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Periodontal Disease Status in Gullah African Americans with Type 2 Diabetes living in South Carolina

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Abstract

Background—African Americans have a disproportionate burden of diabetes. Gullah African Americans are the most genetically homogeneous population of African descent in the US, with an estimated European Caucasian admixture of only 3.5%. This study assessed the previously unknown prevalence of periodontal disease among a sample of Gullah African Americans with diabetes and investigated the association between diabetes control and presence of periodontal disease.

Methods—Gullah African Americans with Type 2 diabetes (n=235) were included. Diabetes control was assessed by HbA1C, and divided into three categories: well controlled, <7%; moderately controlled, 7–8.5%; and poorly controlled, >8.5%. Participants were categorized as healthy, having no clinical attachment loss (CAL) or bleeding on probing (BOP); early periodontitis, having CAL ≥1 mm in ≥2 teeth; moderate periodontitis, having 3 sites with CAL ≥4 mm and at least 2 sites with probing depth (PD) ≥3 mm; and severe periodontitis, having CAL ≥6 mm in ≥2 teeth and PD ≥5 mm in ≥1 site. Observed prevalences of periodontitis were compared to rates reported for the NHANES studies.

Results—All subjects had evidence of periodontal disease: 70.6% had moderate periodontitis and 28.5% had severe disease. Diabetes control was not associated with periodontal disease. The periodontal disease proportions were significantly higher than the reported national prevalence of 10.6% among African Americans without diabetes.

Conclusions—Our sample of Gullah African Americans with type 2 diabetes exhibits higher prevalence of periodontal disease than African Americans, both with and without diabetes, described in NHANES III and NHANES 1999–2000.

Keywords

Type 2 diabetes; Gullah African Americans; Periodontal disease

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Summary: Gullah African Americans with type 2 diabetes have a high prevalence of periodontal disease.

INTRODUCTION

Type 2 diabetes (T2D) is a disorder characterized by chronic hyperglycemia as a result of impaired insulin secretion and action. An estimated 20 million people in the US suffer from diabetes, and the incidence is increasing. Minorities are disproportionately affected by diabetes and its complications.[1] In Western countries 35% of the adult population are estimated to develop periodontal disease, whereas 10–15% will develop severe periodontitis.[2,3] The terms moderate/severe periodontitis have been frequently used to characterize patients with substantial periodontal breakdown. The definitions have been employed both in descriptive epidemiological surveys for classification of the study population and in analytical studies, to determine disease severity. Although extensively used, these terms are often defined empirically and uniquely among various investigators. Therefore, even though several studies have documented racial/ethnic disparities in the US prevalence of periodontitis, these studies differed in their case definitions limiting direct comparisons.[4–8] In several studies, 2–5-fold higher risks of periodontal disease were reported in patients with diabetes.[9–11] Hyperglycemia in patients with diabetes has been thought to be responsible for higher prevalence and severity of periodontal disease.[12,13] Furthermore, some investigators have reported a two-way relationship between diabetes and periodontal disease, proposing that not only are patients with diabetes more susceptible to periodontal infection, but also that the presence of periodontal disease affects glycemic control.[14,15]

In chronic periodontitis, the interplay between periodontal pathogens and the host inflammatory immune system is responsible for destruction of the connective tissue, loss of periodontal attachment and resorption of the alveolar bone. Several inflammatory mediators implicated in periodontal destruction have been identified. Despite the fact that environmental factors appear to provide sufficient disease-provoking factors, not everyone appears to be equally susceptible to periodontal disease.[16] The hypothesis that genetic factors account for this observation has been postulated and supported by a number of studies for which authors found associations between severe periodontal disease and certain composite genotypes.[17,18]

The Sea Island Gullah speaking African-American people (hereafter: Gullah) of coastal South Carolina are considered to be direct descendants of native Africans, primarily from the West African costal region, ranging from present day Senegal and Gambia, south to Angola.[19,20] The South Carolina Gullahs—due to geographic and cultural factors—remain isolated and have less non-African gene admixture in their communities than do other African-American populations. This unique homogeneity positions the Gullahs for studies into genetic influences on disease severity. The relative risk of developing T2D in Gullah African Americans is 3.3, a figure that exceeds that in other communities.[21]

The aim of the present study was to determine the prevalence of periodontal disease and its association with diabetes control in the Gullah T2D population. We also compare the results to reported periodontal disease prevalence in the US using case definitions described in the literature.

MATERIAL AND METHODS

Study Population

Gullah African Americans 13 years-of-age and older with T2D were included in the study. Exclusion criteria included fasting serum C-peptide <1 ng/ml, serum creatinine ≥1.6 mg/dl, abnormal hepatic function, hemoglobinopathy/bleeding disorders, pregnancy, need for antibiotic prophylaxis, and use of recent systemic antibiotic therapy (2 weeks prior). Edentulous or subjects with less than three teeth were also excluded. All subjects answered a detailed questionnaire that focused on their social, medical, and dental history and all

underwent an oral exam. Blood and urine samples were collected for assessing diabetes control status and associated complications.

Recruitment was restricted to residents of South Carolina living along the coastal border and 30 miles inland. Participants were screened from an established cohort study of diabetes among Gullah African Americans (Project SuGar[22]), regularly scheduled community health fairs, recruitment events at local churches, and other community events. The subjects were recruited from June 2004 to May 2006. Elligble subjects were then enrolled and examined in the Clinical Research Center at the Medical University South Carolina (MUSC), Charleston SC or four off-site centers approved by the MUSC Institutional Review committee. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. All subjects provided written informed consent.

Clinical Measurement

Diabetes control was assessed by measuring HbA1C in the peripheral blood. Patients were classified as smokers if they were currently smoking; past smokers if they had smoked in the previous 6 months, but were not smoking currently; and non-smokers. Each subject had a full mouth exam that included measurement of probing depth (PD), the distance from gingival margin to the base of the pocket; bleeding on probing (BOP); clinical attachment loss (CAL, the distance from cemento enamel junction to the base of the pocket). Establishing examiner reliability was vital for accurate oral exam measurements. Oral examiners were calibrated according to the methods previously published by this group: agreement within 1 mm among our three study examiners and the standard ranged from 96–99% for in PD, 91–94% for in CAL, and 99% for CEJ-GM.[23]

Subjects were classified as

- Healthy: No CAL or BOP
- Early Periodontitis: CAL ≥1 mm in ≥2 teeth.
- Moderate Periodontitis[24]: 3 sites with CAL ≥4 mm and at least 2 sites with PD ≥3 mm
- Severe/Established Periodontitis[25]: CAL ≥6 mm in ≥2 teeth and PD ≥5 mm in ≥ 1 site.

CAL and PD exam measurements were rounded down to the next whole decimal number. Blood and urine samples were collected to assess renal function, lipid profiles and HbA1C at the time of enrollment.

Statistical Analysis

AH analyses were performed using SAS software (SAS, version 9.1). All *p*-values reported are two-sided, and the type I error rate was set at 0.05. Univariable summaries are given as mean ± standard deviation, with the median also reported when skewness was evident. The association between trichotomized HbA1C levels and categorized periodontal status was assessed using a chi-squared test. Multivariable analyses were performed using logistic regression and implemented in SAS with Proc LOGISTIC. The fit of the logistic regression was evaluated using recommendations by Hosmer and Lemeshow,[26,27] including computing the Hosmer-Lemeshow goodness-of-fit statistic and critiquing plots of the fitted values versus the leverages and changes to the deviance, chi-squared statistic and coefficients upon removal of each data point.

Safety assessments

All subjects were required to arrive fasting for the study visit. The morning doses of the diabetes medication were held until the completion of the examination. Upon arrival for the study examination, a finger-stick blood glucose (FSBG) was obtained. Subjects for whom FSBG was <70 mg/dl or >350 mg/dl did not continue with the study.

RESULTS

A total of 235 subjects were examined; 173 (73.62%) were female and 62 (26.38%) male. 144 (F/M 113/31) were 51–70 years of age, 74 (F/M 45/29) were 30–50 years, 15 (F/M 13/2) more than 70 years and 2 (F/M 2/0) less than 30 years of age. Diabetes duration was 10.8 ± 9.9 (median = 9.0) years for females and 10.0 ± 9.8 (median = 6.11) years for males. Of the 235 (F/M 133/32) surveyed, 165 (70.2%) had never smoked, 35 (F/M 14/21) 14.9% were current smokers and 35 (F/M 26/9) (14.9%) were past smokers.

Diabetes control

Diabetes status was classified as well controlled if HbA1C was < 7%, moderately controlled if HbA1C was 7–8.5%, and poorly controlled if HbA1C was >8.5%. In our study population of 235 subjects, 92 (F/M 66/26) (39.2%) were well controlled, 71 (F/M 56/15) (30.2%) had moderate control and 72 (F/M 51/21) (30.6%) were poorly controlled. Table 1 gives the distribution of study participants by gender and diabetes control status.

Diabetes related complications and Co-morbidities

Prevalence of hypertension and hyperlipidemia was determined using ADA (American Diabetes Association) recommended targets.[28] Subjects on medications for hypertension or dyslipidemia were included as positive for these conditions even if they met the ADA criteria for targets. ADA recommended targets are: systolic blood pressure (BP) <130 mm Hg and diastolic BP <80 mm Hg; LDL <100 mg/dl; triglycerides <150 mg/dl; HDL >40 (males), >50 (females). Glomerular filtration rate (GFR) was calculated using the MDRD equation.[29] Patients with GFR <60 ml/min were reported as renal insufficient. Table 2 depicts data for co-morbidities. At study commencement, 68.1% of subjects had LDL ≥100 mg/dl; 15.9% had TG ≥150 mg/dl; and 50.2% had low HDL. Because subjects with serum creatinine >1.6 mg/dl at screening time were excluded from the study, the observed proportion of 12% with renal insufficiency underestimates this proportion among the population of Gullah African-Americans with diabetes.

Missing Teeth

Among the 235 study participants, the number of missing teeth was 8.4 ± 6.5, with a range from zero to 25. The mean number of missing teeth did not differ significantly by gender (M 7.8 ± 6.5, F 8.6 ± 6.4), by smoking status (never 8.1 ± 6.0, past 9.3 ± 7.8, current 8.9 ± 6.0), nor by diabetes control (poor 7.7 ± 6.1, moderate 8.7 ± 7.0, well 8.7 ± 6.3).

Peridontal disease and diabetes control

Table 3 summarizes information on clinical attachment loss for the study participants. All subjects had at least 2 teeth with CAL ≥ 2 mm, and nearly 50% of subjects had at least 2 teeth with CAL ≥ 5 mm. Table 4 describes periodontal disease data using the Borell *et al.*[24] and Machtei *et al.*[25] definitions: 70.6% of our participants had moderate periodontitis (Borell) and 28.5% had severe periodontitis (Machtei). Presence of periodontal disease was not associated with diabetes control (p = 0.60 using Borrell's definition; p = 0.35 using Machtei's definition).

Multivariable logistic regression revealed that among the explanatory variables BMI, age, duration of diabetes, smoking status, gender, and HbA1c, only gender was significantly associated with the presence of severe periodontal disease as defined by Machtei. In particular, after adjustment for the other predictors in the model, the estimated odds that females have severe periodontal disease is 0.42 times the odds for males (OR = 0.42, CI = (0.20, 0.88), p = 0.02). This decreased odds of severe periodontal disease is consistent with the significantly lower proportion of current and past smokers observed among females. No association was evident with the other predictors (Table 5). Thus, even after adjustment for potential confounders, no association was found between HbA1c and the presence of severe periodontal disease as defined by Machtei *et al.*[25]

DISCUSSION

Diabetes mellitus and periodontal disease are two relatively common chronic diseases in the US and are believed to be biologically linked [9,30,31]. Several systemic factors are associated with an increased incidence and severity of periodontal disease in patients with diabetes. Current evidence regarding the biologic link between diabetes and periodontal disease supports persistent hyperglycemia leading to exaggerated immuno-inflammatory response to the periodontal pathogenic bacterial challenge, resulting in more rapid and severe periodontal tissue destruction [32,33]. Polymorphonuclear leucocytes (PMN) are considered a first-line host defense mechanism in inflammatory processes. They are primary protective against pathogenic bacteria and play a role in periodontal wound healing. PMN function is impaired in patients with diabetes, reducing their ability to combat infections. An increase in prevalence and severity of periodontal disease in subjects with diabetes is due to reduced PMN chemotaxis, phagocytic defects, and depressed humoral response. Also in a hyperglycemic environment, numerous proteins undergo glycosylation to form advanced glycation end-products (AGE). AGE-mediated events are of primary importance in the pathogenesis of diabetes complications and may also contribute to tissue changes within the periodontium…[34]

Gullah Sea Islanders are a unique population with only 3.5% European gene admixture compared to 17.7% in African Americans living inland.[19] The determination of the extent of European admixture is not only of great anthropological significance but may also shed light on why host responses differ, despite similar environmental and bacterial exposure. Several genetic polymorphisms have been associated with chronic severe periodontitis[17,35,36]. The unique homogeneity of Gullah Sea Islanders makes this population especially attractive for studying the influence of genetics on periodontal disease expression.

Studies to investigate the association between periodontal disease and diabetes mellitus have been conducted using varying case definitions of periodontal disease, with individuals from different populations, age groups, and different types of diabetes, making true assessment of prevalence of periodontal disease in diabetes difficult.[37] In Pima Indians, Emrich[38] found that patients with diabetes had three times the risk of periodontitis compared to patients without diabetes. Lalla *et al.*[39] provided additional evidence that diabetes is an important risk factor for oral disease among the low-income, underserved population of Northern Manhattan. Other studies have not found any difference in the prevalence of periodontal disease and diabetes.[2,40] A recent meta analysis conducted to asses the association between diabetes and periodontal disease concluded that subjects with diabetes had a significantly higher severity, but no statistical difference in the percentage of sites affected by periodontal disease when compared to subjects without diabetes.[41]

We used case definitions of periodontal disease well described in the literature to characterize periodontal disease in our Gullah population with diabetes. Using the same case definition as our moderate periodontitis, Borrell et al.[24] reported an overall prevalence of periodontal disease

of 7.3% in the NHANES III[42] data and 4.2% for the NHANES 1999–2000[43,44] data. African Americans had the highest prevalence of periodontitis, representing 11.4% and 6.8% for the NHANES III and NHANES 1999–2000 studies, respectively. Further, African Americans who reported no prior diagnosis of diabetes had prevalences of 10.6% (NHANES III) and 6.4% (NHANES 1999–2000). The corresponding prevalences for African Americans reporting a diagnosis of diabetes were 31.3% and 12.8%. Our finding of 70.6% prevalence of periodontal disease among Gullah African Americans with diabetes is significantly higher ($p<0.001$) than these national figures, even when compared to the rate among African Americans with diabetes. Our PD measurements were rounded down to the next whole decimal, unlike the NHANES protocol, which rounded up. Thus, we may be underreporting the prevalence of periodontal disease in this population.

In NHANES III and NHANES 1999–2000 among the Black subgroup, 31.7% and 25.7% were reported as current smokers, 13.1% and 13.4 % as former smokers and 55.2% and 60.9% as never smokers[24]. In comparison, 14.9% of our subjects were current smokers, 14.9% former smokers and 70.2% reported to have never smoked. We classified subjects as smokers if they were currently smoking; past smokers if they had smoked in the previous 6 months, but were not smoking currently; and non-smokers. NHANES smoking status was derived from two questions in both surveys. “Do you smoke cigarettes now?” and “Have you smoked at least 100 cigarettes in your entire life?” Smoking status for NHANES was defined as current smokers (subjects who answered “Yes” to both questions), former (subjects who answered “No” to the first question and “Yes” to the second question), and never smokers (subjects who answered “No” to both question”. The difference in smoking classification should be taken in to account when interpreting our study data.

This study represents the first investigation in to the prevalence of periodontal disease in Gullah Africans-Americans. We found significantly higher periodontal disease prevalence in Gullah T2Ds compared to African Americans in the NHANES populations. Our study population, however, is limited to subjects with diabetes and those with well-controlled diabetes served as controls for the poorly controlled subjects. These subjects were predominantly of lower socioeconomic status with limited dental care access. Poor oral health care has traditionally been linked to lower socioeconomic status and may influence our results. Also, 74% of our subjects were women, and 61 % of the subjects were between the ages of 51–70 years. Enrollment of more men and/or younger subjects may change study results; every effort will be made to increase recruitment of these groups for future studies.

Mean total missing teeth (TMT) due to caries or periodontal disease per subject reported for NHANES 1988–1994 and 1999–2002 among dentate non-Hispanic black adults was 6.87 (se = 0.15) and 5.78 (se = 0.14), respectively [45]. In comparison, the mean TMT due to caries or periodontal disease of our 235 Gullah subjects with diabetes was significantly higher ($p<0.01$) at 8.3 (se = 0.42) (range of 0–25). Edentulous or subjects with less than 3 teeth were not included in our study, and the cause of missing teeth was recorded as attributable to decay (caries), trauma, periodontitis or other according to patient recall. We recognize that recall may be erroneous, as often the event occurred several years earlier. Our study results should be interpreted in light of the high number of missing teeth in our sample as compared to that reported in NHANES.

Our report suggests a high prevalence of periodontal disease in the Gullah African-American with diabetes living in South Carolina. Low socioeconomic status, presence of other systemic diseases, and a unique genetic background may increase susceptibility to periodontal disease, all of which warrant further investigation.

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TABLE 1

FREQUENCIES OF DIABETES CONTROL GROUPS

HbA1c (%)	Male	Female	Total	Percent (%)
<7	26	66	92	39.15
7–8.5	15	56	71	30.21
>8.5	21	51	72	30.64
Total	62	173	235	100

TABLE 2

PREVALENCE OF DIABETES-RELATED COMPLICATIONS AND CO-MORBIDITIES AMONG GULLAH SUBJECTS WITH TYPE 2 DIABETES

By Exam/Lab tests and Reported Medications	Frequency (%)
Hypertension	211 (90.2)
Hyperlipidemia	220 (94.0)
Renal Insufficiency (GFR < 60)	28 (12.0)
Self-Reported Symptoms	**Frequency (%)**
Neuropathy	142 (60.4)
Foot Ulcers	15 (6.4)
Amputations	6 (2.6)
Retinopathy	9 (3.8)
CAD	13 (5.5)

Frequency is computed among subjects (n = 235), except for hypertension, hyperlipidemia, and renal insufficiency status, which were determined for 234 subjects.

TABLE 3

PREVALENCE OF ATTACHMENT LOSS IN 2 OR MORE TEETH (N=235)

CAL (mm)	Patients (N)	Cumulative %
≥1	235	100.00
≥2	235	100.00
≥3	218	92.77
≥4	175	74.47
≥5	122	51.91
≥6	77	32.77
≥7	49	20.85
≥8	26	11.06
≥9	16	6.81
≥10	10	4.26

TABLE 4

PREVALENCE OF MODERATE PERIODONTITIS[24] AND SEVERE/ESTABLISHED PERIODONTAL DISEASE[25] AMONG THE GULLAH PARTICIPANTS WITH DIABETES (N=235)

HbA1C	Moderate Periodontitis	Severe Periodontitis
<7%	66	27
7–8.5%	47	16
>8.5%	53	24
Total (%)	166(70.64)	67(28.51)
	$p = 0.60^{+}$	$p = 0.35^{+}$

[+] The p-value in a column corresponds to the test of association between the 3-category HbA1c classification and the periodontal disease classification of that column.

TABLE 5

RESULTS OF MULTIVARIABLE LOGISTIC REGRESSION OF THE BINARY INDICATOR OF SEVERE/ESTABLISHED PERIODONTAL DISEASE[25]

Predictor	Odds Ratio	95% Wald CI	*p*-value
Body Mass Index	1.00	(0.96, 1.04)	0.90
Age	1.01	(0.98, 1.05)	0.44
Duration of Diabetes	0.98	(0.94, 1.02)	0.27
Gender (in terms of females)	0.42	(0.20, 0.88)	0.02
Smoking Status			0.61
Current	0.86	(0.24, 3.07)	0.81
Past	0.44	(0.08, 2.28)	0.33
Never	Reference group		
Hemoglobin A1c			0.69
> 8.5%	1.08	(0.42, 2.77)	0.87
7.0–8.5%	0.72	(0.28, 1.86)	0.49
< 7.0%	Reference group		
Smoking Status by Hemoglobin A1c interaction			0.39
Current, > 8.5%	2.94	(0.46, 18.81)	0.26
Current, 7.0–8.5%	Unable to estimate†		
Current, < 7.0%	Reference group		
Past, > 8.5%	2.73	(0.29, 25.89)	0.38
Past, 7.0–8.5%	4.74	(0.53, 42.37)	0.16
Past, < 7.0%	Reference group		

NOTE: N=214.

†All subjects with hemoglobin A1c levels between 7 and 8.5% who were also current smokers had early periodontitis. Hence this interaction term could not be estimated. Three such subjects were removed from the analysis to ensure a stable model fit.