Factors Influencing the Effect of Race on Established Periodontitis Prevalence

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Abstract

Objective: *This paper identifies differences in prevalence of established periodontitis and evaluates factors that might explain the differences between non-Hispanic African Americans (n=232) and whites (n=199) in the Detroit tricounty area.* ***Methods:*** *Subjects from a disproportionate probability sample of community-dwelling adults were interviewed regarding demographic, psychosocial and enabling factors, dental health-related behaviors, and other risk factors, and had comprehensive in-home dental examinations.* ***Results:*** *The overall prevalence of established periodontitis was 20.8 percent; African Americans exhibited a significantly higher prevalence than whites (29.8% vs 17.7%). The crude association between race and prevalence of established periodontitis was significant (odds ratio [OR]for African Americans=1.98; 95% confidence interval [CI]=1.17, 3.34). After controlling for other covariates, we found the effect of race may be modified by dental checkup visit frequency: African Americans with dental checkups at least once a year had almost a fourfold higher odds of established periodontitis (OR=3.64; 95% CI=1.43, 9.24) than their white counterparts with dental checkups at least once a year (the referent group); while African Americans with a dental checkups once every two years or less often were more than fourfold less likely to have established periodontitis (OR=0.22; 95%CI=0.08, 0.59) than their white counterparts in the referent group.* ***Conclusions:*** *This analysis supports the disparity in periodontal health as part of the black:white health disparity when taking other factors into account. However, periodontal health disparities may be more complex than previously recognized, requiring greater understanding of factors related to dental care utilization in future studies evaluating this disparity. [J Public Health Dent 2003;63(1):20-29]*

Key Words: periodontitis, race, dental health survey.

There is evidence that the health status of Americans has improved over the past half-century; however, this improvement has not been the same across all racial/ethnic groups of the US society (1-5). As an example, African Americans' health has improved considerably, but they continue to bear a higher burden of death, disease, and disability. Oral health has not been an exception to the health disparity between African Americans and whites. Several national surveys since the 1960s have reported periodontal diseases to be more prevalent in African Americans than whites. The Health Examination Survey (HES), conducted from 1960 to 1962, showed that African-American adults had higher mean Periodontal Index scores than whites (6), and the first National Health and Nutrition Examination Survey, conducted in 1970–74, exhibited similar differences between African Americans and whites (7,8). Analysis of the third National Health and Nutrition Examination Survey, conducted in 1988–94 (NHANES III), found that African Americans were more likely than whites to exhibit higher mean clinical attachment loss (CAL) and pocket depth (PD) (9).

Published data on the periodontal status of African Americans have several limitations. The 1985–86 National Institute of Dental Research (NIDR) Adult Survey included only employed adults and older adults at senior citizens centers, presenting an incomplete picture of the oral health of African Americans and whites and thus limiting generalization to the larger population. Brown and colleagues, using the NIDR Adult Survey data, reported that gingivitis and attachment loss were slightly more prevalent in African Americans, while moderate (4–6 mm) and deep pockets (≥7 mm) and gingival recession were substantially more prevalent in African Americans (10). Apart from the five statewide studies conducted in the late 1960s and 1970s (11,12) and the North Carolina-based Piedmont 65+ Dental Study (13-19), studies focusing on the oral health of African Americans since 1970 have been done on small convenience samples of subgroups of the population (20-24). No previous dental study has used a probability sample specifically focused on African Americans, incorporating a sampling strategy that included African Americans with (relatively) higher income and education.

Previous studies have found racial disparities in periodontal health to be associated with age, sex, marital status, education, income, presence of health insurance, history of diabetes, and tobacco use (13,15,24,25). Perceptions of general and oral health also

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have been associated with these disparities (30). However, these disparities are not fully explained by these factors. The purpose of this study is to identify differences between prevalence of established periodontitis and to evaluate factors that might explain the differences between African Americans and whites in the Detroit tricounty area.

Methods

Study Population. The study population was a disproportionate probability sample of adults, 18 years of age or older living in housing units (i.e., apartments or single-family houses) in the Detroit tricounty area. The sampling design has been described in detail elsewhere (31,32). Sampling was conducted utilizing a stratified, clustered, area probability sampling technique using census tracts. To maximize the ability to compare African Americans with whites and to separate the effect of socioeconomic status (SES) from race/ethnicity, the sampling design was disproportionate, with African Americans oversampled and African Americans in higher income census tracts further oversampled. One randomly selected adult from each selected housing unit was interviewed. Oversampling was taken into account by using weights based on the sampling design to represent adults living in the Detroit tricounty area.

Professional interviewers conducted face-to-face interviews lasting 65 minutes to collect data on demographic factors (age, sex, marital status, and education); enabling factors (income, employment status, dental insurance coverage, problems with payment for dental care, and difficulty with transportation to the dental office); psychosocial factors (perception of oral health and of impact of getting gum disease); oral health-related behavioral factors (brushing and flossing frequency and adequacy; use of rubber tip, toothpick, and stimudent; frequency of dental checkups during the past 5 years, and current smoking status); and finally, health characteristics (diabetes status, number of teeth, percentages of teeth with calculus, and gingival bleeding). The response rate for the interview was 71 percent (N=787). At the time of the interview, participants were asked to participate in the second phase of the study, a 50-minute in-home dental examination. Seventy three percent of the individuals interviewed were examined (N=577). The 210 participants who were interviewed but not examined did not differ significantly from those 577 who were examined on age, sex, marital status, race (29% of whites not examined vs 23.5% of African Americans), employment status, having medical or dental insurance, having a usual source of care, or dental checkup frequency. Those who were not examined had slightly higher incomes and were slightly more likely to have ever seen a dentist (96.1% vs 91.3%). Of the 577 individuals examined, 122 (21.1%) did not receive a periodontal assessment; 53 subjects were edentulous; and 69 were dentate, but had medical reasons. It is worth noting that the only statistically significant difference between individuals who received a periodontal assessment (n=455) and the dentate examined participants who did not (n=69) was the prevalence of smoking (32.5% vs 10.4%, respectively; P=.002). Moreover, when compared to dentate individuals, edentulous participants (n=53) were significantly older, less educated, and poorer, and more likely to report difficulties in access to dental care (i.e., difficulty in obtaining care and having a dental checkup). The analyses were restricted to those participants who gave consent to the examination, were dentate, and who reported themselves as non-Hispanic whites or non-Hispanic blacks or African Americans. These inclusion criteria yielded a sample of 431, including 232 African Americans and 199 whites.

Oral Examination. Dental examinations were conducted by dentists trained in the examination protocol from June through December 1994. Examinations were conducted any day or time during the week, using available headlamps and seating. Informed consent was obtained from all participants, and a brief medical history was taken before examinations. Subjects with medical conditions requiring antibiotic prophylaxis were excluded. The dental examination occurred within a few weeks of the interviews using the NIDR 1985–86 Adult Survey protocol (33), modified to include all teeth and four periodontal sites per tooth (mesio-buccal, mid-buccal, mesio-lingual, and disto-lingual). The examination protocol has been described in detail elsewhere (31,32). Briefly, experienced, calibrated examiners assessed periodontal status by examining for gingival bleeding, presence of supra- or subgingival calculus, and measuring probing depths and clinical attachment level. Interrater reliability was assessed prior to initiating the survey with the four examiners examining 10 dentate calibration subjects. The Cohen's kappa statistic for all four examiners ranged from 0.61 to 0.83 for lingual sites and 0.73 to 0.86 for buccal sites (34,35).

Assessment of Established Periodontitis. Previous studies have used several combinations of CAL and PD to establish case definitions (13,36,37). We tested several periodontitis disease definitions prior to arriving at the one used in this analysis for hypothesis testing, with all of them yielding essentially the same result: African Americans were at least 50 percent more likely than whites to have established periodontitis. For this analysis, established periodontitis was defined as a composite of ≥4 sites with CAL≥4 mm and at least one site with PD≥4 mm.

Covariates. Race was the main covariate and was determined from the question "Do you consider yourself white or Caucasian, black or African American, Asian or Pacific Islander, or American Indian, Eskimo, or Aleut?" Ethnicity was measured by asking the question "Do you consider yourself Hispanic or Latino?" Only non-Hispanic whites and non-Hispanic African Americans were included in this analysis. Hereafter, we referred to non-Hispanic African Americans as African Americans and to non-Hispanic whites as whites.

To investigate the race effect adjusted for other factors, the following covariates were included in the analysis: age, sex, marital status, education, income, current employment status, dental insurance, difficulty obtaining dental care, perception of oral health, frequency of dental checkups in the past five years, smoking status, self-reported diabetes, and number of teeth. Age was determined from self-reported birth date and tested in the analysis both as a continuous and categorical variable. The following age categories were used: 18–29 years, 30–39 years, 40–54 years, 55–64 years, and 65 years and older. Sex was as-

sessed by interviewer observation. Education was collected as a continuous variable through the question "What is the highest grade of school or year of college you completed?" and further categorized as less than 12 years of education, 12 years, 13–15 years, or 16 years and above.

Family income, in dollars for the previous completed year, also was collected as a continuous variable through the question "What was (your/your family's) total combined income in 1993 before taxes, including salaries, wages, pensions, dividends, interest, and all other income?" Income was categorized as follows: <$20,000; $20,000–$39,999; $40,000–$69,999; and ≥$70,000. Missing income was imputed by using mean income from the respondent's sampling stratum. Current employment status was assessed from two questions "Are you currently working for pay?" and "Do you work full-time or part-time?" Three categories for employment status were derived from the two questions: working full-time, working part-time, and not currently working. Dental insurance coverage was assessed by the question "Do you have any kind of insurance?" Other questions about dental insurance were asked to determine the type of insurance (Medicaid, private, more than one dental plan). For this analysis, dental insurance was categorized as Medicaid, private insurance, or no dental insurance.

Difficulty obtaining dental care was assessed through the question "Taking everything into account, how easy or difficult would you say it is for you to obtain dental care: very easy, somewhat easy, somewhat difficult, or very difficult?" Self-perception of oral health was assessed from the question "Overall, would you rate the health of your mouth, teeth, and gums as excellent, good, fair, or poor?" Frequency of dental checkups was assessed from the question "During the past five years, how often have you had dental checkups? Would you say more than twice a year, twice a year, once a year, about once every two years, once in five years, and not at all in five years?" These categories were recoded as having dental checkups at least once a year (more than twice a year, twice a year, and once a year) and having dental checkups once every two years or less often (about once every two years, once in five years, and not at all in five years).

Current smoking status was determined from the questions "Do you smoke?" and "Do you smoke cigarettes?" and specified as yes or no. History of diabetes also was specified as a dichotomous variable (presence or absence). Gingival bleeding and calculus were measured as dichotomous variables (presence or absence) for each tooth, then recoded as the percent of teeth (excluding third molars) with the condition.

Statistical Analysis. Demographic, enabling, psychosocial, and oral health-related behavioral characteristics, as well as diabetes and periodontal health-related measures were described using means for continuous variables and proportions for categorical variables. These characteristics were compared between African Americans and whites using the *t*-test and chi-square test for statistical significant testing.

The crude association between race and established periodontitis was calculated using the white population as the reference group. Bivariate logistic regression was used to estimate changes in the odds ratio for race and having established periodontitis, adjusting for each predictor variable individually. A change of ≥15 percent (in either direction) in the odds ratio for race between the univariate and the bivariate analyses was used as a criterion for the effect of race to be considered confounded by a third variable in the model, independent of significance level. Assessment of covariates for inclusion in candidate and final model was performed using three criteria: percent change in the OR for race, significance level of <.05, and variables that did not meet these criteria but had been previously recognized in the literature as important in the causal path (mediators) or considered as confounders and/or effect modifiers (13,15,24-29). Covariates that met at least one of these criteria were included in the final model. Multivariable logistic regression was used to obtain adjusted ORs by controlling for potential mediators, confounders, and/or effect modifiers and to build the best-fitting and most parsimonious model. The Wald statistic was used to test the regression coefficients in the bivariate and multivariable analyses. Plausible two-way interaction terms and their respective main effects were tested in the final candidate models.

All analyses were carried out using SUDAAN (39) to obtain unbiased standard error estimates, while taking into account the complex sampling design. In the tables, the sample sizes are unweighted, while means, proportions, standard errors, and ORs with their 95 percent confidence intervals are weighted to represent the distributions of the two racial groups in the Detroit tricounty area.

Results

Characteristics of Study Population. Table 1 shows the characteristics of the study population stratified by race. When comparing African Americans (n=232) to whites (n=199), there were differences in age distribution, marital status, education, income, dental insurance, and difficulty obtaining dental treatment. African Americans were more likely to have higher percentages of teeth with gingival bleeding and calculus and to have a significantly higher prevalence of established periodontitis. African Americans were significantly younger, more likely to have less than 12 years of education, and to be classified in the lower income categories than their white counterparts. In addition, African Americans were more likely to report being unemployed, to rate their oral health as fair or poor, to have diabetes, and to have a lower mean number of teeth. However, these differences were marginally significant.

Prevalence of Established Periodontitis. Table 2 shows the prevalence of established periodontitis in the total population and stratified by race. The overall prevalence of established periodontitis was 20.8 percent, with African Americans exhibiting a significantly higher prevalence than whites (29.8 percent vs 17.7%, P=.02). Overall, prevalence of established periodontitis was significantly higher among African Americans than whites when stratified by most covariates. The prevalence of established periodontitis increased with age, with African Americans exhibiting a steeper increase. Overall, males exhibited a higher prevalence than females.

Income and education exhibited somewhat unexpected patterns for established periodontitis. For education,

TABLE 1
Characteristics of Population by Racial Group: Detroit Tricounty Area, MI, 1994* *[cont. p. 24]*

	African Americans (*n*=232)		Whites (*n*=199)			Total (*N*=431)	
Variables	*N*	%	*N*	%	*P*-value	*N*	%
Demographic factors							
Mean age (years)	232	39.1 (1.15)	199	42.4 (1.15)	.05	431	41.6 (0.92)
Age group (years)					.04		
18–29	54	29.1 (3.37)	43	25.0 (3.67)		97	26.0 (2.99)
30–39	73	26.8 (4.78)	48	21.3 (3.68)		121	22.7 (2.89)
40–54	59	26.3 (6.84)	66	35.2 (5.05)		125	32.9 (4.07)
55–64	27	10.5 (3.36)	13	5.9 (1.36)		40	7.1 (1.56)
65+	19	7.3 (1.22)	29	12.5 (1.85)		48	11.2 (1.51)
Sex					.61		
Female	137	54.4 (3.02)	108	51.6 (4.40)		245	52.3 (3.34)
Male	95	45.6 (3.02)	91	48.4 (4.40)		186	47.7 (3.34)
Marital status					<.01		
Married	81	39.7 (2.77)	104	61.8 (3.27)		185	56.0 (2.39)
Separated	13	5.0 (1.30)	3	0.7 (0.40)		16	1.7 (0.57)
Divorced	38	12.0 (3.29)	26	8.4 (1.38)		64	9.4 (1.27)
Widow	19	7.3 (2.20)	22	7.5 (1.87)		41	7.5 (1.35)
Single	81	35.9 (4.65)	44	21.6 (3.07)		125	25.3 (2.50)
Education (years)					.01		
<12	39	20.1 (5.44)	20	8.2 (1.55)		59	11.3 (2.02)
12	71	33.1 (2.80)	71	33.9 (4.23)		142	33.8 (3.10)
>12 and ≤15	82	30.8 (4.38)	48	26.9 (3.38)		130	27.9 (2.78)
≥16	40	15.9 (3.44)	60	30.9 (5.81)		100	27.0 (4.53)
Enabling factors							
Income					<.01		
<$20,000	78	32.7 (6.13)	48	17.3 (3.13)		126	21.3 (2.77)
$20,000–$39,999	64	25.2 (3.53)	40	18.6 (1.67)		104	20.3 (1.56)
$40,000–$69,999	61	28.4 (6.97)	61	32.2 (2.83)		122	31.2 (2.70)
≥$70,000	29	13.7 (3.41)	50	31.8 (4.95)		79	27.1 (4.08)
Employment status					.10		
Full-time	136	59.5 (7.16)	120	63.1 (4.52)		256	27.3 (2.99)
Part-time	17	8.1 (2.36)	21	11.4 (2.36)		38	10.6 (1.78)
Not currently working	79	32.4 (5.58)	58	25.5 (3.30)		137	62.1 (3.88)
Dental insurance					.04		
Medicaid	35	14.8 (4.81)	9	3.3 (1.33)		44	6.3 (1.67)
Private	146	66.2 (4.44)	129	69.8 (2.75)		275	68.9 (2.10)
None	50	19.0 (2.36)	60	26.8 (2.82)		110	24.8 (2.06)
Difficulty obtaining care					.01		
Very easy	109	46.2 (5.26)	128	68.0 (4.57)		237	62.3 (3.83)
Somewhat easy	67	33.1 (3.76)	42	19.1 (2.57)		109	23.4 (2.36)
Somewhat difficult	39	16.8 (2.79)	18	8.2 (2.91)		57	10.4 (2.30)
Very difficult	17	4.9 (1.75)	11	3.5 (1.00)		28	3.8 (0.89)
Psychological factor							
Perception of oral health					.09		
Excellent	36	16.5 (3.77)	46	23.1 (2.85)		82	21.4 (2.32)
Good	94	41.4 (3.25)	101	51.5 (4.37)		195	48.9 (3.52)
Fair	82	34.8 (3.83)	42	21.6 (3.87)		124	25.1 (3.20)
Poor	20	7.3 (1.89)	10	3.7 (1.44)		30	4.6 (1.22)

*All *Ns* are unweighted; while means (SE), percents, and *P*-values are weighted to account for the sampling design.

TABLE 1
Characteristics of Population by Racial Group: Detroit Tricounty Area, MI, 1994* *[cont. from p. 23]*

Variables	African Americans (n=232)		Whites (n=199)		P-value	Total (N=431)	
	N	%	N	%		N	%
Health-related behaviors							
Dental checkups frequency					.64		
At least once a year	140	72.0 (5.55)	142	75.1 (4.18)		282	74.4 (3.56)
Once every 2+ years	62	28.0 (5.55)	54	24.9 (4.18)		116	25.6 (3.56)
Current smoking					.76		
Yes	80	33.7 (3.36)	69	32.2 (3.86)		149	32.6 (3.10)
No	152	66.3 (3.36)	130	67.8 (3.86)		282	67.4 (3.10)
Health measures							
Diabetes					.06		
Yes	16	6.7 (2.29)	4	1.6 (0.69)		20	2.8 (0.81)
No	216	93.9 (2.29)	195	98.4 (0.69)		411	97.2 (0.81)
Number of teeth		24.5 (0.46)		25.6 (0.48)	.11		25.3 (0.38)
% of teeth w/ gingival bleeding		23.9 (1.33)		10.8 (1.44)	<.01		14.2 (1.18)
% of teeth w/ calculus		41.2 (3.32)		18.7 (2.3)	<.01		24.6 (2.12)

*All *N*s are unweighted; while means (SE), percents, and *P*-values are weighted to account for the sampling design.

the expected inverse relationship was observed for the total population. However, for either African Americans or whites, this inverse pattern was not as clear-cut, particularly in the two middle categories (i.e., 12 years and >12 to 15 years of education). Likewise, for income the expected gradient was not observed across all categories. However, the prevalence of established periodontitis in the total population, as well as for whites and African Americans separately, on average was higher in the two lower income categories than the two upper categories. A linear increasing pattern of the prevalence of established periodontitis was observed as perception of oral health worsened in the total population and whites. However, this pattern was somewhat different for African Americans. Surprisingly, the prevalence of established periodontitis by frequency of dental checkups exhibited an inverse pattern in African Americans, with those who reported a dental checkup at least once a year during the past 5 years having a higher prevalence.

Bivariate Association between Race and Established Periodontitis Adjusting for Each Covariate. In our analysis of the crude OR for the association between race and established periodontitis, African Americans were twice as likely to have established periodontitis as whites (OR=1.98; 95% CI=1.17, 3.34). In bivariate analyses testing third variables for inclusion in our multivariable logistic regression models, both the magnitude and direction of the change in OR for race varied when covariates were included separately as third variables, with the OR for race ranging from 1.04 when percent of teeth with calculus was included to 2.99 when age-continuous was included (analysis not shown). The percent increase in the OR for race ranged from 0.01 (sex) to 0.51 (age-continuous) and the percent decrease ranged from no change (current smoking) to –0.47 (percent of teeth with calculus). African Americans were approximately three times more likely to have established periodontitis than whites when adjusting for the effect of age specified as either a continuous or categorical covariate and approximately twice as likely when adjusting for sex, marital status, education, income, employment status, dental insurance, difficulty obtaining dental care, perception of oral health, frequency of dental checkup visits, current smoking, diabetes, number of teeth, or percent of teeth with gingival bleeding. The effect of race was no longer significant when adjusting for the percent of teeth with calculus and gingival bleeding. While the effect of race was significant when adjusting for income, education, employment status, and dental insurance, the percent change in the OR was <0.15 percent.

Multivariable Logistic Regression. When age (continuous), sex, marital status, education, income, employment status, perception of oral health, frequency of dental checkups, current smoking, diabetes, number of teeth, and percent of teeth with calculus were included in the main effects-only model (Table 3, Model 1), the adjusted effect of race (OR=1.98; 95% CI=0.98, 4.00) was not substantially different from the crude effect of race (OR=1.98; 95% CI=1.17, 3.34). There was a significant interaction between race and frequency of dental checkup visits, suggesting a differential odds of established periodontitis for African Americans, with those who reported a dental checkup at least once at year during the preceding five years having almost a fivefold greater odds of established periodontitis than whites who reported having a dental checkup at least once a year (the referent group), while African Americans who reported having a dental checkup once every two years or less often were six times less likely than whites in the referent group to have periodontitis

TABLE 2
Prevalence of Established Periodontitis (%) for Selected Covariates, Stratified by Race, Detroit Tricounty Area, MI, 1994* *[cont. p. 26]*

Variables	African Americans (*n*=232) % (SE)	Whites (*n*=199) % (SE)	*P*-value	Total (*N*=431) % (SE)
Overall demographic factors	29.8 (3.42)	17.7 (2.29)	.02	20.8 (1.92)
Age group (years)			<.001	
18–29	5.0 (3.45)	2.2 (2.27)		3.0 (1.92)
30–39	20.5 (5.17)	8.0 (3.49)		11.8 (2.91)
40–54	36.9 (6.82)	23.5 (6.66)		26.3 (5.44)
55–64	65.8 (13.7)	22.2 (12.3)		38.9 (11.6)
65+	84.8 (6.45)	46.5 (8.13)		53.0 (6.55)
Sex			.02	
Female	25.9 (5.29)	15.4 (3.26)		18.2 (2.37)
Male	34.4 (5.28)	20.1 (3.85)		23.7 (3.38)
Marital status			<.01	
Married	33.1 (4.63)	16.4 (2.60)		19.5 (2.28)
Separated	17.4 (10.1)	30.9 (26.2)		21.1 (8.63)
Divorced	56.4 (10.4)	18.8 (8.81)		31.4 (7.50)
Widow	53.4 (12.2)	55.1 (11.1)		54.7 (6.93)
Single	14.1 (5.16)	7.4 (3.82)		9.8 (3.05)
Education (years)			.05	
<12	42.3 (9.35)	37.1 (11.0)		39.5 (8.04)
12	22.5 (2.35)	26.5 (3.77)		25.5 (2.85)
>12 and ≤15	35.8 (5.27)	7.0 (3.73)		15.2 (4.16)
≥16	17.3 (9.72)	12.2 (3.99)		12.9 (2.90)
Enabling factors				
Income			.06	
<$20,000	23.7 (7.01)	23.2 (4.23)		23.4 (3.59)
$20,000–$39,999	43.0 (11.8)	26.7 (6.74)		31.9 (5.60)
$40,000–$69,999	31.5 (9.10)	15.3 (4.78)		19.1 (2.75)
≥$70,000	16.5 (9.03)	11.8 (3.85)		12.4 (3.71)
Employment status			.03	
Full-time	33.2 (5.52)	14.1 (2.93)		18.8 (2.59)
Part-time	10.2 (5.94)	6.6 (6.07)		7.3 (4.96)
Not currently working	28.4 (6.77)	31.5 (4.91)		30.6 (4.05)
Dental insurance			.01	
Medicaid	27.9 (15.2)	12.2 (12.3)		21.5 (11.1)
Private	33.1 (4.93)	16.5 (3.03)		20.7 (1.82)
None	20.3 (8.40)	20.7 (5.95)		20.6 (5.13)
Difficulty obtaining care			.01	
Very easy	31.4 (3.97)	19.7 (3.23)		21.9 (2.86)
Somewhat easy	29.7 (8.77)	7.6 (5.79)		15.5 (5.50)
Somewhat difficult	27.6 (6.46)	12.3 (5.03)		18.7 (2.93)
Very difficult	22.9 (13.3)	49.6 (11.6)		40.8 (10.7)

*Weighted means (SE) and percents.

(OR=0.17; 95% CI=0.04, 0.76) after adjusting for the other covariates (Model 2). In addition, whites who reported having a dental checkup visit once every two years or less often (infrequent dental care users) during the previous five years were more than twice as likely to have established periodontitis as their white counterparts (in the referent group) who reported visiting the dentist at least once a year. However, this difference was not statistically significant (OR=2.54; 95% CI=0.70, 9.18). The deviance chi-square statistic comparing Model 1 and Model 2 indicated that the inclusion of the two-way interaction produced a better fitting model. Removal of covariates that were not statistically significant yielded the final, most parsimonious model, Model 3, as indicated by the deviance chi-square statistic comparing Model 2 and Model 3 (analysis not shown).

The final model, Model 3, included age, employment status, perception of oral health, frequency of dental checkups in the past five years, current smoking status, diabetes, percent of teeth with calculus, and the race * dental checkups interaction term. In Model 3, the odds of established periodontitis for African Americans who reported having a dental checkup at least once a year was almost four times greater than for whites in the referent group, while African Americans who reported visiting the dentist no more frequently than once within the past two years were four times less likely than whites (in the referent group) to have periodontitis (OR=0.22; 95% CI=0.08, 0.59) after adjusting for other covariates. As in Model 2, there was no significant difference between whites who reported having a dental checkup no more frequently than once within the last two years and their white counterparts in the referent group (i.e., those who reported having a dental checkup at least once a year).

Discussion

Our study further reiterates the African-American:white health disparity. Despite the oversampling of higher income African Americans, African Americans were still disproportionately represented in the lower categories of education and income. Moreover, the prevalence of periodontitis was higher for African Americans than whites in most categories for each covariate in the stratified analysis. While income and education in the bivariate analysis reduced the effect of race, an independent effect for race was pervasive. Finally, after adjustment for all covariates in the model,

TABLE 2
Prevalence of Established Periodontitis (%) for Selected Covariates, Stratified by Race, Detroit Tricounty Area, MI, 1994* *[cont. from p. 25]*

Variables	African Americans (n=232) % (SE)	Whites (n=199) % (SE)	P-value	Total (N=431) % (SE)
Psychological factor				
Perception of oral health			.05	
Excellent	6.5 (2.67)	7.6 (3.74)		7.3 (3.00)
Good	37.5 (3.90)	14.3 (2.70)		19.4 (2.24)
Fair	29.6 (4.74)	31.8 (3.49)		31.0 (2.63)
Poor	39.8 (13.6)	44.8 (16.2)		42.8 (11.2)
Health-related behaviors				
Dental checkups frequency			.10	
At least once/year	32.5 (5.20)	13.4 (2.18)		17.8 (1.62)
Once every 2+ years	8.8 (3.32)	27.5 (5.94)		22.7 (4.97)
Current smoking			.02	
Yes	34.3 (5.79)	23.5 (3.20)		26.4 (3.35)
No	27.5 (4.23)	14.9 (3.33)		18.1 (2.37)
Health measure				
Diabetes			.03	
Yes	61.3 (14.4)	46.1 (20.6)		54.7 (13.3)
No	27.7 (3.20)	17.2 (2.30)		19.9 (1.87)

*Weighed means and (SE) percents.

our study showed that the effect of race remained significant in both the main effects and interaction models. However, this effect was modified by the frequency of dental checkups in the past five years. While dental checkup frequency is but one dimension of dental care utilization, the effect modification estimated in our analysis suggests that the disparity in periodontal health attributed to race is more complex than previously recognized and may be further illuminated with a more complete assessment of dental care utilization.

After adjusting for income and education, we found a significant effect for race in the bivariate and multivariable analyses. It has been proposed that the main reason for this persisting effect of race is because income and education are not equivalent across race, hence introducing residual confounding (1,39-42). There is evidence that African Americans have higher mortality and morbidity experience than their white counterparts in similar income and education categories for several other diseases and adverse health outcomes (43-46). Possibly, the racial differences reported in our study reflect the same dynamics for residual confounding.

While it is hard to compare our findings to other racial/ethnic studies using multivariable analysis in similar age cohorts, our findings are consistent with the results of a report from another population-based study, the Piedmont 65+ study of the elderly (13). That study found significant effects for education and income on periodontal health status in the univariate analyses for both blacks and whites. However, in the multivariable analyses for both blacks and whites, the effect of education and income diminished, with behaviors (flossing, dental visits, smoking) and microorganisms (*P. gingivalis* and *P. intermedius*) estimated as significant predictors of periodontal diseases (13,14,16,19). Although there is an age differential between our study population and the Piedmont 65+ study of the elderly, it is plausible to consider similar findings for a younger population, such as that of our study.

In the multiple logistic regression analyses, our study shows that the effects of education and income were not significant in the final model, while a behavioral variable, frequency of dental checkups in the past five years, remained significant. In our analysis, frequency of dental checkups interacted with race, yielding a differential effect of established periodontitis prevalence for African Americans. For whites, the odds for established periodontitis was greater for those who reported less frequent checkup visits, as would be expected, though the point estimate was not statistically significant. The finding of a lower odds for established periodontitis in African Americans who reported having a dental checkup once every two years or less often in the past five years, while surprising, could be a reflection of a greater propensity for African Americans with poorer periodontal health to report a more frequent dental checkup visit pattern. In fact, upon further evaluation of the data, we found that African Americans who reported having dental checkups once every two years or less often were younger, had lower prevalence of periodontitis than African Americans with dental checkups at least once a year and similar prevalence of periodontitis, and had more teeth than whites with dental checkups at least once a year. Those African American participants with less frequent dental checkup visits were also more educated and had higher incomes than African Americans with dental checkups at least once a year, and had similar prevalence of periodontitis and more teeth than whites with dental checkups at least once a year.

Our results for African Americans are somewhat counterintuitive and not consistent with what others have found. Beck and colleagues, using a longitudinal study in an older population, found that among older African Americans only, those without a dental visit in the preceding three years were twice as likely to have periodontitis than their counterparts with a dental visit within three years (13). This association was not found in older whites. However, it is noteworthy that the population studied by Beck et al. was aged 65 years or older and the measures presented for dental care utilization are different in the two studies. Despite the inconsistencies between Beck et al. and our results, Beck and colleagues' finding of an increased odds of periodontal disease

TABLE 3
Multivariable Logistic Models Testing the Association Between Race and Established Periodontitis

	Model 1*			Model 2†			Model 3‡		
Variables	β	SE	OR (95% CI)	β	SE	OR (95% CI)	β	SE	OR (95% CI)
Demographics factors									
Race (main effects)									
Whites (WA)	0.0000	0.0000	1.00						
African Amer. (AA)	0.6814	0.3358	1.98 (0.98, 4.00)						
Race (interaction with dental checkup frequency)				1.6033	0.5072		1.2920	0.4433	
WA: at least once a year						1.00			1.00
AA: at least once a year						4.97 (1.71, 14.42)			3.64 (1.43, 9.24)
WA: once every 2+ years						2.54 (0.70, 9.18)			1.96 (0.60, 6.41)
AA: once every 2+ years						0.17 (0.06, 0.49)			0.22 (0.08, 0.59)
Age (years)	0.1253	0.0289	1.13 (1.07, 1.20)	0.1388	0.0291	1.15 (1.08, 122)	0.1095	0.0140	1.12 (1.08, 1.15)
Sex									
Male	0.1335	0.4578	1.14 (0.44, 2.99)	0.1841	0.466	1.20 (0.45, 3.20)			
Female	0.0000	0.0000	1.00	0.0000	0.0000	1.00			
Marital status									
Married	0.0000	0.0000	1.00		0.0000	1.00			
Separated	−0.4039	1.0609	0.67 (0.07, 6.20)	0.5576	1.3122	0.57 (0.04, 9.02)			
Divorced	1.0065	0.5232	2.90 (0.97, 8.71)	1.1091	0.5871	3.03 (0.88, 10.41)			
Widow	0.4921	0.6539	1.64 (0.41, 6.46)	0.4918	0.7745	1.64 (0.32, 8.32)			
Single	0.7832	0.6251	2.19 (0.59, 8.14)	1.0623	0.5103	2.89 (0.99, 8.45)			
Education (years)									
<12	0.5286	0.8371	1.70 (0.29, 9.85)	0.5632	0.8794	1.76 (0.28, 11.14)			
12	0.3055	0.4627	1.36 (0.51, 3.59)	0.4181	0.5612	1.52 (0.47, 4.94)			
>12 and ≤15	0.0792	0.5118	0.44 (0.12, 1.55)	0.0809	0.5818	1.08 (0.32, 3.68)			
≥16 years	0.0000	0.0000	1.00	0.0000	0.0000	1.00			
Enabling factors†									
Income									
<$20,000	−1.2136	0.7132	0.30 (0.07, 1.33)	−1.2907	0.7468	0.28 (0.06, 1.32)			
<$20,000 to $39,999	−0.3047	0.6604	0.74 (0.18, 2.95)	−0.6262	0.6520	0.53 (0.14, 2.10)			
<$40,000 to $69,999	−0.8265	0.6009	0.44 (0.12, 1.55)	−0.9700	0.5813	0.38 (0.11, 1.29)			
$70,000	0.0000	0.0000	1.00	0.0000	0.0000	1.00			
Employment status									
Full-time	0.0000	0.0000	1.00	0.0000	0.0000	1.00	0.0000	0.0000	1.00
Part-time	−1.5287	0.9360	0.22 (0.03, 1.55)	−1.3981	0.8320	0.25 (0.04, 1.42)	−1.8498	1.0340	0.16 (0.02, 1.38)
Not currently working	−0.8413	0.6036	0.43 (0.12, 1.53)	−0.8027	0.5887	0.45 (0.13, 1.54)	−0.8088	0.3919	0.45 (0.20, 1.01)
Psychological: Perception of oral health									
Excellent	0.0000	0.0000	1.00	0.0000	0.0000	1.00	0.0000	0.0000	1.00
Good	1.3158	0.7982	3.73 (0.70, 19.94)	1.3762	0.8035	3.96 (0.73, 21.42)	1.1998	0.6794	3.32 (0.80, 13.83)
Fair	2.3185	0.7197	10.16 (2.24, 46.09)	2.4338	0.6825	11.40 (2.72, 47.84)	2.0507	0.5277	7.77 (2.57, 23.56)
Poor	2.0837	1.3547	8.03 (0.47, 138.35)	2.0139	1.4704	7.49 (0.34, 164.51)	1.6718	1.1279	5.32 (0.50, 56.90)
Health-related behaviors: Dental checkups frequency									
At least once/year	0.0000	0.0000	1.00	0.0000	0.0000		0.0000	0.0000	
Once every 2+ years	0.0729	0.5133	1.08 (0.37, 3.16)	0.9323	0.6124	See OR for race	0.6722	0.5644	See OR for race
Dental checkups frequency*race				−3.4008	0.8018	See OR for race	−2.7908	0.6380	See OR for race
Current smoking									
Yes	1.3382	0.2363	3.81 (2.32, 6.26)	1.5132	0.2291	4.54 (2.81, 7.35)	1.2086	0.2722	3.35 (1.89, 5.93)
No	0.0000	0.0000	1.00	0.0000	0.0000	1.00	0.0000	0.0000	1.00
Health measures: Diabetes									
Yes	0.0179	0.8370	1.02 (0.18, 5.91)	−0.1249	0.9209	0.88 (0.13, 6.11)			
No	0.0000	0.0000	1.00	0.0000	0.0000	1.00			
Number of teeth	0.0418	0.0375	1.04 (0.96, 1.13)	0.0599	0.0404	1.06 (0.98, 1.16)			
% teeth w/ calculus	0.0284	0.0087	1.03 (1.01, 1.05)	0.0289	0.0090	1.03 (1.01, 1.05)	0.0218	0.0089	1.02 (1.00, 1.04)

*Model including covariates that meet the inclusion criteria. †Model 1 with Race*Checkup Frequency interaction term added. ‡Final model: Model 2 with nonsignificant covariates excluded. SE=standard error of β coefficient. OR=odds ratio. CI=confidence interval.

for those without dental visits within the preceding three years only among African Americans further suggests a differential effect for dental visits between African Americans and whites. The longitudinal nature of the Beck et al. study design could also contribute to explaining the inconsistency between our results and theirs. Therefore, in future studies, it will be important to determine if the paradoxical association, in either direction, between dental checkup visits (and perhaps more generally, dental care utilization) and greater periodontal disease odds persists in African Americans only.

Among the strengths of our study were the sampling design and diverse range of information collected during the interview and further used in this analysis. Another strength is the oversampling of higher-income African Americans. At the time this study was designed, analysis of the 1990 US Census indicated that of all the major metropolitan areas, the demographics of Detroit were the most similar to those of the United States as a whole. The major limitation of the study was its cross-sectional nature, which limited our ability to establish a causal relationship. Another limitation is that only questions related to current smoking were asked during the interview. This could have lead to incomplete adjustment for the effect of smoking and perhaps resulted in residual confounding. However, any misclassification due to using only current smoking status would have been nondifferential and would have biased the association between smoking and established periodontitis toward the null.

This analysis supports the disparity in periodontal health as part of the black:white health disparity, when taking other factors into account. However, periodontal health disparities may be more complex than previously recognized. Our analysis suggests that a greater understanding of factors related to dental care utilization may be illuminating in future studies evaluating this disparity. Further, little is known regarding how social, economic, and behavioral factors operate within each racial group. Future research should be designed to evaluate these factors' associations with periodontal health within each racial group. This type of research would help in further identifying differences between African Americans and whites that may contribute to oral health disparities. Moreover, such research could contribute toward the development of interventions leading to the reduction and eventual elimination of health disparities.

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