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Language and literacy relate to lack of children's dental sealant use

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INTRODUCTION

Dental caries, the most common chronic disease of childhood in the US (1), has been described as a multifactorial disease with a complex interplay of genetic and biological factors, health behaviors, physical and social environments, and dental and medical care at the individual-, family- and community-levels (2).

Socio-economic and racial/ethnic disparities in dental caries have been widely reported. US children living below the federal poverty level have greater dental caries prevalence and severity than those with greater socio-economic advantage. Compared to their non-Hispanic peers, Mexican American children have more caries-affected teeth (1). Likewise, children of Mexican origin and non-Hispanic Black children had a higher prevalence of untreated caries than non-Hispanic White children (3, pg. 40).

Despite advances in clinical techniques and procedures, dental treatment alone will not **reduce oral health disparities nor** eradicate dental caries; the most effective way for individuals and communities to attain good oral health is through health promotion and disease prevention (4). Strong evidence exists to support school-based or school linked pit-and-fissure sealant delivery programs to reduce caries incidence in pits and fissures of children's permanent molars (5, 6). Nevertheless, disparities in sealant use have been documented. Between 1999 and 2002, only 29.5% of US 6-11 year olds had any tooth surfaces sealed, 37.4% of 12-15 year olds and 31.4% of 16-19 year olds. By race/ethnicity, 37.9% of non-Hispanic White children and adolescents had at least one tooth sealed compared to 23.4% of Mexican Americans and 22.7% of non-Hispanic Black children nationally; a higher percentage of children in higher incomes ($\geq 200\%$ federal poverty level) had sealed teeth compared to children in lower income groups (41.4% vs. 22.5% for those living 100-199% federal poverty level and 22.2% for those $< 100\%$ federal poverty level) (15).

Acculturation has been considered an important factor in immigrants' health seeking and preventive behaviors, yet studies relating it to oral health have provided contradictory results

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– some finding immigrants with less dental caries experience but others finding immigrants with more dental caries than similar native populations (7). Cruz et al also report that other studies among immigrants from developing countries have found that the positive association between dental caries and socio-economic position (SEP) diminishes as duration in the industrialized country increases (7). It has been stressed that accounting for the diversity of cultural backgrounds is critical for patient-provider communication and plays a significant role in enhancing the quality of care and improving population health outcomes (8).

The interaction of English as a main language and level of education was found to predict estimates of adult health literacy (9). Likewise, lower oral health literacy scores were found to be risk indicators of poor self-reported oral health among an indigenous population (10).

Functional health literacy includes the ability to understand healthcare providers and health messages and to act on them (11). Practical tasks include the ability to take medications as prescribed and to correctly complete insurance claim forms. Gansky and colleagues derived measures of various skip pattern mistakes made in the 1993-4 California Oral Health Needs Assessment of Children self-administered parent questionnaire as a possible functional health literacy measure showing increased mistake frequency to be significantly related to ECC prevalence even after adjusting for education level and/or household income (12).

To measure population health inequalities, it is recommended that health disparities indices be used, but such indices are yet to be widely applied in oral health disparities research. Koolman and van Doorslaer (13) presented a cross-country comparison on dental care utilization to illustrate the use of the Relative Concentration Index (RCI), a commonly used health disparities index sometimes known as the Health Concentration Index, and facilitate its interpretation. Using data on untreated dental caries in California school children, Cheng et al. (14) provided methods for the use of several health disparities indices applying current US National Center for Health Statistics (NCHS) guidelines to complex sample surveys. Perera & Ekanayake (15) reported statistically significant RCI and Slope Index of Inequality (SII) for measures of SEP relating to DMFS and others have measured oral health care inequalities using the Relative Index of Inequality (16), RCI and/or horizontal inequity indices (17-20).

The aims of this study were to: (1) determine the percent of California's third grade public school children lacking sealants by child, family, and school level factors including SEP, acculturation, and functional health literacy; and (2) measure social disparities for lacking sealants (i.e., the unfavorable health condition) with health disparity indices.

METHODS

California Oral Health Needs Assessment 2004-5 is a complex stratified cluster sample survey of children from randomly selected public elementary schools in California. The survey gathered information on oral health indicators including sealant use from dental screenings performed by trained calibrated dentists and registered dental hygienists (or specially trained school nurses in Los Angeles County) on 10,450 third graders from 182 schools. Lack of sealants was the dependent variable for this analysis. An optional parent questionnaire, **sent home with, and returned by, school children**, obtained socio-demographic information about the child. The one-page questionnaire contained 6 items and 1 skip pattern. The questionnaire was translated to other languages (e.g., Spanish and Chinese).

The independent variables included child participation in the free or reduced-price lunch program (FRL), school's participation in the 2004-5 school year California Children's

Dental Disease Prevention Program (CCDDPP), child race/ethnicity, language spoken at home and the school's percent of English language learners as measures of acculturation, and parent functional health literacy. Race/ethnicity information was collected as White, African American, Hispanic, Asian, or Other, with White as the reference group. Participation in FRL was used as a measure of SEP. These data were gathered at the individual level from the parent questionnaire (yes/no) and at the school level as percent of children participating in the FRL program (%FRL), from the 2005 Academic Performance Index database on the California Department of Education website. Children not participating in the FRL program comprised the reference group, while the school level used a four-group ordinal variable with the lowest %FRL as the reference group. CCDDPP, a school-based prevention program operating throughout California, includes a sealant provision component.

English language as an acculturation indicator was also measured at the individual level (yes/no) and at the school level as a four-group ordinal variable categorizing the percent of English language learners (i.e., children whose first language is not English and participate in school programs to prepare them for ordinary classroom work in English), also from the California Department of Education website. The reference groups were children speaking English at home for the individual level and the group with the lowest percent of English language learners for the school level.

Parent functional health literacy was measured as improperly following the questionnaire skip pattern – omitting a question that should have been answered or answering a question that should have been skipped. The actual text of the question was “During the past year was there a time when you wanted dental care for your child but could not get it?” with response options of “Yes (go to question 4)”, “No (go to question 5)” and “Don’t know (go to question 5)”.

Because the questionnaire was optional, measures derived from the questionnaire (parent functional health literacy and child FRL) had between 53% and 56% missing data. To account for potential bias due to data not missing completely at random, we used multiple imputation with 10 imputed datasets which were analyzed and aggregated to provide multiple imputation estimates and 95% confidence intervals (95% CI). For greater detail, we refer the reader to Gansky and Neuhaus, 2009. (21)

As in the US NCHS monograph (22), the following conventions will be used for this paper. “Disparity” will be defined as “a quantity that separates a group from a specified reference point on a particular measure of health ... expressed [as a]...quantitative measure” providing a basis for measurement and monitoring. “Reference point” will be defined as “the specific value of a...quantitative measure from which a disparity is measured.” Health disparities and their 95% CI were estimated in both absolute and relative terms according to Cheng, et al. (14).

To measure socio-economic disparities, we used the unfavorable condition (no sealants) as the outcome as recommended in recent methodological guidelines (22) to enhance consistency and comparability of relative disparity measures across different indicators and over time. We measured absolute and relative population disparities in lack of sealants. Absolute disparity was measured in three ways: the simple difference between groups, the Slope Index of Inequality (SII), and the Absolute Concentration Index (ACI). The SII is a linear regression-based method that shows the relationship of the population health outcome prevalence (i.e., lack of sealants) by ordinal social group categories (i.e., %FRL and percent of English language learners) in an ascending order and weighted by their population share. The ACI is based on the relationship of the cumulative percent of the population ordered by

social categories with the cumulative amount of the health outcome. Relative disparity was estimated with the Relative Index of Inequality for the mean (RII-mean) which is closely related to the SII; the RII-mean is the SII divided by the mean of the population health outcome (mean absence of sealants) in the population to measure the proportionate change of the outcome between social groups (for a more detailed description, we refer the reader to other sources: 23). SAS version 9.2 (SAS Institute, Cary, NC) and IVEware statistical software (24) were used for the analyses.

RESULTS

As seen in Table 1, results from the complete case and multiple imputation analyses are similar. Overall, the percent of children lacking sealants was high across all racial ethnic groups. However, about two-thirds of non-Hispanic White children lacked sealants, differing significantly from the other groups where about three-quarters lacked sealants. There were no differences (measured in absolute terms) in lacking sealants by CCDDPP participation, or by FRL at the child or school level. A greater percent of children who spoke a language other than English at home did not have dental sealants compared to children who spoke English at home. Similarly at the school level, those with a higher percentage of English language learners had a higher percent of children lacking sealants. More children of parents with lower functional health literacy (omit a question or answer anyway) did not receive sealants than those with higher functional health literacy (follow skip pattern properly).

In general, the health disparity indices indicated that %FRL, a proxy for SEP, was not a determining factor in lacking sealants but percent of English language learners, a proxy for acculturation, was related to lack of sealants (Table 2). With respect to %FRL, the SII estimate indicated that the percentage of children not receiving dental sealants declined by an average of 6 percentage points over the population ranked from lowest to highest SEP. The RII-mean indicated that moving from the bottom to the top of the income distribution was associated with an 8% decline in the percentage without a sealant. The ACI showed a slight upward gradient in no sealant use. But the 95% CIs of these three indices all included zero, indicating a nonsignificant relationship between FRL and lack of sealants.

Regarding percent of English language learners, the SII showed a decline of approximately 8 percentage points and the 95% CI indicated statistical significance. The RII-mean indicated an 11% decline in the lack of sealants when moving across levels of acculturation. The 95% CI excluded zero, indicating a significant relationship between percent of English language learners and lack of sealants. Similarly, the ACI indicated a modest yet statistically significant relationship between percent of English language learners and lack of sealants.

DISCUSSION

The Surgeon General's Report on Oral Health reiterates that dental sealant application is an important procedure that complements fluoride modalities to prevent dental caries in pits and fissures of teeth (1). Nevertheless, pit-and-fissure sealant use is quite low. This California survey of third graders coincided with national estimates (25) in that non-Hispanic White children had a higher percentage of sealed teeth than other racial/ethnic groups; however absolute differences by SEP were not significant. The former finding is important because similar to national estimates, racial and ethnic minorities in California also have higher dental caries rates (26, 27), and would benefit from primary prevention efforts. The latter difference may be due to the measurement of SEP; national estimates used federal poverty level whereas this study used participation in FRL programs (both at the individual and school levels).

To our knowledge, this is the first study to report sealant use by an acculturation factor – language spoken at home – and a potential proxy of parental functional health literacy – ability to follow a questionnaire skip pattern. While SEP did not show a relationship, language and skip pattern error were significantly associated with not having dental sealants. Skip pattern error, analogous to the respondent incorrectly completing forms such as health history or insurance claims, could be seen as an empirical measure of, and potential proxy for, functional health literacy. To be confirmed as a true surrogate, skip pattern mistakes need to relate to a validated measure of functional health literacy; *e.g.* the short version of the Test of Functional Health Literacy of Adults (S-TOFHLA) or Rapid Examination of Adult Literacy in Dentistry (REALD-30) (28). Nevertheless, the fact that two different skip pattern errors in two different self-administered surveys related to two different oral health indicators might mean that skip pattern errors in self-administered surveys could be useful predictors of unfavorable health behaviors or outcomes. Analyses on skip pattern errors using the 1993-4 survey and the 2004-5 survey revealed that the parent or guardian incorrectly completing the questionnaire was related to worse oral health of the child, despite these surveys using a different questionnaire with different items and a different skip pattern (*e.g.* one shorter than the other). Moreover, healthcare providers could potentially use skip pattern mistakes on new patient forms as possible indicators of low literacy skills and focus on conveying clearer health messages (*cf* HP2010 goal 11-2).

This study used multiple imputation to account for missing data. Complete case (unimputed) analyses have been shown to be potentially biased, whereas, the Sequential Regression Multivariate Imputation approach (with 10 imputations and more than 25 variables) provided an estimated 94-95% efficiency (21). Although multiply-imputed data is more robust than complete case data, a limitation of the study is that it assumes data are missing at random (an assumption which cannot be verified in actual studies) and a large amount of data had to be imputed. Nevertheless, examining Table 1 revealed that multiple imputation did not appreciably change resulting estimates compared to complete case; the findings for health literacy measure of skip pattern errors were somewhat attenuated for multiple imputation compared to complete case.

The global disparity indices corresponded to a slight but not statistically significant decline in the unfavorable condition (not receiving sealants) with an increase in SEP. The results indicated that overall, socio-economic disparities in California children did not exist relating to receiving preventive effects of pit-and-fissure sealants on first permanent molars.

These findings need to be placed within the context of health care for children in California. At the time of this survey, CCDDPP provided school-based or school-linked dental sealant programs in 31 counties at elementary schools with at least 50% of students participating in the FRL program. This prevention program, which also included oral health education and topical fluoride, served a total of about 300,000 preschool through sixth grade children annually (29). Unfortunately, due to state budget cuts, this program was discontinued in 2009. In the 2004-5 California Oral Health Needs Assessment data, increased access to dental sealants for some low SEP children from the CCDDPP may have influenced the findings. A future statewide oral health needs assessment is needed to monitor changes in sealant access and children's oral health resulting from the reduced access to preventive services starting in 2009.

Although this analysis of disparities of “no sealants” assessed lacking a desirable and effective preventive measure, children at low and high caries risk may not receive sealants for very different reasons. Children at low risk may present with a sound, caries-free dentition, leading the dentist to decide sealants are not needed. Children at high risk, may present with cavitated lesions or restorations on all pit and fissured surfaces, and thus be

seen too late to receive this preventive benefit. This analysis did not include other factors associated with sealant use such as dental insurance and factors associated with preventive dental utilization. Similarly, another limitation is that measures such as free/reduced-price lunch program participation and time since last dental visit of child were based on parental self-report gathered through questionnaires.

Future studies should focus on clarifying the barriers to sealant application both from the perspective of parents and clinicians. Studies have shown that parents are more likely to obtain dental sealants for their children if they receive such advice from their dentist or dental staff (30), if they have discussed caries prevention with their dentist (31), or if they have heard about sealants or are aware about the purpose of sealants (32). Parental health education and health promotion about sealants could be provided in the dental office and perhaps other educational and health settings. Other mechanisms should also be studied to better understand or help improve the larger problem of low parental functional health literacy.

Clinicians have expressed concerns about poorer outcomes when inadvertently sealing caries or the increased risk of developing caries after full or partial loss of sealants; recent reviews have examined these topics and have reported favorable outcomes suggesting that clinicians should not allow these concerns to outweigh the benefits of sealants (33, 34, 35). The American Dental Association Council on Scientific Affairs published evidence-based clinical recommendations for using pit-and-fissure sealants as a resource for clinicians in their decision-making process; the same report indicates that sealants effectively prevent dental caries initiation and progression (36).

In conclusion, there are clear benefits to using sealants, yet a very low percentage of California children are receiving them. This study suggests that less proficiency and use of English in this US population and low parental functional health literacy are potential barriers that need to be addressed to overcome disparities in sealant utilization. Dental professionals should take care to clearly communicate health messages and instructions to parents who exhibit difficulty with skip patterns on consent or health history forms, since it may be an important signal to check for understanding and to provide additional information or assistance as needed. However, it would be best to always clearly communicate with all patients and use a method such as teach-back (e.g. (37)) to ensure patient understanding.

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Percent of California children lacking sealants by race/ethnicity, socio-economic position, culture/acculturation, and parental functional health literacy, 2004-05

Table 1

Race/Ethnicity	No Sealants				
	Complete Case			Imputed [§]	
	Prevalence	Simple Difference	95% CI [‡]	Prevalence	Simple Difference 95% CI
Non Hispanic White [†]	67.1	0		67.2	0
Non Hispanic Black	74.2	7.1	(1.8, 12.4)*	74.2	7.0 (1.8, 12.3)*
Hispanic	74.3	7.1	(3.2, 11.0)*	74.2	7.0 (3.1, 10.9)*
Asian	77.3	10.2	(5.3, 15.1)*	77.2	10.0 (5.1, 14.9)*
Other	73.2	6.1	(0.5, 11.7)*	73.5	6.3 (0.7, 11.9)*
CA Children's Dental Disease Prevention Pgm					
No [†]	73.1	0		73.4	0
Yes	70.0	-3.1	(-7.5, 1.2)	70.3	-3.2 (-7.4, 1.1)
Socio-economic Position					
<i>If the child participates in Free/Reduced-price Lunch (child level)</i>					
No [†]	72.0	0		72.2	0
Yes	71.5	-0.6	(-4.9, 3.8)	72.7	0.5 (-2.9, 3.9)
<i>% Free/Reduced-price Lunch (school level)</i>					
<25 [†]	69.5	0		69.5	0
25-50	73.6	4.1	(-2.6, 10.7)	73.6	4.1 (-2.6, 10.7)
50-75	71.9	2.4	(-2.8, 7.6)	71.9	2.4 (-2.8, 7.6)
≥75	74.1	4.6	(-0.4, 9.5)	74.1	4.6 (-0.4, 9.5)
Culture/acculturation					
<i>Language spoken at home (child level)</i>					

	No Sealants				Imputed [§]			
	Complete Case							
	Prevalence	Simple Difference	95% CI [‡]	Prevalence	Simple Difference	95% CI [‡]	Prevalence	Simple Difference
English [†]	70.0	0		70.1	0			
Non-English	75.7	5.7	(2.4, 8.9)*	75.7	5.6	2.4, 8.9)*		
%English language Learners (school level)								
<25 [†]	70.6	0		70.6	0			
25-50	72.4	1.8	(-2.7, 6.3)	72.4	1.8	(-2.7, 6.3)		
50-75	76.7	6.1	(0.7, 11.4)*	76.7	6.1	(0.8, 11.4)*		
≥75	74.2	3.6	(-6.0, 13.2)	74.2	3.6	(-5.9, 13.2)		
Health Literacy								
<i>Omit question?</i>								
No [†]	71.4	0		72.3	0			
Yes	78.6	7.1	(0.2, 14.1)*	77.0	4.7	(-1.3, 10.7)		
<i>Answer Anyway?</i>								
No [†]	70.6	0		71.7	0			
Yes	78.7	8.2	(3.5, 12.9)*	76.7	5.0	(1.02, 8.9)*		

* $p \leq 0.05$

[†] Reference group

[‡] 95% confidence intervals (CIs) uncorrected for multiplicity. Stepdown Šidák multiplicity adjusted CIs for nominal race/ethnicity: Absolute - African-American (1.1, 13.1), Hispanic (2.4, 11.9), Asian (4.0, 16.5), Other (0.5, 11.7)

[§] Data combined from 10 multiply imputed datasets (each N=10,450)

^{||} 95% confidence intervals (CIs) uncorrected for multiplicity. Stepdown Šidák multiplicity adjusted CIs for nominal race/ethnicity: Absolute - African-American (1.01, 13.1), Hispanic (2.3, 11.8), Asian (3.7, 16.5), Other (0.7, 11.9)

Table 2

Health Disparities Indices by percent school participation in free/reduced-price lunch program and percent school English learners: Children with No Sealants

Independent Variable	Index [†]	Estimate	95% CI Rescaling Bootstrap (500 resamples)
% Free/reduced-price lunch (school level)	SII	-5.84	(-13.87, 1.82)
	RII-mean	-0.08	(-0.19, 0.02)
	ACI	-0.009	(-0.021, 0.003)
% English language learners (school level)	SII	-7.64	(-14.58, -0.01)*
	RII-mean	-0.11	(-0.20, -0.001)*
	ACI	-0.011	(-0.021, -0.00001)*

[†] SII = Slope Index of Inequality; RII-mean = Relative Index of Inequality for the mean; ACI = Absolute Concentration Index

* $p \leq 0.05$