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Diabetes and Tooth Loss among Working-Age African Americans: A National Perspective

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Abstract

Natural teeth are still lost in adults despite improvements in dental care and access to treatment across the life span. The study examined whether tooth loss can be mitigated in adults experiencing diabetes. National online survey data from the Service Utilization among African Americans with Co-morbid Depression and Diabetes ($n = 275$) were analyzed using logistic regression analyses. Diabetes was most prevalent among men (73.5%) and least prevalent among women (40.6%). In general and among the women, those without diabetes have approximately 50% fewer missing teeth than those with diabetes (odds ratio = .50; 95% confidence interval: 0.30, 0.83). Tooth loss is a traumatic experience and a serious life event that requires professional attention.

Keywords

African American adults; decayed and missing teeth; gender; medication; oral disease; oral health; prescription drugs; type II diabetes

Oral health is critical for increasing quality of life. Cumulative exposure to various risk factors that contribute to losing some or many teeth are particularly pronounced among those unable to maintain an optimum level of oral health. Despite improvements in dental care, insurance, and strategies to retain teeth, adults experiencing chronic illness—such as diabetes—can still lose natural teeth across the life span.

Although the prevalence of tooth loss has declined over the past few decades, it still is a significant public health problem particularly affecting those with intermittent to no connection to dental care in the United States. The complexity involved in oral diseases and other health-related conditions serve as reasons for losing teeth. Type II diabetes is a chronic disease that increases the risk of developing dental and oral diseases directly (e.g., inflammatory gum response), indirectly (e.g., decreased saliva production due to medication), (Griffin, Barker, Griffin, Cleveland, & Kohn, 2009) and more frequently, linked

to social determinants (Finlayson, Williams, Siefert, Jackson, & Nowjack-Raymer, 2010; Newton & Bower, 2005; Watt, 2007). In general, persons with Type II diabetes are more susceptible to bacterial infections and have decreased ability to control bacterial infection. Persons with Type II diabetes are at risk for certain dental problems such as cavities, fungal infections, and delayed healing (Leite, Marlow, & Fernandes, 2013). Chronic periodontal disease and severe dental caries are the primary reasons for tooth loss in adults.

When social determinants are taken into account, adverse outcomes among adults with tooth loss include difficulty in chewing and speaking, smiling, and social stigmas of missing teeth such as interacting with others. Tooth loss and associated dental problems like gum disease can lead to social isolation, poor nutrition, and possibly and increased vulnerability to serious and deadly infections. Varying risk factors for tooth loss have been associated with age (Eke et al., 2015; National Institute of Dental and Craniofacial Research, 2015), mental illness (Okoro, Strine, Eke, Dhingra, & Balluz, 2012), socioeconomic position (Fouad, Al-Sudani, Vehkalahti, & Suominen, 2015; Locker, 2000), and chronic conditions requiring more than six medications (Ward & Schiller, 2013). Even though age may be named as one of the most significant predictors in tooth loss, especially for older people, the factors critical for working-age adults have not been studied as closely and may point to variations in risk factors across racial lines. Therefore, given the rising number of persons with multiple chronic conditions, it is important for public health social workers and other related professionals to attend to possible implications on quality of life.

The incidence of oral health problems will likely increase due to the rapid rise in Type II diabetes and adult obesity rates, especially for African Americans (Flegal, Carroll, Ogden, & Curtin, 2010). According to the Centers for Disease Control and Prevention (CDC; 2010), Type II diabetes will increase from 8 per 1,000 people in 2008, to 15 per 1,000 in 2050. Evidence is accumulating that periodontal disease, one of the most common dental problems and a major cause of tooth loss, is significantly more severe in persons with Type II diabetes (Lalla, Park, Papapanou, & Lamster, 2004; Taylor, 2001b). Evidence suggests that persons with Type II diabetes are at an elevated risk for periodontal disease and periodontal disease is now recognized as a complication of diabetes (Taylor, 2001a, 2001b). The presence of unresolved periodontal infections contributes to poor glycemic control and may predispose to other and possibly more severe complications.

Conceptually, the framework for this analysis was derived from epidemiological theories of the social production of disease (Krieger, 2001; Link & Phelan, 1995). In essence, each individual's relative economic and social position (i.e., race/ethnicity, socioeconomic status [SES], and gender) determines the type of exposure to single event or constant stressors that damage health and access to resources that might lead to improved health outcomes. Among those in the lowest SES ranks, diabetes is thought to increase gum inflammation in the areas surrounding the teeth that specifically affects periodontal tissues (Taylor, 2001a; Williams et al., 2008). There is a greater likelihood that those in low SES will have inadequate dental insurance and/or access to comprehensive dental services. Adequate dental insurance coverage (i.e., payment for dentures, bridges and implants) is necessary to individuals with Type II diabetes in order to maintain and retain teeth that have not been extracted

(Schrimshaw, Siegel, Wolfson, Mitchell, & Kunzel, 2011). It is hypothesized that diabetes would serve as the most significant risk factor in tooth loss among African Americans.

Although improvements to availability of dental care is improving for those with diabetes, an understanding of the underlying social causes related to tooth loss remains needed to improve interventions and to target more precisely prevention efforts. Public health social workers can have a role in oral health preventative care in service provision. There are limited studies that report on tooth loss with a focus on African Americans and different variables such as education level, age, number of medications, and gender. Teeth maintenance deserves some attention as it increases the quality of life, especially among persons diagnosed with Type II diabetes. Therefore, the aim of the present study is to evaluate if there is an association between tooth loss and several other variables like gender, the number of medications prescribed, and dental insurance to consider the relative importance of these factors in understanding the context of adult lives given diabetes.

Method

Data and study population

The study's sample was selected from respondents in the Service Utilization among African Americans with Co-morbid Depression and Diabetes online survey. Respondents were selected from Research Now's E-Rewards National Panel, which comprised 2.5 million people. Known characteristics of panel members (age, race, diabetes diagnosis, and depression diagnosis) were used to determine which members were solicited via email to participate. A total of 3,400 invitations were e-mailed. Of those invited, 688 clicked *yes* on the survey invitation and 275 completed the survey. The survey was available to participants between February 21, 2014 and March 4, 2014. Fifty-four persons terminated or did not complete the survey and the remaining 359 were screened out based on exclusionary criteria (non-Black or White race and younger than 18 years).

Measures

Two dichotomous outcome measures (presence of missing teeth and regular number of missing teeth) were constructed based on two questions about missing teeth. The first question asked, "Do you have any missing teeth?" and the second asked, "How many missing teeth do you have?" If respondents answered the first question with *no* they were classified as having zero missing teeth. Respondents who answered *yes* to the initial question were classified as having 1 to 32 missing teeth. For the subsample that had missing teeth, the number of missing teeth was not normally distributed, therefore we used the median to create a dichotomous variable for missing teeth in the analysis. Responses ranged between no missing teeth (0) and 32 missing teeth. The missing teeth variable was coded as fewer than seven teeth (0) and more than eight teeth (1).

Covariates

Self-reported diabetes status was ascertained by asking participants to respond "No (0)" or "Yes (1)" to the question, "Do you currently have any of the following conditions, Type II diabetes?"

Sociodemographic variables—Gender was measured as female (coded as 0) and male (coded as 1) and age was measured as the number of years attained by the date of the interview. Each variable included in the models as controls were race, coded as Black (1) which included Caribbean Blacks, African Americans, and biracial persons (with at least one Black or African American parent), and White coded as (0). Education was measured as no schooling completed (0), some school or high school diploma (1), some college or associates degree (2), bachelor's degree (3) and graduate study or graduate degree (4). *Income* was measured as annual earnings less than \$50,000 (0), \$50,000 to \$99,999 (1) and \$100,000 or more (2). Education and income served as indicators of SES.

Additional model covariates

To account for the most commonly diagnosed diseases among African Americans that could affect oral health, an index of current health conditions was created. Respondents self-reported conditions in the index ranged from 1 to 6 where depression, arthritis, asthma, hypertension, liver condition, and HIV/AIDS were included in the count. Lastly, the effects of having dental insurance coded dichotomously as “Yes” (1) or “No” (0), perceived self-reported ratings of oral health where Excellent or, Very good (1), Good (2) and Fair or Poor (0) and the number of meds (range 0–15) were also covariates.

Data analysis

The analyses began with a series of bivariate assessments on the extent to which gender, income, the number of missing teeth, as well as prevalence of comorbidities differed by diabetes status. The gender and age distributions in each of the two racial/ethnic groups were also examined. Chi-squared (χ^2) tests (categorical variables) and Student T tests (normally distributed continuous variables) were used to identify significant differences across groups. Logistic regression was used to evaluate differences in the odds of missing teeth, while adjusting for age, gender, income, health conditions, dental insurance, and number of medications. The sample was then stratified by gender to assess its association with diabetes, as well as its role in mediating racial/ethnic differences in missing teeth. Interactions were also examined between race, diabetes and gender. The level of significance was set at 5%. Prevalence ratios (PR) and 95% confidence intervals (CI) were calculated for each variable. Analyses were performed using SAS software version 9.3.

Results

Demographic unadjusted sample distributions for 275 persons are presented in Table 1. Males represented one fourth of the sample (24.7%) and 75% of the men were diagnosed with diabetes. The sample's average age was 55 years. Ranging from 0 to 32 missing teeth, the sample recorded on average eight missing teeth. People with diabetes, on average, were 5 years older than the total sample. By diabetes status, a 12-year difference exists between the two groups where those with diabetes were older than those without (61.8% and 50.0%, respectively). One half of the sample reported an annual income of approximately \$50,000 which is about \$17,000 more than the median household income recorded for African Americans. There were no differences in years of education and number of missing teeth between self-reported people with diabetes and people without diabetes. Bivariate analyses

showed that the distributions of gender, age, and income are not uniform, meaning the differences were statistically significant at $p = .05$.

The logistic regression models presented in Table 2 shows the unadjusted association between missing teeth and diabetes for the total sample as well as for males and females. In the total sample, and among the females, those without diabetes have approximately 50% fewer missing teeth than those with diabetes (PR = 0.50; 95% CI [0.30, 0.83]). In Models 2 and 3, after adjusting for group differences in age, income, dental insurance and comorbidities, the protective effect of not having diabetes persisted among the total sample and among females, but the protected affect was no longer statistically significant.

Table 3 reports the analysis of only persons with self-reported diabetes ($n = 177$). Results indicate a lack of statically significant association between diabetes status and the number of missing teeth. Because the number of missing teeth did not follow a normal distribution, analyses were based on the median number of missing teeth (median = 4). Table 4 shows the results from a stratified gender analysis. Among the sample with diabetes, men recorded more missing teeth than women, but the interaction between Gender and Missing Teeth was not significant. The results with respect to diabetes status show that having diabetes was associated with an increase in the odds of missing teeth among males (PR = 2.71; 95% CI [1.12, 6.55]) when compared to females. The association persisted even after adjusting for potential confounders.

Discussion

Oral health (here defined as number of natural teeth) was analyzed using two complementary perspectives: (a) presence of missing teeth and (b) the number of missing teeth. Tooth loss is a traumatic experience and a serious life event that may require significant social and psychological readjustment. Three significant findings emerged from the analyses for African Americans. Having diabetes was associated with an increase in the odds of missing teeth among men when compared to women. The number of natural teeth, a surrogate for presence of periodontal disease, was not statistically influenced by Type II diabetes in this sample.

These findings are consistent with the evidence from other epidemiological studies that support the notion that diabetes may serve as a precursor to natural teeth loss (periodontitis), particularly among African Americans (Brown et al., 2005; Herman, 2009; National Institute of Dental and Craniofacial Research, 2010; Taylor, 2001b). Although it is not possible to form causality from these cross-sectional data, the results are consistent with the body of literature available supporting the impact of diabetes on poor oral health (Craig et al., 2003; Finlayson et al., 2010; Lalla et al., 2004; Watt, 2007).

As observed in Taylor (2001a) preventing more severe complications resulting from diabetes via poor oral health remains a priority given the evidence that supports evaluating and encouraging access to and use of routine preventive dental care. However, it must be noted that oral cavity assessment is not universally considered as a standard of care in general physical examinations. The present study reported that African Americans use dental

insurance when it is necessary, especially if diabetes is present. We examined whether having dental insurance would counter deteriorating periodontal health among diabetics. Given the data collected, we could not show a direct relationship between using dental insurance and improved oral health. Yet indirectly we show that dental insurance provided access to dental care for 59.6% of the study participants. Saremi and colleagues' (2005) research results also suggest that our findings might indirectly explain why African Americans experience increased mortality associated with diabetes.

We believe that because the prevalence and severity of periodontal disease and other chronic health conditions are known to increase with age, the relative youth of our cohort (on average, 55 years) suggests that these conditions do not independently affect oral health at early disease stages. We tested whether the interaction between Race and Poverty Status as well as Race and Diabetes Status influenced the number of natural teeth. Neither of the interactions tested yielded statistically significant results. Race and Poverty Status appears to serve as independent factors in predicting the number of natural teeth reported.

Being a woman appears to lessen the likelihood that individuals will have fewer natural teeth than the expected 32 adult natural teeth. This finding almost mimics the demonstrated relationships in the Craig et al. (2001) study that found African Americans were less likely to report having a private dentist and had more missing teeth than other racial groups in the study (p. 531). Poor oral health in this sample is evident in that the average number of natural teeth was 25. Prevention of periodontal disease that results in tooth loss requires regular assessment, treatment, and management by dental professionals.

Several studies found, however, no significant association between Type II diabetes and the number of natural teeth. One study reported no significant difference using the Community Periodontal Index (CPI) in which oral disease was divided into three categories: 0 = no or minimal signs of periodontal disease, 1 = intermediate signs of declining oral health; and 2 = severe periodontal disease. Chuang, Sung, Kuo, Huang, and Lee's (2005) study reported no significant difference in the CPI oral health ratings between diabetic and nondiabetic groups. Another study by Macek and Tomar (2009) indicated that dental care visits for adults with diabetes were unrelated to their periodontal health (Macek & Tomar, 2009). However, the findings reported here are similar to the Ueno et al. (2010) study in that periodontal disease as measured by the number of natural teeth is influenced, to some degree, by diabetes status (Ueno et al., 2010). Differences in outcomes may also occur due to respondent characteristics (i.e., race, gender, poverty status, and age) and measurement of diabetes status. The lack of attention to specific demographic characteristics, namely race and poverty status, appear to have contributed to conflicting results (Albandar, Brunelle, & Kingman, 1999; Beck, Koch, Rozier, & Tudor, 1990; Drake, Hunt, & Koch, 1995; Lamster, Lalla, Borgnakke, & Taylor, 2008).

Inadequate literacy represents an obstacle to improving health among racial and ethnic low-income populations due to reading comprehension. The inability to understand health risks, evaluate treatment options, and follow health improvement recommendations illuminate the discordance between what we expect of patient populations and what is required for them to

function optimally seeking health care. Hence, the best diabetes prevention campaign messages may not result in changes in diabetes management behavior.

Even though a clear relationship between Type II diabetes and the number of natural teeth (an indication of periodontal disease) was observed, the outcomes appear to be influenced by other nonmeasured factors and a number of limitations. The presented regression model's strength indicated room for additional research. It is important to keep in mind when interpreting the results of the present study that the data were obtained from an online national sample in the United States. We hypothesized that Type II diabetes affects periodontal health and would lead to a greater loss in natural teeth. The results confirmed the hypotheses that diabetes would serve as the most significant risk factor in tooth loss among African Americans.

However, the present study did not ask questions about the type of dental care services that were provided, the reason for tooth loss, or ask detailed questions about the type of dental insurance held. It is possible that some adults with diabetes who visited a dentist did not receive any kind of periodontal assessment or treatment. Our results indicate that dental visits were not for ongoing monitoring of periodontal disease but for extraction. To properly measure periodontitis, one would need to manually probe for clinical attachment loss and probing depth, the gold standard of measurement. Nevertheless in studies that were not mainly focused on oral health, such as Burt (2005), counting the number of lost teeth represents a good substitute for actual measurements. Another limitation was the cross-sectional nature of the study. Because diabetes status and tooth loss were measured at one point in time, it was impossible to know the true causal order of disease. We relied on the extant literature to guide our research. A more systematic study over time will be necessary to confirm the findings reported here. Other limitations of past literature leading to contradictory results were likely related to the frequent use of small samples of convenience, outdated national surveys, and little attention to the role of race and SES (Albandar et al., 1999; Beck et al., 1990; Drake et al., 1995; Lamster et al., 2008) among urban communities (Finlayson et al., 2010; Watt, 2007). In general, Type II diabetes is very complex, and established long-term health practices are probably difficult to track. The stage of diabetes and tooth loss may have no correlation and represents another area for study. Evidence-based practice to support limited findings among African Americans is limited, and therefore, many challenges exist in which diabetic patients face that are not measured. It is important that the findings presented here are viewed in the appropriate context.

Despite these limitations, this study provides additional evidence that rarely appears in the literature. The study data analyzed in this study capitalized on a national sample that included important factors commonly associated with health disparities; poverty status as defined by socioeconomic gradient and race. Determinants of poor oral health were age, race, and poverty status. It is notable that age is not viewed as a "cause" for periodontitis. Rather, age in the present study, is a reflection of disease accumulation. As for sex, it is generally accepted that males show a higher prevalence of poor oral health than females due to differences in dental visit behavior and attitudes toward oral health (Burt, 2005). However, in the present study, no evidence supported this claim.

Future observational and intervention studies might include other diabetes-related measures of oral health that are more rigorous. Prevention research might focus on improving efforts to increase health literacy and the importance of daily flossing. Based on findings in this study, messages about good oral hygiene are ignored. New directions in research might include focusing on cost effectiveness of early intervention for oral health conditions, dental care use, and understanding more about policies which support funding dental programs in low income communities. It is especially important for all health professionals to promote regular oral examinations given the evidence in the present study.

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Table 1

Descriptive Statistics by Diabetes Status.

	<u>Total Sample</u>	<u>Diabetes = Yes</u>	<u>Diabetes = No</u>	
	<i>N</i> = 275	<i>n</i> = 134	<i>n</i> = 141	<i>p</i> Values
Gender				
Male (%)	24.7	73.5	26.5	0.00
Female (%)	75.3	40.6	59.4	
Age in years <i>M</i> ± (<i>SD</i>)	55.8 ± 3.5	61.8 ± 9.4	50.0 ± 14.3	0.00
Race (%)				
Black or African American or Caribbean	60.7	49.1	50.9	0.88
Whites	39.3	48.2	51.8	
Education (%)				
No schooling completed, Some school or high school diploma	13.8	47.4	52.6	0.42
Some college or associates degree	41.8	43.5	56.5	
Bachelor's degree	22.2	55.7	44.3	
Graduate study or graduate degree	22.2	52.5	47.5	
Income (%)				
Less than \$50,000	50.6	39.6	60.4	0.00
\$50,000 – \$99,999	33.5	53.3	46.7	
\$100,000 or more	16.0	68.2	31.8	
Missing teeth (%)	64.4	54.8	45.2	0.01
Number of missing teeth <i>M</i> ± (<i>SD</i>)	7.7 ± 8.2	8.0 ± 8.4	7.4 ± 8.0	0.58
Oral health (%)				
Excellent or Very good	44.4	53.3	46.7	0.22
Good	28.7	49.4	50.6	
Fair or Poor	26.9	40.5	59.5	
Currently have dental insurance (%)	59.6	47.7	52.4	0.64
Other comorbidities				
Arthritis	39.6	49.5	50.5	0.83
Hypertension	61.8	61.8	38.2	0.00
Did not get prescription filled (%)	23.0	41.0	59.0	0.13
Number of meds				
5 or fewer	69.4	40.7	59.2	0.00
Between 6–11	24.2	65.6	34.4	
More than 11	6.4	82.4	17.6	

Table 2

Prevalence Ratios (PR) and 95% Confidence Intervals (CI) of Missing Teeth in Relation to Gender Categories, $n = 275$ (this is only main effect).

	Missing Teeth		
	Total Sample	Males	Females
	PR [95% CI]	PR [95% CI]	PR [95% CI]
Model 1 ^a			
Diabetes No	0.50 [0.30, 0.83] ^d	1.58 [0.39, 6.40]	0.48 [0.26, 0.85] ^d
Model 2 ^b			
Diabetes No	0.82 [0.44, 1.55]	1.11 [0.21, 6.02]	0.80 [0.39, 1.60]
Model 3 ^c			
Diabetes No	0.84 [0.44, 1.63]	2.93 [0.33, 25.75]	0.81 [0.38, 1.70]

^aModel 1 is unadjusted.

^bModel 2 is adjusted for age, income.

^cModel 3 is adjusted for same variables as Model 2 plus dental insurance, arthritis, hypertension, and number of medications.

^dSignificant findings ($p = .03$) for Total Sample and for Females.

Table 3

Prevalence Ratios (PR) and 95% Confidence Intervals (CI) of Number of Missing Teeth in Relation to Diabetes Status, $n = 177$ (reference group is females and this is only main effect).

Median Number of Missing Teeth			
	Total Sample	Diabetes Yes	Diabetes No
	PR [95% CI]	PR [95% CI]	PR [95% CI]
Model 1 ^a			
Male	2.58 [1.24, 5.28]	2.71 [1.12, 6.55]	2.22 [0.64, 7.69]
Model 2 ^b			
Male	2.60 [1.95, 5.64]	3.03 [1.23, 8.10]	3.36 [0.65, 17.39]
Model 3 ^c			
Male	2.66 [1.17, 6.07]	3.21 [1.10, 9.31]	4.83 [0.78, 30.09]

^aModel 1 is unadjusted.

^bModel 2 is adjusted for sex, age, income.

^cModel 3 is adjusted for same variables as Model 2 plus dental insurance, arthritis, hypertension, and number of medications.

Table 4

Prevalence Ratios (PR) and 95% Confidence Intervals (95% CI) of Number of Missing Teeth in Relation to Gender Categories, $n = 177$ (this is only main effect).

Number of Missing Teeth (Using Median (4) as Cutpoint)			
	Total Sample	Males	Females
	PR [95% CI]	PR [95% CI]	PR [95% CI]
Model 1 ^a			
Diabetes No	1.04 [0.57, 1.90]	1.02 [0.26, 3.9]	0.82 [0.37, 1.69]
Model 2 ^b			
Diabetes No	0.81 [0.40, 1.66]	1.21 [0.21, 6.97]	0.82 [0.37, 1.84]
Model 3 ^c			
Diabetes No	0.75 [0.53, 1.59]	1.11 [0.16, 7.58]	0.57 [0.23, 1.43]

^aModel 1 is unadjusted.

^bModel 2 is adjusted for age, income.

^cModel 3 is adjusted for same variables as Model 2 plus dental insurance, arthritis, hypertension and number of medications.