authority, Research and Evaluation Unit (2001). *Setting:* State primary schools in the London borough of Wandsworth, UK. *Subjects:* All 55 Wandsworth state primary schools including 1968 5-year-old pupils. *Outcome measure:* The school mean dmft score. *Results:* Simple linear regression analysis demonstrated that school mean dmft was statistically significantly associated with all five explanatory variables: English ($P = 0.001$), mathematics ($P = 0.002$), LARR ($P < 0.001$), the percentage of children receiving free school meals ($P < 0.001$) and the school address Jarman score ($P = 0.02$). Stepwise multiple linear regression identified the LARR score and the percentage of children receiving free school meals as the strongest indicators of school mean dmft score explaining 41% of the variation in school mean dmft score. *Conclusion:* Early school performance results in English, mathematics and LARR, the percentage of children receiving free school meals and school address Jarman scores were good indicators of school mean dmft scores in 5-year-old children in the Wandsworth state primary schools.

Key words: dental caries; epidemiology; free school meals; school performance

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The last three decades has seen massive improvements in child dental health in most industrialized countries (1). The percentage of caries-free 5-year-old children in the UK increased from 30% in 1973 to 55% in 1993 (2). More worrying is the evidence suggesting a polarization of disease; dental caries is now increasingly confined to the minority at the right-hand tail of the caries distribution curve (3). The 80–20 phenomenon refers to the trend where 20% of the children harbour 80% of caries experience (4). This phenomenon has led researchers to question the appropriateness of whole-population preventive strategies and heightened the search for indicators that identify those at greater risk (5). However, the quest for reliable caries indicators to identify at-risk individuals has proved disappointing (6).

Several researchers have used an alternative ecological approach to identify at-risk groups and community risk factors with better success (7, 8). The identification of community caries indicators is a practical option and consistent with directed population strategies aimed at specifically targeting high-risk groups (contrary to individuals), thereby preserving variable resources.

Material deprivation is the most widely researched social variable and a consistent marker of childhood caries. Numerous studies have documented the relationship between high caries risk and increased levels of material deprivation using both conventional measures of socioeconomic status and area-based measures of deprivation (9–15). Studies using free school meals receipt as a material deprivation indicator have found high caries incidence in schools with more children receiving free school meals (16, 17). Free school entitlement also affected food choices; schools with a higher proportion of children entitled to free schools also had a lower proportion of children opting for noncariogenic school meals (16).

Numerous studies have found an association between maternal education and child oral health; a mother's educational attainment is a consistent indicator of her offspring's caries status (18, 19). However, the relationship between a child's own school performance and caries status has been rarely explored. The few studies investigating school performance and oral health show that academically successful adolescents have better oral health than their less successful counterparts (20–22). Moreover, Weissenbach et al. (20) found school marks to be more closely related to oral health indices than socioeconomic variables. No study has investigated school performance as a caries indicator in younger school children.

The aim of this ecological study was to investigate whether measures of school performance and socioeconomic circumstances could be used as indicators of school mean dmft scores in 5-year-old children in Wandsworth, UK.

Methods

This ecological study included all 55 Wandsworth state primary schools. Three sets of data (caries, material deprivation and school performance data) were aggregated at the school level.

Caries data were obtained from the BASCD Oral Health Survey of 5-year-old children, in 2001–2002. No sampling methods were used because the survey included all 5-year-old children in all 55 Wandsworth primary schools in Reception and Year 1 classes. The age of the subjects was defined as age in years on the date of the clinical examination (23). Caries data were collected (from October 2001 to April 2002) by one BASCD-trained examiner and recorders using the standard protocol (23).

Material deprivation was measured using the Jarman underprivileged area score (Jarman score) for the school address and the percentage of children in each school in receipt of free school meals (24, 25). The Jarman scores for each of the 22 electoral wards in Wandsworth (based on the 1991 national census) were obtained from the local public health department. These data were used to generate 55 school Jarman scores using school postcodes. Data related to the percentage of children in each school receiving free school meals were obtained from the Local Education Authority, Research and Evaluation Unit.

School performance data included the results of baseline English, mathematics and literacy tests [more formally known as the Linguistic Awareness of Reading Readiness test of emergent literacy test (LARR)]. School-aggregated baseline scores were obtained from the Local Education Authority, Research and Evaluation Unit.

Class teachers routinely and formally assessed all Wandsworth state primary schoolchildren during the first 7 weeks of entering the Reception year (the year in which the child turns 5 years of age). The results from each school are then centralized and processed by the Local Education Authority, Research and Evaluation Unit.

Baseline assessment tests were carried out in September 2000 for Year 1, 5-year-old children and in September 2001 for 5-year-old children in the Reception classes. Of the 1968 5-year olds examined as part of the BASCD survey 2001–2002, 1406 5-year olds were educationally assessed at baseline in September 2000 (Year 1 children) and 562 5-year olds were assessed in September 2001 (Reception class children). The LARR score is age-standardized (26).

The baseline assessment test was evaluated in 1991 and has been used annually to test all Wandsworth state primary school children for the last 10 years. The baseline assessment test used by the Local Education Authority, Research and Evaluation Unit is accredited in accordance with the National Framework for Baseline Assessment

Criteria (27). Wandsworth Local Research Ethics Committee approved the study protocol.

Data analysis

Caries data (input at the time of the clinical examination directly onto a laptop computer in SurveyPlus Version 2 format) were converted into SPSS format and data aggregated according to the 55 Wandsworth schools. School performance and data related to free school meals receipt (obtained in Excel format) were also converted into SPSS format. Caries, school performance and free school meals receipt SPSS files were merged. The school address Jarman scores were entered directly into the merged SPSS file. The final SPSS file contained caries, school performance and material deprivation data (the percentage of children receiving free school meals and school address Jarman scores).

Data pertaining to school mean performance scores (LARR, English and mathematics) and the percentage of children receiving free school meals were obtained for 2000 and 2001. Differences between mean scores for 2000 and 2001 were not statistically significant (LARR $P = 0.12$; English $P = 0.22$; mathematics $P = 0.14$; and free school meals $P = 0.28$). School performance and the percentage of children receiving free school meals data for 2001 were therefore used in the data analysis. School performance results for the previous 8 years were also obtained from the Local Education Authority, Research and Evaluation Unit. Data analysis using the mean school performance scores for this 8-year period produced similar results. The most recent school performance results are presented to avoid redundancy.

Data analysis included descriptive statistics (frequency and distribution and cross-tabulation). Statistical significance testing for associations between explanatory variables and caries experience was carried out using linear regression analysis. Multiple linear regression analysis was used to assess the independent effect of each explanatory variable tested which included the mean school mathematics, English and LARR scores, the percentage of children receiving free school meals and the school address Jarman scores. The level of significance was set at 5%.

Results

Caries, school performance and material deprivation data were obtained for all 55 Wandsworth schools, a response rate of 100%. The BASCD Oral Health Survey of 5-year-old children in Wandsworth for 2001–2002 examined 1968 children. The school mean response rate was 91% (76–100). School performance scores and free school meal receipt data were obtained for 99% of Wandsworth 5-year-old children. Fifty-two per cent of the children were male and the mean age of the sample was 5.5 years (SD 0.28).

The frequency distribution of school mean dmft values approximated a normal distribution. The school mean dmft was 1.66 (SD 0.66) and ranged from 0.23 to 3.32. Table 1 presents descriptive statistics for the outcome and explanatory variables used in this study.

The results of simple linear regression analysis (Table 2) showed that school mean dmft was highly statistically associated with school mean scores in English ($P = 0.001$), mathematics ($P = 0.002$), LARR ($P < 0.001$), the percentage of children receiving free school meals ($P < 0.001$) and school address Jarman scores ($P = 0.02$). The percentage of children receiving free school meals explained

Table 1. Descriptive statistics for outcome and explanatory variables in all 55 Wandsworth primary schools

	Mean (SD)	Minimum value	Quartiles			Maximum value
			25th	50th	75th	
School mean dmft	1.66 (0.66)	0.23	1.25	1.55	2.06	3.32
Mean decayed teeth	1.2 (0.5)	0.2	0.85	1.2	1.5	2.3
Mean missing teeth	0.18 (0.19)	0	0.036	0.14	0.29	0.81
Mean filled teeth	0.27 (0.19)	0	0.14	0.23	0.35	1.05
Mean mathematics score	6.1 (1.65)	2.5	5.0	6.1	7.2	9.9
Mean English score	16.9 (2.2)	12.3	15.0	17.1	18.5	20.9
Mean LARR (literacy) score	94.7 (6.6)	81.7	89.2	94.9	99.2	112.1
School address Jarman score	21.71 (9.7)	9.17	11.9	19.3	29.0	40.31
% of children receiving free school meals	33.6 (22.9)	0	18.5	30	51.1	80

Table 2. Simple linear regression analysis of material deprivation and school performance variables on school mean dmft scores in all 55 Wandsworth primary schools

Simple linear regression	Unadjusted regression coefficient (95% CI)	Level of significance	R^2-value
Mathematics	−0.16 (−0.2 to −0.06)	0.002	0.17
English	−0.13 (−0.21 to −0.06)	0.001	0.2
LARR	−0.048 (−0.072 to −0.024)	<0.001	0.23
% of children receiving free school meals	0.016 (0.01 to 0.023)	<0.001	0.32
School address Jarman score	0.021 (0.003 to 0.039)	0.02	0.095

Table 3. Stepwise multiple linear regression analysis of material deprivation and school performance variables on school mean dmft scores in all 55 Wandsworth primary schools

	Adjusted regression coefficient (95% CI)	Level of significance	R^2-value
LARR	−0.032 (−0.06 to −0.01)	0.006	
% of children receiving free school meals	0.013 (0.007 to 0.02)	0.0001	0.41

32% of the variation in the school mean dmft scores. LARR, English, mathematics and school address Jarman scores explained 23%, 20%, 17% and 9.5% of the variation in school mean dmft, respectively.

Multiple linear regression analysis was used to identify the best indicators of school mean dmft scores using a stepwise technique. The LARR score and the percentage of children receiving free school meals were selected as the strongest indicators and remained in the model. This model comprised of LARR score and the percentage of children receiving free school meals explained 41% of the variation in school mean dmft score (Table 3).

Discussion

This study found that the percentage of children receiving free school meals, school address Jarman scores and mean school performance scores in LARR, mathematics and English were good indicators of school mean dmft scores in 5-year-old children in Wandsworth state primary schools.

The percentage of children receiving free school meals was the strongest caries indicator. This concurs with previous studies using free school meals as a variable, showing higher school caries experience in schools with more children receiving free school meals (16, 17). Not all eligible children opt for free school meals because of the stigma attached to claiming: 31% of the children receive free school meals although 42% of children are actually entitled to claim free school meals in Inner London (25, 28). The percentage of children receiving free school meals is possibly a strong measure of deprivation, representing materially deprived families who would not otherwise be able to afford the cost of school meals.

This study used the Jarman score based on the school address postcode contrary to the subjects' postcodes because the main focus of this study was to establish school caries indicators. The majority of 5-year-old children attend the school closest to their home. It is therefore likely that the school address Jarman scores and the Jarman scores of the subjects' postcodes would be highly correlated as children tend to live within the school catchment area.

The LARR score was the strongest caries indicator amongst the school performance variables explaining 23% of the variation in school mean dmft. However, mathematics and English were also found to be equally good indicators explaining 17 and 20% of the variation in school mean dmft scores, respectively. This result was expected due to covariance.

Multiple regression analysis produced a model comprised of LARR score and the percentage of children receiving free school meals explaining 41% of the variation in school mean dmft. Similar studies have used census and social variables to construct models explaining variations in dmft. One study investigating the effect of deprivation and ethnicity in 5-year-old children in Leeds constructed a model (comprised of the Townsend index and religion) explaining only 9% of the variation in dmft (15). Another study used census and health service data for north-west England and found that their model explained 51% of the variation in ward dmft (29).

School performance and free school meal recipient indicators have several advantages over other

population-based indicators. Other interested bodies routinely collect these data and data can be downloaded from the Department of Education and Skills website (30). These data are therefore readily available and are updated annually. These data are also specifically related to the chosen age group.

It is not surprising that school performance and free school meals receipt were statistically stronger indicators of school caries experience than the more frequently used Jarman scores. Free school meal receipt has a conceptual basis as it is directly related to diet and has dietary consequences. Educational achievement measures such as school performance are good proxy measures of other key determinants of oral health (e.g. parental education) and are theoretically distinct (31). Socioeconomic status governs working and living conditions whilst education reflects lifestyle choices and health behaviours including dietary preferences (32, 33).

This study has some limitations and results should be interpreted with caution. All primary schools in the UK carry out baseline assessment testing of children during the first 8 weeks of formal schooling. However, there is no nationally applied test or assessment procedure for this age group. As different education authorities use different accredited baseline testing methods, these results may not apply to schools in other boroughs using alternative tests. The results related to school performance from this study cannot be therefore generalized. All UK Local Education Authorities apply the same national criteria for free school meals receipt (25). However, further studies are needed to confirm these results in different UK regions and in other countries.

This study did not control for potential confounders such as home language and time spent in preschool education, which may affect early literacy (34, 35). This is a common weakness in ecological studies. However, this may not have influenced our findings. Caries experience may be equally affected by these variables. In this context, the noninclusion of these confounders and other unmeasured variables may well be irrelevant. We do need to confirm this by including early education and bilingual variables (obtained from other Local Education Authority datasets) in future studies.

School-based ecological data could possibly be used to identify high caries schools and target groups through oral health promotion strategies. Schools have traditionally been the target of oral health promotion initiatives using health education messages directed at the entire school population. However, directed population strategies specifically targeting high caries risk schools with a high percentage of children receiving free school meals may be more appropriate than both whole and high-risk population strategies. School meals also provide an opportunity for oral health promotion teams to be involved with other agencies such as caterers and school governors adopting a multisectoral approach to caries prevention.

In summary, school mean performance scores and material deprivation measures were good indicators of school mean dmft scores in 5-year-old children attending state primary schools in Wandsworth, UK. LARR and the percentage of children receiving free school meals were the strongest indicators of school mean dmft scores. Further studies are needed to confirm these findings in different child populations.

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