Oral Health Status of San Francisco Public School Kindergarteners 2000-2005

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Abstract

***Objectives**: To determine the prevalence of dental caries and oral health disparities in San Francisco kindergarten public school children from 2000-2005. **Methods**: The San Francisco Department of Public Health in partnership with the San Francisco Dental Society and assistance from the National Dental Association, has been conducting annual dental screenings of kindergarten children enrolled in the San Francisco Unified School District since 2000. Outcomes assessed from this series of cross-sectional screenings included prevalence of caries experience, untreated caries, treatment needs, and caries severity by child's sex, race/ethnicity, residential zip code, and a proxy for socioeconomic status. **Results**: Of 76 eligible schools, 62-72 participated, and 86-92% of enrolled children (n=3,354-3,527) were screened yearly. Although there was a small, significant decrease over the time period, in 2005, 50.1% of children had caries experience; 28.8% had untreated caries and 7.6% had urgent treatment needs. Each year caries prevalence was greatest for Asian children, those attending schools with > 50% children eligible for the free or reduced-price meal program, and children living in zip codes in and around Chinatown and San Francisco's southern border. **Conclusions**: Despite signs of improvement, caries remains a public health problem especially in Asian and Hispanic children, and children living in certain sections of San Francisco.*

Key Words: Oral health, kindergarten, children, San Francisco, dental caries, prevalence, screening, ethnic groups, zip code

Introduction

Dental caries continues to be a problem for our youngest school-aged children. National statistics show that 28% of children aged 2-5 years have already experienced caries in their primary teeth (1). In California, over half (53.6%) of kindergarten children have had a history of caries while 27.9% have untreated caries (2). While these recent surveys reveal caries prevalence on a national and state level, an oral health assessment study has never been conducted on a representative sample of San Francisco's children. San Francisco is a highly diverse city both economically and ethnically, and thus provides an opportunity to assess oral health disparities. Understanding the extent and socio-demographic distribution of dental disease is an important prerequisite for designing and evaluating effective programs. Though targeted assessments on low-income populations have been done, there is a significant lack of more widespread oral health epidemiological data at the local level to aid in such planning efforts. To help address this deficiency, this analysis was conducted to assess the nature and magnitude of oral health conditions in San Francisco.

For the last five years, a coordinated, annual effort organized by the San Francisco Department of Public Health (SFDPH) has offered dental screenings to all kindergarten children in the San Francisco Unified School District (SFUSD). The Kindergarten Dental Screening Project (KDSP) was started in 2000 as an oral health surveillance program. The authors were approached by the SFDPH to analyze the data being collected over the five-year period to assess the status of the children. As the only school district in the diverse city and county of San Francisco, the information obtained from the screenings offered the opportunity to gauge the oral health status among the San Francisco public school kindergarten-age population and any associated disparities.

The objective of this study was to describe and analyze the oral health status in the San Francisco public school kindergarten population annually from 2000-2005. Findings from this series of cross-sectional studies on caries severity, caries prevalence, and treatment needs by year, sex, race/ethnicity, geographic residence, and socioeconomic status are provided for a large, comprehensive sample of 5-6 year old children, and compared to other national, state, and local oral health surveys.

Methods

Data source. Data were obtained from the annual KDSP conducted by the SFDPH in collaboration with the San Francisco Dental Society (SFDS) and National Dental Association (NDA) from 2000-2005. It is managed by one SFDPH full-time employee with the assistance of a part-time Americorps volunteer. The target population was all kindergarten children attending public elementary

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schools in the SFUSD. A list of all public elementary schools was obtained from the SFUSD School Health Programs Office. Each school was contacted by telephone and offered dental screening services for their kindergarten students. A written notice was also issued to each school via the district newsletter. Of the schools that agreed to participate, a passive consent form was sent home with the child.

Screening methods. Participants were screened by licensed volunteer dentists from the SFDS, SFDPH staff, or NDA at each school site, each school year. A total of 38-47 examiners participated annually, with a core of 22 participating at least 4 out of the 5 total years. No clinical training sessions or periodic calibrations were held due to limited staff resources and uncertainty in knowing the screeners in advance. A written training module detailing the clinical data to be collected and the criteria used for evaluating each data category was provided weeks prior to, and reviewed on the day of the screening by the project manager. The screenings were performed using disposable gloves, tongue blades, and penlights. Data were recorded and entered into Microsoft Access. An evaluation form of the findings, addressed to the parent/guardian, was completed and given to the child, along with a list of dental resources and a contact person at the SFDPH. Additionally, the schools received a list of those children experiencing dental problems and needing treatment.

Data collection. Demographic information obtained from the school district included the child's sex, race/ethnicity, school, and residential zip code. Oral health information obtained during the screening included the number of primary and permanent teeth affected by decay (d/D), missing due to caries (m/M), and fillings (f/F). Treatment need diagnosis was based on the American Dental Association status codes I-IV(3) defined as:

- I = No Visible Dental Problems: individuals apparently requiring no dental treatment.
- II = Mild Dental Problems: individuals requiring treatment, but not of an urgent nature such as pinhead size dental caries, moderate plaque and calculus accumulation, oral prophylaxis recommended, and other oral conditions requiring corrective or preventive measures.
- III = Severe Dental Problems: individuals requiring early treatment of such conditions as large green pea size and/or extensive pinhead cavities, chronic abscess(es), chronic oral infection, heavy calculus accumulation, and insufficient number of teeth for mastication.
- IV = Emergency Dental Treatment Required: individuals requiring emergency dental treatment for such conditions as injuries, acute oral infections, and painful conditions.

For the purpose of this assessment, the tooth-level data collected were used to measure caries prevalence and caries severity on a population level. Two measures of caries prevalence were calculated: caries experience (presence of at least one decayed, missing, filled primary or permanent tooth) and untreated caries (presence of at least one decayed tooth) represented as a percentage. Caries severity was measured using the dmft+DMFT indices as the sum of decayed, missing, and filled primary and permanent teeth for an individual, and taken as the arithmetic mean for the population. Treatment need prevalence was measured as needing any dental treatment (ADA status code II, III, or IV) and needing urgent dental treatment (ADA status code IV).

Proxy data for socioeconomic status (SES) were obtained from the California Department of Education. Information on the proportion of students in each school eligible for the free or reduced-price meal program was used as a surrogate measure of socioeconomic status. The data were obtained and stratified into three SES levels. Lower SES schools: = 50% of children eligible; middle SES schools: 25-49.9% of children eligible; higher SES schools: < 25% of children eligible.

Table 1
Number and percentage of schools and children by year

	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Schools n=76					
School participation	87%	82%	89%	95%	95%
Children					
# Enrolled Kindergarteners in participating schools	3,942	3,766	3,839	3,830	3,868
# Children screened	3,371	3,354	3,527	3,406	3,431

Comparison surveys. The National Health and Nutrition Examination Survey (NHANES) from 1999-2002(1) was used for national comparisons. Secondary analyses of public use data files yielded estimates for the 5-6 year old age group, which allowed for more direct age group comparison. "The California Smile Survey: An Oral Health Assessment of California's Kindergarten and 3rd Grade Children 2006" provided data from the 2004-2005 school year based on 10,949 kindergarteners.(2) Surveys from neighboring counties in the San Francisco Bay Area were obtained from Santa Clara and Alameda counties. "Oral Health Status of Children in Santa Clara County 2001" was the first dental needs assessment for Santa Clara County and included Head Start enrollees plus kindergarten and third grade children attending public elementary schools. Data from 602 kindergarteners were available for comparison (4). "Alameda County Oral Health Survey 2002-2004" was also Alameda's first countywide oral health survey of public school kindergarten and third grade children. Data from 1,741 kindergarteners were available for comparison (5). In addition, the findings were interpreted in the context of two relevant Healthy People 2010 Objectives (6) for 6-8 year

old children. These objectives are (a) to decrease the proportion of children who have experienced dental caries in primary or permanent teeth to 42%, and (b) to decrease the proportion of children with untreated dental caries in permanent or primary teeth to 21%.

Statistical analysis. Data entered into Microsoft Access were transferred into Excel, Stata 8.0, and SAS 8.02 for analysis. Descriptive analysis with percentages and 95% confidence intervals was used to compare the proportions of dental health outcomes in various groups. The differences in these proportions were classified according to the socio-demographic variables (sex, race/ethnicity, income level of school) and year of screening, then tested using chi-square tests. Logistic regression models were developed to (a) assess the odds ratios (ORs) of caries prevalence and treatment need outcomes stratified by socio-demographic variables, and (b) analyze time trends of caries prevalence over the five-year period. For mean dmft+DMFT values, the mean and standard errors were computed. A preliminary one-way analysis of variance (ANOVA) was used to test for an overall time trend of means. Following a significant ANOVA test for linearity of means ($p<.0001$), a linear regression test was used to detect an overall non-zero slope of the means across the five years. Independent samples t-tests were applied to detect differences in mean values among consecutive pairs of years using the Tukey method of adjustment for type I error rate. A two-sided p-value of 0.05 was considered significant for all statistical analyses.

Results

Table 1 shows the number of schools and children participating in the screenings in each of the five years. Of the 76 total public elementary schools in the SFUSD, between 62 (82%) and 72 (95%) schools agreed to take part in the screenings. Among those participating schools, the total number of kindergarten students who received a screening ranged

Table 2
Demographic characteristics of the population by year (%)

Variable	2000-2001 (n=3,371)	2001-2002 (n=3,354)	2002-2003 (n=3,527)	2003-2004 (n=3,406)	2004-2005 (n=3,431)
Gender					
Male	53.1	52.1	53.0	51.7	51.3
Female	46.9	47.9	47.0	48.3	48.7
Race/Ethnicity					
Asian	39.9	35.4	34.9	35.7	34.8
Hispanic	25.8	27.2	24.7	24.4	27.0
Black	12.7	9.6	11.6	13.0	13.4
White	7.0	8.0	9.2	8.9	11.8
Other	11.2	11.2	11.9	12.7	11.1
Unknown	3.0	8.6	7.7	5.4	1.9
School SES Level*					
Low	53.2	53.7	74.1	77.7	70.2
Middle	31.3	33.0	18.7	17.7	23.0
High	13.8	11.8	7.2	4.6	6.9

* based on proportion of students eligible for the free or reduced-price meal program

Figure 1a
Percentage of children with caries experience

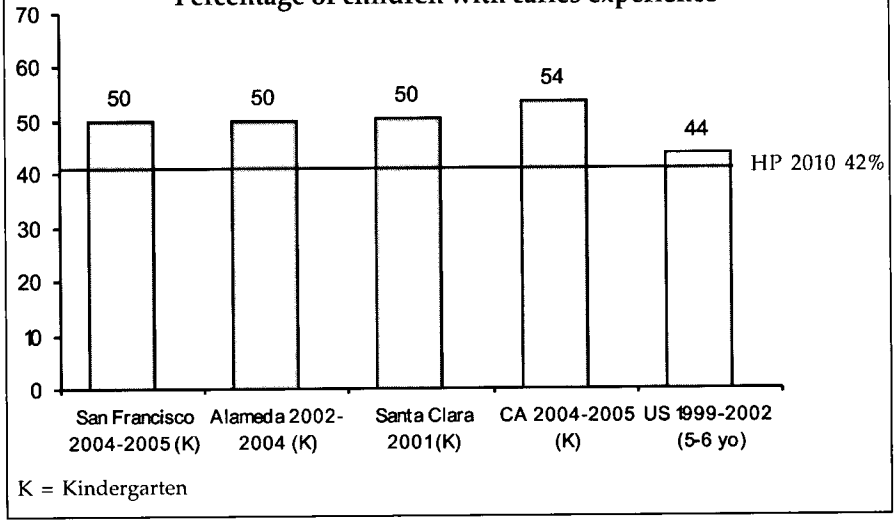

Figure 1b
Percentage of children with untreated caries

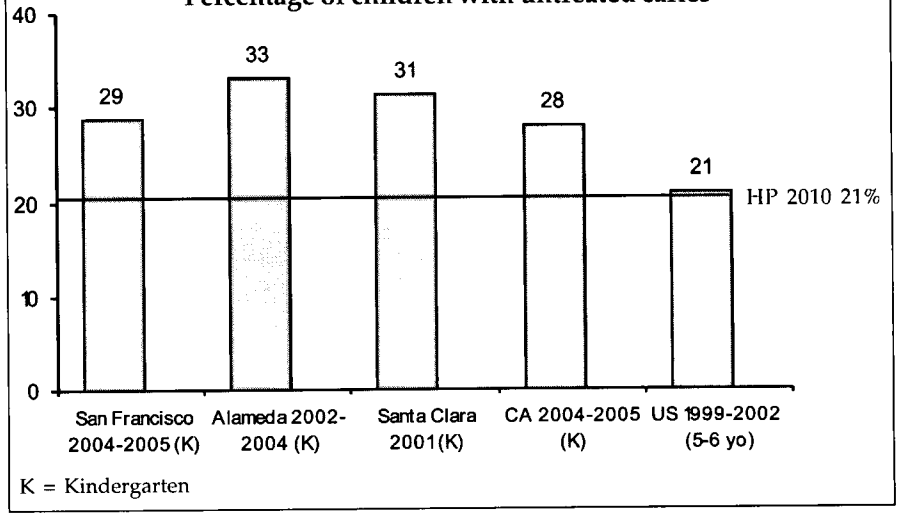

Table 3
Percentage of children with caries experience, untreated caries, and urgent treatment needs by race/ethnicity, school SES level, and year

	2000-2001 (n=3,371)	2001-2002 (n=3,354)	2002-2003 (n=3,527)	2003-2004 (n=3,406)	2004-2005 (n=3,431)
Caries Experience (95% CI)					
Total	60.0 (58.4-61.7)	55.6 (53.9-57.3)	52.6 (50.9-54.2)	51.2 (49.5-52.9)	50.1 (48.4-51.8)
Race/Ethnicity					
Asian	66.2 (63.4-68.7)	61.9 (59.3-64.5)	56.9 (54.3-59.5)	56.6 (54.0-59.2)	55.4 (52.7-58.0)
Hispanic	60.4 (57.1-63.7)	57.2 (54.0-60.4)	56.2 (52.9-59.5)	53.4 (50.0-56.8)	51.6 (48.4-54.8)
Black	58.5 (53.9-63.2)	53.0 (47.5-58.4)	54.1 (49.3-59.0)	48.4 (43.7-53.1)	51.6 (47.0-56.2)
Other	50.9 (45.9-56.0)	51.9 (45.5-58.3)	46.2 (41.1-53.2)	51.4 (45.2-57.5)	45.2 (38.6-51.9)
White	45.1 (38.6-51.5)	32.6 (26.9-38.2)	32.3 (27.2-37.4)	30.7 (25.5-35.9)	32.2 (27.6-36.8)
School SES Level*					
Low	65.5 (63.3-67.7)	61.2 (59.0-63.5)	56.3 (54.4-58.3)	53.9 (52.0-55.8)	53.9 (51.9-55.9)
Middle	57.1 (54.1-60.1)	49.1 (46.2-52.1)	41.5 (37.7-45.2)	44.7 (40.7-48.7)	38.9 (35.5-42.3)
High	45.7 (41.1-50.2)	46.6 (41.7-51.5)	42.7 (36.6-48.8)	30.8 (23.4-38.1)	48.5 (42.1-54.9)
Untreated Caries (95% CI)					
Total	39.1 (37.4-40.7)	37.7 (36.0-39.3)	32.9 (31.3-34.4)	31.6 (30.0-33.2)	28.8 (27.2-30.3)
Race/Ethnicity					
Asian	45.0 (42.3-27.7)	43.7 (41.1-46.4)	39.6 (37.0-42.2)	38.4 (35.8-40.9)	35.4 (32.9-38.0)
Hispanic	38.3 (35.0-41.6)	37.7 (34.6-40.9)	31.2 (28.1-34.3)	31.9 (28.7-35.1)	24.3 (21.5-27.0)
Black	37.5 (32.9-42.1)	33.0 (27.8-38.2)	32.0 (27.4-36.5)	28.1 (23.8-32.3)	30.5 (26.3-34.7)
Other	31.2 (27.0-36.4)	32.6 (26.6-38.6)	27.9 (22.5-33.4)	26.9 (21.4-32.3)	24.9 (19.1-30.6)
White	26.6 (20.9-32.3)	18.7 (14.0-23.4)	20.6 (16.2-25.0)	16.5 (12.3-20.7)	18.3 (14.5-22.1)
School SES Level*					
Low	44.7 (42.4-47.0)	43.1 (40.8-45.4)	35.9 (34.1-37.7)	33.9 (32.1-35.7)	31.9 (30.0-33.7)
Middle	35.5 (32.6-38.4)	31.0 (28.3-33.7)	24.7 (21.4-28.0)	26.4 (22.9-29.9)	21.3 (18.4-24.2)
High	25.2 (21.2-29.2)	31.2 (26.7-35.8)	23.3 (18.1-28.6)	13.5 (8.05-18.9)	21.9 (16.6-27.2)
Urgent Treatment Needs (95% CI)					
Total	9.06 (8.09-10.0)	4.83 (4.10-5.56)	9.07 (8.12-10.0)	7.28 (6.41-8.15)	7.63 (6.75-8.52)
Race/Ethnicity					
Asian	11.7 (10.0-13.5)	7.47 (6.05-8.88)	12.3 (10.6-14.0)	10.1 (8.48-11.6)	10.4 (8.78-12.0)
Hispanic	7.48 (5.73-9.23)	3.29 (2.13-4.45)	7.11 (5.40-8.82)	6.75 (5.04-8.46)	5.50 (4.03-6.96)
Black	8.02 (5.42-10.6)	2.80 (0.99-4.62)	7.80 (5.20-10.4)	5.88 (3.68-8.08)	8.06 (5.56-10.6)
Other	6.91 (4.34-9.49)	3.35 (1.05-5.64)	7.92 (4.65-11.2)	4.28 (1.79-6.77)	6.79 (3.45-10.1)
White	4.26 (1.66-6.85)	0.75 (-0.29-.018)	4.92 (2.56-7.29)	3.30 (1.28-5.32)	3.71 (1.86-5.56)
School SES Level*					
Low	10.4 (9.03-11.8)	5.44 (4.40-6.49)	10.6 (9.38-11.7)	8.16 (7.11-9.20)	8.43 (7.32-9.54)
Middle	8.01 (6.38-9.65)	4.61 (3.37-5.84)	4.99 (3.33-6.66)	4.82 (3.10-6.53)	6.86 (5.09-8.63)
High	6.05 (3.87-8.23)	3.02 (1.33-4.71)	4.35 (1.82-6.88)	1.92 (-0.26-4.10)	2.11 (2.67-3.95)

* based on proportion of students eligible for the free or reduced-price meal program

from 3,354 (89%) to 3,527 (92%) representing a large majority of all public school kindergarten children in San Francisco.

The children's demographic characteristics by year are presented in Table 2. Consistently, there were slightly more males than females. The racial/ethnic make up was diverse, and its distribution did not vary much year to year. Asians (Chinese, Filipino, Japanese, Korean, Samoan, Southeast Asian) accounted for the largest numbers, followed by Hispanics and Blacks. Others (American Indian and Arab) and Whites were similar in proportion, following closely behind. Unknown ethnicity represented those who declined to state it or the response was left blank. The study sample was highly consistent with demographics of the enrolled population (7) indicating a representative sample of the San Francisco public school kindergarten population.

Figures 1a & 1b show percentages of San Francisco kindergarteners from 2004-2005 with caries experience and untreated caries compared to public school kindergarten children from Alameda County, Santa Clara County, and California State, as well as US 5-6 year olds from 1999-2002. Fig. 1a demonstrates that half (50.1%) of all screened San Francisco children entering kindergarten have had at least one tooth affected by caries. Similar results are seen in the two neighboring counties of Alameda and Santa Clara, as well as statewide in California. According to the data extracted by Umo Isong (unpublished analysis of NHANES 1999-2002) all Bay area and state percentages were less favorable than the US from 1999-2002 (44%). The Healthy People 2010 objective is to reduce caries experience in the 6-8 year old population to 42 percent. San Francisco's 5-6 year olds are already experiencing a higher caries rate by 8 percent, and their younger age may place them even farther behind in

Table 4
Mean number of dmft+DMFT by race/ethnicity, school SES level, and year

	2000-2001 (n=3,371)	2001-2002 (n=3,354)	2002-2003 (n=3,527)	2003-2004 (n=3,406)	2004-2005 (n=3,431)
Mean dmft+DMFT (SE)					
Total	3.0 (.06)	2.6 (.06)	2.6 (.06)	2.6 (.06)	2.3 (.06)
Race/Ethnicity					
Asian	3.5 (.11)	3.1 (.10)	3.1 (.11)	3.1 (.11)	2.7 (.10)
Hispanic	3.1 (.13)	2.5 (.11)	2.6 (.11)	2.7 (.13)	2.4 (.11)
Black	2.8 (.17)	2.2 (.17)	2.4 (.13)	2.2 (.14)	2.3 (.13)
Other	2.3 (.16)	2.3 (.20)	2.1 (.19)	2.6 (.22)	2.0 (.21)
White	2.1 (.21)	1.3 (.16)	1.3 (.14)	1.2 (.15)	1.1 (.11)
School SES Level					
Low	3.5 (.09)	2.9 (.08)	2.9 (.07)	2.8 (.07)	2.6 (.07)
Middle	2.8 (.11)	2.3 (.10)	1.8 (.11)	2.0 (.13)	1.6 (.10)
High	1.9 (.14)	1.9 (.14)	1.7 (.16)	1.2 (.19)	1.9 (.19)

Table 5
Adjusted odds ratios (OR) and 95% confidence intervals (CI) for association between socio-demographic variables and oral health outcomes, 2004-2005 (n=3,431)

	Caries experience		Untreated caries		Any treatment needs		Urgent treatment needs	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Race/ethnicity†								
Asians	2.3	1.9,2.9*	2.1	1.6,2.8*	2.1	1.6,2.7*	2.6	1.6,4.3*
Hispanic	1.8	1.4,2.3*	1.1	0.8,1.5	1.1	0.8,1.5	1.2	0.7,2.1
Black	1.8	1.4,2.4*	1.5	1.1,2.1*	1.5	1.1,2.1*	1.8	1.0,3.3*
Others	1.6	1.1,2.2*	1.4	0.9,2.0	1.3	0.9,2.0	1.8	0.9,3.6
White§	1.0		1.0		1.0		1.0	
School SES level‡								
Low	1.1	0.8,1.4	1.6	1.2,2.3*	1.7	1.2,2.3*	4.2	1.7,10.3*
Middle	0.6	0.5,0.9	0.9	0.6,1.3	1.0	0.7,1.4	3.2	1.3,8.2*
High§	1.0		1.0		1.0		1.0	

* $p < 0.05$
† adjusted for school SES level
‡ adjusted for race/ethnicity
§ reference group

reaching this goal. Similar interpretations can be made from Fig. 1b, the proportion of children with untreated caries.

Table 3 shows the percentages of children with caries experience, untreated caries and urgent treatment needs by school year. The overall proportion of children in each category has declined since 2000. Besides the abrupt drop in urgent treatment needs in 2001-2002, the decline in all categories has been steady. Overall trends indicate improvement in oral health: lower proportions of kindergarten children have caries and treatment needs. Caries severity for all children, represented by the mean dmft+DMFT, has also experienced a decline, illustrated in Table 4. Linear regression analysis showed an overall significant linear decrease over time ($p < 0.0001$). However, among consecutive pairs of years, an ANOVA post-hoc pairwise comparison of means showed the difference in means to be statistically significant between the first and second years only ($p < 0.05$). Therefore, although the proportion of children with caries has decreased, caries severity has not seen any significant decline among successive years since 2001-2002. This suggests that caries is becoming more concentrated in fewer children.

Table 5 shows the odds ratios (ORs) of oral health categories stratified by race/ethnicity and school SES level in 2004-2005. Compared to Whites as the reference group, Asians had the highest ORs across all four oral health outcomes. Blacks had significantly higher odds in all four categories, while Hispanics and Others had significantly higher odds in caries experience only. These findings suggest a racial/ethnic disparity in the prevalence for dental caries and treatment needs, most pronounced in the Asian group. Using high SES school as the reference group, there was no significant difference in odds for any caries experience between SES levels of school. However, when adjusting for race/ethnicity, children from low SES schools had 1.63 times the odds of having untreated caries. In addition, children attending low SES schools were greater than four times more likely to have urgent treatment needs than children from high SES schools. These data suggest a school SES-related disparity with kindergarteners attending low SES schools more likely to have untreated caries and treatment needs.

An analysis by zip code of residence showed the overall composite percentage of untreated caries over the five-year period to be highest in the northeast and southern regions of San Francisco. The northeast region corresponded to Chinatown and its surrounding areas: 94108 (50.6%), 94133 (45.8%), 94109 (38.5%), while the southern region included Bayview/Hunter's Point, Visitacion Valley, Outer Mission, Excelsior, and OceanView/Merced/Ingleside districts: 94134 (38.7%), 94112 (37.8%), 94124 (37.1%), 94132 (37.0%). Children residing in these zip codes also had the highest percentages of dental treatment needs. These findings suggest a geographic disparity with highest caries and treatment need prevalence in these specific areas of San Francisco.

Discussion

Despite significant improvements in caries prevalence over the past five years, the data presented in this re-

port indicate that dental caries remains a common childhood disease in the SFUSD kindergarten population, with over half of the children affected by the time they enter school. Perhaps, more importantly, these data indicate that the burden of disease is not distributed evenly across all children. Children of color and from low SES schools had higher levels of caries and treatment needs compared with their white and high SES school counterparts. In addition, children living in the northeast and southern regions of San Francisco were shown to have higher proportions of untreated caries and treatment needs.

The authors' analyses confirmed what previous research has shown: that children of color have higher untreated caries and treatment needs (8-10). In particular, there were about twice as many Asian children with untreated caries and treatment needs than white children in all five years. It is important to consider these results in the context of the uniquely diverse demographic distribution of SFUSD. As a state, California leads the nation in ethnic diversity, and San Francisco has an even more ethnically diverse population than California (11). However, whereas the Hispanic/Latino population makes up the largest ethnic minority group in the state (32.4%) and the nation (12.5%), the largest ethnic minority group in San Francisco is comprised of Asians (30.8%) (11). This diversity is reflected in the SFUSD to an even greater degree with Asians comprising nearly half (48.7%), followed by Hispanics (21.7%), African-Americans (13.9%), Whites (9.8%), and Others (7.9%) of the entire K-12 enrolled student population in 2004-2005 (12). With the current and ongoing growth of Asians and Hispanics in the SFUSD (13), this racial/ethnic disparity could grow even further for these particular groups. It is hoped that these disparities will stimulate research aimed at identifying which subcategory of race/ethnicity within the Asian population might be carrying more of the disease burden.

The well-documented income-related disparity, extensively researched on both the national and local levels (8, 9, 14-16), is also reflected in this study. Children from low SES schools had higher odds of untreated caries and treatment needs, when compared to their high SES school counterparts. These data reinforce the utility of school-based oral health promotion programs such as the California Children's Dental Disease Prevention Program (CDDPP). This program offers preventive oral health services and education to preschool and elementary school children in high need areas, where need is based on the proportion of free/reduced-price meal program participation. However, rather than by school, a more effective approach may be to target the problem by zip code of residence due to the fact that 54% of elementary students attend school outside of their 'home attendance area' in the SFUSD (13).

The results by zip code revealed children residing in the northeast and southern regions of San Francisco to have the highest proportion of untreated caries and treatment needs across all five years. This geographic disparity emphasizes the need to examine more closely the determinants related to the higher burden of disease found in these regions. It is likely that these very same areas consist of families of lower socioeconomic status. According to Census 2000 data, the entire neighborhoods of Chinatown and Bayview/Hunter's Point were considered areas of low-income concentration(17). Furthermore, in a San Francisco study on poverty and children 0-5 years old, nearly half (43.8%) of all poor children were living in just three neighborhoods in San Francisco: Bayview/Hunter's Point, Inner Mission/Bernal Heights, and Visitacion Valley (18), covering a great majority of the same geographic area where children with caries reside.

Another likely factor involved in the high caries prevalence may be tied to the immigrant population in these sections of San Francisco. Health-related beliefs and attitudes vary with culture and may pose barriers to care, such as parental lack of perceived dental need. When mapping areas of minority residence, we find the same southern border of San Francisco as well as Chinatown to contain census tracts which meet the definition of "areas of minority concentration" (17). A more detailed analysis of duration of residence in the U.S., fluoridation history outside of San Francisco, and other cultural factors may shed light on the geographic disparity.

Lastly, another barrier to accessing dental care in these areas may be workforce-related issues. Though San Francisco is considered abundant in dental resources with two dental schools, nine dental public health facilities serving children, and an overall favorable dentist to population ratio of ~1:750 (19), there is a severe lack of actively practicing dental providers in some of these regions. Using GIS mapping, 2005 data showed only eight dentists in 94134 (Visitacion Valley) in a population of 41,134. However the most staggering deficiency was found in 94124 (Bayview/Hunter's Point), where there was only 1 dentist out of a population of 33,170 (20).

Largely due to the fact that the KDSP was not designed as a research project, but rather to provide a dental screening service, the findings of this study are subject to a number of limitations. First, the cross-sectional study design precluded the analysis of temporal associations and cohort effects. Secondly, the nature of oral screenings made it difficult to identify conditions not visually apparent. Since radiographs were not included, the reported levels of caries most likely underestimated the true disease prevalence. The third limitation related to participant and examiner variability. There was annual variability in the number of participating schools and children. Screener variability due to different dentists participating each year, augmented by the lack of rigorous calibration and assessment for intra- and inter-examiner reliability may have resulted in inconsistent data. The fourth limita-

tion regarded the limited number of explanatory variables. Because a questionnaire was not included, there were no primary data to investigate the contribution of factors such as household income, parental education level, employment, duration of residence in San Francisco and the US, primary language, level of acculturation, health-related behaviors and attitudes, and access to and utilization of dental care. The fifth limitation concerned the screening protocol. The Basic Screening Survey, widely used at the state level, uses a three-point scale to categorize dental treatment needs while this survey used a four-point scale. Thus, these measures could not be directly compared. Lastly, since these screenings are conducted only on public school children, the results are not generalizable to all 5-6-year-olds. Historical migration patterns show that one-fourth of children born in San Francisco leave the city before entering kindergarten, one-fourth attend private schools, and one-half attend public schools(13).

Despite the limitations, the study also exhibited two major strengths. The large sample size resulted in a high degree of precision by limiting random sampling error. A great majority of San Francisco's public school kindergarteners were represented in this study, and therefore provided more meaning to these results, making this information highly relevant and useful for policy-making and program planning for this population. Finally, this annual screening project exemplifies successful public health collaboration. The volunteer efforts and donation of supplies by the local dental societies under the leadership of one full-time project manager from the health department made it possible to screen nearly every public school Kindergartener year after year, all at a minimal financial cost. It is hoped that other cities and counties will look to this program as a model in developing their own collaborations.

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