The interaction effects between race and functional disabilities on the prevalence of self-reported periodontal diseases - National Health and Nutrition Examination Survey 2011-2012

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Background: Racial minority groups and adults with functional disabilities (FDs) disproportionally experience periodontal diseases. However, little is known about the interactions of these two characteristics in disease prevalence. The purpose of this study was to examine the association between FDs and periodontal experiences, and to identify whether race has a particular influence on this relationship. **Methods:** Data were derived from the National Health and Nutrition Examination Survey 2011-2012, in a representative sample of adults aged 30 years and older. FDs were defined as experiencing limitations in activities of daily living. The weighted logistic regression models were performed using SAS software. **Results:** The incidence of FDs was associated with a poor self-rated perception of teeth and gum health, gum disease, bone loss, and loss of teeth. The racial minority groups with FDs were more likely to report poor teeth and gum health, loose teeth, and a history of gum disease treatment. Mexican Americans with FDs reported poor teeth and gum health, gum disease, and had been previously treated for gum disease. African Americans with FDs were more likely to be diagnosed with bone loss and loose teeth. **Practical Implications:** Racial minority groups with FDs were more likely to be associated with periodontal disease and poor oral health. To improve oral health, access to dental care among minority populations is important, particularly for people with FDs in community settings. Dentists should reach out to these underrepresented groups to address their oral health needs.

Key words: *Periodontal diseases, Disability, Ethnic minorities*

Introduction

Periodontal diseases (infections and inflammation of the gums and bone that surround and support the teeth) (Beck & Loe, 1993) affect nearly 50% of American adults (Centers for Disease Control and Prevention, 2015) and may increase morbidity (DeStefano *et al.,*1993) and mortality. (Chen *et al.*, 2015) The US annual dental expenditure was estimated to be 110 billion USD in 2012, which is approximately 4% of overall national health expenditure. (Wall, Nasseh, & Vujicic, 2014) The Centers for Disease Control and Prevention's (CDC) Healthy People 2020 suggests that prevention and control of oral diseases are critical for improving a person's overall health and well-being. (U.S. Department of Health and Human Services, 2012) Despite these recommendations, some Americans remain untreated, which is particularly problematic for adults with disabilities.

The World Health Organization (WHO) has defined functional disability (FD) as any limitation in activity that entails disruptions of normal functioning of movement, vision, hearing, or social relationships and interactions. (Centers for Disease Control and Prevention, 2014; World Health Organization, 2001) A disproportionately high prevalence of periodontal diseases affects individuals with FDs. Adults with FDs are also less likely to visit a dentist than those without. In particular, adults living with family members are likely to have lower rates of preventive care because of the stress caused by supporting the family (Bershadsky *et al*., 2012) and the lack of caregiver's time (Wiener *et al.,* 2016).

In general, racial minority groups disproportionately experience poor oral health, including periodontal disease. (Tomar & Lester, 2000; U.S. Department of Health and Human Services, 2012) Yet, the evidence base for the prevalence of periodontal disease among minority populations using the CDC National Health and Nutrition Examination Survey (NHANES) is scant and inconclusive. One previous study concluded that periodontitis was more common in African Americans than in Mexican Americans. (Borrell & Crawford, 2008) In contrast, in recent studies, it has been found that Mexican Americans are more likely to experience moderate and severe periodontal diseases than African Americans. (Eke *et al.,* 2012; Jiménez *et al.,* 2014) However, whether periodontal disease conditions would significantly differ between minority adult populations with and without FDs remains unclear.

The purpose of this study was to examine the association between FDs and periodontal diseases and to determine whether race has a particular influence on this relationship in a nationally representative sample. One advantage of this study is that it validates the importance of access to dental care services among adults with FDs. In addition, racial differences in physical health conditions have been well documented in the United States. Compared with Caucasians, African Americans have poorer mortality rates and perceive their health as being poorer. (Barr *et al.,* 2008; Gibson & O'Connor, 2010; Kroll *et al.,* 2006) Yet, evidence of the relationship of race with FDs and periodontal diseases is limited in nationally representative samples.

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This reasoning has led to two hypotheses:

Hypothesis 1. Adults with FDs are more likely to experience periodontal diseases than those without FDs.

Hypothesis 2. Minority adult populations with FDs are more likely to experience periodontal diseases than those without FDs.

An association between FDs and poor periodontal conditions would suggest that greater physical mobility relates to better periodontal disease status. Recognizing the impact of race, which has not been examined in prior studies on adults with FDs, will guide intervention strategies that may address priority populations in community settings.

Methods

The Institutional Review Board approved the present study. Data were derived from a nationally representative sample of the NHANES 2011–2012, a non-institutionalized US civilian survey conducted by the National Center for Health Statistics (NCHS) at the CDC. A multistage probability sampling design identified representative household samples. All family members aged 1 year and older participated in the Oral health file. The 2011–2012 Oral health file included 9,364 respondents with a total response rate of 72.6%. (Johnson, Dohrmann *et al.,* 2014) In the present study, 1,938 individuals aged 30 years and older were analyzed due to the availability of self-reported periodontal disease information from the NHANES. In addition, only those who answered the questions on the targeted variables were included to meet the purpose of the study.

Measure

Table 1 lists the variables used in the present study. All were self-reported.

Dependent variables

Self-rated teeth and gums health was assessed using the following question, "Overall, how would you rate the health of your teeth and gums?" The original responses consisted of excellent (1), very good (2), good (3), fair (4), or poor (5). The scale was then recoded to fair or poor (1) and excellent, very good, or good (0).

Self-reported periodontal disease was assessed using the following four items from NHANES: "Gum disease is a common problem with the mouth. People with gum disease might have swollen gums, receding gums, sore or infected gums, or loose teeth. Do you think you might have gum disease?", "Have you ever had treatment for gum disease such as scaling and root planning, sometimes called deep cleaning?", "Have you ever been told by a dental professional that you have lost bone around your teeth?", and "Have you ever had any teeth become loose on their own, without an injury?" The original responses consisted of yes (1) or no (2). The scale was reverse-coded, making yes (1) or no (0).

Independent variables

Functional disability: FD was assessed by considering the difficulty in performing the following activities without special equipment: (1) walking one-quarter mile, (2) walking up 10 steps, (3) standing or being on feet for two hours, (4) sitting for two hours, (5) stooping, crouching, or kneeling, (6) reaching over the head, (7) using fingers to grasp or handle small objects, (8) lifting or carrying 10 lbs., (9) pushing or pulling large objects, (10) going out to things like shopping, movies, or sporting events, (11) doing things to relax at home or for leisure, and (12) participating in social activities. The original responses consisted of no difficulty (1), some difficulty (2), much difficulty (3), or unable to do (4). We coded the responses as yes (1) when a respondent reported any difficulty in one or more of the functional activities and no (0) when a respondent reported no difficulty.

Race was classified as Mexican American (1), white (2), or black (3).

Covariates

Additional demographic variables included *age* (20–39 years, 40–59 years, or 60 years and older), *marital status* (married or committed relationship, or single or divorced), and *level of education* (general educational development [GED]/high school and lower, some college, undergraduate degree, or graduate degree).

Health insurance coverage was assessed using the following question: "What kind of health insurance or health care coverage do you have? INCLUDE those that pay for only one type of service (nursing home care, accidents, or dental care). EXCLUDE private plans that only provide extra cash while hospitalized." The original responses consisted of Medicare, Medicaid, private, Medigap, state children's health insurance program, Indian health service, military health plan (including TRICARE, VA, and CHAMPVA), state-sponsored health plan, other government programs, or single service plan (e.g., dental, vision, or prescriptions). We coded the responses as mentioned (1) or not mentioned (0).

Usual source of care: We assessed the usual source of care with the following question: "What kind of place do you go to most often? Is it a clinic, doctor's office, emergency room, or some other place?" The original responses consisted of does not get preventive care anywhere (0), clinic or health center (1), doctor's office or HMO (2), hospital emergency room (3), hospital outpatient department (4), and some other place (5). We coded the responses as having a usual source of care (1) when a respondent reported at least one place or no (0) when a respondent reported no place.

All self-rated teeth and gum health, periodontal disease, and FD items were reverse-scored. Higher scores on all these items indicated the presence of a condition (poor self-rated teeth and gums, poor oral health, or having an FD).

Statistical analysis

Analyses were performed using SAS 9.4 for Windows. (SAS Institute Inc., 2012). Weighted frequencies, means, and standard deviations were calculated for demographic information, self-rated teeth and gum health, periodontal disease, and FD items. Five independent weighted logistic regression analyses were performed for each dependent variable using weighted PROC LOGISTIC.

To assess the effects of race on the prevalence of self-rated teeth and gum health, self-reported periodontal disease and FD status, the interaction effects between FDs and race were also examined using five independent logistic regression analyses. ODDSRATIO and CLASS in the PROC LOGISTIC were utilized to obtain the adjusted odds ratio estimates within this interaction. (SAS Institute Inc, 2014) Figure 1 depicts a conceptual framework with key variables.

Table 1. Weighted Characteristics of the Participants

	Total	ADL limitations		Race		
		At least one	No	Mexican American	Non-Hispanic white	Non-Hispanic Black
Total raw sample	1938	579	1359	194	1055	689
Self-rated teeth and gums						
0= Excellent, very good, good	69%	56%	74%*	41%	73%	55%*
1= Fair, Poor	31%	44%	26%	59%	27%	45%
Might have gum disease						
1= Yes	21%	25%	19%*	39%	20%	22%*
0= No	79%	76%	81%	61%	80%	78%
Ever had treated gum disease						
1= Yes	24%	19%	26%*	22%	25%	22%*
0= No	76%	81%	74%	78%	75%	78%
Ever been told bone loss around teeth						
1= Yes	18%	18%	26%*	14%	19%	15%*
0= No	82%	82%	74%	86%	81%	85%
Any teeth became loose						
1= Yes	20%	24%	18%*	28%	18%	32%*
0= No	80%	76%	82%	72%	82%	68%
ADL limitations	33%			32%	22%	33%*
Covariates						
Age						
1= 20-39	11%	11%	11%*	25%	10%	15%*
2= 40-59	23%	37%	19%	32%	22%	30%
3= 60 or greater	65%	51%	70%	43%	68%	55%
Weighted mean	60.66	59.87	61.09**	52.60	61.81	57.38
(years old; std error of mean)	(0.40)	(0.96)	(0.51)	(1.41)	(0.51)	(0.71)**
Gender						
1=Male	47%	45%	48%*	50%	48%	41%*
2=Female	53%	55%	52%	50%	52%	59%
Race						
1=Mexican American	5%	7%	5%*			
2=Non-Hispanic White	83%	77%	85%			
3=Non-Hispanic Black	12%	16%	11%			
Education						
1=GED/High School and less	42%	54%	39%*	78%	38%	61%*
2=Some college	32%	33%	31%	16%	33%	27%
3=Bachelor's degree or above	26%	12%	30%	6%	29%	12%
Marital status						
1=Married or committed relationship	59%	51%	62%*	64%	62%	36%*
0=Single or Divorced	41%	49%	38%	36%	38%	64%
Usual source of care						
1= Yes	93%	95%	92%*	83%	93%	94%*
0= No	7%	5%	8%	17%	6%	6%
Health Insurance						
1= Coverage	89%	87%	89%*	60%	91%	88%*
0= No coverage	11%	13%	11%	40%	9%	12%

Note. * represents *p* >.05 on the weighted chi square test. ** represents *p* >.05 on the weighted analysis of variance.

Results

Of the total 9,756 participants in the initial data file, 4,200 did not meet the targeted age range (less than 30 years old), 3,049 did not answer the question on FD status, and 573 did not answer the question on race. Therefore, a sample of 1,938 participants was analyzed. Demographic information, oral conditions, and FD status are shown in Table 1.

The first hypothesis stated that adults with FDs would be more likely to experience poorer oral health than those without FDs. As expected, adults with FDs were more likely to indicate poor self-rated teeth and gums, gum disease, loose teeth, a dental diagnosis of bone loss, and to have never been treated for gum disease. Table 2 summarizes the adjusted odd ratios of race and FDs to *self-rated teeth and gums* and four *self-reported periodontal disease* items.

Table 2. Main effects in logistic regressions for the frequency of self-rated teeth and gum health and periodontal diseases

	Self-rated teeth and gums	Might have gum disease	Ever treated gum disease	Ever been told bone loss	Any teeth became loose
	AdjOR (95%Cl)	AdjOR (95%Cl)	AdjOR (95%Cl)	AdjOR (95%Cl)	AdjOR (95%Cl)
Functional disability					
1= Yes	1.56 (1.55-1.56)	1.23 (1.22-1.23)	0.56 (0.56-0.57)	1.09 (1.09-1.10)	1.12 (1.19-1.20)
0= No	1.00	1.00	1.00	1.00	1.00
Race					
1=Mexican American	2.34 (2.33-2.34)	1.88 (1.87-1.88)	1.10 (1.09-1.10)	0.37 (0.36-0.37)	1.36 (1.35-1.36)
2=Non-Hispanic White	1.00	1.00	1.00	1.00	1.00
3=Non-Hispanic Black	1.82 (1.81-1.82)	0.77 (0.75-0.76)	1.08 (1.07-1.08)	0.56 (0.55-0.56)	2.21 (2.21-2.22)
Covariates					
Age					
1= 20-39	1.00	1.00	1.00	1.00	1.00
2= 40-59	0.93 (0.92-0.93)	0.82 (0.82-0.83)	1.94 (1.93-1.94)	0.96 (0.95-0.96)	1.44 (1.43-1.45)
3= 60 or greater	0.51 (0.50-0.51)	0.54 (0.54-0.55)	1.67 (1.67-1.80)	2.06 (2.04-2.06)	1.54 (1.53-1.54)
Gender					
1=Male	1.00	1.00	1.00	1.00	1.00
2=Female	0.80 (0.79-0.80)	1.26 (1.26-1.27)	0.88 (0.87-0.88)	0.95 (0.94-0.95)	0.68 (0.68-0.68)
Education					
1=GED/High School and less	1.00	1.00	1.00	1.00	1.00
2=Some college	0.68 (0.68-0.68)	1.39 (1.39-1.39)	1.66 (1.65-1.66)	1.04 (1.03-1.40)	1.01 (1.00-1.02)
3=Bachelor's degree or above	0.26 (0.26-0.26)	2.16 (2.15-2.16)	1.70 (1.70-1.71)	1.31 (1.31-1.38)	0.37 (0.36-0.37)
Marital status					
1=Married or committed relationship	0.70 (0.69-0.70)	0.89 (0.89-0.89)	0.95 (0.94-0.95)	0.75 (0.75-0.76)	0.89 (0.89-0.89)
0=Single or Divorced	1.00	1.00	1.00	1.00	1.00
Usual source of care					
1= Yes	1.23 (1.23-1.24)	0.49 (0.48-0.49)	1.90 (1.90-1.91)	0.85 (0.84-0.85)	0.59 (0.59-0.59)
0= No	1.00	1.00	1.00	1.00	1.00
Health Insurance					
1= Coverage	0.70(0.69-0.70)	1.00 (0.99-1.00)	0.97 (0.97-0.97)	0.60 (0.59-0.60)	0.96 (0.96-0.97)
0= No coverage	1.00	1.00	1.00	1.00	1.00
Associations with other dependent variables.					
Self-rated teeth and gums					
1= Fair, Poor	n/a	8.02 (8.00-8.03)	0.69 (0.68-0.69)	2.03 (2.02-2.03)	2.05 (2.04-2.06)
0= Excellent, very good, good		1.00	1.00	1.00	1.00
Might have gum disease					
1= Yes	7.95 (7.93-7.96)	n/a	3.02 (3.01-3.02)	2.40 (2.39-2.41)	2.09 (2.08-2.10)
0= No	1.00		1.00	1.00	1.00
Ever had treated gum disease					
1= Yes	0.77 (0.76-0.77)	3.09 (3.08-3.10)	n/a	6.85 (6.84-6.86)	1.17 (1.16-1.17)
0= No	1.00	1.00		1.00	1.00
Ever been told bone loss around teeth					
1= Yes	2.08 (2.08-2.09)	2.38 (2.37-2.38)	6.79 (6.78-6.80)	n/a	4.23 (4.24-4.25)
0= No	1.00	1.00	1.00		1.00
Any teeth became loose					
1= Yes	1.98 (1.97-1.98)	2.13 (2.13-2.14)	1.14 (1.13-1.14)	4.15 (4.14-4.15)	n/a
0= No	1.00	1.00	1.00	1.00	
Raw sample size	1779	1779	1779	1779	1779
AIC	2352.62	1813.05	1857.88	1654.03	2016.40

Note. AdjOR = odds ratio after controlling for other independent variables; Cl = confidence interval; AIC = Akaike information criterion. All analyses were adjusted for age, race, education, marital status, usual source of care, health insurance status and other dependent variables.
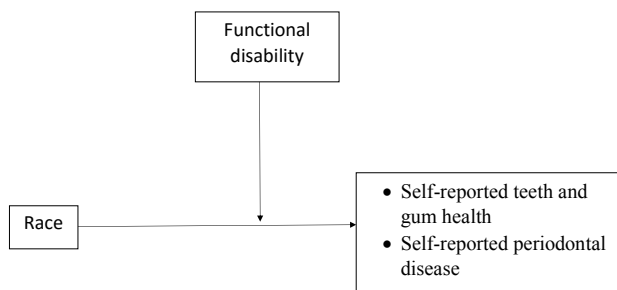
Figure 1. *Conceptual framework to examine the interaction effects. Note. One headed arrows represent coefficients.*

The second hypothesis stated that minority adult populations with FDs were more likely to be associated with poor gum health than those without FDs. As expected, the interactions between race and the presence of FDs had significant effects on all five dependent variables ($p < .05$). Table 3 summarizes the adjusted odd ratios of race to *self-rated teeth and gum health* and the four *self-reported periodontal disease* items when participants indicated that they had FD. The odds ratios of poor self-rated teeth for African and Mexican Americans with FDs were significantly greater than those for Caucasians with FDs. Although Caucasians were more likely to be diagnosed with bone loss by dentists, Mexican Americans and African Americans were more likely to be treated for gum diseases and to experience loose teeth. Compared with African Americans with FDs, Mexican Americans with FDs were more likely to indicate poor self-rated teeth and gum health, perceive having gum disease, and have been treated for gum disease. However, they were less likely to be diagnosed with bone loss or have loose teeth.

Discussion

This study examined the association between FDs and the occurrence of self-reported periodontal diseases, and whether race has a particular influence on this relationship. Having FD was independently associated with greater likelihood of experiencing poor gum and teeth conditions. Minority adult populations with FDs were less likely to be treated for gum

diseases than Caucasians with FDs. The evidence of these negative associations was robust and persisted in the interaction between the presence of FDs and race. In addition, compared with African Americans with FDs, Mexican Americans with FDs were more likely to indicate poor self-rated gum health, but were less likely to experience bone loss.

Our findings are in line with previous findings in elderly people. (Wu *et al.,* 2011) Indeed, it has been reported that adults with FDs were more likely to experience poor gum conditions and overall, minority groups were more likely to indicate poor oral health and lack of access to care. In particular, self-assessment of gum conditions showed racial differences. For example, Mexican Americans were more likely to believe that they had gum diseases than Caucasians. It could be possible that this unique result was associated with the lack of opportunities for receiving dental education. Education is a major social determinant of health. (U.S. Department of Health and Human Services, 2012) Previous studies have found that individuals with access to education were more likely to have better self-reported oral health (Kim *et al.,* 2012) and lower prevalence of periodontal diseases. (McQuistan *et al.,* 2015) In addition, the proportion of adults with severely decayed teeth, indicating poor oral hygiene, could influence the relationship between gum conditions and loose teeth. A previous study has shown that African Americans have more total decayed, missing, or filled permanent surfaces than other racial groups (National Institute of Dental and Craniofacial Research, 2016), which may be associated with experiencing loose teeth. It may be possible that African Americans are not aware of the presence of gum disease while experiencing loose teeth, probably because they receive lesser educational opportunities than Caucasians. (Butani *et al.,* 2008)

As expected, minority groups with FDs experienced poor gum health. This finding indicates that the oral health disparities due to having FDs persisted after controlling for nuisance factors, and suggests that barriers beyond demographic and socioeconomic factors have an impact on poor oral health conditions. FD-related barriers to better periodontal conditions depend on the extent to which needs are met, such as the degree of social support received, the accessibility of oral care services, and the ability to maintain oral hygiene. Mexican Americans with FDs were more likely to have poor self-rated periodontal diseases than African Americans with

Table 3. Interaction effects of race and functional disability status for the frequency of self-rated teeth and gums and self-reported periodontal diseases

	Self-rated teeth and gums	Might have gum disease	Ever treated gum disease	Ever been told bone loss	Any teeth became loose
	AdjOR (95%Cl)	AdjOR (95%Cl)	AdjOR (95%Cl)	AdjOR (95%Cl)	AdjOR (95%Cl)
When functional disability = 1 (Yes):					
Race					
1=Mexican American	2.34 (2.33-2.34)	1.88 (1.87-1.88)	1.10 (1.09-1.10)	0.37 (0.36-0.37)	1.36 (1.35-1.36)
2=Non-Hispanic White	1.00	1.00	1.00	1.00	1.00
3=Non-Hispanic Black	1.82 (1.81-1.82)	0.76 (0.75-0.76)	1.08 (1.06-1.08)	0.56 (0.56-0.58)	2.21 (2.21-2.22)
1 x 3 (Mexican American) x (Non-Hispanic Black)	1.28 (1.27-1.29)	2.48 (2.47-2.49)	1.02 (1.01-1.02)	0.66 (0.66-0.66)	0.61 (0.61-0.61)

Note. AdjOR =adjusted odds ratio; Cl=confidence interval. All analyses were adjusted for age, race, education, marital status, usual source of care, health insurance status and 4 other dependent variables.

FDs. This finding may be associated with the disadvantages Mexican Americans with FDs face in terms of the social determinants of oral health, such as education, costs, and insurance coverage. (Kim *et al.*, 2012; Quandt *et al.,* 2007) Moreover, barriers unique to dental treatment in Mexican Americans with FDs include fear of pain, language, and cultural beliefs. (Maupome *et al.,* 2016; Velez *et al.,* 2016) Furthermore, a review article has revealed that US-born Latinos believe that the aim of brushing teeth is to have clean breath. (Butani *et al.*, 2008) Importantly, however, many studies have indicated that confusion exists in the survey responses among Hispanics and Latinos. (Compton *et al.,* 2013) The US census plans to modify race and ethnicity questions to improve accuracy and reliability in the future. (US Census Bureau, 2016) In addition, little evidence exists to support oral health experiences among Mexican Americans living alone in the US. To understand how having FDs is associated with race and oral health, further research, regarding both disability culture and sociocultural beliefs toward oral health among minority groups is needed.

Our study has several limitations. First, because of the cross-sectional nature of the study, we cannot claim any causal relationships. Although our sample sizes were small, we did not pool multiple data when analyzing the combined effect of disability and race to avoid having duplicated samples across years. Because of the secondary nature of our data, we were unable to identify the number of missing teeth that may influence the experience of periodontal diseases. In addition, self-reported data could not identify the actual effects of periodontal diseases. Given that previous studies have inconclusive results between subjective and objective assessments of periodontal disease prevalence, further studies are needed. (Blicher *et al.,* 2005) Moreover, we could not examine race and ethnicity in heterogeneous Hispanic populations. The NHANES data consist of self-reported responses, which are prone to social desirability biases. It is difficult to conclude whether participants were honest when answering questions. The WHO definition of disability includes individuals with neuromuscular diseases as well as those with obesity, diabetes, and stroke, thereby limiting the generalizability of our findings to a population with a single chronic condition. Furthermore, the NHANES includes only noninstitutionalized individuals. Thus, the results do not represent individuals with FDs in institutional settings.

Conclusions

Despite using a self-reported measure, our findings suggest that having FDs was more likely to be associated with self-reported periodontal disease and poor oral health. Furthermore, the interaction between race/ethnicity and FDs in self-reported periodontal diseases persists because of the unequal prevalence of periodontal diseases across these subgroups. Both African Americans and Mexican Americans with FDs appear likely to continue having worse periodontal diseases. This result suggests that further research and intervention are needed to determine whether a supportive environment for people with disability improves oral health among minority populations. It is important for health care providers, researchers, community workers, and policy makers to understand how people with FDs independently living in a community manage periodontal diseases to promote a healthy lifestyle.

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