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The Role of Partial Recording Protocols in reporting prevalence and severity of Dental Fluorosis

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Abstract

Objectives—To evaluate the role of partial recording protocols (PRPs) in reporting prevalence and severity of dental fluorosis and assess whether prevalence/severity estimates derived from PRPs differ by race/ethnicity.

Methods—Data from the National Health and Nutrition Examination Survey (NHANES) for the years 1999–2004 were analyzed with Stata® v.11. Prevalence of dental fluorosis obtained from a full mouth examination (28 teeth gold standard) was compared to estimates derived from four subsets of teeth (maxillary canine-to-canine; maxillary 1st premolar to 1st premolar; all-premolars; all-molars). Sensitivity, Negative Predictive Value (NPV), absolute bias, and correction factors were calculated against gold standard estimate. Analysis was stratified according to race/ethnicity to assess differences in estimates derived from PRPs.

Results—All subsets underestimated prevalence albeit to varying degrees. Two subsets (all-premolars and all-molars) had prevalence and severity estimates closest to gold standard estimates. The all-molar subset (8 teeth) recorded the highest sensitivity (84.5%) and the lowest absolute bias (3.5%) of all subsets relative to gold standard. Subsets derived from aesthetically relevant teeth produced the lowest fluorosis prevalence. For instance, the maxillary canine-to-canine subset underestimated prevalence by 9.5%; incorporating the maxillary first premolars in the span improved prevalence estimate by 31%. Among non-Hispanic Whites, the all-premolars subset produced estimates closest to gold standard while the all-molars subset produced estimates closest to the gold standard among non-Hispanic Blacks and Hispanics.

Conclusion—While the majority of dental fluorosis in the United States is very mild, concerns regarding its growing prevalence underscore the need for careful monitoring. The use of PRPs offers an alternative method of assessment, with validity of reported prevalence and severity dependent on choice of subset.

Keywords

Dental fluorosis; fluorosis; partial recording protocols; subset of teeth; bias; correction factor; sensitivity; negative predictive value

INTRODUCTION

Partial recording protocols (PRPs) refer to a random or specific subset of teeth for assessing certain oral diseases. They are relevant for generalized conditions such as plaque and gingivitis (1) and have been used extensively in periodontal disease research (1-3). The use of PRPs for measuring periodontal diseases dates back to the 1959 Ramfjörd Periodontal Disease index. Ramfjörd teeth have been used over the years for assessing periodontal diseases as have other combination of teeth and tooth sites (4-8). This method utilizing subset of teeth have been evaluated in epidemiologic settings as a method for assessing clinical attachment level and pocket depth (2, 3, 9) of periodontal disease, however, it has not been extensively studied as a method for assessing dental fluorosis in the United States.

Although PRPs inherently underestimate disease prevalence (8, 9) its usefulness is undeniable in large population surveys where time and budget constraints make full mouth examination infeasible. Alternative protocols that produce valid and reliable dental fluorosis estimates comparable to full mouth examination would be advantageous for efficiency, time and resources. Using the Dean's index, Medina-Solis *et al* (10) compared person-level prevalence estimates of dental fluorosis based on 6 teeth (canine-to-canine) to prevalence derived from full mouth examination (28 teeth) and reported sensitivity of 71.8% and Negative predictive value (NPV) of 44.3%. The study by Adelario AK *et al* (11), which also compared the maxillary canine-to-canine prevalence to those derived from 28 teeth but used the Thylstrup and Fejerskov (TF) index, reported a sensitivity of 90.6% and NPV of 77.5%. Although these studies were conducted in fluorosis endemic communities, they reported conflicting results regarding the relevance of PRPs in assessing dental fluorosis. Furthermore, neither study estimated correction factors relevant for adjustment of underestimated PRP prevalence. These underscore the need for additional studies to further explore PRPs as a method for assessing dental fluorosis especially in non-fluorosis endemic regions.

Prevalence of dental fluorosis has been reported to differ among school age children (12-14), with the highest prevalence reported among non-Hispanic Black children. Distribution of race/ethnicity among school age children might not be representative of adults in the general population, hence the need to report estimates by race/ethnicity among adults and additionally assess whether differences exist with regard to estimates derived from PRPs.

The aims of this study were to assess the validity of different subsets of teeth (PRPs) in reporting prevalence of dental fluorosis and report racial/ethnic differences in utilizing PRPs as a method of ascertaining dental fluorosis relative to estimates obtained from a full mouth examination.

MATERIALS AND METHODS

Data were obtained from the 1999-2004 continuous National Health and Nutrition Examination Survey (NHANES). NHANES is a cross-sectional survey conducted to assesses a range of health indicators including oral health, risk indicators for disease, nutrition status and access to preventive and treatment services for the U.S. non-institutionalized civilian population (15). It uses a complex, multistage, probability-sampling methodology to select primary sampling units (PSUs) of counties. Households from PSUs are sampled and individuals are sampled from selected households. This sampling methodology allows for oversampling of underrepresented groups such as non-Hispanic Blacks, Mexican-Americans, low income Whites, persons at least 60 years old and adolescents 12-19 years old (16). Data collection comprises interviews performed by trained personnel in participants' homes, and examinations performed in the mobile examination center (MEC) (17).

Respective masked variance pseudo-stratum weight, masked variance pseudo-PSU cluster weights and the corresponding MEC respondent weight (4 year weights for 1999-2002, 2 year weights for 2003-2004 and 6 year weights for 1999-2004) were applied to the dataset before data analysis utilizing the appropriate linearized standard errors.

Four subsets of teeth (maxillary canine-to-canine; maxillary 1st premolar to 1st premolar; all-premolars; all-molars) were identified *a priori* based on teeth reported in literature to have the highest occurrence of dental fluorosis (21-23); subsets were also chosen from aesthetically important teeth. Individuals that met study's inclusion criteria were at least 18 years old; had 28 teeth present (besides third molars) and scored for fluorosis. A case was defined as having at least two permanent teeth affected by fluorosis not regarding the level of severity (18). Thus for each subset, individuals with at least 2 fluorosed teeth were considered cases based on that subset.

Severity of dental fluorosis based on the work by Dean (15) was assigned as the second largest score among an ordered set of tooth level scores for each individual. For example, if N teeth were scored on an individual, the following are the ordered tooth level scores ($X_1, X_2, X_3, \dots, X_{(N-1)}, X_N$). The value $X_{(N-1)}$ is the severity score for the individual where X_1 represents the tooth level fluorosis score for the first tooth which can range from 0 (normal teeth) to 4 (severe fluorosis). In other words, person-level tooth scores were ordered from least severe to most severe. The two most affected teeth were selected and the fluorosis score assigned to the individual. If these teeth were not of the same severity, the score for the less severe of the two was assigned the individual. The following person-level fluorosis classifications were subsequently derived. **No fluorosis:** An individual with a set of 0 scores and at most a single score of 0.5 or 1.

Questionable

Scores of 0's, 0.5's and at most a single score of 1, 2, 3, or 4; Individuals with the most severe tooth-level score of questionable were classified as no fluorosis (19, 20). **Very mild:** Scores of 0's, 0.5's, 1's and at most a single score of 2, 3, or 4. **Mild** – Scores of 0's, 0.5's, 1's, 2's and at most a single score of 3, or 4. **Moderate** – Scores of 0's, 0.5's, 1's, 2's, 3's and at

most a single score of 4. **Severe** - Scores of 0's, 0.5's, 1's, 2's, 3's and at least two scores of 4's. Person-level classifications for moderate and severe fluorosis were combined because of the few cases of severe fluorosis that could produce statistically unreliable estimates if analyzed separately. The usefulness of PRPs in correctly classifying individuals with fluorosis was assessed stratifying by NHANES cycle —1999-2002, 2003-2004 and the combined 1999-2004 cycle — for comparison purposes and to highlight variation if any from cycle to cycle.

Statistical analysis

Dental fluorosis was analyzed as dichotomous (Yes/No); race/ethnicity was analyzed as a stratification variable. Distribution of the following baseline covariates: age (18-25, 26-35, 36-45, >45), gender (Male/Female), race/ethnicity (Non-Hispanic Whites, Non-Hispanic Blacks, Hispanics); the Hispanic category comprised Mexican-Americans and other Hispanics; education level (college or more, some college, and high school or less), and poverty-income-ratio (<100% FPL, 100-199% FPL, 200-299% FPL, and 300% FPL) are reported according to the number of teeth scored for fluorosis (28 teeth vs. less than 28 teeth).

Fluorosis prevalence (Yes/No) and severity (very mild, mild, and moderate/severe) were calculated for each subset (maxillary canine-to-canine, maxillary premolar-to-premolar, allpremolars, all-molars) for the different combination of NHANES cycles. These estimates were also assessed after stratifying by race/ethnicity. The respective sensitivity, NPV, absolute bias and correction factors for each subset was subsequently estimated and compared to gold standard estimate (28 teeth).

True fluorosis prevalence was defined as the proportion of individuals with at least 2 fluorosed teeth (cases) based on full mouth examination (28 teeth). **Subset Prevalence** was defined as the proportion of individual with dental fluorosis based on the respective subsets. **Sensitivity:** *Subset Prevalence / True Prevalence*; **Negative Predictive Value:** *True negatives / Test negatives*; **Absolute Bias:** *Test Prevalence – True Prevalence*; **Correction factor:** *True Prevalence / Test Prevalence* or *1 / Sensitivity*

Analyses were performed using Stata® statistical software version 11 (Statacorp College Station Texas, 77847 U.S.A) accounting for weights and complex multistage sampling design of NHANES.

Ethical considerations

The National Institutes of Health, Institutional Review Board approved this study (Exemption # 5887).

RESULTS

Results reported in Table 1 were derived from the combined NHANES (1999-2004) cycle for individuals at least 18 years. Majority (87.8%) were between the ages of 18-45 years, there were slightly more females than males (50.4% vs. 49.6%), non-Hispanic Whites comprised approximately two-thirds of the sample and about one half were at or above

300% of the federal poverty level. The distribution of demographic characteristics differs according to number of teeth scored for fluorosis (<28 vs. 28 teeth). Specifically, among those who had 28 teeth scored, 34.1% of 18-25 year olds, 22.3% of females, 34% of non-Hispanic Blacks, 27.9% of those <100% of the FPL and 19.5% of those with a college degree or more were cases while the corresponding proportions among those with less than 28 teeth were 29.9%, 13.1%, 18.3%, 15% and 10.6% respectively (Table 1).

The prevalence of dental fluorosis based on examining 28 teeth and each respective subset was largest in the 2003-2004 NHANES cycle (Table 2). Specifically, the overall prevalence of dental fluorosis was 18.6% in the 1999-2002 cycle, 30.9% in the 2003-2004 cycle and 22.7% in the 1999-2004 cycle. Prevalence based on the maxillary canine-to-canine subset was 11.7%, 16.0% and 13.2% in the 1999-2002, 2003-2004 and the 1999-2004 cycles respectively (Table 2). Upon stratification by race/ethnicity, the 2003-2004 cycle also yielded the largest prevalence estimate (Result not shown). Irrespective of NHANES cycle, prevalence estimates for Non-Hispanic Blacks were consistently higher than those for non-Hispanic Whites and Hispanics. For instance in the 1999-2004 cycle, the gold standard prevalence among non-Hispanic Blacks was 34.0% compared to 21.1% and 22.8% among non-Hispanic Whites and Hispanics respectively (Table 3).

For each of the 3 NHANES cycles, estimates from the all-premolar and all-molar subsets were closest to those derived from the full mouth examination while the maxillary canine-to-canine subset were the least accurate (Tables 2-3). Specifically, the maxillary canine-to-canine subset underestimated prevalence in the combined 1999-2004 NHANES cycle by about 10% while the all-premolar and all-molar subsets underestimated prevalence by 3.6% and 3.5% respectively (Table 4). Upon stratification by race/ethnicity, the all-premolar subsets yielded estimates for non-Hispanic Whites while the all-molar subset produced estimates for non-Hispanic Blacks and Hispanics that were closer to those derived from full mouth examination (Tables 3). Although the maxillary canine-to-canine subset underestimated prevalence, the high negative predictive value suggests its ability to correctly classify individuals without dental fluorosis as such. The majority of fluorosis cases were of the very mild type and the least common were the moderate/severe fluorosis. This was the pattern irrespective of subset used in assessing dental fluorosis (Figure 1).

DISCUSSION

The aims of this study were to assess the validity of partial recording protocols in estimating prevalence and severity of dental fluorosis and assess racial/ethnic differences in prevalence estimates derived from PRPs. Prevalence estimates derived from four different subsets of teeth were compared to those obtained from the gold standard measure (28 teeth). By virtue of utilizing subsets of teeth in estimating prevalence and severity of an oral condition, estimates derived will be negatively biased (underestimated). Thus, in choosing subsets, careful consideration need to be given to tooth formation period, time of eruption, exposure and duration of exposure to fluoridated products. Although prevalence of fluorosis increases from anterior to posterior teeth (21, 24), incisors and first molars are reported as less likely fluorosed compared to posterior teeth because of the earlier eruption times (21, 25, 26). Thus, subsets comprising premolars and second molars are expected to produce estimates

tending towards estimates derived from full mouth examination. In this study, prevalence was higher in the 2003-2004 NHANES cycle compared to other cycles. This particular cycle had the least number of observations and is based on 2 years of data compared to 4 years of data for the 1999-2002 and 6 years of data from the combined 1999-2004 cycles. In spite of this, prevalence of dental fluorosis appears to be driven by the higher prevalence among non-Hispanic Blacks.

As more teeth are included in a given subset, the better the accuracy of the prevalence and severity estimates become. For instance, prevalence estimates from the maxillary canine-to-canine subset was lower relative to estimates from the maxillary first premolar-to-first premolar subset. Additionally, when equal numbers of teeth are included in different subsets, more accurate results were gotten for posterior compared to anterior subsets. Specifically, prevalence derived from the maxillary first premolar-to-first premolar (8 teeth) subset among 18-49 year olds in the 1999-2004 NHANES cycle was 17.3% while that from the all-molar subset (8 teeth) was 19.2% (Table 4, Figure 1).

To ensure comparability, subsets were selected only from individuals who had 28 teeth present and scored for fluorosis, thus excluding individuals with less than 28 teeth even if they had the particular subsets present and/or scored. This criterion was instated in order to standardize the denominator for tooth prevalence calculations at the cost of sample size. Furthermore, dental fluorosis is not distributed equally between anterior and posterior teeth; the distribution of missing teeth is also not random across age groups, race/ethnicity, SES and area of the mouth. Therefore including only subjects with 28 teeth was done in an attempt to minimize potential confounding caused by these factors. Other studies investigating PRPs (10) included everyone regardless of number of teeth present and/or scored; this may explain some of the differing results. Specifically, the study by Medina-Solis *et al* reported a sensitivity of 71.8% for maxillary canine-canine subset. This was higher than was observed in this study (50.8%). Their reported negative predictive value of 44.3% (10) was however lower compared to the NPV (89%) reported in this study. On the contrary, the study by Adelario AK *et al* reported maxillary canine-to-canine sensitivity of 90.6%, and NPV of 77.5 % (11); a sensitivity estimate higher than we observed but lower NPV. The underestimated prevalence of about 10% from the maxillary canine-to-canine subset we reported is within the range of biases reported by Adelario AK *et al* (11). The U.S is not a fluorosis endemic country; this may also explain some of the differences reported. Additionally, the property of a test is also of value in explaining these results. The sensitivity and specificity of a test are not affected by prevalence but the negative predictive and positive predictive values (PPV) are. As prevalence increases, so does the PPV. The NPV however decreases as prevalence increases, thus we expect that in non-fluorosis endemic regions such as the United States, the NPV for a given subset will be higher than in fluorosis endemic regions.

Full-mouth fluorosis examination is time-consuming, reliability and reproducibility can be problematic even with extensive training. It has been proposed that using both a polarized White light (PWL) and quantitative light induced fluorescence imaging (QLF) for measuring dental fluorosis in the NHANES would mitigate some of these issues. Following successful pilot testing in a fluorosis endemic region of Thailand (27), these imaging techniques

designed to take high-resolution photographs of the facial surfaces of the maxillary canine-to-canine teeth span (27) are to be implemented in the 2013-14 NHANES cycle. Based on the results of this analysis, the maxillary canine-to-canine subset considerably underestimates prevalence of dental fluorosis compared to full mouth examination (11.4% vs. 18.6%), (16.0% vs. 30.9%) and (13.2% vs. 22.7%) for the 1999-2002, 2003-2004 and 1999-2004 NHANES cycles respectively. Expanding the maxillary canine-to-canine subset to include the maxillary first premolars appreciably improved estimates. Although prevalence derived from the maxillary first- premolar-to-first-premolar falls short of the gold standard estimate, it increased the prevalence of 13.2% derived from the canine-to-canine subset to 17.3%. Incorporating the first premolars in this imaging technique could potentially increase the accuracy of estimates.

These results will serve as useful resource for researchers interested in utilizing these imaging techniques because they provide valuable qualitative and quantitative data that can be expected from subsets and the tradeoffs in terms of sensitivity and underestimation (bias). Although the imaging techniques take photographs of only the facial surfaces of aesthetically important teeth, research has shown that fluorosis affects all teeth surfaces equally, making it unnecessary to examine all surfaces (25). This is however not always the case, as a distinction was reported in fluorosis endemic regions when the TF index was employed (1, 25).

Depending on race/ethnicity, certain subsets produced more accurate estimates than others. Specifically, among non-Hispanic Whites, the all-premolars subset produced more accurate estimate while the all-molars subset produced estimates closest to that of gold standard for non-Hispanic Blacks and Hispanics. Due to the location of the premolars and molars, they are not ideal for the fluorosis imaging cameras but could be of value in clinical settings, small research settings and for public health surveillance purposes where a great degree of accuracy might not be required. Sub-setting of teeth can save time and resources especially in large surveys, where some degree of underestimation may be an acceptable tradeoff for lower costs.

The correction factors reported in Table 4 were calculated to adjust the underestimated subset prevalence. A simple multiplication of the respective subset correction factors by the subset prevalence produces the observed prevalence from 28 teeth. Although these correction factors are unique to NHANES 1999-2004 cycle. To assess their external validity, a cross validation with other datasets will be required. More simply, for these correction factors to be applicable beyond our data, the distribution of correction factors from prior NHANES surveys or similarly designed surveys in other populations that have utilized a full mouth dental fluorosis examination needs to be assessed. Besides differences due to random error, we expect these correction factors to vary by fluorosis prevalence. However, for a given fluorosis prevalence, if these correction factors fall within a narrow range of values for each subset, then their applicability in a wide range of settings can be inferred.

Study limitations

Individuals with 28 teeth present and scored for fluorosis were included as study participants to ensure baseline uniformity and comparability among person-level estimates. Excluding

individuals with less than 28 teeth scored for fluorosis may not reflect the general population. Therefore, results may not be generalizable given that those with 28 teeth differ from those with <28 teeth with regard to fluorosis status (Table 1).

This was a descriptive study and no explicit confounder adjustment was done besides restricting to those with 28 teeth present and scored for fluorosis.

Conclusion

Prevalence of dental fluorosis using PRPs on aesthetically important teeth was considerably lower than was derived from full mouth examination and was mostly the very mild type. Of the subsets derived from aesthetically important teeth, the maxillary premolar-to-premolar subset appears to provide more accurate prevalence estimates. In general, subsets of either all-premolars or all-molars depending on race/ethnicity produced results closest to those obtained from a full mouth examination.

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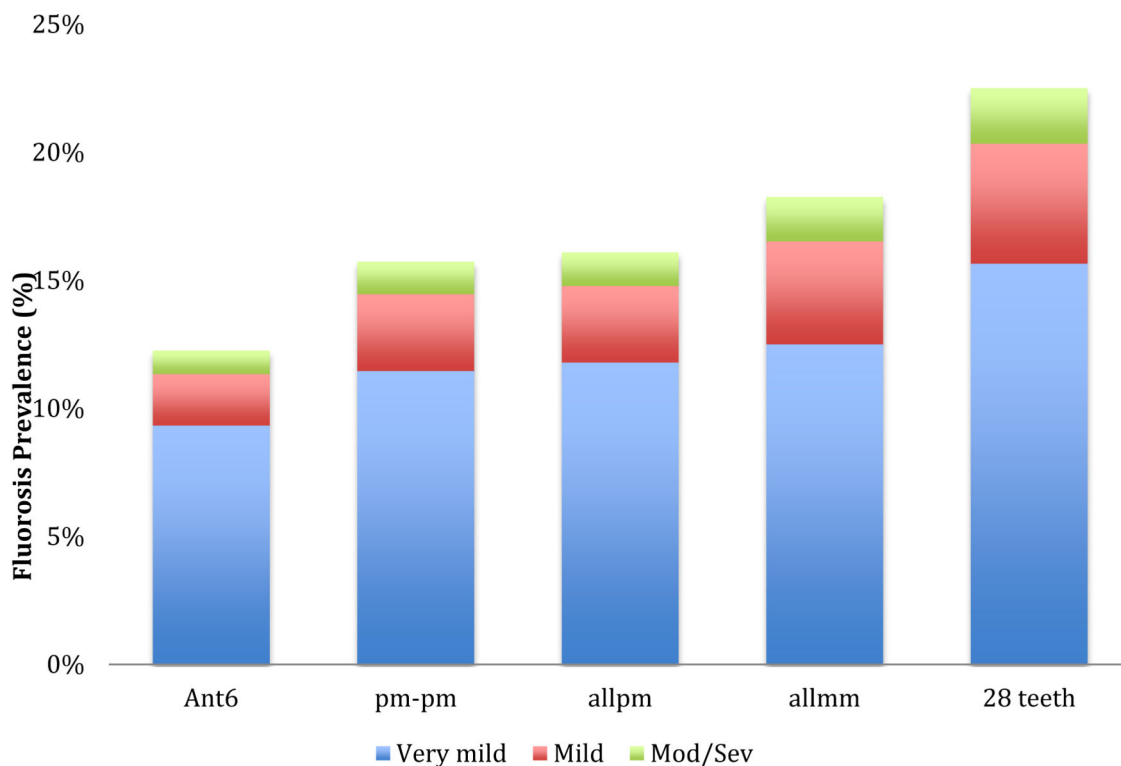
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Disclaimer

The views expressed in this study are those of the authors and do not necessarily represent the views of the National Institute of Dental and Craniofacial Research, National Institutes of Health or the United States Government.



*Data were derived from the National health and nutrition examination survey (NHANES) for the years 1999-2004. Eligible individuals were at least 18 years old, participated in the mobile examination portion of the NHANES examination and had 28 teeth besides the 3rd molars scored for dental fluorosis. Weights were based on the 6 year combined MEC respondent weight and calculated as recommended by the NCHS. The number of observations meeting the inclusion criteria was 4,143 corresponding to 56,105,522 individuals. Ant6- Estimates are based on examination of the maxillary canine-to-canine teeth (6 teeth) only. Pm-pm- Estimates are based on examination of the maxillary first premolar-to-first premolar teeth (8 teeth) only. Allpm- Estimates are based on examination of all-premolar teeth (8 teeth) only. Allmm- Estimates are based on examination of all-molar teeth (8 teeth) only. 28 teeth- Estimates are based on examination of 28 teeth excluding the third molars

Figure 1.

Prevalence and severity of dental fluorosis for individuals at least 18 years old based on four subsets of teeth relative to full mouth examination, NHANES 1999-2004

*Data were derived from the National health and nutrition examination survey (NHANES) for the years 1999-2004. Eligible individuals were at least 18 years old, participated in the mobile examination portion of the NHANES examination and had 28 teeth besides the 3rd molars scored for dental fluorosis. Weights were based on the 6 year combined MEC respondent weight and calculated as recommended by the NCHS. The number of observations meeting the inclusion criteria was 4,143 corresponding to 56,105,522 individuals. Ant6- Estimates are based on examination of the maxillary canine-to-canine teeth (6 teeth) only. Pm-pm- Estimates are based on examination of the maxillary first premolar-to-first premolar teeth (8 teeth) only. Allpm- Estimates are based on examination

of all-premolar teeth (8 teeth) only. Allmm- Estimates are based on examination of all-molar teeth (8 teeth) only. 28 teeth-Estimates are based on examination of 28 teeth excluding the third molars

Table 1

Baseline characteristics of study participants aged 18 years, overall and according to dental fluorosis status, NHANES 1999-2004*

	N	Col %	Dental Fluorosis cases			
			28 teeth scored		<28 teeth scored	
			N	Row %	N	Row %
Total	8,272	100	4,143	22.7	4,129	13.6
Age Category						
18-25	3,045	24.1	761	34.1	318	29.9
26-35	2,273	30.0	236	20.7	197	16.4
36-45	2,198	33.1	101	13.3	133	7.86
>45	761	12.8	32	13.5	50	7.20
Gender						
Female	4,404	50.4	572	22.3	373	13.1
Male	3,868	49.6	558	22.5	325	14.0
Race/ethnicity [§]						
NH Whites	3,474	67.8	419	21.1	226	11.7
NH Blacks	1,883	12.0	323	34.0	221	18.3
Hispanics	2,916	20.2	388	22.7	251	16.3
Poverty-income-ratio						
<100%	1,855	15.8	283	27.9	182	15.0
100-199%	1,851	18.5	265	26.5	193	17.5
200-299%	1,115	14.2	136	20.6	98	13.6
300%	3,451	51.6	446	20.8	225	11.4
Education Status						
College or more	1,372	25.5	164	19.5	70	10.6
Some College	1,954	32.0	230	22.9	158	13.4
High school	3,394	42.5	306	22.0	299	12.9

† Cases of dental fluorosis comprised individuals who had fluorosis present on at least two teeth while Non cases comprised individuals with no fluorosed teeth, one fluorosed tooth or questionable fluorosis.

* Data were derived from the National health and nutrition examination survey (NHANES) for the years 1999-2004. Individuals were at least 18 years old regardless of number of teeth scored for fluorosis, and participated in the mobile examination portion of the NHANES examination. Weights were based on the 6 year combined MEC respondent weight and were calculated as recommended by the NCHS. There were 8,272 observations for individuals 18 years and older

§ Hispanics comprised individuals who identified as Mexican-Americans, Other Hispanics OR Other race

Table 2

Prevalence, Sensitivity and Negative predictive value (NPV) of dental fluorosis from four subsets of teeth relative to full mouth examination (28 teeth) derived from the respective NHANES cycles*

	<u>1999-2002[†]</u>			<u>2003-2004[‡]</u>			<u>1999-2004[§]</u>		
	Prevalence	Sensitivity	NPV	Prevalence	Sensitivity	NPV	Prevalence	Sensitivity	NPV
28 teeth [#]	18.6%			30.9%			22.7%		
Ant 6 ^{**}	11.7%	63.1%	92.2%	16.0%	51.9%	82.3%	13.2%	58.0%	89.0%
Pm-Pm ^{††}	15.1%	81.0%	95.8%	21.7%	70.4%	88.3%	17.3%	76.2%	93.5%
All Pm ^{‡‡}	15.9%	85.6%	96.8%	25.4%	82.1%	92.6%	19.1%	84.0%	95.5%
All-molar ^{§§}	16.4%	88.1%	97.4%	24.8%	80.3%	91.9%	19.2%	84.5%	95.6%

* Data were derived from the National health and nutrition examination survey (NHANES) for the years 1999-2004. Eligible individuals were at least 18 years old, participated in the mobile examination portion of the NHANES examination and had 28 teeth besides the 3rd molars scored for dental fluorosis.

[†]Weights were based on the 4-year MEC respondent weight. The number of observations meeting the inclusion criteria was 2,787 corresponding to 55,876,512 individuals

[‡]Weights were based on the 2 year MEC respondent weight. The number of observations meeting the inclusion criteria was 1,356 corresponding to 56,563,543 individuals.

[§]Weight were based on the 6 year combined MEC respondent weight and calculated as recommended by the NCHS. The number of observations meeting the inclusion criteria was 4,143 corresponding to 56,105,522 individuals.

[#]Estimates are based on examination of 28 teeth excluding the third molars.

^{**}Estimates are based on examination of the maxillary canine-to-canine teeth (6 teeth) only

^{††}Estimates are based on examination of the maxillary first premolar-to-first premolar teeth (8 teeth) only

^{‡‡}Estimates are based on examination of all-premolar teeth (8 teeth) only

^{§§}Estimates are based on examination of all-molar teeth (8 teeth) only

Table 3

Results of stratification according to race/ethnicity comparing dental fluorosis estimates derived from partial reporting protocols to full mouth examination, NHANES 1999-2004^{*}

	1999-2004 cycle								
	<u>NH-Whites</u> [†]			<u>NH-Blacks</u> [‡]			<u>Hispanics</u> [§]		
	Prevalence	Sensitivity	NPV	Prevalence	Sensitivity	NPV	Prevalence	Sensitivity	NPV
28 teeth [#]	21.1%			34.0%			22.8%		
Ant 6 ^{**}	12.7%	60.0%	90.3%	17.8%	52.5%	80.3%	13.6%	59.5%	89.3%
Pm-Pm ^{††}	16.2%	76.8%	94.2%	24.1%	71.0%	87.0%	17.9%	78.7%	94.1%
All Pm ^{‡‡}	18.2%	85.9%	96.3%	25.8%	75.9%	88.9%	19.3%	84.8%	95.7%
All-molar ^{§§}	17.5%	82.6%	95.5%	29.4%	86.6%	93.5%	20.9%	91.9%	97.7%

* Data were derived from the National health and nutrition examination survey (NHANES) for the years 2003-2004. Eligible individuals were at least 18 years old, participated in the mobile examination portion of the NHANES examination and had 28 teeth besides the 3rd molars scored for dental fluorosis. Weights are based on the 6 year combined MEC respondent weight and were calculated as recommended by the NCHS. The number of observations meeting the inclusion criteria was 4,143 corresponding to 56,105,522 individuals. Individuals of 'other race' were excluded from stratified analysis

[†] Non-Hispanic Whites only, the number meeting inclusion criteria was 1,791 corresponding to 39,513,204 individuals

[‡] Non-Hispanic Blacks only, the number meeting inclusion criteria was 844 corresponding to 5,546,347 individuals.

[§] Hispanic group comprise Mexican Americans and other Hispanics, the number meeting the inclusion criteria was 1,360 corresponding to 8,446,506 individuals.

[#] Estimates are based on examination of 28 teeth excluding the third molars.

^{**} Estimates are based on examination of the maxillary canine-to-canine teeth (6 teeth) only

^{††} Estimates are based on examination of the maxillary first premolar-to-first premolar teeth (8 teeth) only

^{‡‡} Estimates are based on examination of all-premolar teeth (8 teeth) only

^{§§} Estimates are based on examination of all-molar teeth (8 teeth) only

Table 4

Prevalence, absolute bias and correction factors for four subsets of teeth for assessing dental fluorosis relative to full mouth examination, NHANES 1999-2004^{*}

1999-2004			
	Prevalence[†]	Absolute bias[‡]	Correction factor[§]
28 teeth [#]	22.7%		
Ant 6 ^{**}	13.2%	-0.095	1.72
Pm-Pm ^{††}	17.3%	-0.054	1.31
All Pm ^{‡‡}	19.1%	-0.036	1.19
All-molar ^{§§}	19.2%	-0.035	1.18

* Data were derived from the National health and nutrition examination survey (NHANES) for the years 1999-2004. Eligible individuals were at least 18 years old, participated in the mobile examination portion of the NHANES examination and had 28 teeth besides the 3rd molars scored for dental fluorosis. Weights were based on the 6 year combined MEC respondent weight and calculated as recommended by the NCHS. The number of observations meeting the inclusion criteria was 4,143 corresponding to 56,105,522 individuals.

[†] Proportion of individuals with at least two fluorosed teeth irrespective of severity based on the respective number of teeth examined

[‡] Difference between the subset prevalence and true prevalence based derived from full mouth examination.

[§] Inverse of respective subset sensitivities

[#] Estimates are based on examination of 28 teeth excluding the third molars.

^{**} Estimates are based on examination of the maxillary canine-to-canine teeth (6 teeth) only

^{††} Estimates are based on examination of the maxillary first premolar-to-first premolar teeth (8 teeth) only

^{‡‡} Estimates are based on examination of all-premolar teeth (8 teeth) only

^{§§} Estimates are based on examination of all-molar teeth (8 teeth) only