Periodontitis in the United States: Beyond Black and White

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Abstract

Objectives: This paper examines whether historical disparities in periodontal status between African Americans and whites in the United States have increased, decreased, or remained the same over the 15-year period between the First National Health and Nutrition Examination Survey (NHANES I, 1971–74) and the Third National Health and Nutrition Examination Survey (NHANES III. 1988–94). Methods: This study compared the magnitude of the relative and absolute differences in the periodontal status of African-American and white adults in NHANES I and again in NHANES III. Results: The prevalence of periodontitis in the US adult population in NHANES I was 31.6 percent, with African Americans exhibiting higher prevalence than whites. In NHANES III, using a different case-definition for periodontitis, the overall prevalence was 11.9 percent, with African Americans again exhibiting higher prevalence than whites. The magnitude of the intrasurvey relative and absolute differences between African Americans and whites increased between NHANES I and NHANES III. This finding remained after adjustment in the logistic regression analyses. After adjustment for all covariates in the model, African Americans were more likely to exhibit periodontitis than whites in both NHANES I (odds ratio [OR]=1.31; 95% confidence intervals [CI]=.78, 2.19) and NHANES III (OR=2.09; 95% CI=1.68, 2.60). However, the CI included 1.00 in NHANES I. Conclusions: Disparities in periodontitis between African Americans and whites are pervasive and have increased over time. This increase appears to be driven by social, cultural, and behavioral factors. [J Public Health Dent 2002;62(2):92-101]

Key Words: periodontitis, racial disparities, race, periodontal status.

Disparities in health status between the African-American and white populations of the United States have been documented for years (1-7). While some improvements in the health of the whole population have occurred, the persistence of disparities between the racial groups indicate that such improvement has been uneven. Indeed, this improvement differential has actually contributed toward widening the disparities gap (8-13). Racial disparities in oral health have been reported from national surveys such as the first Health Examination Survey (HES, 1960-62), the First National Health and Nutrition Examination Survey (NHANES I, 1971-74), and more recently, the Third National Health and Nutrition Examination

Survey (NHANES III, 1988–94). Disparities of a similar nature have also been reported in more localized surveys (14-20).

Previous studies, both national and local in scope (20-28), have found racial disparities in periodontal health to be related to age, sex, marital status, education, income, geographic region, presence of health insurance, history of diabetes, and tobacco use. They also have been associated with perceptions of general and oral health (29), although the observed disparities have not been explained fully by these factors. While results of studies on trends in periodontal conditions can be compared only to a limited degree because of different measurement scales used and different populations seen, one

study reported a decline in periodontal diseases across the entire US population over time (22), while three others did not (16,30,31). Only one of these reports, on racial trends at the state level between 1965 and 1981 (20), found a decrease in periodontitis for all ages in whites along with an increase in African Americans of all ages except in the 25-39-year-old age group. Given the revived interest in oral health disparities between subgroups of the American population that accompanied the release of the Surgeon General's report on oral health status (32), it is important to assess the magnitude of these disparities to establish a baseline reference. This paper examines whether historical disparities in periodontal status between African Americans and whites in the United States have increased, decreased, or remained the same over a period of about 15 years.

Methods

Study Population and Design. Data for this study came from NHANES I (demographic, medical history, dental examination, and health needs) and NHANES III (household questionnaire and clinical examination) public-use data files. The files for each survey were merged to obtain all variables needed for the analyses. For NHANES I, we used data for individual tooth Periodontal Index scoring during the periodontal assessment rather than the mean score included in the dental examination file (33). Both surveys assessed the health status of a nationally representative sample of the civilian noninstitutionalized US population. Samples were obtained through a stratified multistage probability sampling design. Full descriptions of the sample design in NHANES I and NHANES III have

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been reported elsewhere (34,35). NHANES I drew a sample of 28,043 persons aged 1 to 74 years, of whom 20,749 (74%) persons were randomly selected to participate in the dental/medical components of the survey. NHANES III yielded a sample of 33,994 persons 2 months of age or older, of whom 31,311 (92%) received a complete examination. The present study was limited to the records of persons aged 17 years or older in NHANES I (n=17,030) and NHANES III (n=18,162). Of the 8,214 persons who had at least one tooth and received a periodontal assessment in NHANES I, 8,116 persons were classified as African American (n=1,774) or white (n=6,342). However, only 5,753 persons had data on individual tooth scoring during the periodontal assessment (1,444 African Americans and 4,226 whites). The number of records available for analysis varied depending on the variable used. Of the 14,188 who had at least one tooth and received a periodontal assessment in NHANES III, 13,670 were classified as African Americans (n=4,313) or whites (n=9,357). To test the hypothesis of no change in periodontal status between the two national surveys, we compared the magnitude of the absolute and relative differences in periodontal status of African-American and white adults from similar age cohorts in NHANES I and in NHANES III. The change in the case definition of periodontitis between the surveys did not permit direct cross-comparison.

Clinical Examination. NHANES I. The oral examination included a dental caries assessment, periodontal examination and oral hygiene status, occlusion assessment, an enamel biopsy, and a dental treatment need assessment. A complete description of the protocol used is given elsewhere (36).

The Periodontal Index (PI) (37) was used to assess the extent of periodontal disease. Developed as a ratio scale, this index assigned scores of 0, 1, 2, 6, and 8 to each tooth according to the extent of gingival inflammation, the presence of a periodontal pocket, and the firmness of teeth in their sockets. Required field equipment was reduced to a mouth mirror and sometimes a periodontal probe. All teeth present in the mouth, including third molars, were examined.

NHANES III. The periodontal examination was conducted in only two randomly chosen quadrants, one maxillary and one mandibular, with the assumption that conditions in these two quadrants would represent the mouth. Two sites, buccal and mesiobuccal, were examined for each tooth. Third molars were excluded because of their frequent extraction in young adulthood, so a maximum of 14 teeth and 28 sites per individual were examined. More detailed information on the procedures protocol for NHANES III can be found elsewhere (38).

Clinical attachment loss (CAL), pocket depth (PD), and gingival recession were measured at the mid-buccal and mesiobuccal surfaces of each tooth by probing (39). CAL was defined as the distance in millimeters (mm) from the cemento-enamel junction (CEJ) to the bottom of the pocket/sulcus. PD was defined as the distance from the free gingival marginal (FGM) to the bottom of the pocket/sulcus. Gingival recession was defined as the distance from the CEJ to the FGM. Each measurement was rounded to the next lowest whole millimeter.

Study Variables. Assessment of Periodontitis. For NHANES I, a previous study had used the term "disease with pockets" referring to a combination of gingivitis and ≥ 3 mm pockets (16). For the case definition in NHANES I, we defined prevalence of periodontitis for an individual as the presence of at least four teeth, each with a demonstrated periodontal pocket (or a PI score of 6) (37). For NHANES III, previous studies had used several combinations of CAL and PD to establish case definitions (25,40,41). However, these definitions were tailored to specific populations for testing specific hypotheses. After some testing of several combinations and distributions of CAL and PD, we defined prevalence of periodontitis in NHANES III as the presence of two or more sites with CAL≥3 mm and one or more sites with PD ≥4 mm. However, these conditions did not have to be present in the same site. Because African Americans exhibited the worst periodontal conditions in both surveys, any cutoff point or distribution used to define periodontitis would result in a higher prevalence for African Americans.

Covariates. The main independent variable of interest was race, and it was defined as African American or white in both surveys. Hispanic ethnicity was not recorded in NHANES I and thus could not be included in this analysis.

To investigate the race effect adjusted for other factors, the following variables were included in the analysis: age at interview, sex, marital status, education, income, census region, self-perception of general and oral health, presence of medical insurance, history of diabetes, and tobacco use. NHANES I and NHANES III used the same or similar questions to record these covariates, although some recoding was necessary for analysis purposes. As opposed to five categories (excellent, very good, good, fair, and poor) in NHANES III, perception of oral health included only four categories (excellent, good, fair, and poor) in NHANES I. Categories in the marital status question originally included married, living together with someone as married, widowed, divorced, separated, or never married. These categories were grouped into married (married or living together with someone as married), single, divorced (separated or divorced), and widowed. Education was collected as a continuous variable (number of years of education) from 0 to 17 years in both NHANES I and NHANES III. For the purpose of this analysis, the recoding of education resulted in the following categories: <12 years, 12 years, and >12 years of education. Total family 12-month income during the past year also was collected as a continuous variable and recoded after using the inflation calculator developed by the Consumer Price Index (42). Income distribution in NHANES I was used to determine the categories used in this study. The incomes in NHANES III were adjusted to the equivalent dollar amount in NHANES I, with income categorized as low, medium, and high. These categories represented ≤\$4,999, \$5,000 to \$9,999, and ≥\$10,000 in NHANES I, and ≤\$16,999, \$17,000 to \$34,999, and ≥\$35,000 in NHANES III.

The question "Have you ever been told by a doctor that you have diabetes?" was used to assess the history of diagnosed diabetes in both surveys. Women who manifested diabetes only during pregnancy were not considered as diabetics in NHANES III; this distinction was not made in NHANES I. Smoking status was derived using

		1	NHANES I			NHANES III				
	African A	mericans	Wh	ites		African A	mericans	Wh	ites	
Variables	n	%	n	%	P-value†	n	%	n	%	P-valuet
Age (years)	2,466	39.0 (0.64)‡	11,352	40.9 (0.31)	.01	4,313	36.8 (0.37) [‡]	9,357	40.3 (0.46)	<.01
Sex										
Male	877	44.2	4,468	47.8		1,955	44.7	4,502	49.2	
Female	1,589	55.8	6,884	52.2	.06	2,358	55.3	4,855	50.8	<.01
Marital status										
Married	1,229	54.9	8,010	71.5		1,817	41.9	6,186	67.0	
Single	522	22.9	1,702	17.3		1,537	36.9	1,730	20.0	
Divorced	396	14.3	660	5.5		682	16.5	785	9.1	
Widowed	311	7.8	973	5.7	<.01	260	4.8	647	3.9	<.01
Education										
<12 years	1,620	60.8	4,669	35.3		1,515	31.0	3,730	22.0	
12 years	518	25.5	3,285	33.1		1,603	38.7	2,751	34.0	
>12 years	22 1	13.7	3,011	31.6	<.01	1,163	30.3	2,871	44.0	<.01
Income§										
Low	1,279	42.3	2,883	18.2		1,765	43.5	2,809	20.3	
Medium	734	38.2	3,665	32.7		1,270	32.9	2,795	31.3	
High	337	19.5	4,391	49.2	<.01	837	23.6	2,925	48.4	<.01
Geographic region										
Northeast	430	18.8	2,537	25.0		775	17.3	1,038	20.6	
Midwest	504	20.7	2,795	26.5		817	19.2	1,752	24.7	
South	1,082	44.2	2,760	21.1		2,398	54.3	3,637	32.7	
West	450	16.2	3,260	26.7	<.01	327	9.2	2,930	22.0	<.01
Perception of health	L									
Excellent	69	12.0	642	22.0		738	18.6	1,591	22.9	
Very good	95	18.5	794	25.4		1,020	24.8	2,445	34.1	
Good	219	38.1	1,100	35.3		1,631	37.6	3,385	31.8	
Fair	154	18.8	522	14.0		780	16.3	1,672	9.6	
Poor	74	12.6	146	3.2	<.01	144	2.7	262	1.6	<.01
Perception of oral health¶										
Excellent	15	2.8	266	12.7		319	8.4	833	12.4	
Very good		—				559	13.9	1,369	19.6	
Good	145	30.5	1,007	42.2		1,401	33.1	3,051	35.9	
Fair	169	38.0	691	28.0		1,257	29.6	2,596	21.4	
Poor	158	28.7	428	17.1	<.01	709	14.9	1,420	10.7	<.01
Insurance										
Yes	273	58.9	2,383	82.4		2,550	87.9	6,073	93.8	
No	309	41.1	764	17.6	<.01	80	12.1	587	6.2	<.01
History of diabetes										
Yes	115	3.3	348	2.4		225	4.4	530	3.5	
No	2,334	96.7	10,903	97.6	.02	4,088	95.6	8,825	96.5	.05
Smoking status										
Current	270	49.0	1,123	39.3		1,331	31.3	2,187	28.0	
Former	79	13.6	726	23.0		639	13.8	2,290	24.4	
Never	261	37.5	1,355	37.7	.01	2,342	54.9	4,880	47.6	<.01

 TABLE 1

 Characteristics of US African-American and White Adults: NHANES I*, 1971–74 and NHANES III, 1988–94

*Sample size in NHANES I varies upon the variable used in the analysis, e.g., age and sex have a sample size of 13,818; education and presence of insurance have 13,324 and 3,729, respectively. †P-values for *t*-test or chi-square test of independence between racial group within survey. ‡Mean (SE). [§]Categories for income represent \leq \$4,999, \$5,000 to \$9,999, and \geq \$10,000 in NHANES I, and \leq \$16,999, \$17,000 to \$34,999, and \geq \$35,000 in NHANES II, respectively. [¶]Perception of oral health was recorded as four categories in NHANES I.

two questions in both surveys, "Do you smoke cigarettes now?" and "Have you smoked 100+ cigarettes in your life?" Smoking status was defined as current smokers (subjects who answered "yes" to both questions), former smokers (subjects who answered "no" to the first question and "yes" to the second question) and never smokers (subjects who answered "no" to both questions).

Statistical Analysis. Characteristics of the population in NHANES I and in NHANES IIII, stratified by race, were described using means for continuous variables and proportions for categorical variables. Comparison between African Americans and whites were performed using the *t*-test and chi-square test for significance differences.

Prevalence of periodontitis was described for each racial group in each survey by age groups, sex, marital status, education, income, geographic region, perception of general and oral health, presence of health insurance, history of diabetes, and smoking status. Three sets of chi-square tests were performed to evaluate differences in the prevalence of periodontitis: (1) the Cochran-Mantel-Haenszel test to evaluate the independence of periodontitis by race, stratified by each covariate; (2) the test for homogeneity of the racial groups over covariate categories; and (3) the test for independence between race and periodontitis within each covariate category. The test for homogeneity was performed to assess differences across racial/ethnic groups over each covariate category. In addition, tests for trend were performed to investigate any trends in prevalence by age groups, perception of general health, and perception of oral health within racial groups in each survey. Prevalence ratios and differences in periodontitis between African Americans and whites also were calculated to assess the relative and absolute magnitude of the effect of race in each survey. Multiple logistic regression analysis was performed to assess the independent effect of race while controlling for selected covariates in each survey.

All statistical analyses were carried out using STATA (43) and SUDAAN (44). These software packages allowed observations to be weighted to represent the US population, taking into account the complex sampling design.

TABLE 2
Prevalence of Periodontitis for US Adults, Stratified by Demographic and
Health-related Covariates: NHANES I and NHANES III [cont. page 96]

	NHANES I							
-	African Amer.		Whites				Absolu	
Variables	n	%	n	%	<i>P</i> *†	AA:W‡	AA≠W‡	
Overall prevalence	1,444	37.1	4,226	30.4	.04	1.22	6.7	
Age groups								
17–24 years	303	17.8	733	7.5	.03	2.37	10.3	
25–34 years	280	23.9	835	22.4	.78	1.07	1.5	
35–44 years	262	35.3	773	33.5	.74	1.05	1.8	
45–54 years	170	65.2	588	38.5	.00	1.69	26.7	
5564 years	128	54.0	382	45.3	.30	1.19	8.7	
65–74 years	301	49.0 [§]	915	54.4 [§]	.33	0.90	-5.4	
75+ years								
Male	585	41.9	1,935	31.3	.01	1.34	10.6	
Female	859	31.9	2,291	29.4	.50	1.08	2.5	
Marital status								
Married	724	41.7	3,064	32.6	.04	1.28	9.1	
Single	301	16.1	597	11.8	.19	1.36	4.3	
Divorced	247	45.4	261	40.7	.51	1.11	4.7	
Widowed	167	52.3	303	48.3	.64	1.08	4.0	
Education								
<12 years	983	38.5	1,878	37.2	.76	1.03	1.3	
12 years	296	38.8	1,258	25.4	.02	1.53	13.4	
>12 years	106	24.2	953	26.2	.75	0.92	-2.0	
Low income	750	39.9	1,050	35.9	.40	1.11	4.0	
Medium income	443	33.8	1,457	32.1	.70	1.05	3.7	
High income	184	35.4	1,567	26.4	.06	1.34	9.0	
Northeast region	237	39.1	848	33.6	.33	1.16	5.5	
Midwest region	296	50.1	1,212	29.0	.02	1.73	21.1	
South region	657	34.5	954	33.9	.91	1.02	0.6	
West region	254	27.5	1,212	26.5	.84	1.04	1.0	
Percept. of health								
Excellent	48	33.9	236	25.3	.36	1.34	8.6	
Very good	58	50.8	320	26.2	.07	1.94	24.6	
Good	128	50.4	460	39.9	.26	1.26	10.5	
Fair	90	60.4	192	53.3	.43	1.13	7.1	
Poor	48	66.6¶	45	61.0 [§]	.63	1.09	5.6	
Percept. oral health								
Excellent	10	18.9	97	23.2	.77	0.81	-4.3	
Very good		_						
Good	97	53.3	462	25.0	.02	2.12	28.3	
Fair	125	45.1	379	39.7	.46	1.14	5.4	
Poor	133	61.3¶	297	52.0 [§]	.24	1.18	9.3	
Insurance	170	49.5	947	34.6	.14	1.43	14.9	
No insurance	183	52.5	288	42.6	04	1 23	99	
History of diabetes	57	50.4	121	53.1	80	0.95	-27	
No diabetes	1.378	36.7	4.071	29.8	.00 N4	1 23	<u> </u>	
Current smoker	171	62 1	501	20.0		1.20	72.2	
Former emolor	1/ I AC	267	265	20 5	.00 Q/I	0.05	_1 Q	
Navar emokod	1==	12 5	400	20.0	.0 1 00	1 40	-1.0	
THEVEL SHICKED	100	43.3	40/	47.4	.08	1.49	14.3	

**P*-values for chi-square test of independence between racial groups and periodontitis in each category of the third variable. †All *P*-values for Cochran-Mantel-Haenszel test of association and chi-square test of homogeneity between racial groups and periodontitis stratifying by a third variable were significant in each survey with the exception of the *P*-values for homogeneity for education (*P*=.22), income (*P*=.21) and geographic region (p=0.07) in NHANES I. ‡Prevalence ratio and absolute differences in periodontitis between African Americans and whites. §*P* trend, <.001. ¶*P* trend, <.01.

TABLE 2Prevalence of Periodontitis for US Adults, Stratified by Demographic andHealth-related Covariates: NHANES I and NHANES III [cont. from page 95]

	NHANES III								
	African	Amer.	Wh	ites		Ratio	Absolu. AA≠W‡		
Variables	n	%	n	%	P*†	AA:W‡			
Overall prevalenc Age groups	4,248	19.6	9,232	10.7	<.01	1.83	8.9		
17-24 years	939	4.0	1,661	2.0	.01	2.00	2.0		
25–34 years	1,089	14.8	1,993	6.7	<.01	2.21	8.1		
35-44 years	988	22.5	1,699	10.0	<.01	2.25	12.5		
45–54 years	451	32.7	1,110	17.3	<.01	1.89	15.4		
55-64 years	380	41.1	1,078	19.2	<.01	2.14	21.9		
65–74 vears	305	38.4	980	17.9	<.01	2.14	20.5		
75 years	96	31.3 [§]	711	19.5 [§]	.06	1.60	11.8		
Male	1,922	24.5	4,442	13.3	<.01	1.84	11.2		
Female	2,326	15.6	4,790	8.2	<.01	1.90	7.4		
Marital status	,								
Married	1,799	23.1	6,128	11.8	<.01	1.95	11.3		
Single	1,516	12.4	1,701	3.7	<.01	3.35	8.7		
Divorced	670	22.1	769	13.7	<.01	1.61	8.4		
Widowed	247	34.3	625	19.0	<.01	1.81	15.3		
Education									
<12 years	1,473	24.7	3,650	17.4	<.01	1.41	7.3		
12 years	1,588	19.9	2,723	11.1	<.01	1.79	8.8		
>12 years	1,155	14.2	2,800	7.0	<.01	2.02	7.2		
Low income	1,733	21.8	2,747	15.8	<.01	1.37	6.0		
Medium income	1,254	18.3	2,767	10.7	<.01	1.71	7.6		
High income	834	17.6	2,907	8.1	<.01	2.17	9.5		
Northeast region	763	21.7	1,018	12.0	<.01	1.80	9.7		
Midwest region	807	18.8	1,737	11.3	<.01	1.66	7.5		
South region	2,355	19.5	3,580	11.3	<.01	1.72	8.2		
West region	323	18.3	2,897	7.6	.012	2.40	10.7		
Percept. of health Excellent	728	15.7	1.580	6.4	<.01	2.45	9.3		
Very good	1.004	14.2	2.422	8.8	<.01	1.61	5.4		
Good	1.611	21.6	3,332	12.3	< 01	1.76	93		
Fair	768	25.3	1 643	20.2	02	1.75	51		
Poor	137	36.15	253	21.59	.05	1.67	14.6		
Percept. oral health	314	62	823	28	.00	2 21	34		
Very good	552	11.0	1 362	4.6	- 01	2 59	73		
Good	1 394	15.6	3 029	93	< 01	1.68	63		
Fair	1 238	22.9	2 569	15.9	< 01	1 44	70		
Poor	689	37.6	1 386	25.4§	< 01	1 48	12.0		
Insurance	2 523	18.8	6,004	10.0	< 01	1 88	88		
No insurance	366	15.0	584	10.0	03	1 44	4.8		
History of diabetee	233	38.4	523	19.9	.00	1.33	185		
No diabetee	4 025	187	8 707	10.3	< 01	1 91	Q /		
Current smoker	1 315	27 4	2 147	17 1	< 01	1 60	10.7		
Former smoker	673	24.5	2 261	122	< 01	1 85	11 2		
Never smoked	2,309	14.0	4,824	5.6	<.01	2.50	8.4		

**P*-values for chi-square test of independence between racial groups and periodontitis in each category of the third variable. †All *P*-values for Cochran-Mantel-Haenszel test of association and chi-square test of homogeneity between racial groups and periodontitis stratifying by a third variable were significant in each survey with the exception of the *P*-values for homogeneity for education (*P*=.22), income (*P*=.21) and geographic region (p=0.07) in NHANES I. ‡Prevalence ratio and absolute differences in periodontitis between African Americans and whites. ^S*P* trend, <.001. [¶]*P* trend, <.01.

These analyses produced unbiased estimates of standard errors. In the tables, the numbers of subjects per category are unweighted; however, all means and their standard errors, percentages, odds ratios (OR) and their 95 percent confidence intervals (CI) are weighted to represent the two racial groups in the US population.

Results

Population Characteristics. Table 1 shows a comparison of characteristics between racial groups in NHANES I and in NHANES III. Between NHANES I and NHANES III, African Americans showed greater improvements than whites in education, income, self-perceptions of general and oral health, presence of health insurance, as well as reduction in the prevalence of smoking. However, despite these improvements, sociodemographic characteristics of African Americans still fell short when compared to the characteristics of whites in NHANES III.

NHANES I. Overall, African Americans had significantly more periodontitis than whites, as indicated by higher mean PI scores during the periodontal assessment (data not shown). The overall prevalence of periodontitis in NHANES I was 31.6 percent, with African Americans exhibiting a significantly higher prevalence than whites (37.1% vs 30.4%, P=.04; Table 2). When stratifying individually by age groups, sex, marital status, perception of general and oral health, presence of health insurance, diabetes and smoking status, the prevalence of periodontitis was significantly higher among African Americans (Table 2). In general, the prevalence of periodontitis increased with age in both racial groups. However, this increase reached its peak in the age group 45 to 54 years in African Americans and then declined. Significant heterogeneity between and within racial groups was present across categories of most covariates. Overall, the prevalence of periodontitis exhibited significantly increasing trends across age groups (younger to older), and when related to self-perception of both general health (excellent to poor) and oral health (excellent to poor).

The relative and absolute differences in the prevalence of periodontitis were such that African Americans were more likely to have periodontitis

	NHANES I	NHANES II
Variables	OR (95% CI)	OR (95% CI)
Crude effect for race (African-Americans:whites)	1.35 (1.01, 1.80)	2.05 (1.67, 2.50)
Race effect adjusted for age	1.55 (1.13, 2.13)	2.51 (2.03, 3.10)
Race effect adjusted for age and education	1.45 (1.04, 2.03)	2.19 (1.77, 2.70)
Race effect adjusted for age and income	1.36 (0.98, 1.88)	2.02 (1.63, 2.51)
Race effect adjusted for age and socioeconomic indicators (SEI)	1.38 (0.98, 1.93)	1.95 (1.57, 2.41)
Race effect adjusted for age, SEI, and diabetes	1.38 (0.98, 1.94)	1.94 (1.57, 2.40)
Race effect adjusted for age, SEI, and smoking status*	1.48 (0.91, 2.39)	1.98 (1.59, 2.47)
Race effect adjusted for age, SEI, diabetes, and smoking status*	1.45 (0.89, 2.37)	1.97 (1.58, 2.46)
Race effect adjusted for age, SEI, and insurance*	1.34 (0.84, 2.14)	2.11 (1.69, 2.64)
Race effect adjusted for age, SEI, and time since last dental visit†		1.87 (1.50, 2.33)
Race effect adjusted for age, SEI, diabetes, smoking status, and insurance*	1.37 (0.86, 2.20)	2.15 (1.71, 2.70)
Race effect adjusted for age, SEI, diabetes, smoking status, and time since last dental visit†		1.91 (1.52, 2.40)
Race effect adjusted for all covariates‡	1.31 (0.78, 2.19)	2.09 (1.68, 2.60)

 TABLE 3

 Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Effect of Race on Periodontitis

*The change in the widths of the CI in NHANES I is due to missing values in smoking status and insurance.

+The variable "Time since last dental visit" was not collected for the age cohort of interests in NHANES I.

‡Adjusted for age, sex, marital status, education, income, geographic region, perception of general and oral health, presence of insurance, history of diabetes, and smoking status in both surveys. In addition, an adjusted OR of 2.01 (1.61, 2.51) for NHANES III was obtained when last dental visit was included.

than whites, with a ratio of 1.22:1.00 (range=0.81-2.37) and an overall absolute difference of 6.7 percent (range=[-5.4] - 26.7). The greater ratio was observed in the age group 17-24 years, while the greatest absolute difference was observed in the age group 45-54 years. There were a few exceptions where whites exhibited higher prevalence of periodontitis than African Americans (i.e., in those aged 65-74 years, those with >12 years of education, those with perceived excellent oral health, diabetics, and former smokers).

NHANES III. African Americans had a significantly higher prevalence of bleeding, calculus, higher mean CAL and PD, and greater tooth loss (data not shown). The overall prevalence of periodontitis in US adults was 11.9 percent, with the prevalence among African Americans being almost twice that among whites (19.6% vs 10.7%, P<.01) (Table 2). Overall, there were significant racial differences in the prevalence of periodontitis within and between most categories of age, sex, marital status, education, income, self-perception of general and oral health, history of diabetes, and smoking status. African Americans often retained a significantly higher prevalence of periodontitis than whites after stratifying for each covariate individually. Education and income presented the expected inverse association with the prevalence of periodontitis in both racial groups. However, poorer and less educated African Americans had a higher prevalence than did their white counterparts. As in NHANES I, the prevalence of periodontitis also was greater in the older age groups and in those with poor self-perceptions of their general or oral health.

The magnitude of the relative and absolute differences in the prevalence of periodontitis showed that African Americans had higher prevalence than whites, with an overall ratio of 1.83:1.00 (range=1.25–3.35) and an absolute difference of 8.9 percent

FIGURE 1 Race and Periodontitis in the US Population: 15-year Trends

(range=2.0–21.9). The greater ratio and absolute difference were observed in those who reported their marital status as single and were aged 55–64, respectively.

Race Effect after Adjustment for Covariates in NHANES I and in NHANES III. The effect of race was evaluated through a logistic regression model controlling for selected covariates in each survey (Table 3). The crude prevalence OR of periodontitis for African Americans was significantly greater than 1.00 in each survey. In both NHANES I and NHANES III, the ORs remained stable even after adjustment for age, the socioeconomic indicators of income and education, diabetes, smoking, and other variables. However, the confidence intervals included 1.00 in NHANES I, and they widened further when variables with missing values were included in the analysis for NHANES I. The greatest decline in NHANES III was observed when a behavioral covariate, time since last dental visit, was included in the model. (This variable was not collected for the groups of interest in NHANES I.)

Age Trends in NHANES I and in **NHANES III.** Figure 1 illustrates age trends in the prevalence of periodontitis in each survey. A shift in the age of the higher prevalence of disease in African Americans from 45 to 54 years in NHANES I to 55 to 64 years in NHANES III also was demonstrated. This shift could reflect the increase in African Americans' life expectancy over the past 20 years or perhaps a cohort effect or teeth survival bias. Despite the fact that different methods were used to assess periodontitis, the African-American:white pattern remained much the same in NHANES I and in NHANES III.

Discussion

To our knowledge, this study is the first to assess the magnitude of oral health-related racial disparities over time at the national level. Our analysis indicated that the relative and absolute disparities in the prevalence of periodontitis between African Americans and whites have increased from NHANES I to NHANES III. The prevalence ratio increased from 1.22 in NHANES I to 1.83 in NHANES III, while the absolute prevalence difference between African Americans and whites increased from 6.7 percent in NHANES I to 8.9 percent in NHANES III. These differences were consistent in the multiple logistic regression analyses for each survey after adjusting for known risk factors and socioeconomic indicators. While the overall prevalence of periodontitis appeared to diminish in NHANES III when compared to NHANES I (11.9% vs 31.6%), this diminution could be attributed to the different methods used to measure periodontitis in NHANES III. However, we tried several definitions for periodontitis, either more sensitive or more specific, without changing our results. It is noteworthy that there is evidence that the half-mouth scoring used in NHANES III could underestimate the prevalence of disease (45-47).

Oral health differentials between African Americans and whites have been documented in the United States since data have been collected (16-27). These differences were persistent after controlling for known risk factors and indicators, including income and education. While most of the studies had used race as an independent variable, one study suggested that the role of causal variables such as microbiological ecology and host resistance in juvenile periodontitis could account for the differences between African Americans and whites (23). Historically, race has been used to explain the health disparities between African Americans and whites by classifying genetic variations in humans and placing racial groups in a hierarchy system with Anglo-Saxons at the top (48). However, there is compelling evidence that there is no biologic basis for race (49-52). It has long been documented, and more recently confirmed by the Human Genome Project working draft, that all humans are identical in at least 99.9 percent of human genetic variation. Perhaps there is more variation within groups than between groups (53-56). Therefore, race per se is unlikely to explain disparities in general.

Other factors that have been suggested as possible explanations for health disparities include, but are not limited to, socioeconomic position (SEP), social factors, cultural factors, and behavioral factors. These factors have not been studied in depth, however, and frequently they are simply terms tossed into a discussion without further exploration or justification. More recently, an environmental, or contextual, effect has been suggested as a possible explanation for health disparities (57-59). Other factors to be considered, specifically concerning African Americans, are residential segregation, discrimination, and/or racism (60-66). The recognition that these factors are part of the causal chain for which the endpoint is the disparities in numerous measures of health indicates how complex the association of traditional risk factors and outcomes can be. The same situation most likely exists with respect to the disparities in oral health. In fact, 10 years ago, Petersen proposed a theoretical approach stressing the role of social, material, and cultural factors to explain social inequalities in dental health in Denmark (67).

Our study found an inverse association between the prevalence of periodontitis and (a) education and (b) income. This association was more pronounced in whites. Similar findings were observed throughout the prevalence ratios, absolute differences, and the multiple logistic regression analyses. Our findings were consistent with previous studies where education and income partly explained periodontitis among racial/ethnic groups (16,23, 27). Similarly, several reviews of the literature on general health in the United States suggest that racial disparities in health are widening and that these disparities are substantially attenuated when adjusting for SEP (9,68,69). Other studies have shown that within the same SEP strata, African Americans frequently have higher rates of mortality and morbidity than whites (70,71). It has been suggested that the persistent effect of race, after adjusting for the indicators for SEP, is because these indicators are not equivalent across races, leaving room for residual confounding (9,72-74).

In general, self-perception of health can influence individuals' attitudes toward the health care system and preventive behaviors. Self-perception of health could give a perspective on a patient's view of his or her health, the individual's prior experience with the health care system, as well as specific services an individual received (75-77). There is evidence that African Americans are more likely to perceive their general health as fair or poor than whites (78-80). Similarly, analysis from the International Collaborative Study of Oral Health Outcomes (ICS-II) showed that whites have more positive attitudes about their oral health than do African Americans (29). For both general and oral health, perceptions of health have been found to be associated with the patient's actual clinical status (28,80). Our findings did not show a consistent pattern in the relative and absolute differences of periodontitis between African Americans and whites between NHANES I and NHANES III. However, the multiple logistic regression analyses showed that the impact of self-perception of general and oral health on periodontitis might have increased. Analysis (not shown) indicated that when perception of general and oral health were excluded from the model, the effect of race (OR=1.31; 95% CI=.80, 2.15) remained unchanged in NHANES I while adjusting for other covariates. In contrast, this effect increased from 2.09 (95% CI=1.68, 2.60) to 2.22 (95% CI=1.77, 2.79) in NHANES III. This increase could indicate a decline in African Americans' attitude toward health over time. This type of change in attitude could translate into less access to care and, therefore, negative health behaviors and more clinical disease.

While the effects of environment, cultures, and behavior have been recognized as possible explanations for health disparities, these effects had not received much attention until recently. The environmental or contextual effect, a new and promising concept, has an effect independent of individual characteristics on people's well-being and quality of life (81). The proposed contextual effect might be the physical features of the area shared by individuals; the availability of a healthy or an unhealthy environment; services provided, privately or publicly, to support people in their daily living; the sociocultural features of a neighborhood; and the reputation of a neighborhood. The health-related exposures in the environment, or context, vary based on racial/ethnic composition. Alcohol and tobacco use behaviors are good examples of the interaction of individuals and their social environment (82-84). There is evidence that these products are targeted toward minority neighborhoods and communities (9,59). The environmental, or contextual, effect can play an important role in terms of dental services provided, access to care, and culture-sensitive providers. Therefore, the mechanisms by which environment, SEP, culture, and behaviors intertwine to influence health deserve attention and should not be ignored.

Finally, residential segregation, discrimination, and racism have been documented to adversely affect African Americans' physical and mental health (60-65). Residential segregation acts similarly to the contextual effect by limiting access to care, better schools, employment opportunities, hazardous environmental exposures, and poor-quality housing. Therefore, segregated areas have an independent effect after controlling for individual characteristics, including SEP indicators. In addition, if socioeconomic segregation is also present, these areas represent an exacerbation of intense disadvantage (85). The exposure to racial discrimination leads to subjectively experienced stress that can have an effect on health status. In fact, stress has been associated with periodontal disease in a predominantly white population (86), so it is plausible to expect that racism and discrimination could have an even greater effect on African Americans' periodontal health.

In summary, racial disparities in periodontal health are pervasive and have increased over recent times. However, as the composition of America changes, explanations for oral health differences need to include a broader range of aspects of the society in which we live. These disparities, as with those in general health, appear to be driven by social, cultural, and behavioral factors. Therefore, research aimed at reducing disparities in periodontitis should focus on the manner in which these factors affect the known causes of periodontal diseases.

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