School Performance Indicators as Proxy Measures of School Dental Treatment Needs: A Feasibility Study

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Abstract

Objective: *This ecological study assessed the feasibility and predictive ability of readily available educational indicators as proxy measures of school dental treatment needs in York Region elementary school children, Canada.* ***Method:*** *Data sources included York Region Dental Health Unit dental screening data (2003-2004); area-based income data from Statistics Canada (2001) based on school address postcodes; grade three and grade six school performance results in reading, writing mathematics and English as a second language (ESL) data (2003-2004) obtained from publicly accessible educational websites.* ***Results:*** *Data analyses included 219 schools. Pearson's correlations showed that schools with a higher percentage of children needing urgent dental treatment had significantly higher proportions of children scoring below provincial averages in all six school performance categories. Hierarchical stepwise multiple linear regression analysis showed that two school performance variables remained in the model after controlling for area-based median family income and ESL variables: the percentage of grade six pupils scoring below the provincial average in writing and the percentage of grade 3 pupils scoring below the provincial average in reading.* ***Conclusions:*** *The study established the feasibility of using school-level school performance indicators as proxy measures of school-level dental treatment needs. School performance results were good predictors of urgent dental treatment in York Region elementary school children. Further studies are needed using data from other jurisdictions to determine the utility of educational indicators in oral health programs.*

Key Words: Educational measurement; caries, dental; treatment need.

Introduction

School dental screening programs have evolved over the past decade in response to the increasing polarization of childhood dental diseases. The majority of children in industrialized countries are now caries free with high levels of caries found in a minority of children (1). Consequently, targeted dental screening programs have been suggested as more cost-effective than universal dental screening approaches (2). The province of Ontario in Canada adopted a targeted school dental screening program in 1997-8. Schools are allocated to caries risk strata based on decay rates in kindergarten children (3). High caries risk schools have ≥14.0% of kindergarten children with two or more decayed teeth; medium risk schools have between 9.5% and 13.9% of children with two or more decayed teeth and low risk schools have ≤ 9.4% of children with two or more decayed teeth (3). Risk strata are used to determine whether or not further screening will be undertaken in a school, and if so, which grades will be screened. The main aim of the screening program is to identify children with urgent dental treatment needs and ensure access to care. Despite the apparent cost-effectiveness of a targeted program, a comparison of the newly adopted targeted program with the previous universal screening approach showed that the targeted program identified only 58% of children with urgent dental treatment needs and 43.5% of children with any dental treatment need.

A socio-environmental approach may provide possible alternatives to dental screening using social determinants as proxy measures of oral diseases in groups such as schools or local communities. Parental education is a consistent and strong predictor of child oral health at the individual and group level (4). Since parental education is highly correlated with a child's own educational attainment, some researchers have attempted to use the child's own school performance as an indicator of dental treatment needs. For example, school performance was a strong predictor of school caries experience and restorative treatment need in two UK studies (5, 6). The relationship between school performance and dental treatment needs in Canadian school children has not been explored.

This study had two objectives. The first objective was to examine the feasibility of using readily accessible, contemporaneous and aggregate school performance data as proxy measures of school-level dental treatment needs. The second objective was to identify the strongest predictors of school dental treatment needs controlling for educational and deprivation confounders.

Materials and Methods

The first study objective examining feasibility was conducted by exploring Ontario's educational assessment system, accessing multi-agency data sources and evaluating the lo-

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Table 1
Pearson's correlation matrix for school performance, dental treatment need and other variables

	2	3	4	5	6	7	8	9	10
1) % Urgent dental treatment	0.34**	0.32**	0.28**	0.27**	0.34**	0.28**	-0.19**	0.26**	0.25**
2) % Below average in grade 3 reading		0.73**	0.46**	0.43**	0.44**	0.46**	-0.27**	0.07	0.03
3) % Below average in grade 3 writing			0.48**	0.45**	0.49**	0.48**	-0.21**	-0.09	-0.11
4) % Below average in grade 3 mathematics				0.79**	0.73**	1.00**	-0.18*	-0.08	-0.13
5) % Below average in grade 6 reading					0.78**	0.79**	-0.18*	-0.07	-0.03
6) % Below average in grade 6 writing						0.73**	-0.20**	-0.07	-0.06
7) % Below average in grade 6 mathematics							-0.18*	-0.08	-0.13
8) Median Family Income								-0.13	-0.05
9) % Grade 3 ESL learners									0.53**
10) % Grade 6 ESL learners									

*=p <0.05; **=p <0.01

gistics of merging different data sources. The study met the second objective of this ecological study by using three school aggregated data sources:

Oral health data. York Region Public Health Unit provided school dental screening data. Public health trained dental hygienists screened 59,266 children in 219 elementary schools in 2003-2004 using a standardized screening protocol (3). The percentage of children in each school requiring urgent treatment was the outcome measure of interest. Children with urgent dental treatment needs had untreated severe traumatic dental injuries, large visible cavities, acute swollen gingivae, infection or reported pain.

School performance data. School performance data were obtained from the Ontario's education assessment organization: the Education Quality and Accountability Office (EQAO). Schoolteachers annually assess Ontario's grade three (eight-year old) and grade six (11-year-old) school children using EQAO standard tests. Ninety-three percent of grade three children and 94% of grade six children participated in EQAO administered tests in 2003-2004.

The EQAO tabulates yearly results and publishes by school on publicly accessible websites (7). The school performance indicators used in this study were the percentage of grade three and grade six children scoring below the provincial avérage in reading, writing and mathematics in 2003-2004.

Socioeconomic and additional educational data sources. Area-based income data were extracted from Statistics Canada (2001) websites based on school address postcodes. A postcode analyser program matched school postcodes to Census Dissemination Areas (CDAs). The CDA is the smallest unit for which census data are released. A search of the Canadian Census 2001 CDA aggregated income database enabled us to obtain median family income data for the dissemination area in which each school was located (8). The percentage of grade three and six children in each school whose primary language was not English (English as a Second Language learners [ESL]) was also obtained from EQAO websites (7).

Statistical Analysis

Oral health, school performance, area based income and ESL data were entered into a common data file and analyzed using the Statistic Package for Social Sciences (SPSS) version 14. Data analysis included Pearson's correlations and stepwise hierarchical multiple linear regression to control for the collinearity of school performance variables. Statistical significance was set at p<0.05.

Results

Dental treatment need data were obtained for all 219 York Region elementary schools. The authors identified matching school performance, ESL and area-based median family income data for 209 schools. Data were not obtained for 10 schools because EQAO suppresses public access to data from schools testing fewer than 15 students to maintain student anonymity.

The percentage of children in each school needing urgent dental treatment ranged from 0% to 12% with a mean school percentage of 3.6% (s.d=2.2). The percentage of grade three children scoring below the provincial average in reading, writing and maths ranged from 2% to 86.3%. The range was 3% to 76% for grade six children.

Table 1 shows the correlation matrix for the association between the percentage of children needing urgent dental treatment and school performance indicators. Schools with higher percentages of children needing urgent dental treatment had significantly more children scoring below the provincial average score in all school performance categories (p<0.01). Schools with more grade three and six ESL learners had a higher percentage of children requiring urgent dental treatment (p<0.001). There was an inverse association between the percentage with urgent needs and median family income (p=0.005).

Table 1 also shows some collinearity between explanatory variables. Variance Inflation Factors (VIFs) exceeding 10 are indicative of problematic multicollinearity (9). The authors decided to use a two–step hierarchical multiple regression technique (even though multiple regression analyses showed moderate statistical multicollinearity with VIFs <4) because we know that school performance variables are conceptually

Table 2
Stepwise hierarchical multiple linear regression for predicting the percentage of children requiring urgent dental treatment (dependent variable)

Variables	Beta Coefficient	p value
Step 1		
% of children scoring below average in grade 3 reading	0.21	0.006
% of children scoring below average in grade 6 writing	0.23	0.002
R^2	0.13	
Step 2		
% of children scoring below average in grade 3 reading	0.17	0.03
% of children scoring below average in grade 6 writing	0.28	<0.001
Median family income	-0.06	0.36
% of grade 3 ESL learners	0.26	<0.001
R^2	0.196	

highly correlated (10). A stepwise technique eliminated redundant variables from the urgent dental treatment predictor model reducing the risk of a Type I error (9). Step 1 entered the six significant school performance indicators into the model using a stepwise approach (Table 2). Two variables were selected as the strongest predictors of the percentage of children requiring urgent dental treatment: the percentage of grade three children scoring below the provincial average in reading ($p<0.002$) and the percentage of children scoring below the provincial average in grade six writing ($p<0.004$). In step 2, educational and deprivation confounders (the percentage of grade three ESL learners and median family income) were entered into the model with step 1 selected variables. Both the percentage of children scoring below the provincial average in grade three reading and grade six writing remained in the step 2 model. The final step 2 model explained 19.6% of the variance in the percentage of children requiring urgent dental treatment.

Discussion

This study established the feasibility of using school performance results as proxy measures of school dental treatment needs. All data sources were easily obtained, relatively current, and matched without great difficulty.

The results of the study also concur with Crowley *et al.*'s (5) ecological UK study of six to 11-year-old children. Their study found that school performance results in English, Mathematics and Science were significant predictors of the percentage of children requiring restorative dental treatment also independent of area-based measures of deprivation. To the authors' knowledge, this is the first and only North American published study to use school aggregated school performance markers as predictors of school- level dental treatment need.

School performance indicators were significant predictors of the percentage of children requiring urgent school dental treatment need after controlling for deprivation factors. The fact that school performance variables remained in the model and explained the majority of the variance in the percentage of children with urgent needs, suggests that school performance is more than just a proxy measure of deprivation. The independent relationship between school aggregated school performance and dental treatment need suggests that school performance may be capturing other salient contextual factors (e.g. home environment factors, neighborhood factors, parental involvement and social capital) shown to be related to dental caries experience (11-13) and possibly related to dental treatment need.

Ecological data are useful for public health planning. Using readily accessible ecological data to identify school-level dental treatment needs without having to screen children during the school period is clearly advantageous from a school disruption, dental workforce and financial perspective. Identifying schools with potentially high dental treatment needs using proxy measures could also have oral health promotion implications. Oral health promotion recognizes that individual health behaviors are heavily influenced by social and environmental factors and advocates population rather than individual focused preventive strategies (14). The organizational change component of oral health promotion focuses on creating health conducive environments in schools, workplaces or other collective settings (15). This means that schools with a high percentage of children with urgent dental needs identified using school performance proxies could potentially become targets for oral health promotion and directed population strategies including fluoridated milk schemes and nutrition programs (16). Moreover, from a common risk factor perspective, nutrition-related oral health promotion initiatives could have the added benefit of improving both educational and oral health outcomes (17-19).

The study was limited by the inherent weaknesses of ecological studies: we cannot make inferences about individuals based on group characteristics. Yet, ecological studies can be used to generate hypotheses and formulate theoretical pathways. This study provides the authors with a rationale for conducting further studies using individual level data to explore theoretical pathways linking child educational attainment, deprivation and oral health. With regards to the reliability of our data sources, the psychometric properties of EQAO grade three and six tests evaluated in 1999 used misclassification (the probability of a student being correctly marked) as a measure of reliability. Probabilities ranged from 70% to 90%. The authors must accept the standards held by the Public Health Units who collected the dental screening data using established protocols, given that no data exist to confirm the reliability of dental screening data. A further shortcoming is the use of data

from only one Ontario health region. This study needs to be replicated using other health region data to establish generalization.

In conclusion, this study demonstrated the feasibility of using the school performance results of grade three and six children in York region, Canada as proxy indicators of school dental treatment needs. School performance indicators remained statistically significant predictors of school urgent dental treatment needs even after controlling for other known deprivation markers.

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