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Disability and immigration status interaction and the risk of periodontal disease

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THESIS

DISABILITY AND IMMIGRATION STATUS INTERACTION AND THE RISK OF PERIODONTAL DISEASE

by

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DEDICATION

I would like to dedicate this work to my loving family.

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AND THE RISK OF PERIODONTAL DISEASE

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ABSTRACT

Objective: To evaluate whether disability and immigrant status influence the likelihood of having periodontal disease.

Methods: This cross-sectional study analyzed data from the 2011-2014 National Health and Nutrition Examination Survey (NHANES). Study selection criteria included: age 30 or older, available periodontal examination data, and documented disability and immigration status. Periodontal disease was coded as none/mild vs moderate/severe. Participants were categorized into: U.S.-born or U.S. citizens without a disability, U.S. citizens with a disability, immigrants without a disability, and immigrants with a disability. Logistic regression was performed using SAS software 9.4, considering complex sampling.

Results: Of the study participants (n=6954), 61.0% were U.S. citizens without disabilities. Our next largest group, U.S. citizens with a disability, comprised 24.5% of our participants. Participants who identified as immigrants without disability comprised 11.5%, while individuals with concurrent immigration and a disability accounted for 2.6%. The highest periodontal disease was detected in immigrants with disabilities (65.7%), followed by 48.5% of immigrants without disabilities, and 47.7% of U.S. citizens with disabilities, while periodontal disease was lowest for US citizens without disabilities (32.1%). Logistic regression analysis found that US citizens with a disability had almost twice the odds of periodontal disease compared to US citizens without a disability (OR=1.93, 95% Cl: 1.63, 2.28). Immigrants without disabilities (OR=1.99, 95% Cl:1.61,2.46) had significantly higher odds of periodontal disease compared to non-disabled US citizens, while the strongest relationship was for immigrants with disabilities (OR=4.04, 95% Cl:2.94,5.55). Despite these differences, a multivariate logistic regression analysis assessing the modification effects of disability status on the citizen-periodontal disease association did not detect a statistically significant relationship (p=0.64).

Conclusion: Both immigration and disability status were associated with increased odds of periodontal disease, with higher odds of periodontal disease experienced by immigrants with disabilities. Although this group had higher odds than expected from immigration or disability alone, the multivariate analysis did not find significant evidence that disability changed the relationship between citizen and periodontal disease, perhaps due to small sample size.

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LIST OF ABBREVIATIONS

CDC ....U.S. Centers for Disease Control and Prevention

CI...Confidence Interval

NHANES ....National Health and Nutrition Examination Survey

OR.. Odds Ratio

QoL ....Quality of Life

WHO ....World Health Organization

INTRODUCTION

Background

Oral health is a significant component of overall health and well-being (Peres et al., 2019). It influences not only physical functioning but also social interactions, self-esteem, and quality of life (Spanemberg et al., 2019). In addition to health, quality of life (QoL) refers to a person's perception of emotional, social, and functional aspects of life (Spanemberg et al., 2019). Maintaining good oral health enables individuals to eat comfortably, speak clearly, and engage in social settings, thereby supporting self-esteem. In contrast, poor oral health can lead to compromised chewing, speech difficulties, and social isolation, reducing QoL and contributing to health inequities (Peres et al., 2019). According to the World Health Organization (WHO), oral diseases, including dental caries, periodontal disease, and tooth loss, affect approximately 3.5 billion people worldwide. A significant oral health condition that impacts adults in the United States is periodontal disease.

Periodontal disease is the inflammation and infection of the tissues surrounding teeth. It is irreversible and involves losing supporting tissues, such as bone, around the teeth, resulting in tooth loss (CDC, 2018). (Eke et al., 2018). In addition to the effects on the mouth, periodontal disease has been linked to systemic conditions, such as diabetes, which further supports the interconnection between oral health and overall health (Peres et al., 2019). It affects over 40% of U.S. adults and is more prevalent in underserved populations (Eke et al., 2018). According to the Office of Disease Prevention and Health Promotion (2020), disabled and immigrant populations face greater health disparities, social injustices, and a higher risk of developing health problems, such as periodontal disease. Adults, especially those with disabilities, are more likely to have poor oral hygiene, periodontal disease, and untreated decay (Durbin et al., 2021). Individuals with disabilities have been reported to have a 56% to 92% prevalence of periodontal disease, which has been associated with decreased QoL (Chavis & Macek, 2022). This can be primarily attributed to the population's greater challenges in accessing dental services. People with specialized health care often need providers who are trained to manage complex conditions, but those providers are not always easy to find. Limited income, low insurance coverage, and difficulty navigating the healthcare system are other obstacles that individuals with disabilities face (Morgan et al., 2012). Physical and cognitive limitations make it difficult for individuals to perform a daily oral hygiene routine effectively, such as brushing and flossing, and make traveling to dental appointments more difficult (Morgan et al., 2012).

Similarly, immigrants encounter many obstacles when accessing dental care, especially during acculturation, adapting to new cultural norms. Language barriers, high poverty rates, and lack of eligibility for federal or state health programs further complicate seeking dental care (Luo et al., 2018; Wilson et al., 2018). As a result, immigrants in the United States are more likely to have untreated tooth decay and periodontal disease than U.S. natives and naturalized citizens (Wilson et al., 2018). Wilson et al. (2018) found that the prevalence of periodontal disease among immigrant populations in the U.S. was about 51%, which is higher than the national average. This can be attributed to the experience of navigating the healthcare system in a foreign country, struggling to understand new cultural norms, and potentially losing family support, which may hinder individuals from seeking care (Durbin et al., 2021). These challenges may be more pronounced for immigrants with disabilities, who must manage the combined effects of disability-related care needs and the difficulties of immigration and acculturation. Despite these barriers, no study exists that explores the combined relationship between disability and immigration status on the prevalence of periodontal disease. Understanding these combined disparities is critical to developing targeted interventions to improve access to dental care and reduce oral health inequities in vulnerable populations.

Hypothesis

Based on current studies, we hypothesize that disabled immigrants will have poorer oral health status and a higher prevalence of periodontitis when compared to disabled and non-disabled U.S.-born citizens and immigrants.

METHODS

This cross-sectional study analyzed data from the 2011-2014 National Health and Nutrition Examination Survey (NHANES). NHANES is a United States survey conducted by the Centers for Disease Control and Prevention (CDC). It collects health and nutrition status data in children and adults across all 50 states and the District of Columbia. NHANES dental examiners, who are licensed dentists, were trained for standardization and calibration purposes.

Study selection criteria included participants aged 30 years or older, documented disability and immigration status, and available periodontal examination data. Participants missing any data were not included in the study.

Main Predictor

The primary exposure in this study was immigration status. Participants were asked if they were U.S.-born or U.S. citizens. Those who answered yes were classified into 1) U.S.-born or U.S. citizen, and those who answered no were classified as 2) non-U.S.-born or immigrant. The secondary exposure was disability status, assessed using the NHANES' physical functioning questionnaire. Participants were asked the following yes/no questions: do physical, mental or emotional limitations keep you from working, does it limit the amount of work you can do, do you need special equipment to walk, experience confusion/memory problems, have physical, mental, and/or emotional limitations, and lastly, require special healthcare equipment. If they answered yes to at least one of the questions in the physical functioning questionnaire the participant were classified as disabled. If not, the participant was labeled as able bodied. Citizenship and disability status was tested for an interaction effect and later was combined into a 4-category variable: U.S.-born or U.S. citizens without a disability (reference group), U.S. citizens with a disability, Immigrants without a disability, and Immigrants with a disability.

Main Outcome

The study's primary outcome was the prevalence and severity of periodontal disease. Periodontal disease was classified as 1) None/Mild and 2) Moderate/Severe. Adults aged 30 years and older qualified for the periodontal examination if they had at least one natural tooth and did not require taking antibiotic prophylaxis due to a health condition (n=6954). A full-mouth periodontal examination was completed and included an assessment of gingival recession (REC) and probing depth (PD) measured at six sites per tooth (mesial-buccal, mesial-lingual, mid-buccal, mid-lingual, distal-buccal, distal-lingual), excluding third molars. REC was measured as the distance between the free gingival margin and the cementoenamel junction (CEJ). PD was measured as the distance from the free gingival margin to the bottom of the sulcus/periodontal pocket. Clinical attachment loss (CAL) was calculated as the difference between PD and REC. Periodontitis is defined as 1) severe periodontitis, with two or more interproximal sites with CAL 6mm or greater (not on the same tooth) and one or more interproximal sites with PD 5mm or greater; 2) moderate periodontitis, with two or more interproximal sites with CAL 4mm or greater (not on the same tooth) or two or more interproximal sites with PD 5mm or greater (not on the same tooth); and 3) mild periodontitis, with two or more interproximal sites with CAL 3mm or greater and two or more interproximal sites with

PD 4mm or greater (not on the same tooth) or one or more sites with 5mm or more (Eke et al., 2018).

Covariates

Potential confounding variables were identified and included in the model. The following variables included demographic information such as participants' sex (Male, Female). Age was coded as a continuous variable (30, 31, 32, etc.). Participants' race was categorized into four groups (Non-Hispanic White, Non-Hispanic Black, Hispanic, Other). Poverty status was included and classified into three groups based on poverty-to-income ratio (Low income (PIR: <1.39), Middle income (PIR: ≥ 1.39 and <3.99), High income (PIR: ≥ 3.99). Participants were asked whether they had ever been diagnosed with diabetes (coded yes or no). Alcohol consumption was considered, and participants were asked if they had at least twelve alcoholic drinks in the past year (coded yes=current drinkers or no=non-drinkers). Smoking status was included, and participants were asked if they had smoked at least a hundred cigarettes in their lifetime. Participants who answered "no" were coded as "never smokers." Participants who answered "yes" were asked if they currently smoke cigarettes. Those who answered every day and some days were coded as "current smokers," and those who responded not at all were coded as "former smokers." Insurance status was also considered and categorized into three groups (Uninsured, Private, and Public insurance). Lastly, the time of participants' last dental visit (coded Year or less and more thansa year) and if in the previous year needed dental treatment but could not (Did not need treatment or received care and not able to get care) were included in the model.

Statistical Analysis

Descriptive analysis was conducted to summarize the characteristics of the study population. Participants were categorized into the previously mentioned four groups: U.S.-born or U.S. citizens without a disability (reference group), U.S. citizens with a disability, Immigrants without a disability, and Immigrants with a disability. Frequencies and percentages were summarized for categorical variables, while continuous variables, such as age, were summarized by mean. Statistical significance for descriptive categorical variables was evaluated using the chi-square test.

A univariable logistic regression analysis was conducted to assess the association between immigrant status and disability status with periodontal disease (none/mild vs moderate/severe). A multivariate logistic regression analysis was conducted to evaluate the association between immigration status and disability status (independent variables) with periodontal disease (dependent variable), adjusting for potential covariates. Adjusted odds ratios and 95% confidence intervals (CI) were estimated to assess the strength of association while controlling for potential confounders. All statistical tests were measured for significance under a 0.05 threshold. Statistical analyses were conducted using SAS software 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

Descriptive statistics of the demographic and socioeconomic characteristics of participants are provided in Table 1. Of the study participants (n=6954), 61.0% (n=4244) were U.S. citizens who did not report disabilities. The next largest group, comprising 24.5% (n=1706) of participants, was U.S. citizens who identified as having disabilities. Meanwhile, 11.8% (n=821) of participants were immigrants who reported having no disabilities, making this the third most represented category. The smallest group in the study, accounting for 2.6% (n=183) of participants, was immigrants who reported having disabilities.

The characteristics of the study population varied across the four groups in almost all covariates, as shown in Table 1. Gender was similar across all four groups, with no significant difference ($p<0.0573$). Age, however, varied significantly across groups, U.S. citizens with disabilities being the oldest (mean 57±0.4 years) and immigrants without disabilities the youngest (mean 43±0.5 years) ($p<0.0001$). Race and ethnicity varied significantly among the groups. Non-disabled U.S. citizens were predominantly non-Hispanic White (73.50%), while U.S. citizens with disabilities showed similar patterns, with 74.59% identifying as non-Hispanic Whites. Immigrants with no reported disability were primarily Hispanic/multiracial individuals (62.05%), while disabled immigrants had the highest proportion of Hispanic/Multiracial participants overall (69.88%). Income also varied; immigrants with disabilities had the most significant proportion of low-income individuals (63.38%), whereas U.S. citizens with no disabilities had the highest proportion of high-income individuals (43.95%).

Table 1.**Characteristics of Study Population: 2011-2014 National Health and Nutrition Examination Survey (NHANES)**						
		US Citizen w/out Disability n (%)	US Citizen w/ Disability n (%)	Immigrant w/out Disability n (%)	Immigrant w/ Disability n (%)	P-Value
Age	Mean (sd)	50 +/- 0.3	57 +/- 0.4	43 +/- 0.5	51 +/- 1.4	<.0001
Gender	Male	2113 (49.47)	799 (46.14)	410 (51.42)	89 (47.33)	0.0573
	Female	2131 (50.53)	907 (53.86)	411 (48.58)	94 (52.67)	
Race/Ethnicity	Non-Hispanic White	1923 (73.50)	842 (74.59)	31 (11.22)	8 (7.89)	<.0001
	Non-Hispanic Black	1027 (10.77)	459 (11.91)	57 (5.32)	13 (5.05)	
	Non-Hispanic Asian	521 (4.42)	91 (2.18)	268 (21.41)	44 (17.18)	
	Hispanic/Multiracial	773 (11.31)	314 (11.32)	465 (62.05)	118 (69.88)	
Income Group	Low (PIR<1.39)	1227 (19.27)	876 (37.80)	425 (51.40)	121 (63.38)	<.0001
	Medium (PIR 1.39-3.99	1581 (36.78)	555 (36.68)	246 (30.38)	46 (27.08)	
	High (PIR 4+)	1436 (43.95)	275 (25.52)	150 (18.22)	16 (9.54)	
Alcohol	Current Drinker	2995 (82.13)	1163 (77.36)	449 (67.66)	80 (51.49)	<.0001
	Non-Drinker	960 (17.87)	447 (22.64)	254 (32.34)	78 (48.51)	
Diabetes	Yes	535 (10.17)	448 (22.46)	75 (6.50)	53 (26.26)	<.0001
	No	3708 (89.83)	1257 (77.54)	745 (93.50)	129 (73.74)	
Insurance	Private	2794 (75.20)	659 (49.97)	302 (37.14)	39 (23.29)	<.0001
	Public	619 (10.44)	749 (35.68)	109 (10.88)	65 (32.04)	
	Uninsured	768 (14.36)	240 (14.34)	409 (51.99)	79 (44.67)	
Last Dental Visit	In Last Year	2073 (64.34)	705 (55.18)	246 (35.67)	53 (36.34)	<.0001
	Greater than a Year Ago	1516 (35.66)	759 (44.82)	458 (64.33)	111 (63.66)	
Needed Dental Care	But Couldn't Get it	712 (12.35)	506 (25.24)	222 (29.09)	77 (45.98)	<.0001
	Received Care	3506 (87.65)	1190 (74.76)	554 (70.91)	99 (54.02)	
Smoking Status	Current Smoker	725 (15.41)	433 (26.15)	109 (13.53)	21 (12.15)	<.0001
	Former Smoker	1007 (25.63)	505 (29.96)	156 (20.14)	51 (24.04)	
	Never Smoker	2509 (58.96)	766 (43.89)	556 (66.33)	111 (63.81)	

When comparing behavioral covariates, U.S. citizens with no disabilities were more likely to be current alcohol drinkers (82.13%) but less likely to have diabetes (10.17%). In contrast, immigrants with disabilities were more likely to be alcohol drinkers (51.49%) and have diabetes (26.26%). Smoking status significantly varied across the groups (p<0.0001). U.S. citizens with disabilities had the highest rate of current (26.16%) and former (29.96%) smokers. Immigrants without disabilities were more likely to be non-smokers (66.33%). There was a significant difference when comparing insurance coverage; U.S. citizens with no disabilities had the highest proportion of individuals with private insurance (75.20%), were more likely to have had a dental visit in the last year (64.34%) and were more likely to receive dental care when needed (87.65%). U.S. citizens with disabilities had the highest proportion with public insurance (35.68%), while immigrants without disabilities had the highest uninsured rate (51.99%) and were more likely to have had a dental visit over a year ago (64.33%). Interestingly, immigrants with disabilities were more likely to be uninsured (44.67%) and more likely to have needed dental care but could not get it (45.98%).

Of the study population, 3221 participants were identified as having moderate to severe periodontal disease, representing 46.3% (Table 2). The prevalence of periodontal disease varied across different demographic groups. The highest proportion was observed among immigrants with disabilities, where nearly three-quarters (65.7%) of individuals in this group were affected. This was followed by immigrants without disabilities, of whom 48.5% had periodontal disease. Similarly, 47.7% of U.S. citizens with disabilities were affected. The lowest prevalence was found among U.S. citizens without disabilities, where only 32.1% were diagnosed with periodontal disease.

Table 2. **Periodontal Disease Status of Study Participants: 2011-2014 National Health and Nutrition Examination Survey (NHANES)**

	A. None/Mild Periodontitis	B. Moderate/Severe Periodontitis	Total
1. U.S.-Citizen w/out Disabilities	2512 (67.86)	1732 (32.14)	4244 (61.03)
2. U.S.-Citizen w/ Disabilities	759 (52.29)	947 (47.71)	1706 (24.53)
3. Immigrants w/out Disabilities	401 (51.49)	420 (48.51)	821 (11.81)
4. Immigrants w/Disabilities	61(34.31)	122 (65.69)	183 (2.63)
Total	3733 (53.68)	3221 (46.32)	6954

Univariable logistic regression analyses found that U.S. citizens with a disability had approximately twice the odds of having periodontal disease as the reference group, U.S. citizens without a disability (OR=1.93, 95% Cl: 1.63, 2.28). These results were statistically significant. Similarly, immigrants without a disability had significantly higher odds of periodontal disease compared to U.S. citizens without a disability (OR=1.99, 95% Cl: 1.61, 2.46). The strongest association was found for immigrants with disabilities, who had four times higher odds of periodontal disease compared to U.S. citizens without disabilities (OR =4.04, 95% CI: 2.94, 5.55). These findings are detailed in Table 3.

Table 3. Univariable Logistic Regression Model: Relationship between Immigration and Disability Status with Periodontal Disease

	Point Estimate	95% CI
A. U.S.-Born or U.S.-Citizen w/ Disabilities	1.93	1.63,2.28
B. Immigrants w/out Disabilities	1.99	1.61,2.46
C. Immigrants w/Disabilities	4.04	2.94,5.55

In the multivariable logistic regression model, the analyses found that U.S. citizens with a disability had approximately the same odds of having periodontal disease as the reference group, U.S. citizens without a disability (OR=1.01, 95% Cl:0.84,1.20). However, these results were not statistically significant. In contrast, immigrants without a disability had significantly higher odds of periodontal disease compared to U.S. citizens without a disability (OR=1.47, 95% Cl: 1.10, 1.97). The strongest association was found for immigrants with disabilities, who had nearly two times higher odds of periodontal disease compared to U.S. citizens without disabilities (OR =1.76, 95% CI: 0.98, 3.16). When assessed using the multivariate logistic regression analysis, there was no significant modification effect of disability status on the link between citizenship and periodontal disease (p=0.64). Detailed results are presented in Table 4.

Our multivariable logistic regression analysis revealed that males had significantly higher odds of developing periodontal disease (OR = 1.87, 95% CI: 1.56,2.24) when compared to females. For each year of increase in age, the odds of periodontal disease increased by 6% (OR = 1.06, 95% CI: 1.05,1.07). When comparing racial groups, our analysis found that non-Hispanic-Whites had significantly lower odds of periodontal disease compared to non-Hispanic Blacks (OR = 2.28, 95% CI: 1.76,2.97), Hispanics (OR = 1.75, 95% CI: 1.41,2.16), and Other race (OR = 1.88, 95% CI: 1.43,2.48). Our analysis found a statistically significant association between poverty status and periodontal disease. Low-income individuals (below the poverty line; OR = 1.50, 95% CI: 1.17,1.92) and medium-income individuals (at the poverty line; OR = 1.49, 95% CI: 1.15,1.93) had significantly higher odds of periodontal disease compared to high-income individuals (above the poverty line).

Participants who reported a diabetic diagnosis were found to have increased odds of periodontal disease (OR = 1.42, 95% CI: 1.11,1.90), which was statistically significant. The prevalence of periodontal disease did not differ between current alcohol drinkers, participants who reported drinking at least 12 alcoholic drinks in the past year (OR = 0.98, 95% CI: 0.75,1.29) compared to non-drinkers. Smoking was a strongly associated with periodontal disease. Current smokers had significantly higher odds of periodontal disease (OR = 3.85, 95% CI: 3.22,4.62), while former smokers showed an elevated risk of periodontal disease (OR = 1.56, 95% CI: 3.22,4.62) compared to non-smokers.

When compared to participants with private insurance, uninsured individuals had a significantly higher probability of developing periodontal disease (OR = 1.66, 95% CI: 1.32,2.09). Individuals with public insurance had a slightly higher risk of periodontal disease, but findings were not statistically significant (OR = 1.07, 95% CI: 0.83,1.38). Participants who had a dental visit in the last year were less likely to have periodontal disease (OR = 0.49, 95% CI: 0.41,0.59). Individuals who reported needing a dental appointment but could not get one in the past year had higher odds of periodontal disease (OR = 1.53, 95% CI: 1.21,1.94) compared to individuals who received care.

Table 4. **Multivariable Logistic Regression Results for Periodontal Disease**			
	OR	95% CI	P-Value
Disability/Immigration Group (ref= US Citizen/Non-Disabled)			
US Citizen + Disabled	1.01	0.84,1.20	0.9552
Immigrant + Non-Disabled	1.47	1.10,1.97	0.0096
Immigrant + Disabled	1.76	0.98,3.16	0.0603
Age	1.06	1.05,1.07	<.0001
Gender (ref='Female')			<.0001
Male	1.87	1.56,2.24	
Race/Ethnicity (ref='Non-Hispanic White')			<.0001
Non-Hispanic Black	2.28	1.76,2.97	
Hispanic	1.75	1.41,2.16	
Other	1.88	1.43,2.48	
Income Group (ref='High (PIR 4+)')			0.0035
Medium (PIR 1.39-3.99)	1.49	1.15,1.93	
Low (PIR<1.39)	1.50	1.17,1.92	
Current Alcohol Drinker	0.98	0.75,1.29	0.8967
Diabetes ='Yes'	1.42	1.11,1.80	0.0045
Insurance (ref='Private')			<.0001
Public	1.07	0.83,1.38	
Uninsured	1.66	1.32,2.09	
Last Dental Visit (ref='In Last Year')			<.0001
Greater than a Year Ago	0.49	0.41,0.59	
Needed Dental Care: But Couldn't Get it	1.53	1.21,1.94	0.0005
Smoking Status (ref='Never Smoker')			<.0001
Former Smoker	1.56	1.28,1.91	
Current Smoker	3.86	3.22,4.62	
*No evidence of effect modification for US Citizen+Disabled (p-value =0.6435)			

DISCUSSION

This study examined the relationship between immigration status, disability status, and the prevalence of periodontal disease among U.S. adults aged 30 years and older, using NHANES data from 2011-2014.

Our study found that immigrants with disabilities demonstrated the highest odds of periodontal disease, with odds four times greater than those of U.S. citizens without disabilities. This finding is not surprising since minority groups, such as immigrants and disabled individuals, face greater barriers to oral health in the United States. This supports a previous study that found the experience of moving to a new country to be especially difficult for people with disabilities (Durbin et al., 2021). Multiple factors, such as language barriers, navigating unfamiliar healthcare systems, and accessing affordable housing and transportation, contribute to these difficulties (Durbin et al., 2021). Although not significant, our p-value (0.06) was borderline statistically significant, potentially due to the small sample size (2.6%). Our results support the need for a larger sample size and further research into this population. Immigrants without disabilities had significantly higher odds of periodontal disease. Despite not having a disability, this group was twice as likely to have periodontal disease compared to U.S. citizens without a disability. It suggests that immigration status alone, independent of disability, may be a more substantial risk factor for poor oral health. These findings are consistent with previous literature, which found that immigrants have poorer oral health than U.S. citizens (Wilson et al., 2018). These disparities can be attributed to multiple factors, including delays or avoidance of treatment due to cultural barriers, low income, limited resources, and a lack of dental insurance (Banihashem Rad et al., 2024). It affirms that even without coexisting disabilities, immigrants remain disproportionately susceptible to poor oral health. However, the multivariate logistic regression analysis assessing the modification effects of disability status on the citizenship and periodontal disease association did not detect a statistically significant relationship (p=0.64). This suggests that while immigration status and disability status independently contribute to periodontal disease, our data did not provide sufficient evidence that disability status alone significantly modified the citizenship-periodontal disease association, most likely due to our small sample of immigrants with disabilities.

Interestingly, after testing for confounding factors, U.S. citizens with disabilities did not have increased odds of periodontal disease compared to non-disabled U.S. citizens. A possible explanation is that, despite their disability, U.S. citizens have more access to federal assistance programs, such as Medicaid or Social Security Disability Insurance (SSDI), that include dental coverage in some states (Muchomba & Kaushal, 2021). Additionally, U.S. citizens may have greater language fluency, stronger familial or social support, and familiarity navigating the healthcare system (Durbin et al., 2021; Morgan et al., 2012). This suggests that these factors may be protective, contributing to reduced oral health conditions, such as periodontal disease, despite the greater odds observed.

Several sociodemographic and behavioral covariates were also significantly associated with periodontal disease, and their influence may disproportionately affect individuals based on citizenship status, disability, or both. For example, males had significantly higher odds of periodontal disease compared to females. This supports prior studies that attribute poor oral hygiene habits, higher risk of being uninsured, and less likely to utilize preventative care compared to females (Ioannidou, 2017).

Increasing age was also significantly associated with greater odds of periodontal disease. Older adults, especially those with disabilities, may experience long-term exposure to risk factors, reduced immune function, and chronic health conditions that make dental visits more challenging (Raphael, 2017). Older immigrants may be at greater risk due to ineligibility for federal programs that have residency and immigration requirements.

Racial and ethnic minorities, including non-Hispanic Blacks, Hispanics, and individuals identifying as multiracial or other, had significantly higher odds of periodontal disease compared to non-Hispanic Whites. This is especially relevant to immigrants with disabilities, who often face challenges related to their race, immigration status, and health needs, which limit their access to care. Low-income and middle-income individuals, specifically those living below and at the poverty line, had substantially greater odds of periodontal disease compared to high-income groups. Uninsured individuals and those with public insurance had significantly higher odds of periodontal disease compared to individuals with private insurance. These findings highlight challenges that immigrants, especially those with disabilities, face, such as not qualifying for federal or public programs, limited resources, and the cost of transportation. As Northridge et al. (2020) suggested, individuals with low income, limited or no insurance, and those belonging to racial or ethnic minority populations are more likely to have poor oral health. This can be attributed to barriers to preventative care, such as a lack of access, leading to oral disease.

According to the CDC, both diabetes and tobacco use are recognized risk factors for periodontal disease. These risk factors increase the risk for severe and moderate periodontal disease (Eke et al., 2018). Consistent with this evidence, our study found that individuals who reported having diabetes had significantly higher odds of periodontal disease compared to those without the condition. This supports previous studies that highlight the relationship between systemic and oral health and found that diabetes can worsen oral health conditions (U.S. Department of Health and Human Services, 2021). For disabled immigrants, this relationship may be even more pronounced. Limited access to medical care, poor diabetes management, and lack of oral health education can increase the risk of periodontal disease. These individuals may go undiagnosed or untreated, which could potentially exacerbate the severity of periodontal disease. Our study found smoking status to be strongly associated with periodontal disease. Current smokers had significantly higher odds of periodontal disease, with odds nearly four times greater than non-smokers. Additionally, former smokers displayed elevated odds of periodontal disease when compared to non-smokers. Our results support research identifying smoking as a modifiable risk factor for periodontal disease; the severity of the disease would reduce with smoking cessation (Leite et al., 2018). Limited to smoking cessation programs and increased stress, especially for people with disabilities, smoking can significantly affect oral health risk. Surprisingly, our analysis did not find a statistically significant association between current alcohol drinkers, individuals who had at least twelve alcoholic beverages in the past twelve months, and periodontal disease. Our findings did not support previous studies that found alcohol consumption as a risk factor for oral health diseases, such as periodontal disease (U.S. Department of Health and Human Services, 2021). These findings can potentially be attributed to alcohol quantity and drinking patterns.

Several studies have found a strong relationship between access to care and oral health diseases. In our study, individuals who had not seen a dentist in the past year or could not access needed care had significantly higher odds of periodontal disease. These findings are relevant for immigrants and individuals with disabilities because they are more likely to lack dental insurance, have limited resources, limited transportation, language barriers, or inaccessible clinics. Immigrants may avoid or delay care due to these barriers in addition to fear of immigration status. Our findings support previous literature emphasizing the important role of preventative dental care, especially in underserved populations (Northridge et al., 2020). These results affirm that the structural and social determinants, immigration status, and disability contribute to oral health disparities.

The univariable logistic regression model independently examined the association between each group and periodontal disease, without adjusting for confounding variables. In this model, U.S. citizens with disabilities, immigrants without disabilities, and immigrants with disabilities have significantly higher odds of periodontal disease when compared to U.S. citizens without disabilities. Immigrants with disabilities had the strongest association with four times the odds of periodontal disease. Our multivariable logistic regression model adjusted for confounding variables and found that the odds were reduced. The association for U.S. citizens with disabilities and immigrants with disabilities was no longer statistically significant. This suggests that socioeconomic and behavioral factors (e.g., age, gender, income, etc.) may explain a portion of the initial relationship. These differences highlight the importance of accounting for confounding factors when examining disparities in periodontal disease across groups with varying immigration and disability status.

Public Health Implications

The association between immigration and disability status and periodontal disease highlights the need for public health strategies to address disparities in oral health. Public health efforts should focus on expanding policies that improve dental insurance coverage to increase accessibility to care, specifically to low-income, immigrant, and disabled populations—for example, lowering Medicaid's residence and immigration requirements. Additionally, dental settings should ensure accessibility for disabled individuals, offer interpreters, and provide multilingual education materials on preventative care and risk factors such as diabetes and smoking. Addressing transportation barriers, such as expanding affordable public transit options, should be a priority. Extending clinic hours into evenings or weekends can help accommodate individual who work multiple jobs. Lastly, public health efforts should focus future research on immigrants with disabilities to better understand their oral health in America.

Strengths and Limitations

A significant strength of this study is the use of nationally representative NHANES data. Our outcome, periodontal disease, was measured and not-self-reported, using standardized assessments conducted by trained and calibrated examiners, thus reducing reporting bias. Our immigration variable was inclusive; any participant who identified as an immigrant, regardless of the years they have resided in the U.S., was included in the study. The method we used to distinguish disability status was wide-ranging, comprising individuals with physical, mental, or emotional limitations. In addition, we had an abundance of potential confounding variables that we adjusted for in the association between immigration status, disability status, and periodontal disease.

However, there were limitations. For example, causality was not established in this cross-sectional study design. Self-reported disability and immigration status may be subject to reporting and selection bias due to perceived consequences. Our study did not account for the length of time immigrants had been in the United States, which may influence their experience and oral health outcomes. Behavioral factors, such as diabetes, smoking, and alcohol consumption, may have been subject to recall and reporting bias due to discrimination. Lastly, our sample size was too small, which may have influenced the significance of our results, especially our lack of ability to detect a statistically significant modifying relationship between citizenship and disability status on periodontal disease.

Conclusion

This study highlights significant disparities in periodontal disease prevalence associated with immigration and disability status. Our findings indicate that immigrants, particularly those with disabilities, may face the highest risk of periodontal disease. Although the highest prevalence of periodontal disease was observed among immigrants with disabilities, the multivariate logistic regression analysis suggested that disability status did not significantly affect the relationship between citizenship and periodontal disease ($p=0.64$), which disproves our hypothesis. However, this may be attributed to our small sample size of immigrants with disabilities. The combination of behavioral and social health determinants that immigrants and disabled individuals face may influence their accessibility to dental care. Additionally, risk factors such as diabetes, smoking, lack of insurance, and infrequent dental visits contribute to a higher likelihood of periodontal disease, which can be exacerbated in disabled immigrant populations. Addressing these barriers through public health initiatives can promote oral health equity.

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