

THE ASSOCIATION BETWEEN INCOME DISPARITIES AND PRENATAL  
ORAL HEALTH: RESULTS FROM THE 2009-2011 NORTH CAROLINA  
PREGNANCY RISK ASSESSMENT MONITORING SYSTEM

by

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## ABSTRACT

CHELSEA GILL. The association between income disparities and prenatal oral health: Results from the 2009-2011 North Carolina Pregnancy Risk Assessment Monitoring System. (Under the direction of DR. LARISSA R. BRUNNER HUBER)

Access to adequate dental care is a problem in the U.S., particularly for economically disadvantaged individuals. During pregnancy, women are at increased risk of developing adverse oral health conditions, such as periodontitis, which can potentially lead to negative birth outcomes. Prior studies have examined racial disparities in oral health, but few have examined the association between household income and prenatal oral health outcomes and access to oral health care. The purpose of this study was to examine further the effect of health disparities, measured through self-reported income, on prenatal oral health and access to oral health care services. This study was a secondary data analysis of 3,111 women between 18 and 45 years of age who participated in the 2009-2011 North Carolina Pregnancy Risk Assessment Monitoring System (PRAMS). Annual household income was self-reported by participants and classified as low ( $< \$50,000$ ) or high income ( $\geq \$50,000$ ). Information on the two outcomes, negative prenatal oral health outcomes and access to oral health during pregnancy, were also self-reported. Logistic regression was used to obtain odds ratios (ORs) and 95% confidence intervals (CIs). After adjusting for maternal education, marital status, and maternal age, women of lower income had twice the odds of having negative oral health outcomes during pregnancy compared to women of higher income (OR=2.22, 95% CI: 1.44 – 3.43). After adjusting for maternal education, marital status, and maternal race/ethnicity, women of lower income had over four times the odds of being unable to access oral health care compared to

women of higher income (OR=4.21, 95% CI: 2.81 – 6.30). While race/ethnicity may be an effect modifier of the income-negative oral health outcomes association, it was not an effect modifier of the income-access to oral health care association. Findings may inform the development of interventions designed to reduce the impact of health disparities on prenatal oral health and access to oral health care. However, additional studies examining household income and negative prenatal oral health outcomes and access to oral health care during pregnancy are needed to confirm these findings.

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## CHAPTER 1: INTRODUCTION

Health disparities refer to inconsistencies in the availability of basic resources that are necessary to achieve and to maintain good health (National Institutes of Health [NIH], 2013). Socioeconomic status (SES) is often cited as a contributor to health disparities, especially among racial/ethnic minorities, women, and elderly populations (Shavers, 2007). Health disparities are caused by discrepancies in provisions available to various populations that result in unequal health outcomes among them. The National Institutes of Health (NIH) defines health disparities as differences in the incidence, prevalence, mortality, and burden of disease and other adverse health conditions that exists among specific population groups in the United States (Bell, 2012). The North Carolina Office of Minority Health and Health Disparities has a similar definition, stating that health disparities are significant differences or inequalities in health that exist between whites and racial/ethnic minorities.

Social determinants of health are an underlying cause of health disparities among various racial/ethnic groups. According to the World Health Organization (WHO), social determinants of health are the conditions in which people are born, grow, live, work, and age. These circumstances are influenced by the distribution of money, power, and resources. Thus, while health disparities are most frequently measured in terms of racial/ethnic disparities, insufficient income is often cited as a barrier for access to the resources and health care services needed for good health. Income inequality has been

associated with a number of differences in health, including quality of life and access to care (Lynch, et al., 2000). Since 1979, gaps in income have become increasingly significant between those in low, middle, and high-income brackets (Center on Budget and Policy Priorities, 2015).

Some of the most common inequalities in health between populations include differences in mortality, morbidity, quality of life, health behaviors, access to health care, and access to resources necessary for good health. According to the Institution of Medicine, raising awareness of these health disparities among healthcare providers, insurance companies, and policy makers is key to addressing them and narrowing the gap between populations (Bell, 2012).

Healthy People 2020 is a science-based, ten-year plan with objectives and benchmarks to provide a roadmap for tracking the nation's health, with the overarching goal of improving the health of all Americans by the year 2020 (Office of Disease Prevention and Health Promotion, 2015). Oral health is one of 42 Healthy People 2020 topic areas and includes objectives related to oral health disparities and access to care (National Center for Health Statistics [NCHS], 2012). Recognition of the importance of oral health to overall health is increasing, in part due to its being named one of the top twelve leading health indicators for Healthy People 2020 (NCHS, 2012). Many prevalent oral health issues can be prevented and treated with regular dental visits; however, in 2007, only 44.5% of Americans over the age of two reported having had a dental visit in the past 12 months (Office of Disease Prevention and Health Promotion, 2015c). Healthy People 2020 aims to increase the proportion of children, adolescents, and adults who used the oral health care system in the past twelve months to 49.0% by

the year 2020 (Office of Disease Prevention and Health Promotion, 2015d). More specifically, Healthy People 2020 addresses access to affordable oral health care, a commonly cited barrier. In 2007, 75% of Federally Qualified Health Centers (FQHCs) had an oral health component. The target outcome for Healthy People 2020 aims to increase this percentage to 83%. In addition, Healthy People 2020 aims to increase the percentage of local health departments with an oral health prevention or care program from 25.8% (in 2007) to 28.4%.

Access to adequate dental care is a problem in all parts of the United States. Approximately one-third of Americans, including racial and ethnic minorities, individuals with chronic diseases, the elderly, and those people who are economically disadvantaged, face challenges accessing dental care (American Dental Association [ADA], 2015). Oftentimes members of economically disadvantaged populations are dependent on other resources, such as government funding and government programs, in order to access dental health care (de la Fuente-Hernandez & Acosta-Gio, 2007). In 2010, 181 million Americans did not see a dentist (ADA, 2015b), and 27.4% of adults age 20-44 years had untreated dental caries in 2011-2012 (Centers for Disease Control and Prevention [CDC], 2015). The most commonly cited barrier for dental care is lack of finances and/or dental insurance (Health Policy Institute, 2014). In all age groups, lower-income individuals are more than twice as likely to have untreated dental caries compared to higher-income individuals (Institute of Medicine and National Research Council, 2012).

Many women, including half of those who have dental issues, do not see a dentist during pregnancy (Hunter & Yount, 2011). Women who are pregnant generally use

dental services less frequently and at lower levels than does the overall population (Timothe, Eke, Presson, & Malvitz, 2005). In 2007-2009, 35% of women in the United States reported that they did not have a dental visit within the last year, and 56% of women did not visit a dentist during pregnancy (American College of Obstetricians and Gynecologists, 2013). Findings suggest that oral health issues in low-income pregnant women are not related to poor oral health care practices, but to the need for dental services and oral health education. Common barriers to dental care include preferential access to patients with a payor source, an insufficient number of dental providers, and inadequate funding for dental programs. Barriers specific to women of lower SES include low literacy, inadequate transportation, failure to value oral health needs, and language barriers (Hunter & Yount, 2011). Common sociodemographic indicators for oral health disparities include SES, race, and ethnicity (NCHS, 2012). With regard to education, 54.2% of adults over the age of 25 visited a dentist in 2012, compared to just 18.2% of individuals with a high school education. With respect to income, individuals with family incomes greater than 400% of the poverty threshold had the highest percentage of dental visits (55.9%), while individuals with family incomes below the poverty threshold had the lowest rate (27.0%) in 2012 (Office of Disease Prevention and Health Promotion, 2015b).

Millions of Americans are living with one or more common oral health diseases, including dental caries (cavities), periodontal (gum) disease, cleft lip and palate, oral and facial pain, and oral and pharyngeal (mouth and throat) cancers (Office of Disease Prevention and Health Promotion, 2015c). Increasingly, research has linked oral health, especially periodontal (gum) disease, to a variety of chronic diseases, including diabetes,

heart disease, and stroke (Office of Disease Prevention and Health Promotion, 2015c). In pregnant women, poor oral health has also been found to be associated with a number of adverse pregnancy outcomes, including premature birth and low birth weight (Office of Disease Prevention and Health Promotion, 2015c). Clearly, prenatal oral health is an important facet of overall health because maternal oral health has significant implications for birth outcomes, as well as infant oral health. Thus, the purpose of this study was to examine further the effect of health disparities, measured through self-reported income, on prenatal oral health and access to oral health care services. Findings may inform the development of interventions designed to reduce the impact of health disparities on prenatal oral health and access to oral health care.

## CHAPTER 2: LITERATURE REVIEW

### 2.1 Background and Significance of Prenatal Oral Health

Due to the many changes that occur in the body during pregnancy, expectant mothers are at increased risk for developing adverse oral health conditions, including oral lesions, dental caries, pregnancy oral tumors, loose teeth, gingivitis, and periodontitis (Silk, et al., 2008). These oral health diseases can potentially lead to a number of systemic diseases, including atherosclerosis, diabetes, and coronary heart disease (Cottrel-Carson, 2003). Some of these conditions are also associated with adverse pregnancy outcomes, including preeclampsia, preterm birth, and low birth weight (Silk, et al., 2008).

Periodontitis is a destructive inflammation of the periodontium due to bacterial infiltration (Silk, et al., 2008). Periodontal disease results in increased levels of inflammatory markers, which are produced in response to periodontal pathogens and their toxins. The chronic inflammation associated with periodontal disease increases uterine stimulating factors, such as prostaglandins, which appear to affect placental function and, potentially, the induction of labor (Hasegawa et al., 2003).

Elevated levels of inflammatory markers have been found in the amniotic fluid of women with periodontitis. More specifically, researchers have found oral bacteria in the amniotic fluid and placenta of women with preterm labor and periodontitis. It is likely that this inflammatory response prematurely initiates labor (Silk, et al., 2008). However,

some studies have found that the pathogens themselves (i.e., *Tannerella forsythia*, *Porphyromonas gingivalis*, and *Aggregatibacter actinomycetemcomitans*), rather than an increase in inflammatory markers, are what can potentially trigger preterm labor (Dasanayake, et al., 2008).

Preventive oral health care is especially important during pregnancy due to hormonal changes, which increase the risk of gingivitis, a milder form of and precursor to periodontal disease (Ressler-Maerlender, Krishna, & Robison, 2005). Gingivitis is the most common oral disease during pregnancy, with a prevalence rate of 60% to 75%; approximately one-half of women who have existing gingivitis conditions have significant exacerbation during pregnancy (American Academy of Periodontology [AAP], 2004). Women are at increased risk for developing gingivitis during pregnancy due to fluctuations in progesterone and estrogen levels in combination with changes in oral flora and a decreased immune response. Pregnant women are also at increased risk for developing dental caries due to increased acidity in the oral cavity, sugary dietary cravings, and limited attention to oral health (Silk, et al., 2008).

In addition to birth outcomes, maternal oral health has an impact on infant and child oral health. High levels of cariogenic bacteria in mothers can lead to an increase of dental caries in the infant, and children of mothers who have a high number of dental caries are more likely to develop dental caries themselves (Silk, et al., 2008).

## 2.2 Key Epidemiological Studies on Prenatal Oral Health and Pregnancy Outcomes

Since numerous studies have examined the effects of prenatal oral health on pregnancy outcomes, this section of the literature review focuses only on findings from large meta-analyses and systematic reviews conducted after the year 2010. A systematic

search was conducted through the PubMed database using keywords: “periodontal disease,” “pregnancy outcomes,” and “review.” For studies addressing the association between prenatal oral health and pregnancy outcomes, location was not an inclusion factor. Studies that were not in English were excluded. A meta-analysis of studies examining the association between periodontal disease and the development of preeclampsia suggested that periodontal disease is an independent indicator of preeclampsia (Huang et al., 2014). A literature search conducted to identify relevant papers produced 11 studies involving 1,118 women with preeclampsia and 2,798 women without preeclampsia that met the inclusion criteria. The population locations examined included the United States, Turkey, Colombia, Brazil, Thailand, India, Brazil, Korea, and Canada. Pooled odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were calculated and compared. Women with periodontal disease before 32 weeks of gestation had nearly four times the risk of developing preeclampsia compared to pregnant women without periodontal disease (OR=3.69; 95% CI: 2.58-5.27).

A systematic review based on case-control studies was conducted to evaluate if periodontal disease could be a risk factor for preterm birth, low birth-weight, and preterm low birth-weight (Corbella et al., 2012). A systematic search identified 17 case-control studies, accounting for a total of 10,148 patients. Pooled ORs demonstrated that periodontal disease was associated with statistically significant increased odds of preterm birth (OR=1.78; 95% CI: 1.58, 2.01), low birth-weight (OR=1.82; 95% CI: 1.51, 1.20), and preterm low birth-weight (OR=3.00; 95% CI: 1.93, 4.68).

### 2.3 Oral Health in North Carolina

North Carolina ranks 37<sup>th</sup> in the United States in terms of overall health according to America's Health Rankings (NCDHHS, 2015). Oral health is an integral part of general health and quality of life due, in part, to the numerous associations between oral health and chronic diseases. The loss of teeth may affect both mental and physical health. Imai and Mansfield (2015) determined that adults in North Carolina who had lost six or more teeth were more likely to report poor or fair general health. Oral infections and/or loss of teeth can exacerbate chronic diseases such as diabetes, kidney disease, and cardiovascular disease. Poor oral health may also cause dental pain and discomfort that can significantly impact an individual's ability to live a normal life (Imai & Mansfield, 2015). Despite North Carolina's below average oral health status, the state is ranked 18<sup>th</sup> in the United States for the percentage of fluoridation with 87.5% of the water supply being fluoridated (CDC, 2012).

The percentage of adults in North Carolina who have had permanent teeth removed due to tooth decay or gum disease is 47.8% (Imai & Mansfield, 2015). According to America's Health Rankings, one of the key challenges in North Carolina is the limited availability of dentists. In 2014, among the 50 United States, North Carolina ranked 32<sup>nd</sup> for dental visits and 47<sup>th</sup> for the number of dentists per capita (American Public Health Association [APHA], 2015).

### 2.4 Health Disparities in North Carolina

As noted, health disparities refer to inconsistencies in the availability of basic resources that are necessary to achieve and to maintain good health (NIH, 2013). The North Carolina Office of Minority Health and Health Disparities defines health

disparities as significant differences or inequalities in health that exist between whites and racial/ethnic minorities (Bell, 2012). The most pronounced and persistent disparities are those defined by race and ethnicity (Matsuo, Rozier, & Kranz, 2015). The launch of Healthy People 2010 in January 2000, placed emphasis on eliminating health disparities nationwide; this remains a goal for Healthy People 2020. Health disparities are often measured by comparing the health of one group (defined as the reference group) with the health of other groups (Carter-Pokras & Baquet, 2002).

While not as commonly addressed, household income and SES are often cited as causes for health disparities. In 2014, North Carolina ranked 37<sup>th</sup> in the United States for income disparities and 43<sup>rd</sup> for disparities in health status (APHA, 2015). Government funding designations are often based on the percentage of poverty; in turn, poverty designations are based on annual household income. An individual is defined as living in poverty if his or her household income is below the threshold for that family size and composition (e.g. the threshold for a 4 person household is \$24,300 in 2016) (United States Department of Health and human Services [USDHHS], 2016).

## 2.5 Prenatal Oral Health Disparities

Prenatal oral health disparities refer to inequalities in the availability of resources, such as access to oral health care, between pregnant women of different population groups. These discrepancies often result in unequal health outcomes among the varying populations and are often racially or ethnically based. Few studies have directly examined the role of household income on prenatal oral health. However, SES can play a significant role in health disparities, in part due to the cost of resources such as oral health care and dental insurance. The type of coverage also plays a role in access to

dental health care; women on Medicaid are 24% to 53% less likely to seek dental care than are all women with private insurance (Gaffield, Gilbert, Malvitz, & Romaguera, 2001).

In some instances, it is not a lack of available resources, but rather a lack of knowledge of the importance of oral health care during pregnancy that affects whether or not a woman receives necessary oral health care. It has been suggested that while some women have the means to seek oral health care services, others do not realize that they have an oral disease and instead believe that poor oral health is normal during pregnancy and/or that dental treatments could harm their unborn child. Moreover, many women are not informed by their obstetricians that they should seek dental care during pregnancy (Al Habashneh, et al., 2005).

Oral health literacy is a relatively new concept that is critical in efforts to reduce oral health disparities and to improve oral health and access to oral health care. Oral health literacy is important because those with low oral health literacy are usually at highest risk for oral diseases. These individuals tend to be those of low income, low education, and minorities (Horowitz & Kleinman, 2011).

## 2.6 Key Epidemiological Studies on Health Disparities and Oral Health

A systematic search of PubMed using the key words “health disparities” or “socioeconomic status” or “SES” or “income” or “income disparities” and “oral health” identified five articles, which were then reviewed to determine their relevance. Of these, three studies were deemed relevant and examined the association between health disparities and oral health in adults in the United States.

Imai and Mansfield (2015) analyzed data from the North Carolina Behavioral Risk Factor Surveillance System (BRFSS) (2006, 2009, and 2010) to examine how oral health is related to general health. A total of 43,622 North Carolina residents responded to the interviews for these three years. The primary focus of this study was to examine the impact of oral health (defined as the loss of teeth) on overall health; however, findings related to income were also included. Specifically, the researchers noted a dose-response relationship between income and tooth loss with lower incomes being associated with higher increased odds of having six or more teeth removed (<\$15,000: OR=2.96, 95% CI: 2.45 – 3.58; \$15,000 - \$25,000: OR=2.27, 95% CI: 1.91 – 2.70; \$25,000 - \$35,000: OR= 2.13, 95% CI: 1.78 – 2.55; and \$35,000 - \$50,000: OR=1.66, 95% CI: 1.41 – 1.95; vs. referent of  $\geq$  \$50,000). Associations between race/ethnicity and loss of teeth were weaker, and most were not statistically significant.

Nasseh and Vujicic (2014) analyzed data from the 2002, 2004, 2006, 2008, and 2010 BRFSS to measure dental care utilization between poor and non-poor adults at the state level to demonstrate how income disparities have grown over time. For the purpose of this study, poor adults were defined as those individuals at or below the federal poverty threshold. At the state level, poor adults faced greater access barriers to dental care than did non-poor adults. As states limit dental coverage through Medicaid, poor adults are at greater risk of experiencing poor oral health outcomes and access to oral health care (Nasseh & Vujicic, 2014).

Manski et al., (2012) examined the associations of wealth and income on dental utilization in a population of older Americans using data from the 2008 Health and Retirement Study (HRS). This population included 17,217 individuals aged 51 years and

older. Wealth was divided into Wealth Deciles within the study population by percentile: 1-3 Wealth Deciles (10<sup>th</sup> – 30<sup>th</sup> percentile), 4-6 Wealth Deciles (40<sup>th</sup> – 60<sup>th</sup> percentile), 7-9 Wealth Deciles (70<sup>th</sup> – 90<sup>th</sup> percentile), and 10 Wealth Deciles (100<sup>th</sup> percentile) with the minimum wealth being -\$553,270 and the maximum wealth being \$55,441,000. Income was divided into poor, low income, middle income, and high income, with poor being defined as at or below 100% of the poverty line, low as 101%-199%, middle as 201% - 400%, and high as over 400%. Both wealth and income had strong and independent positive effects on dental care use by older Americans, meaning that the likelihood of utilizing dental care decreased with a decline in wealth (1-3 Wealth Deciles: OR=0.235, 95% CI: 0.181 – 0.307, 4-6 Wealth Deciles: OR=0.399, 95% CI: 0.315 – 0.504, 7-9 Wealth Deciles: OR=0.713, 95% CI: 0.558 – 0.912, and 10 Wealth Deciles: Referent). The likelihood of utilizing dental care also decreased with a decline in income (Poor: OR=0.450, 95% CI: 0.420 – 0.692, Low income: OR=0.686, 95% CI: 0.590 – 0.797, Middle income: OR=0.749, 95% CI: 0.656 – 0.854, and High income: Referent).

## 2.7 Key Epidemiological Studies on Health Disparities and Prenatal Oral Health

A systematic search of PubMed using the key words “health disparities” or “socioeconomic status” or “SES” or “income” and “prenatal oral health” produced seven articles, which were then reviewed to determine their relevance. Of these, three studies were considered relevant and examined the association between health disparities and prenatal oral health. Most studies examining health disparities and prenatal oral health focused primarily on racial and ethnic disparities rather than income disparities; however, some studies addressed income in the bivariate analysis.

Hwang, Smith, McCormick and Barfield (2011) examined the association between racial/ethnic disparities and maternal oral health among 35,267 women who participated in the 2004-2006 Pregnancy Risk Assessment Monitoring System (PRAMS) from 10 states (Alaska, Arkansas, Maine, Michigan, Mississippi, Nebraska, New York, Ohio, South Carolina, and Utah). Non-Hispanic black women were more likely than were non-Hispanic white women to have a dental problem after adjusting for age, income, education, insurance status before pregnancy, adequacy of prenatal care, and smoking (OR=1.19 and 95% CI: 1.05-1.35). Additionally, after adjustment for the same factors, non-Hispanic black women and Hispanic women were less likely to obtain dental care during pregnancy than were non-Hispanic white women (OR=0.87, 95% CI: 0.77-0.98 and OR=0.77, 95% CI: 0.64-0.91 respectively). While this study focused primarily on racial/ethnic disparities, the authors did note that the proportion of pregnant women who did not seek dental care despite a dental problem was greatest in mothers who had Medicaid versus private insurance and in those women in the lowest income bracket. Furthermore, the authors suggested that minority and low income women did not seek dental care during pregnancy due to stressors such as poor domestic relationships, personal finances, and employment, as well as dental related factors, including perception of dental experience, attitude toward dental providers, importance of oral health, perceived ability to pay for care, time constraints, and dental providers' and office staff attitudes toward clients.

In a cross-sectional study of 599 pregnant women recruited at the UNC Women's Clinic Ultrasound Unit in North Carolina, Boggess et al. (2011) examined racial/ethnic and economic health disparities to determine if they were associated with prenatal oral

health knowledge. Significant gaps in oral health knowledge during pregnancy between different racial/ethnic groups were identified. Women of racial or ethnic minorities and those with economic disadvantages had less oral health knowledge than did women who were not of a racial or ethnic minority or economically disadvantaged. The majority of the women in this study (95.7%) were aware of the relationship between sugar intake and dental caries (cavities) and the importance of caring for their teeth. However, many women did not know that it is safe to receive oral health care during pregnancy. A greater percentage of Hispanic women believed that routine dental care is unsafe during pregnancy than did white or black women (25.3%, 5.2%, and 9.7%, respectively; ( $P < .001$ )). Similarly, a greater percentage of Hispanic women believed that it is normal to lose a tooth during pregnancy than white women (28.9% and 10.8%, respectively); ( $P < .001$ ). When asked whether or not they would rank their oral health as “good” or “excellent” 32% of Hispanics, 77.1% of Whites, and 62.7% of Blacks said “yes;” ( $P < .001$ ). Overall, racial or ethnic minority women and those with economic disadvantages had less oral health knowledge than did women who were not of a racial or ethnic minority or did not have an economic disadvantage. It was also suggested that oral health knowledge may be a predictor of use of dental services; however, it is difficult to determine the contributions of lack of knowledge and lack of access to care to oral health outcomes. Last, the researchers noted no significant interactions between race or ethnicity and education, race or ethnicity and income, or education and income. Some limitations of this study were the small sample size and limited generalizability due to the fact that participants were recruited from only one clinic in Chapel Hill, NC.

Chung et al. (2014) conducted a small study ( $n=99$ ) to examine sociodemographic

disparities and clinical oral health during pregnancy. Participants attending a group prenatal care program in San Francisco, CA completed questionnaires addressing race/ethnicity, income, education, dental insurance, oral hygiene practices, and dental care utilization; clinical examinations for periodontal probing depths (PD), bleeding on probing (BOP), plaque assessment, and visual detection of untreated decay were also conducted. When compared with Whites, Hispanic women had a greater percentage of sites with: BOP,  $PD \geq 5$  mm, and Plaque Index (PI) scores of  $\geq 2$ , ( $P = 0.05$ ); and greater untreated decay (Chi-square 13.3,  $P < 0.001$ ). Lower income (defined as  $< \$20,000$ ) was related to greater untreated decay (Chi-square 7.6,  $P < 0.01$ ), and those with public (versus private) dental insurance had a greater percentage of sites with BOP and  $PD \geq 5$  mm, ( $P < 0.05$ ), and a greater likelihood of untreated decay (Chi-square 16.9,  $P < 0.001$ ). Compared with those of the highest education level, participants in the lowest level group had higher percentage BOP,  $P < 0.05$  (Chung et al., 2014). Some limitations of this study were the small sample size; limited generalizability due to the racial/ethnic breakdown of the study (65% Hispanic, 20% white, and 15% other); the fact that participants were recruited from only one program in San Francisco, CA; and the division of household income into  $< \$20,000$  and  $\geq \$20,000$  which may have resulted in some economically disadvantaged individuals being placed in the “higher” income category.

## 2.8 Gaps in the Literature

There is clear evidence of an association between prenatal oral health and adverse pregnancy outcomes. This association emphasizes the importance of having access to and utilizing oral health care during pregnancy. Racial/ethnic and socioeconomic factors associated with oral health status are also well documented in the general United States

population, with minority and lower income groups tending to have poorer oral health. However, little has been reported on health disparities within the population of pregnant woman in the United States (Chung et al., 2014), particularly as they pertain to income disparities. Prior studies on prenatal oral health have focused primarily on racial and ethnic disparities rather than income disparities, although most did find some evidence of income disparities and their effect on prenatal oral health in unadjusted results. However, studies examining the association between income disparities and oral health in the general adult population have consistently found that those of lower income tend to have poorer oral health outcomes and limited access to care compared to those of higher income (Imai & Mansfield, 2015; Nasseh & Vujicic, 2014; Manski et al., 2012). From this literature review, it appears that there is a gap in studies of health disparities, measured by income, and prenatal oral health outcomes and access to oral health care during pregnancy. Moreover, prior studies had small sample sizes and lacked generalizability (Boggess et al., 2011 & Chung et al., 2014). Findings from this study may help to address these limitations and to fill the gaps in this area of research.

## CHAPTER 3: HYPOTHESES

This study examined the association between income disparities and prenatal oral health outcomes among women who participated in the 2009-2011 North Carolina Pregnancy Risk Assessment Monitoring System (PRAMS).

The following hypotheses were examined:

1. Women of lower household income have increased odds of developing negative oral health outcomes during pregnancy, (e.g. extractions and fillings) compared to women of higher socioeconomic status.
2. Women of lower household income have increased odds of being unable to access oral health care during pregnancy (i.e., they needed care but were unable to see a dentist) compared to women of higher household income.
3. The association between household income and developing negative health outcomes during pregnancy differs by category of maternal race/ethnicity.
4. The association between household income and access to oral health care during pregnancy differs by category of maternal race/ethnicity.

## CHAPTER 4: METHODS

### 4.1 Study Design and Population:

This retrospective cohort study used data from the 2009-2011 North Carolina Pregnancy Risk Assessment Monitoring System (N.C. PRAMS). North Carolina was chosen for this study because the state ranks 37<sup>th</sup> in the United States in terms of overall health according to America's Health Rankings (NCDHHS, 2015). In 2014, North Carolina ranked 32<sup>nd</sup> for dental visits and 47<sup>th</sup> for the number of dentists per capita (APHA, 2015). In addition, North Carolina ranked 43<sup>rd</sup> for disparities in health status and 37<sup>th</sup> for income disparities. In regard to pregnancy outcomes, in 2014, North Carolina ranked 40<sup>th</sup> for low birth weight and 32<sup>nd</sup> for preterm births. N.C. PRAMS data from 2009-2011 represent the most recent years of data that include all of the key variables necessary for this study.

The N.C. PRAMS is a joint initiative between the North Carolina State Center for Health Statistics (NCHS) and the Centers for Disease Control and Prevention (CDC) to lower rates of low birth weight and infant mortality (CDC, 2013). N.C. PRAMS is a continuing annual surveillance system, which is conducted to provide data on certain self-reported maternal behaviors, conditions, and experiences that occur shortly before, during, and after pregnancy among women who deliver live-born infants. Women who have had a recent live birth are selected from state birth certificate files. Each state samples between 1,300 and 3,400 women per year divided

among three to six strata. Many states stratify by the mother's race or ethnicity. Typically, the sample is large enough to estimate risk factors within 3.5% at 95% confidence; however, the proportions within the individual strata are less precise (within 5% at 95% confidence) (CDC, 2013). The PRAMS employs a complex sampling and weighting design to account for variations in response rates among women with certain characteristics, such as being unmarried or of lower education. Most states (including North Carolina) oversample low birthweights to ensure that there is an adequate sample representative of the population.

Each of the 37 states that participate in PRAMS administers a set of "core" questions to each of the women surveyed. States may opt to include additional questions that are tailored to the state's specific population and needs. North Carolina developed three state specific questions regarding oral health to include in their surveys: (NC65) Did you go to a dentist or dental clinic? (Y/N); (NC66) When in a dentist office or dental clinic, did you have any of the following? a. Cleaning (Y/N), b. Filling (Y/N), c. Extraction (Y/N), d. Other treatment (Y/N); and (NC67); and (NC67) Did you need to see a dentist for a problem but were not able to? (Y/N).

Women who have recently given birth to a live infant are initially contacted by mail, introduced to PRAMS, informed of the purpose of the study, and told that they will be receiving a questionnaire packet in the mail shortly. The mailed questionnaire packet includes a cover letter explaining the procedure and purpose of the study, the PRAMS questionnaire, a list of frequently asked questions, a three-year calendar (to be used as a memory aid for answering the questions), and a participation incentive such as coupons for certified birth certificates, participation

in a raffle for a cash award, postage stamps, bibs, cash (a dollar bill), and magnetic picture frames (CDC, 2013). The week following the receipt of the initial packet, a reminder/thank you letter is mailed to participants. A second packet is mailed one to two weeks later if there is no response, and then a third packet is mailed to all remaining nonrespondents. If there is still no response, a telephone call is made one to two weeks after the last mailing (CDC, 2013). The purpose of this procedure is to encourage participation and to decrease the potential for loss to follow-up.

#### 4.2 Inclusion Criteria

A total of 3,111 women were available for analysis from the 2009-2011 N.C. PRAMS. Women were excluded from this study if they were not between 18 and 45 years of age (n=101) or if they did not answer the questions regarding income (n=165). For the negative oral health outcome analysis, participants were further excluded if they did not answer the questions regarding oral health outcomes (n=1,654), education (n=3), smoking status (n=1), and prenatal care (n=9). Thus, 1,178 women were available for income-negative oral health outcomes analysis. For the access to care analysis, in addition to the age and income exclusions, participants were excluded if they did not answer questions regarding access to oral health care (n= 15), race (n=1), education (n=6), marital status (n=1), smoking status (n=3), and prenatal care (n=26). Thus, 2,793 women were available for the income-access to oral health care analysis.

#### 4.3 Exposure Assessment

The exposure for this study was self-reported income. Study participants were asked to select their household income bracket from seven categories: less than

\$10,000; \$10,000 to \$14,999; \$15,000 to \$19,999; \$20,000 to \$24,999; \$25,000 to \$34,999; \$35,000 to \$49,999; and \$50,000 or more. The median household income in North Carolina for 2014 was \$46,693 (United States Census Bureau, 2016).

Thus, women with household incomes below the median household income were considered to be the exposed (low income) and women with household incomes above the median household income were considered to be the unexposed (high income).

#### 4.4 Outcome Assessment

Two outcomes were considered in this study: negative oral health outcomes and access to dental care during pregnancy. Women were asked to provide information on oral health needs and services while pregnant. If women answered “yes” to needing extractions, fillings, or other treatments they were considered to have the negative oral health outcome. If women answered “yes” to needing to see a dentist for a problem but being unable to they were considered to have the lack of access to oral health care outcome.

#### 4.5 Covariate Assessment

Information on demographics, lifestyle, and pregnancy characteristics collected through PRAMS were considered and addressed as potential confounding factors. The confounders that were considered were based on the literature review and other factors that are not believed to be on the causal pathway between the exposure and outcome variables. These potential confounders included maternal age, marital status, educational level, race/ethnicity, prenatal care, and smoking status (Corbella, et al., 2012). Prenatal care may be a confounder because women

who receive adequate prenatal care during pregnancy may be more likely to be referred to a dentist and/or informed of the need and safety of receiving oral health care during pregnancy. Prenatal care was based on the number of prenatal care visits a woman had with a healthcare professional during her pregnancy and was defined as inadequate (<14 visits) or adequate ( $\geq$ 14 visits) (Office on Women's Health, 2012). Maternal alcohol use may also be a confounder of the exposure-outcome associations since it is associated with negative oral health outcomes, including periodontitis (Wang, Lv, Wang, & Jiang, 2016), but it was not analyzed due to the small number of women who indicated they drank alcohol during pregnancy (n=2). Maternal age, marital status, educational level, race/ethnicity, and prenatal care data were extracted from birth certificate records. Smoking status was self-reported by participants on the PRAMS questionnaires (CDC, 2015).

#### 4.6 Data Analysis

##### 4.6.1 Univariate Analysis

Summary statistics were calculated to describe the sample population. Frequencies and percentages were calculated to describe the various demographic, pregnancy, lifestyle, and general health characteristics of the sample population.

##### 4.6.2 Bivariate Analysis

Logistic regression was used to calculate unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) to determine the crude association between self-reported income and negative oral health outcomes and access to oral health care. In addition, other potential risk factors for the two oral health outcomes were identified.

##### 4.6.3 Multivariate Analysis

Adjusted ORs and 95% CIs were calculated using multivariate logistic regression to evaluate the associations between self-reported income and the two prenatal oral health outcomes. Potential confounders that were considered included maternal age, marital status, educational level, race/ethnicity, prenatal care, and smoking status (Corbella, et al., 2012). Variables were considered to be confounders if they changed the crude OR by at least 10% (Maldonado & Greenland, 1993).

SAS-callable SUDAAN was used in the analyses to account for the complex sampling design used by PRAMS. SAS-callable SUDAAN uses a subpopulation statement in the analyses meaning that the exclusions do not affect the generalizability of the results. If the data set is subset, meaning that observations not to be included in the subpopulation are deleted from the data set, the 95% CI cannot be calculated correctly. When the subpopulation option is used, only the cases defined by the subpopulation are used in the calculation of the estimate, but all cases are used in the calculation of the 95% CI. Thus, those who are excluded from the analysis do not affect the generalizability of the results (Institute for Digital Research and Education, 2016).

#### 4.6.4 Power and Sample Size

N.C. PRAMS data available for analysis from 2009-2011 includes 3,111 women. Alpha was set at 0.05, power at 80%, and the ratio of unexposed (high SES) to exposed (low SES) was 1.08:1 for negative oral health outcomes and 0.54:1 for access to oral health care. The frequency of negative oral health outcomes among the unexposed (high SES) was 26.57%, and the smallest detectable OR was 1.45. The

frequency of limited access to oral health care among the unexposed (high SES) was 21.41%, and the smallest detectable OR was 1.32

## CHAPTER 5: RESULTS

### 5.1 Negative Oral Health Outcomes

#### 5.1.1 Univariate Results

Of the women analyzed for negative oral health outcomes, most were between 25 and 34 years of age (58.46%), married (71.65%), and non-Hispanic White (68.29%); most also had at least a college education (43.29%) (Table 1a). Annual household income was fairly evenly distributed, with 52.09% of women below \$50,000 and 47.91% at \$50,000 or more. Most participants (72.00%) did not experience negative oral health outcomes during pregnancy (i.e., fillings, extractions, or other treatments).

#### 5.1.2 Bivariate Results

Women of lower income (<\$50,000) had over four-fold increased odds of having a negative oral health outcome during pregnancy compared to women of higher income ( $\geq$ \$50,000), and this result was statistically significant (OR= 4.44, 95% CI: 3.21 – 6.14; Table 2). Women between 18 and 24 years of age had twice the odds of having a negative oral health outcome during pregnancy compared to women who were between 25 and 34 years of age (OR=2.22, 95% CI: 1.45 – 2.92). In contrast, women between 35 and 45 years of age had reduced odds of having a negative oral health outcome during pregnancy (OR=0.51, 95% CI: 0.32 – 0.80). There was a dose-response relationship between maternal education and negative

prenatal oral health outcomes. Specifically, women who had more education had lower odds of having a negative oral health outcome during pregnancy (Some college: OR= 0.58, 95% CI: 0.38 – 0.87; College graduate and above: OR=0.23, 95% CI: 0.15 – 0.34; and Less than high school: OR=1.87, 95% CI: 1.02 – 2.42; vs. High school [referent]).

Non-Hispanic Black women had over twice the odds of having a negative oral health outcome during pregnancy compared to Non-Hispanic White women (OR=2.50, 95% CI: 1.73 – 3.62). Hispanic women also had increased odds of having a negative oral health outcome during pregnancy compared to Non-Hispanic White women (OR=1.49, 95% CI: 0.83 – 2.68), though the result was not statistically significant. Women of other races had slightly decreased odds of having a negative oral health outcome during pregnancy compared to Non-Hispanic White women (OR=0.91, 95% CI: 0.44 – 1.87); however, this finding was not statistically significant. Women who were not married and women who smoked during pregnancy had over three times the odds of having a negative oral health outcome during pregnancy (OR= 3.41, 95% CI: 2.47 – 4.72 and OR=3.21, 95% CI: 1.90 – 5.43, respectively).

### 5.1.3 Multivariate Results

After adjusting for maternal education, marital status, and maternal age, the income-negative oral health outcomes association was attenuated, but remained statistically significant. Specifically, women of lower income had 2.22 times the odds of having a negative oral health outcome during pregnancy compared to women of higher income (95% CI: 1.44 – 3.43).

#### 5.1.4 Results Stratified by Race /Ethnicity

Race/ethnicity may be an effect modifier of the income-negative oral health outcomes association. Among Non-Hispanic White women, Non-Hispanic Black women, and Hispanic women, lower income was associated with increased odds of having a negative oral health outcome during pregnancy (OR=2.39, 95% CI: 1.49 – 3.58; OR=1.81, 95% CI: 0.57 – 5.76; and OR=11.82, 95% CI: 1.16 – 120.33, respectively; Table 4a). However, among women of other races/ethnicities, lower income was associated with decreased odds of having a negative oral health outcome during pregnancy (OR=0.21, 95% CI: 0.01 – 4.16). The small sample sizes for Hispanic women and women of other races/ethnicities which resulted in imprecise confidence intervals may partially explain the findings among these groups.

### 5.2 Access to Oral Health Care

#### 5.2.1 Univariate Results

Of the women analyzed for access to oral health care, most were between 25 and 34 years of age (53.78%), married (61.31%), and Non-Hispanic White (59.54%) (Table 1b). Education was fairly evenly distributed (16.06% less than high school, 26.68% high school, 25.98% some college, and 31.28% college graduate or above). The majority of participants (68.06%) had an annual household income of below \$50,000 and were unable to access oral health care during pregnancy (77.95%).

#### 5.2.3 Bivariate Results

Women of lower income (<\$50,000) had almost seven times the odds of being unable to access oral health care during pregnancy compared to women of higher income ( $\geq$ \$50,000), and this result was statistically significant (OR= 6.74, 95% CI:

4.84 – 9.38; Table 2). Women between 18 and 24 years of age had almost twice the odds of being unable to access oral health care compared to women between 25 and 34 years of age (OR=1.62, 95% CI: 1.28 – 2.04). In contrast, women between 35 and 45 years of age had reduced odds of being unable to access oral health during pregnancy (OR=0.78, 95% CI: 0.55 – 1.10). There was a dose-response relationship between maternal education and access to oral health care during pregnancy. Specifically, women who had more education had decreased odds of being unable to access (College graduate and above: OR=0.31, 95% CI: 0.23 – 0.43; Some college: OR= 0.68, 95% CI: 0.51 – 0.90; and Less than high school: OR=1.86, 95% CI: 1.36 – 2.54 vs. High school [referent]).

Non-Hispanic Black women, Hispanic women, and women of other races had increased odds of being unable to access oral health care during pregnancy compared to Non-Hispanic White women (OR=2.27, 95% CI: 1.75 – 2.95, OR=2.82, 95% CI: 2.08 – 3.81, and OR=1.82, 95% CI: 1.13 – 2.89, respectively), and these results were statistically significant. Women who were not married had almost three times the odds of being unable to access oral health care during pregnancy compared to women who were married (OR=2.87, 95% CI: 2.31 – 3.56). Women who received inadequate prenatal care during pregnancy had 1.30 times the odds of being unable to access oral health care during pregnancy compared to women who received adequate prenatal care during pregnancy (95% CI: 1.04 – 1.62), and women who smoked during pregnancy had 2.16 times the odds of being unable to access oral health care during pregnancy compared to women who did not smoke during pregnancy (95% CI: 1.57 – 2.96). These results were both statistically significant.

### 5.2.3 Multivariate Results

After adjusting for maternal race/ethnicity, maternal education, and marital status, the income-access to oral health care association was attenuated, but remained statistically significant. Specifically, women of lower income had 4.21 times the odds being unable to access oral health care during pregnancy compared to women who were of higher income (95% CI: 2.81– 6.30).

### 5.2.4 Results Stratified by Race/Ethnicity

Race/ethnicity was not an effect modifier of the income-access to oral health care association. Among Non-Hispanic White women, Non-Hispanic Black women, Hispanic women, and women of other races/ethnicities, lower income was associated with increased odds of being unable to access oral health care during pregnancy (OR=4.70, 95% CI: 2.77 – 7.95; OR=1.87, 95% CI: 0.85 – 4.14; OR=6.98, 95% CI: 1.71 – 28.54; and OR=3.23, 95% CI: 0.89 – 11.71, respectively; Table 4b).

## CHAPTER 6: DISCUSSION

### 6.1 Summary of Main Findings

The proposed hypotheses were confirmed in this population-based study, with household income being positively associated with both negative prenatal oral health outcomes and access to oral health care during pregnancy. Specifically, after adjustment for confounders, women of lower household income had statistically significant increased odds of both outcomes compared to women of higher household income. Race/ethnicity may be an effect modifier of the income-negative oral health outcomes association; however, it did not modify the income-access to oral health care association.

Few studies have investigated how income is associated with oral health outcomes among pregnant women. However, the findings of the current study were consistent with prior studies that examined income disparities and oral health in the general adult population (Imai & Mansfield, 2015; Nasseh & Vujicic, 2014; and Manski et al., 2012). In various adult populations, researchers have found that individuals with lower household incomes have poorer oral health outcomes and are less likely to utilize or to be able to access oral health care.

Although research on income and prenatal oral health is sparse and has largely focused on racial/ethnic disparities, findings from the current study are congruent with unadjusted results for income in those studies. Specifically, prior studies have found that women of lower income tend to have poorer prenatal oral health outcomes and are less

likely to utilize or to be able to access oral health care (Hwang, Smith, McCormick and Barfield, 2011; Boggess et al., 2011; and Chung et al., 2014). Thus, the associations between income disparities and oral health outcomes and access to oral health care are consistent across various populations.

There are many mechanisms potentially involved in the association between household income and oral health outcomes and access to care, including financial resources, dental insurance, perceived ability to pay for care, time constraints, health literacy, need for care, perceptions of the importance of oral health (especially during pregnancy), availability of care, attitudes towards dental providers, perceptions of dental experiences, and provider knowledge or comfort in treating pregnant women (Hwang, Smith, McCormick and Barfield, 2011 and Chung et al., 2014).

## 6.2 Strengths and Limitations

### 6.2.1 Nondifferential Misclassification

Since income and prenatal oral health variables were measured using self-reported data, there is the potential for nondifferential misclassification of the exposure or outcome. This type of misclassification could occur when the participant is trying to give socially desirable responses or is embarrassed to answer truthfully. Furthermore, income was reported as a categorical variable and may have obscured differences between people collapsed into the same category. If income had been reported on a continuous scale it may have allowed for the creation of more meaningful levels for this analysis. Should these types of misclassification occur, it would bias the results towards the null.

### 6.2.2 Selection Bias

N.C. PRAMS uses a complex stratified systematic sampling method to select survey participants. The number of participants for the 2009-2011 N.C. PRAMS was 5,526 women (2009: n=1,895; 2010: n=1,810; 2011: n=1,821), with response rates of 62.7% in 2009, 55.6% in 2010, and 54.3% in 2011. Although these response rates are somewhat low, they are higher than BRFSS response rates, which were 49.1% for landlines and 35.3% for cell phones in 2012 (CDC, 2013b). There is the possibility that women who participated in the study differed from those who did not participate. For example, women who participated in the survey might have been healthier and more cognizant of their health than were those women who did not participate. The extent to which participation in the study would be related to both income and prenatal oral health is unknown. However, if selection bias did occur, it would result in an over or underestimation of the true association.

### 6.2.3 Information Bias

There is the potential for information bias; it is possible that participants of low SES may have been embarrassed to report truthfully on their oral health and/or access to oral health care, especially if the cause was financial burden. If this type of information bias occurred, it would bias the results away from the null.

### 6.2.4 Confounding

The potential confounders that were addressed in this study were restricted to variables in the 2009-2011 N.C. PRAMS dataset. Multiple potential confounders were assessed, including maternal age, marital status, educational level, race/ethnicity, prenatal care, and smoking status (Corbella, et al., 2012). Maternal

alcohol may also be a confounder of the exposure-outcome associations, but it was not analyzed due to the small number of women who indicated they drank alcohol during pregnancy (n=2). Although PRAMS does not collect information on diet, chewing tobacco use, drug use, and geographic location within North Carolina, these could be potential confounders since they are related to both SES and oral health outcomes. Also, there may be other unknown confounders in the association between health disparities and prenatal oral health. Failure to control for these known or unknown confounders could result in an over or underestimate of the true association.

#### 6.2.5 Generalizability

The 2009-2011 N.C. PRAMS used a complex, weighted sampling design to ensure that the sample was representative of the general population. Women who gave birth to babies of low birth weight were oversampled to ensure that the sample is representative of the population. Assuming internal validity, the results of this study could be generalized to women of childbearing age between 18 and 45 years in North Carolina. A limitation of the PRAMS questionnaire and dataset is that PRAMS only includes data for the state as whole and does not account for disparities by geographic location, such as differences in access to care between rural and urban locations.

#### 6.2.6 Significance

This study examined the association between income disparities through self-reported income and prenatal oral health in a large sample of North Carolina women who had live births. This study is significant due to the relatively poor health status of North Carolina. North Carolina is below average on ratings for overall health, oral health, health disparities, and birth outcomes, including birth weight and preterm

births (APHA, 2015). Few studies have examined the association between health disparities and prenatal oral health outcomes and access to oral health care during pregnancy. Understanding the association between self-reported income and prenatal oral health outcomes and access to oral health care will assist health care providers, including primary care physicians, obstetricians, dentists, and public health professionals, in counseling and educating their patients on the importance and safety of oral health care during pregnancy.

Given that lower income was associated with poor oral health outcomes and reduced access to care, efforts need to be focused on educating women on the safety and importance of oral health care during pregnancy and increasing access to oral health care during pregnancy for women of lower income across all races/ethnicities. In addition to educating women on the safety and importance of oral health care during pregnancy, many providers, including primary care physicians, obstetricians, dentists, and public health professionals, need to be educated further on this topic. Moreover, health professionals should address and aim to reduce the negative stigma surrounding dental visits in order to improve attitudes about going to the dentist.

Knowledge of the association between income and prenatal oral health outcomes and access to oral health care could potentially encourage policy changes to increase access to oral health care during pregnancy through increased government funding for more safety net dental clinics, more affordable dental insurance with broader coverage, incentives (such as tax breaks or reduced licensure fees) for dentists to provide need based services and/or more flexible payment plans, and increases in the number of dentists per capita in North Carolina. According to

America's Health Rankings, one of the key challenges in North Carolina is the limited availability of dentists. In 2014, among the 50 United States, North Carolina 47<sup>th</sup> for the number of dentists per capita (APHA, 2015). In order to address the shortage of dentists in North Carolina there could be incentives to encourage dentists to relocate to North Carolina and to encourage new dentists to remain in North Carolina upon graduation from dental school. To increase access to oral health care in underserved areas, there is the potential for increases in government funding toward public service loan forgiveness programs for recent dental school graduates to work in an underserved area to pay off their dental school loans.

Additional studies in diverse populations are needed to confirm the findings of this study and to evaluate further whether race/ethnicity is an effect modifier of the income-prenatal oral health outcomes associations. It would also be beneficial to examine whether or not location (i.e. urban vs. rural) plays a role in this association. There could be distinct differences between urban and rural locations, such as whether or not the drinking water is fluoridated, or whether or not there are an adequate number of dentists per capita. Although North Carolina is ranked 18<sup>th</sup> for Water Fluoridation the state still has below average oral health status. It would be meaningful to further examine potential causes for this discrepancy, including the use of water bottles rather than regularly drinking fluoridated water, and to determine if there is a relationship between the locations of fluoridated water sources and residents with poor oral health.

While this study did not examine prenatal oral health knowledge, future studies could further examine whether or not women know that it is not only safe, but

also recommended to visit a dentist and to receive dental treatments during pregnancy. Findings could determine whether or not prenatal oral health literacy affects prenatal oral health outcomes and access to oral health care during pregnancy. Last, future studies examining income and oral health outcomes and access to oral health could potentially examine income differently, such as by using a continuous scale or further categorizing income. Manski et al. (2012) examined wealth in addition to income; it may be meaningful to further examine other indicators of income and wealth, such as home ownership or the amount of debt an individual has. Previous studies have not used a consistent measure of income; it may be beneficial to develop and to use a universal measure of income to allow for better comparison across studies.

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Table 1a: Characteristics of Women Participating in the N.C. PRAMS 2009-2011:  
Negative Oral Health Outcomes

<b>Variable</b>	<b>N</b>	<b>%</b>
<b>Demographics</b>		
<b>Income</b>		
< \$50,000	567	52.09
≥ \$50,000	611	47.91
<b>Maternal Age in years</b>		
18-24	249	23.92
25-34	690	58.46
35-45	239	17.63
<b>Maternal Race/Ethnicity</b>		
Non-Hispanic White	826	68.29
Non-Hispanic Black	221	19.22
Hispanic	71	7.06
Other	60	5.42
<b>Maternal Education</b>		
Less than high school	84	8.07
High school	230	22.15
Some college	298	26.49
College graduate and above	566	43.29
<b>Marital Status</b>		
Married	883	71.65
Other	295	28.35
<b>Pregnancy</b>		
<b>Prenatal Care</b>		
≥14	470	42.21

<14	708	57.79
<b>Lifestyle</b>		
<b>Maternal Smoking</b>		
Yes	88	7.82
No	1090	92.18
<b>Negative Oral Health Outcomes</b>		
Yes	313	28.00
No	865	72.00

Table 1b: Characteristics of Women Participating in the N.C. PRAMS 2009-2011:  
Access to Oral Health Care

<b>Variable</b>	<b>N</b>	<b>%</b>
<b>Demographics</b>		
<b>Income</b>		
< \$50,000	1817	68.06
≥ \$50,000	976	31.94
<b>Maternal Age in years</b>		
18-24	830	32.24
25-34	1510	53.78
35-45	453	13.97
<b>Maternal Race/Ethnicity</b>		
Non-Hispanic White	1696	59.54
Non-Hispanic Black	624	21.24
Hispanic	324	14.09
Other	149	5.12

<b>Maternal Education</b>		
Less than high school	384	16.06
High school	689	26.68
Some college	748	25.98
College graduate and above	972	31.28
<b>Marital Status</b>		
Married	1787	61.31
Other	1006	38.69
<b>Pregnancy</b>		
<b>Prenatal Care</b>		
≥14	998	38.06
<14	1795	61.94
<b>Lifestyle</b>		
<b>Maternal Smoking</b>		
Yes	291	10.08
No	2502	89.92
<b>Access to Oral Health Care</b>		
Yes	2195	77.95
No	598	22.05

Table 2: Unadjusted Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Association between Selected Demographic, Pregnancy, and Lifestyle Characteristics and Oral Health Outcomes and Access to Oral Health Care

Variable	Negative Oral Health Outcomes		Access to Oral Health Care	
	OR	95% CI	OR	95% CI
<b>Demographics</b>				
<b>Income</b>				
< \$50,000	4.44	3.21 – 6.14	6.74	4.84 – 9.38
≥ \$50,000	1.00	Referent	1.00	Referent
<b>Maternal Age in years</b>				
18-24	2.06	1.45 – 2.92	1.62	1.28 – 2.04
25-34	1.00	Referent	1.00	Referent
35-45	0.51	0.32 – 0.80	0.78	0.55 – 1.10
<b>Maternal Race/Ethnicity</b>				
Non-Hispanic White	1.00	Referent	1.00	Referent
Non-Hispanic Black	2.50	1.73 – 3.62	2.27	1.75 – 2.95
Hispanic	1.49	0.83 – 2.68	2.82	2.08 – 3.81
Other	0.91	0.44 – 1.87	1.81	1.13 – 2.89
<b>Maternal Education</b>				
Less than high school	1.87	1.02 – 3.42	1.86	1.36 – 2.54
High school	1.00	Referent	1.00	Referent
Some college	0.58	0.38 – 0.87	0.68	0.51 – 0.90
College graduate and above	0.23	0.15 – 0.34	0.31	0.23 – 0.43
<b>Marital Status</b>				
Married	1.00	Referent	1.00	Referent
Other	3.41	2.47 – 4.72	2.87	2.31 – 3.56
<b>Pregnancy</b>				
<b>Prenatal Care</b>				

≥14	1.00	Referent	1.00	Referent
<14	1.27	0.94 – 1.72	1.30	1.04 – 1.62
<b>Lifestyle</b>				
<b>Maternal Smoking</b>				
Yes	3.21	1.90 – 5.43	2.16	1.57 – 2.96
No	1.00	Referent	1.00	Referent

Table 3: Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Association between Self-Reported Income and Oral Health Outcomes and Access to Oral Health Care

Self-Reported Income	Negative Oral Health Outcomes <sup>a</sup>		Access to Oral Health Care <sup>b</sup>	
	OR	95% CI	OR	95% CI
< \$50,000	2.22	1.44 – 3.43	4.21	2.81 – 6.30
≥ \$50,000	1.00	Referent	1.00	Referent

<sup>a</sup> Adjusted for maternal education, marital status, and maternal age

<sup>b</sup> Adjusted for maternal education, marital status, and maternal race/ethnicity

Table 4a: Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Association between Self-Reported Income and Negative Oral Health Outcomes Stratified by Race/Ethnicity

Income	Negative Oral Health Outcomes <sup>a</sup>							
	Non-Hispanic White		Non-Hispanic Black		Hispanic		Other	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
< \$50,000	2.39	1.49 – 3.58	1.81	0.57 – 5.76	11.82	1.16 – 120.33	0.20	0.01 – 4.16
≥ \$50,000	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent

<sup>a</sup> Adjusted for maternal education, marital status, and maternal age

**Table 4b: Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Association between Self-Reported Income and Access to Oral Health Care Stratified by Race/Ethnicity**

<b>Income</b>	<b>Access to Oral Health Care <sup>b</sup></b>							
	<b>Non-Hispanic White</b>		<b>Non-Hispanic Black</b>		<b>Hispanic</b>		<b>Other</b>	
	<b>OR</b>	<b>95% CI</b>	<b>OR</b>	<b>95% CI</b>	<b>OR</b>	<b>95% CI</b>	<b>OR</b>	<b>95% CI</b>
< \$50,000	4.70	2.77 – 7.95	1.87	0.85 – 4.14	6.98	1.71 – 28.54	3.23	0.89 – 11.71
≥ \$50,000	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent

<sup>b</sup>. Adjusted for maternal education and marital status