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ABSTRACT

Sociodemographic and clinical factors associated with poor oral health outcomes among US adults

By

Apexa B Patel

Spring 2019

INTRODUCTION: Oral health disparities remain a significant public health issue for US adults: 47.2% of US adults suffer from some form of periodontal diseases and 9% US adults have advanced periodontal disease. Unfortunately, not much is known about the sociodemographic and clinical factors associated with these poor oral health outcomes. This study aims to estimate the association of sociodemographic and clinical factors and poor oral health outcomes among US adults.

METHODS: Data from the 2013-2014 National Health and Nutrition Examination Survey (NHANES) were used in the analysis for the participants aged 30 years and older (n=4813). All analyses were done in SAS 9.4 and weighted due to complex survey sampling methods. Logistic regression models were used to examine the association between sociodemographic and clinical factors and poor oral health outcomes.

RESULTS: This study found that the survey participants ages 30-44 years and participants from low socioeconomic status had decreased association for periodontal diseases. Furthermore, participants who aged 65 years and older and who were from Hispanic and Non-Hispanic Black race/ethnicity had increased association for periodontal diseases. Limited access to dental care also had increased association for the advanced periodontal disease.

Conclusion: To develop future interventions that can address oral health disparities, further research is needed that examines the sociodemographic and clinical factors impacting poor oral health outcomes.

**Sociodemographic and Clinical factors associated with Poor Oral Health Outcomes among US
Adults**

by

Apexa B Patel

BDS, GUJARAT UNIVERSITY

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment

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APPROVAL PAGE

Sociodemographic and Clinical factors associated with Poor Oral Health Outcomes among US Adults

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Author's Statement Page

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Apexa Patel

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TABLE OF CONTENTS

ACKNOWLEDGMENTS	iii
LIST OF TABLES.....	v
INTRODUCTION.....	1
1.1 Background.....	1
1.2 Research aim and Hypothesis.....	2
REVIEW OF THE LITERATURE.....	3
2.1 Oral Health Disparities.....	3
2.2. Sociodemographic and Clinical factors associated with Poor Oral HealthOutcomes...4	
METHODS AND PROCEDURES.....	11
3.1 Study Design.....	11
3.2 Statistical Analysis.....	14
RESULTS.....	16
4.1 Descriptive Statistics.....	16
4.2 The association between Sociodemographic and clinical factors and poor oral health outcomes.....	16
DISCUSSION AND CONCLUSION.....	19
5.1 Discussion.....	19
5.2 Study Limitations.....	19
5.3 Implications of Findings, Recommendations and Conclusions	20
REFERENCES.....	23

List of Tables

Table 1 Descriptive Statistics of the Sample

Table 2 Summary of regression analysis involving the sociodemographic and clinical factors

CHAPTER I – INTRODUCTION

1.1. Background

Negative oral health conditions such as gingivitis (red, swollen gums) and periodontitis (damage to the soft tissue and bones supporting the teeth resulting in loose or loss of teeth) are common among adults and ultimately can lead to periodontal disease which is one of the biggest threats of poor oral health.¹ Recent findings on periodontal disease from the CDC report suggest that approximately 47% of U.S. adults aged 30 years and older suffer from some form of periodontal disease and 9% of U.S. adults have an advanced periodontal disease. Periodontal disease increases with age and around 70% adults 65 years and older have periodontal disease in the United States.¹

Oral health disparities remain a significant public health issue both worldwide and in the United States. The disparities in oral health care may contribute to poor oral health outcomes like periodontal diseases due to unmet dental needs. For example, periodontal diseases are more prevalent among Mexican Americans and Non-Hispanic Blacks compared to Whites.² Furthermore, people from low socioeconomic status and current smokers are more prone to suffer from periodontal disease. One reason for these disparities may be because people from low socioeconomic status lack access to appropriate dental care and they may lack understanding of the oral health literacy to make healthy life choices. Approximately 47 million U.S. populations are affected by barriers to oral health care access.^{1,4}

Severe periodontitis is the 6th most prevalent disease globally affecting about 743 million people worldwide. Periodontal disease is the major cause for teeth loss in adults worldwide and contributes for edentulism and masticatory dysfunction which will affect their nutrition, quality of life and self-esteem and it has a huge impact on economic outcomes and healthcare costs. Periodontal diseases account for 3.5 million years lived with disability and the loss of productivity from periodontal disease accounts for 442 billion worldwide and for severe periodontitis it accounts for 54 billion USD/year worldwide. Oral health is important for overall nutrition and for the control of different acute and chronic diseases. Improvement in oral

health can reduce the risk of mastication and swallowing problems and nutritional deficiencies. Individuals who have mastication problems due to teeth loss or pain are more likely to eat soft, easily chewable food and avoid well-balanced diet which may raise sugar and fat consumption levels, increasing their risk for other chronic diseases like diabetes, cardiovascular diseases.^{2,3}

Various sociodemographic and clinical factors associated with poor oral health may help us to address these oral health disparities. In the study by Almerich-Silla et al (2017), researchers found that higher prevalence of periodontal disease is associated with sociodemographic factors such as low socioeconomic status, low educational attainment, as well as with male gender, age, and smoking, among a representative sample of the population of the Valencia region of Spain. Some studies have established the associations between various sociodemographic and clinical factors and poor oral health outcomes worldwide, yet there remains a gap in the research about the association between sociodemographic and clinical factors and poor oral health outcomes in the United States due to few research studies were conducted involving the US population. Furthermore, the earlier research studies focused only on some of the sociodemographic and clinical factors such as smoking status, diabetes status, gender, race, access to care, education and socioeconomic status.⁵

1.2 Research Aim and Hypothesis

The aim of the present study was to examine the relationship of sociodemographic and clinical factors with the poor oral health outcomes among US adults, 30 years and older using National Health and Nutrition Examination Survey data 2013-2014. The research question for the study is that “What is the association between various sociodemographic and clinical factors and poor oral outcomes, mainly periodontal diseases, among US adults 30 years and older?”

The hypothesis is that participants who had poor access to dental care, low income, diabetes, were recurrent smokers, not US citizens, and males would have an increased association for poor oral health outcomes.

CHAPTER II – Literature Review

2.1. Oral Health Disparities

In the United States, we have made considerable progress in the prevention, diagnosis, and treatment of oral diseases and yet certain populations of US adults still experience disproportionate and unacceptable burdens of oral diseases. Oral diseases like periodontal disease and dental decay are considered as a major public health burdens in the United States and they disproportionately affect disadvantaged and underserved communities.

In a study by Patrick et al. (2006), the authors provided an organizing framework to address oral health disparities in the United States, with a focus on social and cultural determinants. Their conceptual model included various environmental, economic, social and cultural practices, social integration, individual factors, and biological factors that are associated with the oral health disparities. The authors mentioned that to reduce the oral health disparities in the United States, we need to prioritize interventions for individuals from low socioeconomic status, as they are more prone to face obstacles and barriers in accessing the oral health care and oral health interventions.⁶

In a study by Fischer et al. (2017), the authors mentioned that oral health conditions like dental caries and periodontal disease remain the most common burden in the United States affecting the disadvantaged and underserved communities, which was also concluded in the first US Surgeon General's report covering oral health.²² The researchers suggested that there is a need to support interdisciplinary research for identification, understanding and addressing the oral health disparities as certain segments of the older adults in the US may be affected by having poor oral health outcomes disproportionately due to having poor access to dental care.⁷

2.2. Sociodemographic and Clinical factors associated with Poor Oral Health Outcomes

In a research study by Almerich-Silla et al. (2017), the researchers conducted a cross sectional study on socioeconomic factors and severity of the periodontal diseases of the adult

population of the Valencia region of the Spain. The study was conducted in 35 health centers randomly selected out of 111 health centers. They asked adults aged between 35-44 years old at these health centers if they would like to participate. This study had a sample of 733 persons and presence of the periodontal pocket was a dependent variable. The results of the adjusted multiple logistic regression model found significant increased association between the socioeconomic factors such as lower socioeconomic status, smoking, primary education, male gender, age and poor oral health.⁵

In a study by Huang and Park(2015), the researchers examined the relationship between sociodemographic characteristics (US older adults who were poor and from minority racial/ethnic groups) and poor oral health outcomes (measured using the oral health quality of life (OHQOL) and number of permanent teeth) from the National Health and Nutrition Examination Survey (NHANES) 2005–2008. Logistic and linear regression analyses of the 2,745 adults aged ≥ 65 years suggested that there was a significant association between poverty and minority race/ethnicity and having lower oral health quality or life and fewer permanent teeth. The authors suggested further examination of racial/ethnic variation in OHQOL domains so that interventions can be developed in future to improve the oral health of these racial/ethnic groups.⁸

In another study by Malecki et al. (2015), the researchers examined the effect of individual-, psychosocial-, and community-level predictors of oral health status among 1453 adult Wisconsin residents who participated in the 2010 Survey of the Health of Wisconsin Oral Health Screening project. The authors found significant oral health disparities across all the individual-, psychosocial-, and community-level predictors. The researchers found that poor oral health outcomes such as dental caries were greatest among the participants with a high school education or less, non-Whites, single individuals, low-socioeconomic status and those who did not have any health insurance. Specifically, the investigators found that costs in accessing dental care appeared to be the primary factor associated with unmet oral health care needs.⁹

In a report by Eke et al. (2015), the investigators used data from the National Health and Nutrition Examination Survey (NHANES) 2009-2010 and 2011-2012 cycles and summarized

prevalence, severity and extent of the periodontitis in US adults 30 years and older. They used standard surveillance case definitions and defined periodontitis as a combination of clinical attachment loss and periodontal probing depth from 6 sites per tooth including all teeth, except for the third molars. The researchers found that 64.7 million US adults had periodontitis, with 8.9% having severe periodontitis during the year 2009-2012. The prevalence of Periodontitis was significantly associated with increasing age and was more common among male participants; highest among the Hispanics (63.5%) and Non-Hispanic blacks (59.1%), followed by Non-Hispanic Asian Americans (50.0%), and lowest in Non-Hispanic Whites (40.8%). The prevalence of periodontitis was higher with increasing poverty levels and lower education. The researchers found that about 62% of persons with less than 100% of federal poverty level had periodontitis. The findings of the report confirmed that there is a high burden (45.9%) of periodontitis in US adults aged 30 years and older and suggested the need of better understanding the factors affecting the periodontitis and the disparities among sociodemographic groups so that, the appropriate public health action can be taken to prevent and control periodontitis in US adults 30 years and older.¹⁰

In the study by Mutamuliza et al. (2015), the researchers conducted a cross-sectional study to estimate the prevalence of the periodontal disease and associated risk factors among the individuals aged 15-65 years old who attended the Department of Dentistry of the Rwanda Military Hospital during July -December 2013. This study had a sample size of 1282 patients. The investigators found that older age, a lower level of education, poor oral hygiene, frequency of tooth brushing, attending dental clinic only in an emergency, diabetes mellitus, HIV/AIDS, and smoking were significantly associated with the periodontal disease.¹¹

Zhang et al. (2014), analyzed data from the Chronic Disease and Risk Factor Surveillance survey during the year 2010 in China. The investigators analyzed a sample of 1800 participants, 18 years and older. The survey had a total of 162 surveillance locations, out of which 3 were selected as pilot study sites. They conducted oral examination by trained professionals and participants were considered of having moderate periodontitis if they have 4-5 mm pockets and severe periodontitis in case of ≥ 6 mm pockets. The researchers used multivariate logistic regression models to estimate the independent association of various sociodemographic

factors with periodontal disease. They found that the survey participants who had diabetes were 2.4 times more likely to have periodontal disease. Male participants and participants from rural households were also significantly more likely to have periodontal disease. The researchers found an inverse association between having at least six years of education and severe periodontitis.¹²

In a report by Bloom et al. (2012), the researchers presented findings from the 2008 National Health Interview Survey (NHIS) and provided prevalence estimates of oral health status of 17,337 U.S. adults aged 18-64 years of age by sociodemographic and clinical factors. However, in this report, the oral health status was defined as the oral health of the mouth and teeth and it was based on the individual's self-assessment of the condition of his or her oral health; no clinical measurements were taken by the health professional. The report found that about 13,002 U.S. adults reported of having very good or good oral health; 17% adults reported fair oral health and 7% reported having poor oral health. The participants who had Medicaid were 5 times more likely to report having poor oral health and twice more likely to not visit dentist in more than 5 years compared to the participants who had a private health insurance. Forty two percent adults reported that they could not afford the dental treatment and of not having the dental insurance.¹³

In a study by Borrell et al. (2006), the researchers estimated the association of socioeconomic disadvantage and having periodontal disease. The investigators used cross-sectional data from the dental Atherosclerosis Risk in Communities (ARIC) with a sample of 5677 U.S. adults aged 45 to 64 years old. The researchers found that low-income Whites were more likely to have severe periodontitis and in African Americans having low education and income levels contributed to severe periodontitis. Furthermore, they found that Low-income Whites living in disadvantaged neighborhoods had increased chance of having periodontal diseases (OR 1.8, 95% CI 1.2-2.7) compared to Whites who had high-incomes and living in advantaged neighborhoods.¹⁴

Smoking and Periodontal disease

Tomar and Asma (2000) analyzed data from the third National Health and Nutrition Examination Survey, conducted during the year 1988-1994. They analyzed data of 13,650 U.S. adults aged ≥ 18 years, who provided information about their tobacco usage and who were examined by trained dentists. The researchers considered participants to have periodontitis if they had ≥ 1 site with clinical periodontal attachment level, probing depth ≥ 4 mm and if it was ≥ 4 mm apical to the cemento-enamel junction. Current smokers were defined as any survey participants who had smoked ≥ 100 cigarettes over their lifetime and who were smoking at the time of the interview; former smokers were defined as any survey participants who had smoked ≥ 100 cigarettes but were not current smokers at the time of the interview; never smokers were any survey participants who had not smoked ≥ 100 cigarettes in their entire lifetime.¹⁵

The researchers found that about 75% of the periodontal cases were associated with the current smoking. Furthermore, current smokers were 4 times more likely (OR 3.97; 95% CI 3.20- 4.93) to develop periodontal disease compared to the never smokers after adjusting for age, gender, race/ethnicity, education, and income: poverty ratio. They also found a dose response relationship between the current smokers and odds of periodontal disease. Former smokers were also more likely (OR 1.68; 95% CI 1.31- 2.17) to develop periodontal disease compared to the never smokers. The authors concluded that in the United States smoking is a major contributory factor for developing the periodontal disease and more than 50% of the cases of the periodontal disease is attributed to the smoking.¹⁵

Diabetes and periodontal disease

Sun et al. (2018), used data from the National Health Insurance Research Database in Taiwan. The researchers identified newly diagnosed cases of Type 1 diabetes mellitus for the T1DM cohort and frequency matched them with people who did not have type 1 diabetes mellitus for the non-T1DM cohort. The T1DM had 4248 participants and non-T1DM cohort had 16992 participants. They found the association between type 1 diabetes mellitus and

periodontal disease as in their study participants who had type 1 diabetes mellitus were at increased risk of developing the periodontal disease.¹⁶

Preshaw et al. (2012), mentioned in their review article from the epidemiological data of various other studies that people who have poorly controlled diabetes (both type 1 and type 2 diabetes mellitus) are three times more likely to get periodontal disease and the authors suggested integration of oral and periodontal health promotion along with the diabetes management. The authors also suggested that people who have poorly controlled diabetes should be considered at the risk for developing the periodontal disease and should be informed about it.¹⁷

Silvestre et al. (2009), studied frequency of periodontal disease in a group of type 1 diabetes mellitus patients, aged 18-50 years old, who were recruited at the Endocrinology department of the Dr. Peset University Hospital, Spain. The researchers conducted logistic regression analysis to evaluate how the periodontal disease relates with the metabolic control, duration of the diabetes and complications of the diabetes. The investigators found that the diabetes mellitus type 1 patients had a higher greater bleeding index, deeper periodontal pockets and also, periodontal attachment loss compared to non-diabetics and they concluded that people with type 1 diabetes mellitus have increased susceptibility to the periodontal disease.¹⁸

Myllymäki et al. (2018), investigated the association between periodontal condition and type 2 diabetes mellitus. The researchers conducted population based prospective cohort study among 395 people of the Oulu city of the Finland. The researchers conducted baseline examinations during the 1990-1992 and follow-up examinations during the year 2007-2008. They concluded that an exposure–response relation exists between the presence of deepened periodontal pockets and type 2 diabetes mellitus. They concluded that there is a link between poor periodontal condition and type 2 diabetes mellitus, and periodontal disease could be a predictor for the development of type 2 diabetes mellitus.¹⁹

Kaur et al. (2009), conducted a research study to evaluate the association between type 1 and type 2 diabetes mellitus and prevalence and extent of the periodontal disease. The researchers recruited participants from the population-based survey called “The Study of

Health in Pomerania (SHIP)". Their study comprised of 145 type 1 diabetes mellitus and 2647 non-diabetic participants who were 20-59 years old and, and 182 type 2 diabetes mellitus and 1314 non-diabetic participants who were 50–81 years old. The investigators assessed periodontal disease by attachment loss and number of missing teeth. They conducted multivariable regression analysis and concluded that type 1 diabetes mellitus was positively associated with the periodontal disease but, type 2 diabetes mellitus was significantly associated with the periodontal disease only in females and attachment loss was positively associated with type 2 diabetes mellitus among participants who were 60-69 years old. The researchers concluded that compared to non-diabetic participants, severity of periodontal disease is significantly higher among the participants who had both type 1 diabetes mellitus and type 2 diabetes mellitus.²⁰

Summary

Several studies have documented poor oral health outcomes, specifically related to periodontal disease by income, age, smoking status, diabetes status, access to dental care and race/ethnicity for the past decade. However, the majority of the earlier studies were conducted outside the United States and also, they had relatively small sample sizes. Furthermore, only a few of them focused on both the sociodemographic and clinical factors. There was inconsistency in defining periodontal disease as earlier studies used different clinical measures for it. Only a very few earlier studies focused on US adults 30 years and older and there is a need to understand the association of periodontal disease and sociodemographic and clinical factors as it is more prevalent with increasing age and more importantly, the aging population is increasing in the US and world. In the United States there is a need to understand various sociodemographic and clinical factors that influence oral health to reduce the oral health disparities and develop future interventions. Therefore, we aim to further explore the association of various sociodemographic and clinical factors associated with poor oral health outcomes such as periodontal disease and advanced periodontal disease among US adults 30 years and older.

CHAPTER III – METHODOLOGY

3.1 Study Design

This research study analyzed data from the National Health and Nutrition examination survey (NHANES) from the year 2013-2014. NHANES is an important component of the National Center for Health Statistics (NCHS), which is the part of the Centers for Disease Control and Prevention (CDC).^{16,17} CDC is responsible for generating vital and health statistics for the United States. The NHANES Program started in the early 1960s with a series of surveys focusing on different population groups or health topics but it became a continuous program with a changing focus on a different health and nutrition measurements to meet the emerging demands in the year 1999. NHANES survey examines a nationally representative sample of approximately 5,000 people annually, located in different counties across the United States. Each year fifteen counties are visited for the survey.^{21,22}

NHANES is a unique program that combines both the interview component and physical examination component of the survey participants and is used to assess the health and nutritional status of the United States Population. The interview component of the survey consists of demographic, socioeconomic, dietary, and health-related questions and it is conducted at the participant's home by trained interviewers using the Computer-Assisted Personal Interview (CAPI) system. The physical examination component of the survey includes medical, dental, physiological measurements, and laboratory tests conducted by a team of highly trained medical professionals including a physician, medical and health technicians.²²

The findings of the NHANES survey are used to assess the predisposing factors of the diseases and prevalence of the major diseases. Information from the survey participants is being used to determine their health and nutritional status and its association with disease prevention and health promotion efforts. Data from the NHANES survey are being used in epidemiologic and health sciences research and it also helps in developing strong policies for the public health, in designing health programs and in expanding the knowledge of the US population.^{21,22,23}

Eligibility criteria:For this study, survey participants 30 years and older were included because the data from the participants aged ≤ 30 years was not available from the NHANES 2013-2014 dataset and because periodontal diseases are more prevalent in adults aged 30 years and older in the United States.

Variables of Interest

1) Dependent Variables

Poor oral health Outcomes

For poor oral health outcomes, this study used two variables from the NHANES 2013-2014 survey: periodontal disease (Gingivitis and Periodontitis) and advanced periodontal disease (Periodontitis). Study participants who answered 'yes' to the following question were coded as having "Periodontal disease": "Have you ever had treatment for gum disease such as scaling and root planning, sometimes called 'deep cleaning'?" Participants who answered 'yes' to the following question were coded as having "Advanced Periodontal Disease": "Have you ever been told by a dental professional that you have lost bone around your teeth?" Study participants who answered yes to the questions for both the periodontal disease and advanced periodontal disease were coded as having "Periodontal disease plus advanced periodontal disease" which refers to the most severe form of the periodontal disease (Severe periodontitis).

2) Independent Variables

Age

The participants aged 30 years and older at the time of participation were included in this study; other participants were excluded as the poor oral health outcomes like periodontal diseases are more prevalent among the U.S. adults 30 years and older and data for the outcome variables (periodontal disease and advanced periodontal disease) were not available for the participants who were younger than 30 years of age. Ages were recoded into three categories: 1) 30-44 years 2) 45-64 years 3) 65 years and older.

Gender

Individuals were grouped into male and female based on the self-reported responses at the time of screening for the survey.

Race/ethnicity

Participants were categorized into four categories based on the self-reported responses of the participants during the survey: Hispanic, Non-Hispanic Black, Non-Hispanic White, Other Race - Including Multi-Racial.

Marital Status

Participants were categorized into four groups based on the self-reported responses: Married or living with a partner, Widowed, Divorced or Separated, Never Married.

Citizenship Status

Participants were categorized into two groups based on the self-reported responses: U.S. Citizens and Non-U.S. Citizens.

Diabetes Status

Participants were categorized into three groups (Yes, No and Borderline) based on the self-reported responses to the question, "Has your doctor told you that you have diabetes?" Here, borderline diabetes is defined as blood sugar levels higher than normal but not high enough to be diabetes. Borderline diabetes was assessed by asking participants whether a doctor told them if they had prediabetes.

Socioeconomic Status

Participants were categorized into three groups based on the self-reported responses and these categories were chosen as they represented commonly used percentages of the poverty guidelines (i.e., 130 percent and 185 percent of the guidelines), by federal programs, in determining eligibility. The survey participants reported their family

monthly income in dollar amounts and based on that index for the ratio of monthly income to poverty was calculated using the 2013 and 2014 Department of Health and Human Services' (HHS) poverty guidelines. The index for the ratio of monthly income to poverty was then grouped into three categories such as ≤ 1.30 , $1.30 < \text{to} \leq 1.85$, and > 1.85 . For this study, the socioeconomic status was defined as follows: 1) Low socioeconomic status for participants who were at monthly poverty level index ≤ 1.30 , 2) Middle socioeconomic status for participants who were at monthly poverty level index > 1.30 to ≤ 1.85 and, 3) High socioeconomic status for participants who were at monthly poverty level index > 1.85 .

Current Smokers

Participants were categorized into two groups based on the self-reported responses to the question about their history of recent tobacco use: Yes and No. The survey participants were asked the following question, "Used any tobacco product last 5 days?"

Limited access to dental care

Participants were categorized into two groups (yes or no) based on the self-reported responses to the question, "During the past 12 months was there a time when you needed dental care but could not get it at that time?"

3.2 Statistical analysis

For this study, all analyses from the NHANES 2013-2014 survey data were performed using SAS 9.4 (Statistical Analysis System, Cary, NC, USA). The survey data of NHANES 2013-2014 included selected 14,332 people who participated from thirty different survey locations. From these 14,332 persons, 10,175 persons completed the interview and 9,813 persons completed the examination part of the survey. This study had a sample size of 4,813 U.S. adults 30 years and older.

For all 4,813 participants, descriptive statistics were conducted for characteristics including age, gender, marital status, citizenship status, race/ethnicity, diabetes status, current

smoking status and limited access to dental care. Logistic regression models were used to explore the association between sociodemographic and clinical factors and poor oral health outcomes. Regression analysis involved three regression models to explore the association between sociodemographic factors and poor oral health outcomes. The regression models were as follows: 1) periodontal disease 2) advanced periodontal disease and 3) combined periodontal disease and advanced periodontal disease.

Results of the logistic regression models were reported as odds ratios and 95% confidence interval. For all regression analysis, a two-sided P value < 0.05 was considered statistically significant in this study.

CHAPTER IV – RESULTS

4.1. Descriptive Statistics

In this analysis, overall 4,813 participants aged 30 years and older were included from the NHANES 2013-2014 Survey. Individuals were excluded from the analysis if they had missing data on the variables of interest. For the age, 43.85% of respondents were age 45-64 years; 33.21% respondents were age 30-44 years and 22.95% participants were age 65 years and older.

Female participants were 52.37% and male participants were 47.63% in this study. Most respondents (67.05%) were married or living with a partner; 15.44% participants were divorced or separated; 10.22% respondents were unmarried, and 7.24% respondents were widowed. Most participants were US Citizens (91.61%); had a middle socioeconomic status (60.63%) and were of Non-Hispanic White (67.87%) race/ethnicity. At the time of the survey, 16.31% of participants had limited access to dental care; 20.30% of participants were current smokers and 12.18% respondents had diabetes.

Periodontal Disease and Advanced Periodontal Disease Characteristics

Out of the 4,813 survey participants, 21.34% (N=1086) had periodontal disease, 12.17% (N=620) had advanced periodontal disease and 6.58% (N=343) had both periodontal disease and advanced periodontal disease (Table 1).

4.2 The association between sociodemographic and clinical factors and poor oral health outcomes

The association between age and poor oral health outcomes

Participants age 30-44 years had a reduced association for advanced periodontal disease (OR=0.40, 95% CI=0.27-0.58) and combined periodontal disease and advanced periodontal

disease (OR=0.47, 95% CI=0.29-0.75) compared to participants age 45-64. (Table 2). Participants age 65 years and older had an increased association for advanced periodontal disease (OR 1.50, 95% CI 1.14-1.97) and combined periodontal disease and advanced periodontal disease (OR 1.59, 95% CI 1.06-2.39) compared to the participants age 45-64 (Table 2).

The association between gender and poor oral health outcomes

Results of the regression analysis of this study did not find a statistically significant difference between gender and periodontal disease and advanced periodontal disease (Table 2).

The association between marital status and poor oral health outcomes

Results of the regression analysis of this study did not find a statistically significant difference between categories of marital status and periodontal disease and advanced periodontal disease (Table 2).

The association between race/ethnicity and poor oral health outcomes

Participants from Hispanic race/ethnicity had increased association for periodontal disease (OR 1.85, 95% CI 1.40-2.44), and combined periodontal disease and advanced periodontal disease (OR 1.60, 95% CI 1.10-2.31) compared to participants from the Non-Hispanic White race/ethnicity (Table 2).

The association between socioeconomic status and poor oral health outcomes

Participants from the low socioeconomic status had decreased association for developing periodontal disease (OR 0.68, 95% CI 0.55-0.84), advanced periodontal disease (OR 0.77, 95% CI 0.59-0.99) and combined periodontal disease and advanced periodontal disease (OR 0.56, 95% CI 0.37-0.85) compared to the participants from the high socioeconomic status (Table 2).

The association between citizenship status and poor oral health outcomes

Participants who were Non-US Citizens had no association for periodontal disease and advanced periodontal disease compared to US Citizens (Table 2).

The association between diabetes status and poor oral health outcomes

Participants who had diabetes had no association for periodontal disease and advanced periodontal disease compared to participants who did not have diabetes. Furthermore, participants who had borderlinediabetes status had no association for periodontal disease and advanced periodontal disease compared to participants who did not have diabetes (Table 2).

The association between current smokers and poor oral health outcomes

The current smokers had decreased association for periodontal disease (OR 0.78, 95% CI 0.65-0.94) compared to participants who were not current smokers. Furthermore, the current smokers had increased association for the advanced periodontal disease (OR 1.19, 95% CI 1.03-1.38) compared to participants who were not current smokers (Table 2).

The association between limited access to dental care and poor oral health outcomes

Participants who had limited access to dental care had increased association for advanced periodontal disease (OR 1.67, 95% CI 1.22-2.29) compared to participants who did not have limited access to dental care. Furthermore, participants who had limited access to dental care had no significant association for periodontal disease and, combined periodontal disease and advanced periodontal disease (Table 2).

CHAPTER V – DISCUSSION

5.1 Discussion

The purpose of this study was to examine the associations between sociodemographic and clinical factors and poor oral health outcomes among United States adults 30 years and older. Poor oral health outcomes such as periodontal disease remain a major public health issue for US adults. To develop interventions and strategies for reducing oral health disparities, there is a need to understand the association of sociodemographic and clinical factors and poor oral health outcomes.

Overall, results from this study suggest that the survey participants aged 65 years and older had increased association for periodontal and advanced periodontal diseases and the study participants who were age 30-44 years had decreased association for periodontal diseases. The finding is analogous to the research study conducted by Mutamuliza et al. (2015) in which the researchers found deterioration of periodontal status with increasing age.¹¹ Hispanic and Non-Hispanic Black participants had increased association for periodontal diseases which is similar to findings of the report by Eke et al. (2015).¹⁰ The survey participants who had limited access to dental care had increased association for advanced periodontal diseases which support the suggestions of the study by Fischer et al. (2017) in which the researchers stated that disproportionate poor oral health outcomes are prevalent among US adults due to poor access to dental care.⁷ The current smokers had increased association for periodontal and advanced periodontal diseases which is congruent with the prior research results of the study by Tomar and Asma (2000).¹⁵ The results also suggest that survey participants from low socioeconomic status had decreased association for periodontal diseases. This finding is similar to the results of the research study by Bertoldi et al. (2013), where the researchers found that an increase in socioeconomic status corresponded to worsening of the periodontal condition.²⁸

5.2 Study Limitations

This study is subject to limitations. First, this study used cross-sectional data from the NHANES 2013-2014 survey data and therefore it is not possible to establish a causal relationship between sociodemographic and clinical factors and poor oral health outcomes. Second, oral health outcome data were based on self-report and therefore might be subject to information bias, recall bias, and social desirability bias.²² Information bias could influence responses of the survey participants as they may lack oral health literacy to understand some of the terminology used in the survey questions and therefore, the responses from the survey participants from the low socioeconomic status may suggest underestimation or overestimation of the association between sociodemographic and clinical factors and poor oral health outcomes. The recall bias could have resulted due to recall error of remembering past events and it may result in underestimation of the association between various sociodemographic and clinical factors and periodontal diseases in this study. The social desirability bias could have resulted because the survey questionnaire used in the study involved some sensitive or private questions, which also may have lead to underestimation of the association between various sociodemographic and clinical factors and periodontal diseases.

Furthermore, in this study for the outcome variables because the responses of the survey participants were self-reported, it is more likely that the survey participants from low socioeconomic status had never visited a dentist or a health professional so, they would have responded no to the survey questions for the periodontal disease (if they had received a treatment for the gum diseases) or advanced periodontal disease (have you ever been told by a dental professional that you have lost bone around your teeth?) even though they would have the disease. Also, using the survey responses from asking questions for defining the status of their periodontal disease would not be an accurate measure compared to using the clinical examination measures to define the periodontal diseases.

However, this research study had several strengths worth noting this study was based on a nationally representative sample, the NHANES survey includes rigorous data collection

with reliable instruments and, the information for the poor oral health outcomes was collected by interviews/clinical examination by highly trained health professionals.

5.3 Implications of Findings, Recommendations and Conclusions

This study found that participants aged 30-44 years and participants from low socioeconomic status had decreased association for periodontal diseases while participants aged 65 years and older, who were from Hispanic and Non-Hispanic Black race/ethnicity, had limited access to dental care and were current smokers had increased association for periodontal and/or advanced periodontal diseases. However, cautious interpretation is recommended and there is a need for conducting longitudinal studies for further assessing the estimation of the association between sociodemographic and clinical factors and poor oral health outcomes.

Our study findings suggested that limited access to dental care is positively associated with periodontal disease and cost affordability is an important issue for oral health care access. We need to develop policies that address the cost of oral healthcare; for example, making oral healthcare affordable for all the people by expanding the oral health care insurance coverage. Sometimes, US adults face issues in finding a dentist who will accept their Medicaid insurance and treat their dental problems. We should direct our efforts in expanding oral health delivery services, improving the Medicaid reimbursement, and promoting oral health education.

Furthermore, oral health interventions require support from federal and state governments to implement new social policies and allocate funds appropriately so that we can reduce oral health disparities. There is a need to organize and prioritize interventions to people at all socioeconomic levels, with a particular focus to address the special needs of low-resourced individuals who face obstacles and barriers in accessing oral health care and interventions. We should also integrate oral health care and primary care and implement oral health prevention in primary health care settings. We should give basic training to the primary health care professionals by incorporating the oral health core clinical training in their health care professional training and education. Providing training to the primary health care

professionals would help them in the identification of common oral diseases and providing referrals to the dentist, dental health care professionals or specialists. It will also help in improving provider-to-provider communication, and more importantly, oral health of vulnerable populations of the United States. We should implement a standard set of oral health clinical competencies for primary health care professionals and modification in payment policies should be done so that we can efficiently address costs of implementing oral health competencies and provide incentives to health care systems and professionals.^{26,27}

We should make efforts to develop strategies to improve behavioral, lifestyle, and community-level social changes as that will help us to prevent poor oral health outcomes. The oral health interventions and policy efforts must be directed towards including a 'fundamental-social-cause approach' that will benefit all the individuals, regardless of their socio-economic status, resources, or behaviors. We should focus on taking state and community-based approaches in addition to the national surveys for oral health research and surveillance so that we can identify cost-effective solutions for prevention and treatment of oral health diseases. Furthermore, we need to monitor the impacts of the oral health care reform in the US adults continuously, so we can identify additional barriers and develop effective solutions to reduce oral health disparities.

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Table 1: Descriptive Statistics of the Sample

Survey Characteristic	Frequency
	n (%)
Age:	
30 – 44	1547 (33.21%)
45-64	1960 (43.85%)
65+	1306 (22.95%)
Gender	
Male	2290(47.63%)
Female	2523(52.37%)
Marital Status:	
Married or living with a partner	3016 (67.05%)
Widowed	436 (7.24%)
Divorced or Separated	809 (15.44%)
Never Married	549 (10.22%)
Missing	3 (0.05%)
Citizenship Status	
US Citizen	4158 (91.61%)
Non-US Citizen	645(8.24%)
Missing	10(0.15%)
Race/Ethnicity	
Hispanic	1040(13.39%)
Non-Hispanic Black	974(11.02%)
Non-Hispanic White	2102(67.87%)
Other Race - Including Multi-Racial	697(7.72%)

Socioeconomic Status	
Monthly poverty level index <= 1.30	1566(22.48%)
Monthly poverty level index >1.30 to <= 1.85	634(11.92%)
Monthly poverty level index > 1.85	2332(60.63%)
Missing	281(4.97%)
Limited access to dental care	
Yes	988(16.31%)
No	3769(82.83%)
Missing	56(0.86%)
Diabetes Status	
Yes	716(12.18%)
No	3929(84.44%)
Borderline	165(3.34%)
Missing	3(0.04%)
Current Smokers	
Yes	995(20.30%)
No	3261(69.95%)
Missing	557(9.75%)
Periodontal Disease	
Yes	1086(21.34%)
No	3705(78.31%)
Missing	22(0.34%)
Advanced Periodontal disease	
Yes	620 (12.17%)
No	4157(87.29%)
Missing	36(0.54%)
Periodontal Disease+ Advanced Periodontal Disease	
Yes	343 (6.58%)

No	3411 (72.46%)
Missing	1059(20.96%)

Table 2: Summary of regression analysis involving the socio-demographic and clinical factors

	Periodontal Disease	Advanced Periodontal Disease	Periodontaldisease + Advanced Periodontal Disease
Survey Characteristic	OR (95% CI)	OR (95% CI)	OR (95% CI)
1. Age			
<ul style="list-style-type: none"> • 30-44 Years 	0.95 (0.83-1.10)	0.40*** (0.27-0.58)	0.47*** (0.29-0.75)
<ul style="list-style-type: none"> • 45-64 Years 	Ref	Ref	Ref
<ul style="list-style-type: none"> • >=65 years 	1.24 (0.94-1.62)	1.50*** (1.14-1.97)	1.59*** (1.06-2.39)
2. Gender			
<ul style="list-style-type: none"> • Male 	0.95 (0.76-1.18)	1.03 (0.79-1.35)	1.01 (0.75-1.36)
<ul style="list-style-type: none"> • Female 	Ref	Ref	Ref

<p>3. Marital status</p> <ul style="list-style-type: none"> • Widowed • Divorced or Separated • Never Married • Married or Living with partner 	<p>0.78 (0.54-1.13)</p> <p>1.12 (0.82-1.52)</p> <p>1.01 (0.70-1.47)</p> <p>Ref</p>	<p>0.96 (0.68-1.35)</p> <p>1.00 (0.69-1.45)</p> <p>1.20 (0.81-1.79)</p> <p>Ref</p>	<p>0.84 (0.51-1.37)</p> <p>0.96 (0.55-1.66)</p> <p>1.00 (0.59-1.69)</p> <p>Ref</p>
<p>4. Race/Ethnicity</p> <ul style="list-style-type: none"> • Hispanic • Non-Hispanic Black • Other Race - Including Multi-Racial • Non-Hispanic White 	<p>1.62** (1.20-2.19)</p> <p>1.32** (1.01-1.73)</p> <p>1.09 (0.72-1.67)</p> <p>Ref</p>	<p>1.06 (0.77-1.45)</p> <p>1.20 (0.89-1.63)</p> <p>1.36 (0.88-2.09)</p> <p>Ref</p>	<p>1.38 (0.85-2.23)</p> <p>1.68* (1.17-2.42)</p> <p>1.22 (0.67-2.21)</p> <p>Ref</p>
<p>5. Income</p> <ul style="list-style-type: none"> • Monthly poverty 	<p>0.68***</p>	<p>0.77*</p>	<p>0.56***</p>

<ul style="list-style-type: none"> level index <= 1.30 < Monthly poverty level index <= 1.85 Monthly poverty level index > 1.85 	<p>(0.55-0.84)</p> <p>1.03 (0.74-1.45)</p> <p>Ref</p>	<p>(0.59-0.99)</p> <p>1.17 (0.79-1.72)</p> <p>Ref</p>	<p>(0.37-0.85)</p> <p>1.31 (0.68-2.51)</p> <p>Ref</p>
<p>6. Citizenship</p> <ul style="list-style-type: none"> Non-US Citizen US Citizen 	<p>1.18 (0.84-1.66)</p> <p>Ref</p>	<p>1.03 (0.67-1.57)</p> <p>Ref</p>	<p>1.33 (0.80-2.22)</p> <p>Ref</p>
<p>7. Diabetes Status</p> <ul style="list-style-type: none"> Yes Borderline No 	<p>1.21 (0.83-1.78)</p> <p>1.16 (0.81-1.65)</p> <p>Ref</p>	<p>0.96 (0.69-1.33)</p> <p>1.35 (0.73-2.48)</p> <p>Ref</p>	<p>1.17 (0.63-2.16)</p> <p>1.20 (0.75-1.92)</p> <p>Ref</p>
<p>8. Current smokers</p> <ul style="list-style-type: none"> Yes No 	<p>0.78** (0.65-0.94)</p> <p>Ref</p>	<p>1.19* (1.03-1.38)</p> <p>Ref</p>	<p>1.15 (0.81-1.65)</p> <p>Ref</p>

<p>9. Limited access to dental care</p> <ul style="list-style-type: none"> • Yes • No 	<p>1.24 (0.92-1.67)</p> <p>Ref</p>	<p>1.67** (1.22-2.29)</p> <p>Ref</p>	<p>1.20 (0.79-1.84)</p> <p>Ref</p>
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*=p<.05; **p<.01; ***p<.001