Statistical Model for Assessing the Impact of Targeted, School-based Dental Sealant Programs on Sealant Prevalence Among Third Graders in Ohio

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Abstract

Objectives: Since Ohio school-based dental sealant programs target economically disadvantaged groups, simple comparison of sealant prevalence between schools with sealant programs and those without is problematic due to underlying disparities between the two in sealant prevalence. The goal of our analysis was to estimate the impact of sealant programs on sealant prevalence among third graders in Ohio by applying a statistical model to data from a 1998–99 Ohio oral health screening survey of schoolchildren to control for differences in background characteristics. Methods: Included in the analysis were 9,747 third graders at randomly selected schools in Ohio. Chi-square statistics and survey logistic regression were used to analyze the association of sealant presence with school sealant program participation, dental care payment method, sex, race, and school lunch program eligibility. Results: The unadjusted odds ratio for dental sealant presence was 3.4 (95% confidence interval [CI]=2.6, 4.4; P<.01). Adjusting for race and income, the odds of having dental sealants among children in schools with dental sealant programs increased to 4.8 (95% CI=3.5, 6.5; P<.01). Conclusions: Not controlling for confounders can result in underestimation of the impact of targeted school sealant programs. [J Public Health Dent 2003;63(3): 195-99]

Key Words: caries prevention, survey logistic regression, school sealant programs, confounding, effect modification.

Dental sealants selectively prevent pit and fissure dental caries. Approximately 90 percent of caries in permanent teeth of children occurs on tooth surfaces with pits and fissures (1). Although the full potential of dental sealants has not been realized nationally, measures have been taken to increase sealant prevalence among children. With a baseline of 11 percent, the target of objective 13.8 in Healthy People 2000 was for 50 percent of 8- and 14-year-old children to have one or more dental sealants (2). However, the most recent national data for the objective indicate a national sealant prevalence of only 23 percent (3). In addition, significant disparities were observed by race/ethnicity, with blacks (11%) and Mexican Americans (10%) having much lower sealant prevalence than whites (26%). With the target for the dental sealant objective 21.8 for Healthy People 2010 remaining at 50 percent (4), reducing or eliminating such disparities remains a challenge.

Targeted school-based dental sealant programs, in which the sealants are placed at the school, or school-linked programs, in which students are contacted through schools but receive sealants off-site, are considered to be successful strategies for preventing caries (Community Guide) and for reaching minority and low-income children (5). In Ohio, targeted school-based dental sealant programs began in the mid-1980s, expanding from a single demonstration program in one city in 1984 to 21 programs serving 44 counties in 2002. In 1997-98, approximately 12,000 second grade students received sealants in Ohio school-based programs. Statewide oral health assessments have shown increases in the prevalence of dental sealants among 8-year-olds from 11 percent in 1987–88 to 26 percent in 1992–93 (6).

Nationally, eight out of 10 sealant programs target schools in some manner. In particular, two-thirds of targeting programs use the percent of students eligible for the school lunch program as a criterion for selecting schools (7). Ohio's school-based sealant programs are specifically targeted to children from low-income families through the school lunch program. Enrollments at schools eligible for the program tend to be disproportionately minority and low-income. The underlying Ohio population is 87.1 percent white, 11.5 percent black, 1.6 percent Hispanic, 1.1 percent Asian/Pacific Islander, and less than 1 percent other (8). Children in families earning below 185 percent of the federal poverty level (\$30,821 for a family of four in 1998) were eligible for the school lunch program. Grade level and proportion of the student population from low-income families are the primary school eligibility criteria for Ohio school-based sealant programs. For urban schools, at least 50 percent of students must be eligible for the school lunch program. Students in rural school districts, where families are believed to be less likely to enroll their children in the lunch program, are eligible if the median family income is less than 150 percent of the federal poverty guideline. In 2000, Ohio sealant programs reached approximately half of all elementary schools that met the income-based targeting criteria.

The Ohio Department of Health conducted an oral health survey of children during the 1998–99 school year to monitor the prevalence of dental caries and dental sealants for Ohio

Send all correspondence and requests for reprints to: Dr. Kim, Department of Psychology, 200 Porter Hall, Ohio University, Athens, OH 45701. E-mail: kim2.747@ohio.edu. Ms. Lehman and Dr. Lemeshow are with the Center for Biostatistics, Ohio State University. Dr. Siegal is with the Ohio Department of Health. Manuscript received: 12/31/01; returned to authors for revision: 3/12/02; final version accepted for publication: 7/1/02. schoolchildren, as well as estimate the impact of school-based sealant programs. Rather than using the Healthy People 2010 indicator of 8-year-olds, children in the third grade were selected for evaluating the impact of sealant programs because most school-based dental sealant programs are targeted to second grade classrooms. By determining sealant prevalence in grade three, the full impact of Ohio school-based sealant programs is better assessed because 8-year-old children are distributed among several grade levels.

An initial analysis of the survey data assessing the impact of school-based programs on sealant prevalence has been reported (9). While the original review provides a valuable descriptive tool, to understand the true relationship of school sealant programs and sealant prevalence the potential impact of differences in race and income between children in schools with sealant programs and those without also should be considered. Since the majority of sealant programs target schools with minority children from lower income families (with low sealant prevalence), schools with mainly white, middle-class children (with higher sealant prevalence) are much less likely to be chosen. The result is a possible underestimation of the effect of school sealant programs, since the children at schools with sealant programs also may be less likely to receive sealants in other settings, due to these demographic factors. Thus, it is necessary to adjust for the underlying differences (called "confounders") between these two groups of children in order to ascertain the real impact of school sealant programs on sealant prevalence.

The purpose of the current analysis is to estimate the impact of schoolbased sealant programs on dental sealant prevalence among third graders in Ohio by using a statistical model to control for potential confounders. Potential confounders include baseline characteristics such as method of payment for dental care, eligibility for school lunch program (proxy for family income), sex, and race of the child.

Methods

Database. The Ohio Department of Health's 1998–99 oral health survey of students in grades 1–3 sought to monitor the prevalence of dental caries and dental sealants. Sample children were obtained from the eligible elementary schools in Ohio. Eligible schools included only those with all three grades and complete data on enrollment and school lunch program participation. Three hundred forty-two of 1,857 public schools from 87 of 88 Ohio counties were selected randomly by the probability-proportional-to-size approach. Of the selected schools, 335 agreed to participate. Classrooms were selected randomly at participating schools, with a total enrollment of 34,668. Oversampling of children in the primary grade of interest for this survey resulted in 19,471 eligible third graders.

Parental consent was obtained and oral health screenings were performed for a total of 11,191 third graders (57.5% participation rate). Of the 11,191 students who received an oral screening, 9,747 had complete questionnaires and were used for subsequent data analysis.

Sampling weights were calculated based on the relationship of the number of children screened in each grade, in each school, and in each county. Thus, the 9,747 children in the sample represent 125,802 third graders in Ohio.

Data Collection Methods. A total of 12 dental hygienists and dentists completed the clinical screening. Screeners were trained in the survey methods recommended and published by the Association of State and Territorial Dental Directors (10). Mouth mirrors, artificial lighting and, when necessary, dental explorers were used in the assessment.

Main Variables of Interest. The outcome is a two-level (binary) variable that takes on the value 0 if a child has no sealants, and 1 if a child has sealants. Since the purpose of this study is to estimate the impact of a school-based dental program, the main covariate of interest is the presence/absence of a school-based dental sealant program.

Baseline Characteristics. The following children's baseline characteristics were considered potential confounders: method of dental care payment (family or self-pay, Medicaid, other dental insurance), sex, race (white, nonwhite), and eligibility for school lunch program (yes, no). Information on a child's eligibility for the school lunch program was reported by the parent or guardian completing the

consent form/questionnaire. This selfreported information was validated with school records at 12 schools, and we found 95 percent agreed and another 5 percent were equally divided between false positives and false negatives. The payment method for each child's dental care was elicited through the questionnaire and sex and race were determined by the screener that examined each child. Children in families earning below 185 percent of the federal poverty level (\$30,821 for a family of four in 1998) were eligible for the lunch program.

Statistical Analysis. The analysis was carried out in three phases. First, potential confounders were compared between children in schools with a sealant program and children in schools without a sealant program. Since all variables were measured as categorical variables in the survey, design-based Pearson chi-square statistics were used for hypothesis testing. Second, the unadjusted (crude) impact of the presence of school-based dental sealant programs was estimated. Finally, multivariable survey logistic regression was used to investigate the impact of a school-based dental sealant program after controlling for potential confounding variables.

Since the relationship between school-based dental sealant programs and the presence/absence of sealants in children is of primary interest in building a model, the decision to add a variable was not based on its statistical significance, but rather on whether the presence of that variable in the model significantly changed the odds ratio of having any sealant for children in schools with sealant programs vs students in schools without sealant programs (11). Baseline characteristics were considered to be confounding factors and were included in the final model if the odds ratio of having any dental sealant for the children in schools with sealant programs compared with children in schools without sealant programs changed by at least 10 percent after adding the characteristic to the model (11). After initial identification, a full model was built with all the confounders identified in the preliminary step plus the main covariate of interest. Then, each of the confounders was removed from the full model one at a time to check the impact on the odds ratio for the presence of sealants. The purpose of this

step was to check for correlations between confounders and remove variables that, in the presence of other covariates in the model, were not strong confounders. A variable was considered to be an effect modifier if the interaction term between the characteristic in question and the sealant program variable was significant at the α =.05 level.

Potential confounders were selected from available survey information. In this study, school lunch program eligibility was used as a proxy for income. Potential geographic and school differences were not considered.

All of the analyses were conducted using STATA Statistical Software: Release 7.0 (Stata Corporation, College Station, TX). STATA is a complete statistical software package with a full range of statistical and graphical capabilities. STATA accommodates stratification, clustering, and unequal statistical weights and can perform survey logistic regression (12).

Results

Table 1 presents the estimated number of children with dental sealants and their weighted proportions. Overall, about 35 percent of Ohio third graders had dental sealants, which is higher than the national estimate of 26 percent (4). Note that 57 percent of children in schools with dental sealant programs had sealants, compared to 29 percent of children in schools without sealant programs.

Comparison of Baseline Characteristics. Baseline characteristics were investigated to assess comparability of the children screened in schools with dental sealant programs and children in schools without a dental sealant program. Among 9,747 children, 8,809 were white and 938 were nonwhite. A summary of the results is shown in Table 2. The two groups were different with respect to all baseline characteristics. In particular, 84 percent of children who attended schools with no sealant programs were white and 16 percent were nonwhite, which was consistent with the racial breakdown for Ohio. However, in schools with sealant programs the percentage of nonwhite children rose sharply to 46 percent. The racial differences between the two groups resulted from the fact that three-fourths of all black

 TABLE 1

 Weighted Counts and Proportions of Third Grader Students with Dental Sealants, Ohio, 1998–99*

	School-based Sealant Program N (%)	No School- based Sealant Program N (%)	Overall Proportion (%)	95% CI for Proportion
Dental sealants present	14,908 (57)	28,552 (29)	35	(32, 37)
No dental sealants present	11,098 (43)	71,244 (71)	65	(63, 68)
Total number of children	26,007	99,795		

*Due to rounding, numbers may not add up to exactly the total number of children in each category.

TABLE 2

Comparison of Baseline Characteristics*						
	School-based Sealant Program	No School- based Sealant Program	Test P- value†			
Total number of children	26,007	99,795				
Payment method						
Self-pay	7,341 (28%)	33,515 (34%)	<.01			
Medicaid	10,194 (39%)	17,345 (17%)				
Dental insurance	8,472 (33%)	48,934 (49%)				
Sex						
Male	11,407 (44%)	49,129 (49%)	.03			
Female	14,599 (56%)	50,666 (51%)				
Race						
White	13,961 (54%)	83,642 (84%)	<.01			
Nonwhite	12,046 (46%)	16,153 (16%)				
Eligible for school lunch program						
Yes	18,592 (71%)	35,146 (35%)	.01			
No	7,414 (29%)	64,650 (65%)				

*All counts and proportions are weighted. Due to rounding in reporting, the numbers in each category may not add up to exactly the total number of children in each category. †All *P*-values are the results of design-based Pearson chi-square statistic.

TABLE 3
Final Model: Adjusted Odds Ratios from Survey Logistic Regression of Dental
Sealants and School-based Dental Sealant Program

	Model Coefficient	Odds Ratio			 р_
		Adjusted	Std.Error	95% CI	value
Intercept	-0.31				
Dental sealant program	1.57	4.81	0.75	(3.53, 6.54)	<.01
Eligible for school	-0.58	0.56	0.05	(0.46, 0.67)	<.01
Nonwhite race	-0.36	0.70	0.11	(0.51, 0.95)	.02

third grade children screened were eligible for the meal program, compared to 29 percent of white children screened. Likewise, 71 percent of children who attended schools with sealant programs were on the school lunch program, more than twice that of children at schools without sealant programs (35%).

Unadjusted Odds Ratios. From the survey logistic regression model, the estimated crude odds ratio was 3.4 (95% confidence interval [CI]= 2.6 to 4.4; *P*<.01). This number also can be computed from the categorization of the estimated 125,802 children in third grade, classified according to the pres-ence/absence of dental sealants and whether or not the school the child attends has a dental sealant program, using the cross-product of the appropriate cells in Table 1:

 $\frac{14,908 \times 71,244}{11,098 \times 28,552} = 3.4$

Thus, the odds of having any dental sealant were 3.4 times higher for children in schools with dental sealant programs than for children in schools with no sealant program, without adjusting for any other covariates.

Model Building. Next, it was determined whether the association between dental sealants and school sealant programs was confounded by other factors. Two variables met the criteria for being confounders: race and eligibility for the school lunch program. The odds ratio for dental sealants changed by 18 percent and 25 percent with the presence of race and lunch program eligibility, respectively. These two variables, along with the school sealant program variable, were used to build a final model.

With race already in the model, removing the eligibility for the school lunch program variable changed the odds ratio for dental sealants by 15 percent (odds ratio changed from 4.8 to 4.1), indicating that the school lunch program variable should not be dropped from the model. Removing race from the model changed the odds ratio by 7 percent (odds ratio changed from 4.8 to 4.5) with the presence of eligibility for school lunch program, which is close to the general guideline of 10 percent. Furthermore, since race was considered a particularly meaningful covariate, this variable was kept in the model as a confounder.

The effect of school sealant pro-

FIGURE 1 Percentage of Third Grader Students with Dental Sealants, by Racial Group and Sealant Program Participation



FIGURE 2

Percentage of Third Grader Students with Dental Sealants, by Eligibility for School Lunch Program and Sealant Program Participation



Schools Without A Sealant Program

grams on sealant prevalence between different races and economic groups also was explored. Figure 1 shows the percentage of third graders with dental sealants, by racial group and presence of a school sealant program. Although school sealant programs inSchools With Sealant Programs

creased sealant prevalence in nonwhite children from 17 percent to 51 percent, the percentage of white children with dental sealants also doubled from 31 percent to 62 percent. Similarly, the sealant program increased dental sealant prevalence even for children who were not eligible for a school lunch program (Figure 2). Effect modifiers were determined by assessing the significance of the interactions of race and eligibility for the school lunch program with the main covariate, school-based sealant program. Neither interaction was significant (P=.18 for the sealant program x race interaction, and P=.62 for the sealant program x eligibility interaction), indicating that sealant programs did not significantly reduce the disparities in sealant prevalence seen between race and economic groups. Therefore, the final model had two variables: eligibility for the school lunch program and race. Table 3 gives the final model coefficients as well as adjusted odds ratios estimates. The odds of having dental sealants for children in schools with dental sealant programs was 4.8 times greater than children in schools without dental sealant programs (95% CI=3.5, 6.5), after controlling for race and school lunch program eligibility.

Discussion

Based on the final logistic regression model, the odds of dental sealants in children in schools with dental sealant programs vs children in schools without a sealant program were found to be 41 percent higher after adjusting for differences in race and economic status than the original crude odds ratio estimate (4.8 vs 3.4). Many oral health surveys conducted by public health agencies are analyzed for basic descriptive findings without adjusting for confounders or effect modifiers. This study demonstrates that controlling for underlying differences between the two groups led to a significantly larger result, perhaps strengthening the case for public health programs seeking funding to initiate school-based dental sealant programs.

As previously reported, at schools with sealant programs all racial and economic groups in this study surpassed the Healthy People 2010 goal for sealant prevalence, while their counterparts in schools without such programs did not. The model indicated that the disparities in sealant prevalence between races and those of different economic status were not significantly reduced by school sealant programs. This finding, however, begs the question of whether or not it should be a public health program goal to eliminate disparity that may result from overtreatment of white children from middle and upper income families rather than undertreatment of low-income nonwhites. The failure of sealant programs to eliminate disparity should not overshadow the large increases in sealant prevalence among children from minority and low-income families, largely associated with appropriately targeted sealant programs.

Although the survey used probabilistic sampling to obtain a large representative sample of Ohio third graders, there are some limitations when using or interpreting the results of the survey data. Despite the fact that by today's standards a 57.5 percent participation rate is favorable, the extent to which the screened children differed from the 43.5 percent excluded for lack of parental consent is unknown. Likewise, the same uncertainty applies to the 13 percent of screened child excluded due to incomplete questionnaires. Parental responses to the questionnaire in this survey carries the limitation of all selfreported information. Furthermore, misclassification of race/ethnicity groups by screeners also could have been an issue, although not likely a major one, given Ohio's underlying population.

This study stresses the importance of considering underlying differences when attempting to estimate the impact of school sealant programs. Logistic regression provides a useful tool for simultaneously controlling for multiple confounders.

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