

Disparity in the Prevalence of Pit and Fissure Sealants Among 12-Year-Old Children in Puerto Rico: A Cross-Sectional Study

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Abstract

Background

Pit and fissure sealants (PFS) are an important tool in preventing and managing caries development on primary and permanent posterior teeth in children and adolescents. Among children living in Puerto Rico, particularly those of low socioeconomic status, this preventive measure has historically been underutilized. The completion of the Government Health Insurance (GHI) reform in 2000 marked a pivotal moment, expanding access to PFS across the entire island. In this study, we compared oral health data from 12-year-old school-attending children in Puerto Rico in 1997 and 2011 to evaluate changes in PFS prevalence and socioeconomic disparities, using school type as a proxy for socioeconomic status.

Methods

This cross-sectional study used two probabilistic samples ($n = 1,587$ in 2011 and $n = 1,435$ in 1997) of 12-year-olds enrolled in school, stratified by GHI region, school type, and sex. Calibrated examiners evaluated the presence of PFS on at least one permanent first molar. Logistic regression models compared PFS prevalence by school type in 1997 and 2011, adjusting for sex and region. A P -value ≤ 0.05 was considered statistically significant.

Results

Sex distribution and school type were similar in 1997 (49% female; 18% private schools) and 2011 (53% female; 23% private schools). Between 1997 and 2011, PFS prevalence increased among all children (4.3% vs. 18.1%), as well as among children attending private (11.1% vs. 25.8%), public rural (3.4% vs. 16.3%), and public urban schools (2.5% vs. 16.9%). Participants attending public-rural and public-urban schools were less likely to have sealants, both in 1997 ($OR_{\text{public-rural}}=0.19$; 95% CI: 0.07–0.46; $OR_{\text{public-urban}}=0.17$; 95% CI: 0.06–0.48) and in 2011 ($OR_{\text{public-rural}}=0.57$; 95% CI: 0.33–0.99; $OR_{\text{public-urban}}=0.60$; 95% CI: 0.39–0.93), versus those from private schools.

Conclusions

PFS prevalence increased among 12-year-old school-attending children in Puerto Rico across all school types between 1997 and 2011, a period that coincided with island-wide GHI implementation. However, disparities between children attending public and private schools persisted. These findings suggest that expanded insurance coverage alone may be insufficient to eliminate disparities in preventive dental care and that socioeconomic background may influence PFS utilization.

Background

Pit and fissure sealants (PFS) are physical barriers that prevent bacterial growth. Applied to chewing surfaces, they serve as a primary tool to prevent and control caries development on primary and permanent posterior teeth in children and adolescents [1, 2]. PFS also function as a secondary preventive intervention by arresting the progression of non-cavitated carious lesions [3]. Although dental sealant use increased among adolescents aged 12–19 years in the United States between 1999–2004 and 2011–2016, prevalence remained lower among minority and economically disadvantaged children than among their non-Hispanic White counterparts [4].

The first population-based study assessing the oral health status of 12-year-old children living in Puerto Rico was conducted in 1997 [5]. The study found a lower prevalence of PFS on first permanent molars among children in Puerto Rico than among mainland U.S. children sampled during a similar period (4.3% vs. 18.5%). It also identified a significant disparity in PFS prevalence between children attending public and private schools, with school type used as a proxy for socioeconomic status (SES) [5, 6].

In 1993, the government of Puerto Rico initiated the Government Health Insurance (GHI) reform, a Medicaid expansion that included oral health coverage for medically indigent populations [7]. Although implementation began in 1993, full integration across all municipalities and regions was not achieved until 2000 [8]. More than a decade after island-wide implementation, its impact on preventive dental care remained unclear. Similarly, limited evidence exists in the United States regarding how expanded Medicaid coverage influences oral health outcomes among children and adolescents. One study reported a positive association between expanded Medicaid coverage and improved oral health outcomes, particularly among non-Hispanic Black populations [9]. However, persistent oral health inequalities have been reported among children and adolescents in Puerto Rico and the United States [4, 8].

This study aimed to address this knowledge gap by comparing PFS prevalence among 12-year-old school-attending children in Puerto Rico using data from two cross-sectional surveys conducted in 1997 and 2011. We also assessed differences by school type at each time point. Data were collected in 2011 using the same sampling framework as in the 1997 study, enabling direct comparison of the findings [8, 10]. Given the GHI reform's goal of expanding access to care among medically underserved populations, we hypothesized that PFS prevalence would be higher in 2011 than in 1997 and that differences between children attending public and private schools would be smaller in 2011.

Methods

A multistage, stratified probabilistic sampling design was used to estimate PFS prevalence among 12-year-old school-attending children in Puerto Rico in 1997 and 2011, enabling population-level inference. The methodology for this study has been described in detail elsewhere [8]. As in the 1997 study, school type (public vs. private) was used as a proxy for socioeconomic status (SES) [5, 8]. In Puerto Rico, children attending public schools are considered to be of low-to-middle SES, whereas those attending

private schools are considered to be of high SES [5]. These divisions were confirmed using household income information collected from a subset of the study population (n = 122), as previously described by Torres et al. [6]. Most parents of children attending public schools reported a total annual family income of ≤\$20,000 (74%). In contrast, most parents of children attending private schools reported a total annual family income of >\$40,000 (77%), with minimal overlap between school types [6].

A probability sample of 133 out of 1,843 schools was selected proportional to enrollment size and stratified by 1997 GHI regions, school type, and sex. The 11 administrative 1997 GHI regions were as follows: "North," "East," "Metropolitan," "San Juan," "Central," "Southeast," "Ponce," "Southwest," "West," "Northwest," and "Northeast." Public schools were further stratified by urban and rural locations consistent with the 1997 design [5, 8]. Ten boys and ten girls were then randomly selected from each school's list of 12-year-old students enrolled in 5th to 7th grade using a computer-generated list of random numbers.

Sample

This study is a secondary analysis of data collected during the 1997 and 2011 oral health surveys, which have been described in previous publications [5, 8]. The sampling, recruitment, and data collection procedures for the 2011 survey, including the collection of medical history and demographic information, have been described previously [8].

Students were recruited following an informational session where the purpose of the study was explained to the headmaster and the homeroom teacher. A letter of invitation, informed consent form, medical history questionnaire, and demographic information form were sent to potential participants to be completed by the parents or custodians of the children. The demographic information collected included date of birth, sex, ethnicity, dental insurance information, and home address. In previous publications based on the 1997 and 2011 surveys, sex was referred to as gender and categorized as male or female. Because gender identity was not assessed, the term sex is used throughout the present study. Medical information collected included history of medical conditions, medications, and any food or drug allergies. Once children and their parental/legal guardians consented to participate in the study, potential candidates were screened for inclusion.

Children were deemed eligible to participate in the present study if they had ASA I and ASA II physical status as defined by the American Society of Anesthesiologists [11] and were aged 12 years when the dental examination took place. Participants who were subject to dental or medical procedures requiring antibiotic prophylaxis (i.e., children with a previous endocarditis diagnosis) or those who were incapable of meeting the study protocol requirements (e.g., severe autism) were excluded.

Oral Evaluations and Outcome Variable

Oral evaluations were conducted from November 2010 through May 2011. Two examiners performed the oral soft and hard tissue assessments, as in the 1997 protocol [5]. The presence of PFS was assessed using visual-tactile criteria. Portable equipment, a dental chair, an external light source, and an air compressor were used; no radiographs were taken. The examiners were trained and calibrated to a minimum level of agreement of 0.75 (kappa) using the modified National Institute of Dental Research diagnostic criteria [8, 12]. Repeated examinations were performed in 10% of the subjects to assess inter- and intra-examiner reliability. PFS prevalence was defined as the presence of at least one PFS on a permanent first molar.

Statistical methods

All statistical analyses were conducted using normalized inverse probability weights accounting for clustering by school, both in 1997 and 2011. We computed descriptive statistics (frequencies and percentages) to describe the sample. Logistic regression models were used to compare the odds of PFS presence by sex and school-type categories; predicted probabilities were calculated for school-type categories and adjusted for sex and region. All analyses were conducted at a 0.05 level of statistical significance in SAS statistical software version 9.4 (SAS Institute, Cary, NC).

Results

In 2011, a total of 1,587 schoolchildren were examined; 53.1% ($n = 842$) were females, and 77.2% ($n = 1,226$) were enrolled in public schools. The overall prevalence of PFS in the sample was 18.08% (95% CI: 15.45%–20.71%). Students attending private schools had the highest PFS prevalence (25.81%; 95% CI: 19.33%–32.29%), followed by students attending public-urban schools (16.90%; 95% CI: 13.05%–20.74%) and public-rural schools (16.27%; 95% CI: 11.82%–20.72%). In the adjusted analysis, children from public-rural and public-urban schools were less likely to have sealants in 2011 ($OR_{\text{public-rural}}=0.57$; 95% CI: 0.33–0.99; $OR_{\text{public-urban}}=0.60$; 95% CI: 0.39–0.93) compared with those from private schools.

Comparison between 1997 and 2011

In 1997, 1,435 subjects from 74 schools were examined. As depicted in Fig. 1, the sociodemographic distribution of the sample was similar in 1997 and in 2011.

The prevalence of PFS increased among all participants (from 4.33% in 1997 to 18.08% in 2011) and in all income and geographic categories: private schools (from 11.06% in 1997 to 25.81% in 2011), public-rural schools (from 3.41% in 1997 to 16.27% in 2011), and public-urban schools (from 2.47% in 1997 to 16.90% in 2011) (Fig. 2). Children from public-rural and public-urban schools were less likely to have sealants in 1997 ($OR_{\text{public-rural}}=0.19$; 95% CI: 0.07–0.46; $OR_{\text{public-urban}}=0.17$; 95% CI: 0.06–0.48) than those who attended private schools in 1997 (Fig. 3). The estimated adjusted probability of having at least one sealant on a permanent first molar was lower among children attending public schools than

among those attending private schools in both years. In 1997, the adjusted difference was 8.20 percentage points for public-rural schools ($P < 0.001$) and 8.39 for public-urban schools ($P = 0.001$). In 2011, the corresponding difference was 8.49 percentage points for public-rural schools ($P = 0.04$) and 7.83 for public-urban schools ($P = 0.02$) (Table 1).

Table 1
Sealant Prevalence* (95% confidence intervals) by Type of School, adjusted for sex and health region

School type	1997		2011	
	Adjusted prevalence (95% CI)	p-value	Adjusted prevalence (95% CI)	p-value
Private (ref.)	10.29 (6.07; 16.93)	-	23.08 (16.67; 31.04)	-
Public urban	1.90 (0.78; 4.56)	0.001	15.25 (11.68; 19.69)	0.02
Public rural	2.09 (1.02; 4.22)	< 0.001	14.59 (10.98; 19.13)	0.04

* Adjusted prevalence estimates and p-values were obtained from logistic regression models, which included sex and health region, and accounted for clustering in the design and were weighted using normalized inverse probability weights.

Discussion

In this cross-sectional study, we analyzed the prevalence of PFS on first permanent molars among 12-year-old school-attending children in Puerto Rico in 1997 and 2011. Overall, prevalence increased from 4.3% in 1997 to 18.1% in 2011, with gains observed across all school types. Despite these improvements, sealant use in Puerto Rico remained low in 2011.

Puerto Rico’s PFS prevalence was within the lower range of international estimates [13–17]. In 2011, even children attending private schools—the group with the highest prevalence in our study and a proxy for higher socioeconomic status—had a PFS prevalence of 25.8%, compared with 51.7% among U.S. adolescents aged 12–15 years during 2011–2016 [4]. Prevalence in Puerto Rico was also lower than the estimates reported for non-Hispanic Black adolescents (37.2%) and Mexican American adolescents (45.0%) in the United States [4]. Differences in age ranges, populations, survey periods, and outcome definitions limit direct comparisons. Taken together, these contrasts raise the possibility that barriers beyond socioeconomic differences within Puerto Rico contribute to the limited use of sealants on the island.

The increase in PFS we observed occurred during a period of expanded GHI coverage. However, the cross-sectional design does not permit attribution of this increase to the reform. Medicaid expansion has been associated with improved oral health outcomes among children in the United States [9], and implementation of Child Health Plus in New York was accompanied by an increase in sealant prevalence from 16.7% to 36.0% among lower-income third graders [18]. However, evidence from other settings shows that expanding insurance coverage or service availability does not necessarily eliminate socioeconomic disparities in dental care utilization or oral health outcomes [19–23].

Despite improvements across all school types, children attending public schools remained significantly less likely to have PFS than those attending private schools. By 2011, PFS prevalence was descriptively similar among children attending public-rural and public-urban schools. Thus, the primary contrast was between public and private schools rather than between the geographic categories of public schools. Although the odds ratios comparing public- with private-school children moved closer to the null in 2011, the adjusted absolute prevalence difference remained approximately eight percentage points. The disparity therefore persisted rather than being resolved. A similar school-type pattern was reported in Saudi Arabia, where children attending public schools were significantly less likely to have sealants than those attending private schools [24]. Patterns by sex, however, were less consistent. Girls had significantly lower odds of having PFS than boys in 1997, but this difference was not observed in 2011, when the point estimate was above the null (Fig. 3).

The persistent school-type disparity may be interpreted within the World Health Organization (WHO) conceptual framework for action on the social determinants of health, which recognizes the roles of structural factors and the health system in shaping health inequities [25]. Limited dental service utilization may partly explain this disparity. In 2003, 48% of children and adolescents enrolled in Puerto Rico's government health plan had not visited a dentist during that year [26]. Other health systems show a similar disconnect between coverage and utilization. In Spain, combined public and private coverage was associated with greater dental service utilization than public coverage alone [19]. In South Korea and Brazil, expanded coverage or greater service availability was associated with improvements in some oral health outcomes, although socioeconomic disparities and untreated disease persisted in certain contexts [20, 21, 23]. Low-income children also remain more likely to experience unmet dental needs and less likely to receive preventive care [22]. Collectively, this evidence underscores that the scope, quality, accessibility, and preventive orientation of services may be as important as insurance coverage, consistent with the WHO recommendation to integrate essential oral health services into universal health coverage benefit packages to promote equitable access to preventive care [27].

Several factors may contribute to the differences in PFS use between children attending public and private schools, including household resources, parental education, awareness of available services, geographic accessibility, and patient–provider relationships [24, 28, 29]. Provider-related factors, including clinical decision-making, sealant-placement practices, and perceptions regarding sealant effectiveness, may also affect PFS use [24, 29]. Future interventions should combine access to

preventive services with health-literacy initiatives for families and dental professionals. School-based sealant programs may be particularly valuable for reaching children from underserved communities [30].

In 2017, Puerto Rico enacted Law No. 63-2017, the Law to Guarantee Access to Oral Health Services for All Patients in Puerto Rico. It established requirements for periodic oral examinations and dental cleanings, including the submission of an oral examination certificate for students attending public and private schools in kindergarten and grades 2, 4, 6, 8, and 10 [31]. Because it was enacted after the study period, this law cannot explain the changes observed between 1997 and 2011; however, it represents a relevant policy response to persistent gaps in preventive oral health care. Updated surveillance is needed to evaluate PFS prevalence following implementation of this policy and after major events that may have affected access to dental services, including Hurricane Maria, the 2019–2020 earthquakes, and the COVID-19 pandemic.

This study has several limitations. Individual-level information on household income, parental education, and occupation was not available for the full sample. Consequently, school type was used as a proxy for socioeconomic status, and broader social determinants of health could not be examined. The comparison of two cross-sectional samples cannot establish causality or attribute the observed increase to GHI implementation. Furthermore, without formal interaction tests, changes in the magnitude of the associations with school type and sex cannot be established. Because sealant presence at examination reflects both placement and retention, children whose sealants had been completely lost may have been classified as not having PFS. The estimates, therefore, represent sealants present at examination rather than cumulative receipt. Finally, the sample was limited to 12-year-old children attending school and may not be generalizable to other age groups or children not enrolled in school.

This study has several strengths. Both surveys used probability sampling designs that permitted population-level estimates, and comparable sampling and examination methods were used in 1997 and 2011. Examinations were conducted by trained and calibrated examiners with acceptable reliability, strengthening the comparability of findings across survey years.

Further research, including mixed-methods studies, is needed to identify barriers to PFS utilization among children living in Puerto Rico, particularly those from socioeconomically disadvantaged communities. Subsequent oral health objectives and surveillance reports in Puerto Rico show that sealant delivery remained limited after the study period, although differences in age groups and outcome definitions prevent direct comparison with our findings [32–34]. Because Puerto Rico is not included in NHANES oral health examinations, island-wide surveillance remains essential [4]. Interventions combining school-based sealant delivery, improved dental service utilization, and health-literacy strategies may help reduce disparities. Broader policies addressing structural and social determinants of health will also be required to achieve equitable improvements in preventive dental care among children living in Puerto Rico.

Conclusions

PFS prevalence among 12-year-old school-attending children in Puerto Rico increased across all school types between 1997 and 2011, during a period of island-wide GHI implementation. However, children attending public schools remained significantly less likely to have PFS than those attending private schools, and an adjusted absolute gap of approximately eight percentage points persisted. Expanded insurance coverage alone may therefore be insufficient to eliminate disparities in preventive dental care. Updated surveillance and interventions addressing dental service utilization, health literacy, and structural and social determinants of health are needed to increase PFS prevalence equitably among children living in Puerto Rico.

Abbreviations

ASA

American Society of Anesthesiologists

GHI

Government Health Insurance

NHANES

National Health and Nutrition Examination Survey

OR

Odds ratio

PFS

Pit and fissure sealants

SES

Socioeconomic status

WHO

World Health Organization

Declarations

Ethics approval and consent to participate: The Medical Sciences Campus, University of Puerto Rico (MSC-UPR) Institutional Review Board (Protocol No. 0360105) approved the study. Written informed consent was obtained from the parents/legal guardians of each participating child, and child assent was obtained prior to enrollment in the study. All procedures were conducted in accordance with the Declaration of Helsinki.

Consent for publication: Not applicable

Availability of data and materials: The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: MJT was a major contributor to data interpretation and manuscript writing. ARE conceived and coordinated the study and contributed to the critical revision of the manuscript. HGH conducted the literature review and contributed to drafting and critically revising the manuscript. JIP contributed to the first draft and critical revision of the manuscript. MM conducted clinical oral examinations in the study conducted in 2011 and contributed to the critical revision of the manuscript. BGG contributed to the critical revision of the manuscript. SRT performed statistical analysis and contributed to the interpretation and critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures

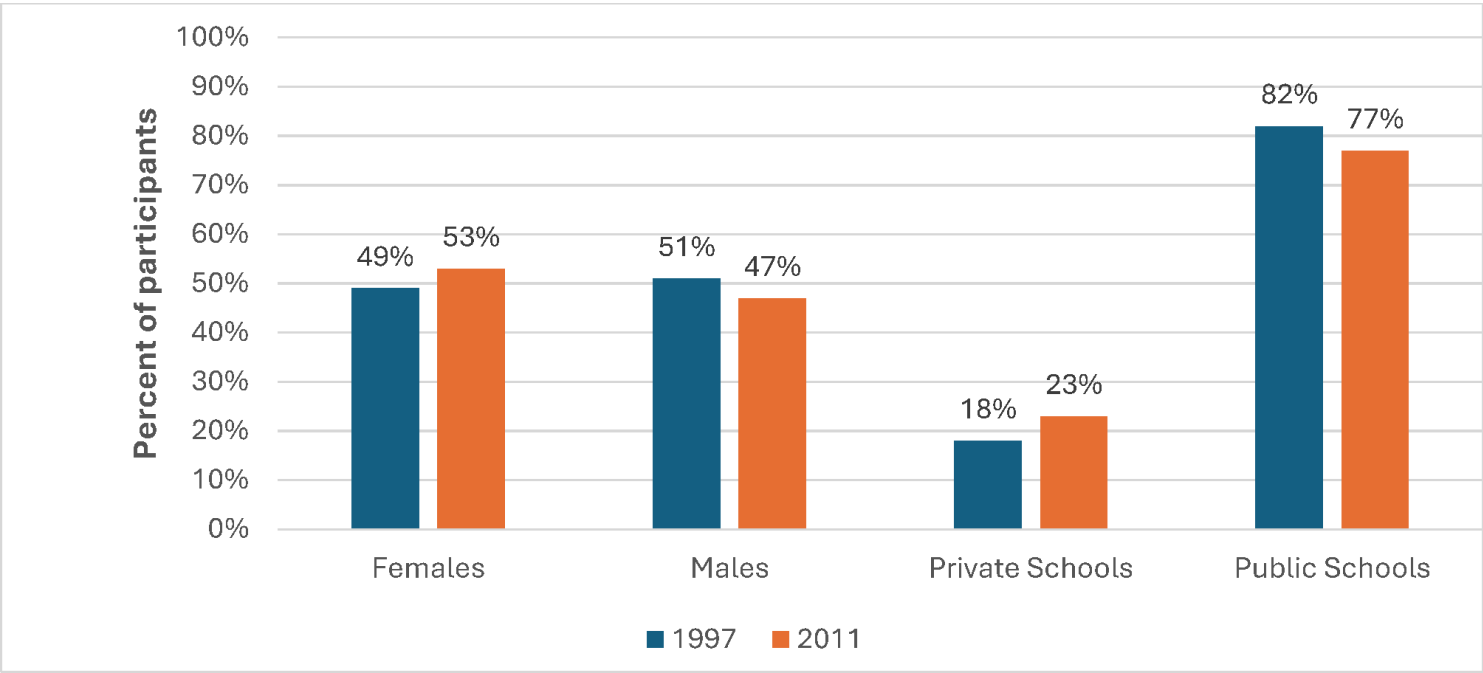


Figure 1

Sociodemographic characteristics of study participants in two time periods.

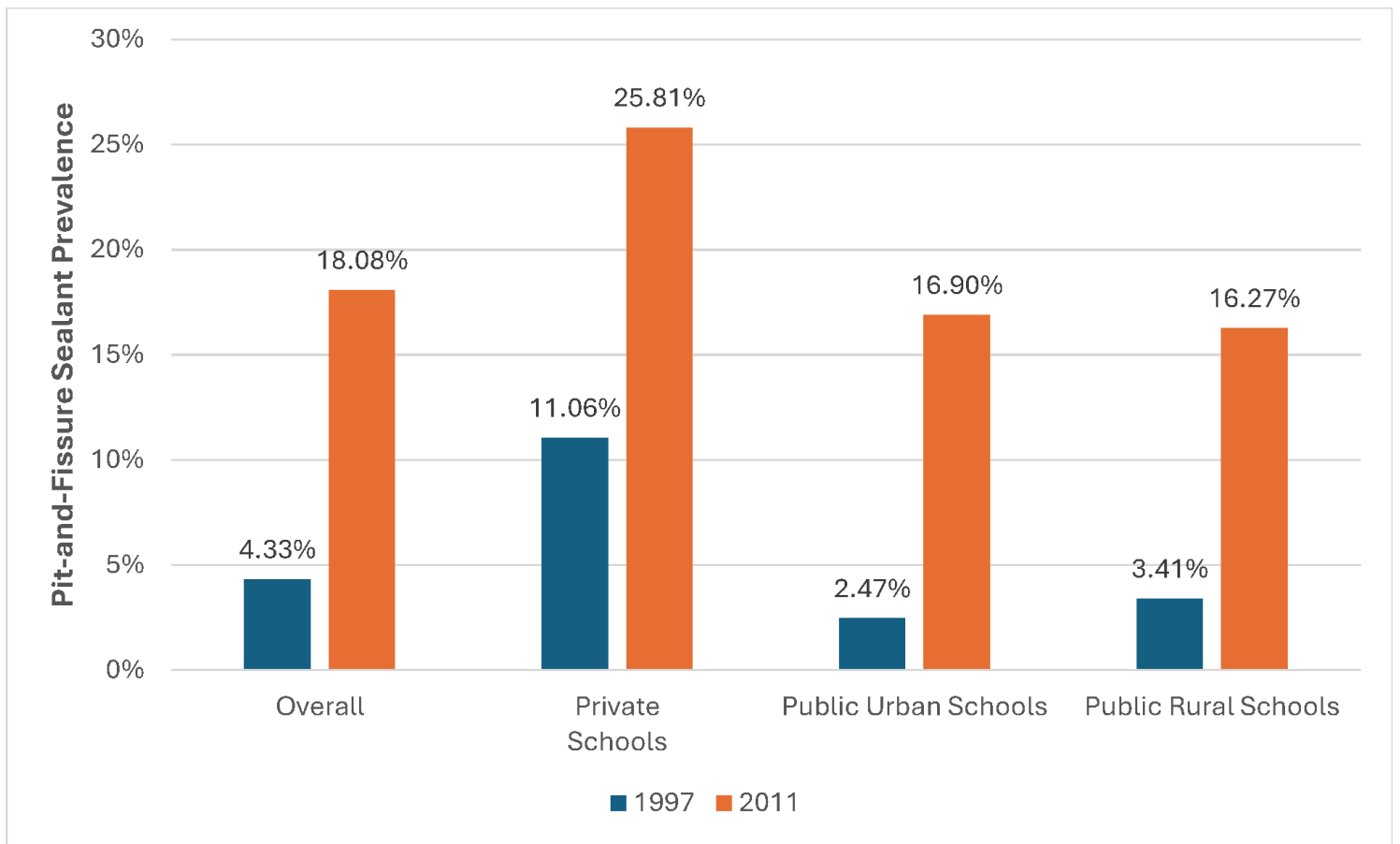


Figure 2

Prevalence of pit and fissure sealants on at least one permanent first molar, overall and by school type.

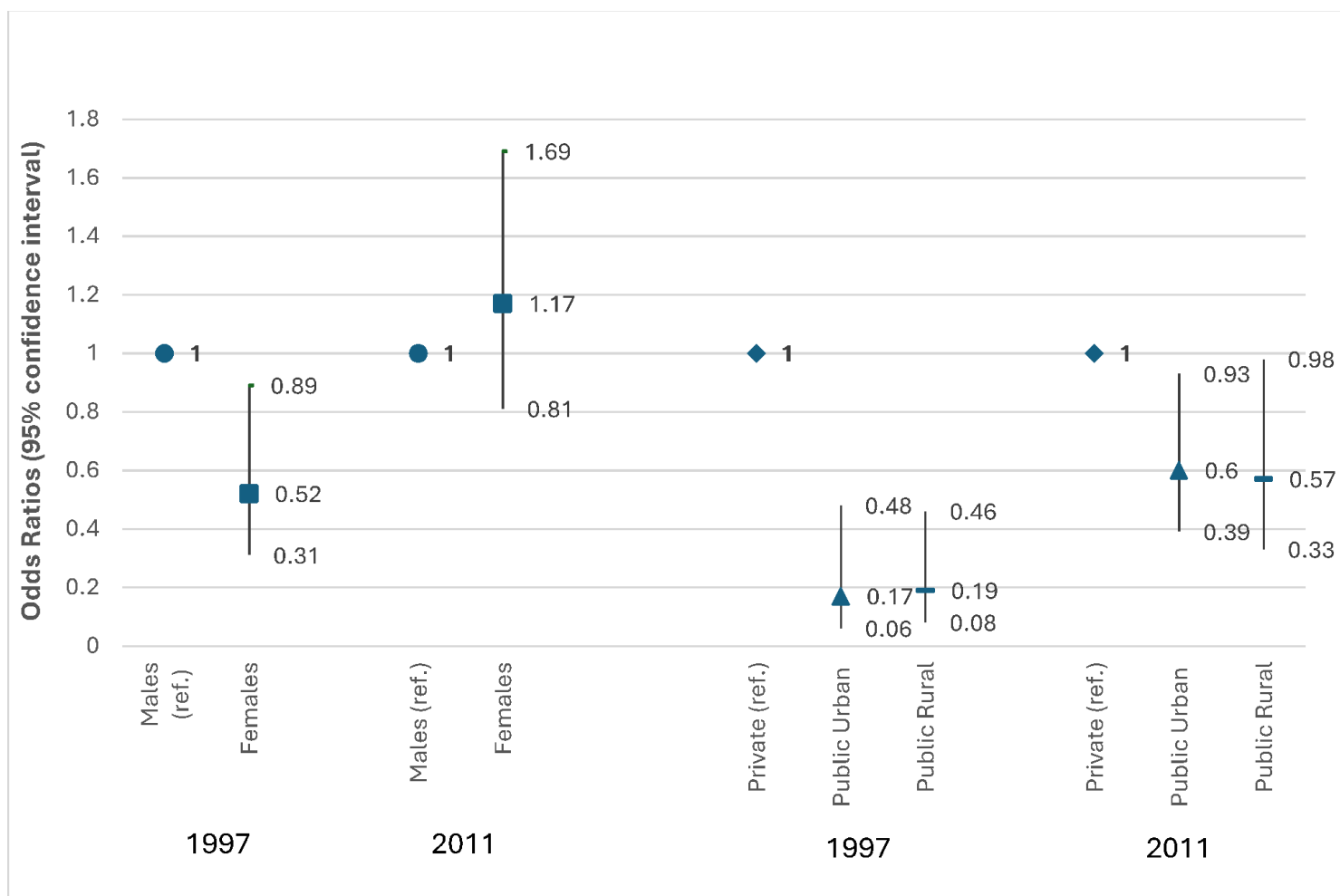


Figure 3

Adjusted odds ratios (95% confidence intervals) for having a sealant on at least one permanent molar, according to participant sex and school type, in 1997 and 2011. Estimates were obtained from logistic regression models, which included participant sex, school type, and health region, for each study year separately.