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Oral Health Disparities Across Racial/Ethnic Groups.

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ORAL HEALTH DISPARITIES ACROSS RACIAL/ETHNIC GROUPS

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Introduction

It seems obvious to Americans that health inequalities exist in this country. Protests about healthcare legislation are often publicized. The recent Patient Protection and Affordable Care Act has drawn mixed reactions but was intended to address healthcare inequalities. Health topics fill the pages of magazines, newspapers, and websites and the minutes of television and radio shows. Americans seem to have a great interest in their own health and health trends. They may even know from their own experiences that health disparities exist. Interestingly, there is a separation in the minds of many Americans between physical health and oral health. Although the teeth, gums, and related structures are obviously part of the human body, the mouth is often viewed as a separate, non-medical entity. The many people who have visited emergency rooms in hopes of relieving oral pain, only to be referred to a dental professional, could attest to this. Unfortunately, with separation comes marginalization. Oral health receives some attention, but nowhere near the level accorded to general and preventative health. Because of the marginalization of dentistry from medicine, much less is known about oral health disparities than about physical health disparities. Vital health statistics track morbidity and mortality in the United States population, but an equal source of information on the general population's oral health does not exist. The disconnection between oral and general health appears to translate into a lack of knowledge of oral health disparities. The more research that accumulates on oral health will allow initiatives to be taken similar to those in other countries that have reduced health disparities. Enough knowledge exists to know that inequalities in oral health exist, but the extent of the disparities deserve greater attention.

This study aims add to existing knowledge about disparities in oral health. Special attention is paid to the inequalities that exist between races. Socioeconomic status is often

associated with inequalities in various forms, and is thus an important aspect of this study as well. Socioeconomic status is indicated in the current study by education level and annual family income. One main goal was to uncover the disparities that exist between racial/ethnic categories even when socioeconomic status has been accounted for. By controlling for education and income, this uncovers the extent of the disparities solely based on race. By knowing the differences between races, this can help indicate the possibility for other impacting factors other than socioeconomic status such as health behaviors, environmental factors, and discrimination.

It was assumed that the study would reveal clear disparities across racial/ethnic categories. The hypothesis was that White Americans, as the majority group, would consistently have the most favorable results among the outcome variables of tooth count, self-rated condition of teeth, presence of decay in at least one tooth, and ownership of dentures. Furthermore, it was thought that African Americans and Mexican Americans would alternate in having the least favorable results.

The design of the study permitted testing the above hypotheses. Data were taken from a nationally representative study with a large sample size (National Health and Nutrition Examination Survey 2007-2008). By using a national survey, oral health status of people in different racial categories nationwide could be investigated instead of a small subset of the population or of a very specific area. Additionally, statistical analyses illuminated the specific effects that different sociodemographic variables have on oral health outcomes. The impact of each independent variable could be determined net of all the other variables.

The findings clearly indicated oral health disparities. However, Whites did not always show the “most favorable” results. This was in part due to ambiguity in the meaning of some of the dependent variables. Nonetheless, it was seen that overall, Mexican Americans and African

Americans are in a less favorable position compared to Whites when it comes to oral health. As this study will show, the findings indicate some concerns for the two main minority groups.

Literature Review

Oral health disparities persist across various sociodemographic groups in the United States. The status of people's oral health may be indicated by their self-rated oral health, presence of periodontitis (severe loss of tooth attachment and supporting tissues), tooth count, or decay (American Dental Association [ADA]). Studies show that minorities and those with lower levels of education and income oftentimes have poorer oral health.

One way to determine oral health status is by classifying the perception an individual has of his or her own oral health. Such a measurement may be termed oral health-related quality of life, or OHRQOL (Seirawan, Sundaresan, and Mulligan 2011). Seirawan, Sundaresan, and Mulligan (2011:194) noted the importance of this measurement as it treats the patients as "human beings with their own perceptions" rather than objects who possess anatomical structures of interest. In their research, they used data from the 2003-2004 version of the National Health and Nutrition Examination Survey (NHANES) and selected those questions that ask about people's perceptions of their oral health, which constitute the Oral Health Impact Profile (OHIP) (Seirawan, Sundaresan, and Mulligan 2011). Of the 6,183 individuals surveyed, the average OHIP score was 2.8 out of 28, with 28 being the worst score; thus, if 100% was to represent the worst possible score, the mean score would only be 9.9% (Seirawan, Sundaresan, and Mulligan 2011). According to the research of Wu et al. on NHANES (1999-2004) for survey respondents age 60 and over, the oral health self-ratings are significantly associated with the amount of missing, decayed, and filled teeth (Wu, Plassman, Liang, Remle, Bai, and Crout

2011). An increase in the number of decayed and missing teeth is associated with lower self-rated oral health scores, while an increase in the number of filled teeth is associated with higher self-rated oral health scores (Wu et al. 2011).

Wu et al.'s research also highlighted the association between race and self-perception of oral health. While only 21.4% of Whites labeled their oral health as "poor," 36.8% of African Americans and 35.5% of Hispanics described their oral health as "poor" (Wu et al. 2011). When other variables including socioeconomic status, social support, health behaviors and conditions, and dental checkups were accounted for, the differences lessened but were still significant in that African Americans were still 31percent less likely, and Hispanics even less likely than that, to rate their oral health as "good" or "very good" compared to Whites (Wu et al. 2011). When considering dentate and edentulous (toothless) respondents separately and controlling for other variables, the difference between Whites and African Americans lost its significance, while the difference between Whites and Hispanics still showed that Hispanics report their oral health to be significantly worse than Whites (Wu et al. 2011). Thus, the disparity in oral health self-ratings between Whites and African Americans could somewhat be explained by "clinical oral health outcomes and other covariates" such as health status and socioeconomic status, but this is not the case for the differences between Whites and Hispanics (Wu et al. 2011).

Similarly, Sabbah, Tsakos, Sheiham and Watt used data from adults 17 and older from NHANES III (1988-1994) to determine that White Americans have better perceived oral health than African Americans, Mexican Americans, and other ethnic groups (Sabbah, Tsakos, Sheiham, and Watt 2009). While 27.6 percent of Whites reported perceptions of poorer oral health, this number was larger for African Americans (41.7%), Mexican Americans (48.8%), and other ethnicities (34.7%) (Sabbah et al. 2009). When the variables of ethnicity, sex, age,

smoking, and dental insurance were controlled for, other races still showed higher probabilities of poorer perceived oral health compared to Whites, with African Americans having an odds ratio of 2.17, Mexican Americans having an odds ratio of 3.04, and other ethnicities having an odds ratio of 1.66 (Sabbah et al. 2009). When the variables of education and poverty-income ratio were also accounted for, these disparities lessened, reducing the odds ratios to 1.65 for African Americans, 1.78 for Mexican Americans, and 1.33 for other races (Sabbah et al. 2009).

In the aforementioned research of Seirawan et al., African Americans reported the highest (worst) mean oral health-related quality of life score compared to Whites, Hispanics and other races (Seirawan, Sundaresan, and Mulligan 2011). With 28 being the highest and worst score, African Americans reported a mean score of 3.17 while Whites had a mean score of 2.77, and Hispanics had a mean score of 2.35 (Seirawan, Sundaresan, and Mulligan 2011). In other words, Hispanics had the best score of the three (Seirawan, Sundaresan, and Mulligan 2011). This contradicts the research of Sabbah, Tsakos, Sheiham, and Watt which demonstrated that Mexican Americans had the highest probability of perceived poorer oral health compared to Whites and African Americans (Sabbah et al. 2009).This may be related to the fact that in Seirawan et al.'s research, Mexican Americans were combined with all other Hispanics, making it a much more heterogeneous group than Mexican Americans alone (Seirawan, Sundaresan, and Mulligan 2011). The authors noted that income and education were associated with the scores, as those with higher levels of income and education had lower (better) scores than those with less income or education (Seirawan, Sundaresan, and Mulligan 2011). Sabbah, Tsakos, Chandola, Sheiham and Watt also found this relationship in their research on NHANES III (1988-1994) respondents age 17 and over; with every lower level of education and poverty-income ratio, there was a significant increase in the probability of reporting poorer perceived oral health (Sabbah,

Tsakos, Chandola, Sheiham, and Watt 2007). In addition, Seirawan et al., stated, "It seems that there is an interaction between race and place of birth where place of birth played the most important role" (Seirawan, Sundaresan, and Mulligan 2011:197). This was seen even after accounting for sociodemographic variables and variables related to dental visits, perceived needs, and saliva indicators (Seirawan, Sundaresan, and Mulligan 2011). The scores of black respondents born outside the United States were better than those born in the country (Seirawan, Sundaresan, and Mulligan 2011). Furthermore, the scores of African American respondents born outside the United States were better than Whites born in the country, but this difference was not statistically significant (Seirawan, Sundaresan, and Mulligan 2011).

In addition to people's self-rated oral health, clinical examinations can reveal their oral health status. Conditions related to the gums may be used to determine the level of oral health of an individual. Borrell, Burt, Gillespie, Lynch, and Neighbors studied the prevalence of periodontitis in Whites and African Americans using NHANES I (1971-1974) and NHANES III (1988-1994) respondent data for persons over 17 years of age (Borrell, Burt, Gillespie, Lynch, and Neighbors 2002). In NHANES I they defined periodontitis as "the presence of at least four teeth, each with a demonstrated periodontal pocket" and in NHANES III they defined it as "the presence of two or more sites with CAL [clinical attachment loss] $\geq$ 3mm and one or more sites with PD [pocket depth] $\geq$ 4mm (Borrell et al. 2002). In other words, the crevice between the tooth and gums may form a pocket upon deterioration of gum tissue (American Dental Association [ADA]). NHANES I data showed that periodontitis was significantly more common in African Americans (37.1%) than Whites (30.4%) (Borrell et al. 2002). After individually controlling for the variables of age, sex, marital status, perceived general and oral health, health insurance, diabetes and smoking habits, periodontitis was still significantly more frequent in

African Americans (Borrell et al. 2002). Periodontitis was 1.22 times more likely to occur in African Americans compared to Whites (Borrell et al. 2002). Similar results were obtained using the NHANES III data with the prevalence of periodontitis in African Americans at 19.6% and the prevalence in Whites at 10.7% (Borrell et al. 2002). Generally, the occurrence of periodontitis was still significantly higher in African Americans than Whites after controlling for other variables individually (Borrell et al. 2002). The ratio of the prevalence of periodontitis in African Americans to Whites was 1.83 to 1.00 (Borrell et al. 2002). The authors noted that in NHANES I and III, "the ORs [odds ratios] remained stable even after adjustment for age, the socioeconomic indicators of age and education, diabetes, smoking, and other variables" (Borrell et al. 2002). The odds ratios of 1.22 (NHANES I) and 1.83 (NHANES III) reveal a greater racial disparity in periodontal status over time despite a less inclusive definition of periodontitis in NHANES III (meaning less people overall were classified as having it compared to NHANES I) (Borrell et al. 2002). Less people were considered to suffer from it, but there became more of a difference between the races (Borrell et al. 2002). Differences in periodontitis across races were also seen in Sabbah et al.'s research on NHANES III respondents 17 years of age and above (Sabbah et al. 2009). African Americans had the highest probability of having moderate periodontitis (13.7%), while Mexican Americans had a probability of 8.7 percent, and Whites had the lowest probability with 8.3 percent (Sabbah et al. 2009). After controlling for ethnicity, age, sex, smoking and dental insurance and in comparison to Whites, African Americans had an odds ratio of 2.71 and Mexican Americans had an odds ratio of 1.91 for moderate periodontitis (Sabbah et al. 2009). After also controlling for education and poverty-income ratio, these odds ratios were 2.19 for African Americans and 1.06 for Mexican Americans (Sabbah et al. 2009).

Borrell, Burt, Gillespie, Lynch, and Neighbors also noted the "expected inverse association" between the occurrence of periodontitis and education and income in both African Americans and Whites (Borrell et al. 2002). This relationship was marked for in the White respondents (Borrell et al. 2002). African Americans with less education and income still showed a higher frequency of periodontitis than Whites of a comparable education and income level (Borrell et al. 2002). Likewise, Sabbah et al.'s study on NHANES III respondents 17 years old and above examined the trends in oral health observed "at each lower level of the social hierarchy," or in other words across social gradients (Sabbah et al. 2007). The findings indicated a gradient such that as income declined, there were higher levels of gingival bleeding, loss of attachment, and pocket depth (Sabbah et al. 2007). Gradients were also seen in the association between periodontal disease and income and education (Sabbah et al. 2007). The relationship between socioeconomic status (represented by poverty-income ratio and education) and periodontal disease still showed significance even after controlling for dental insurance, age, sex, ethnicity, diabetes and smoking (Sabbah et al. 2007). These confounders lessened the significance but did not eliminate the gradients, meaning they only partially explain why social gradients exist in oral health (Sabbah et al. 2007). Other possible confounders of such gradients such as social network and support were studied by Tsakos, Chandola, Newton, Kawachi, Sheiham, Marmot and Watt (Sabbah, Tsakos, Chandola, Newton, Kawachi, Sheiham, Marmot, and Watt 2011). Data from NHANES (2001-2004) respondents over 60 years old were used (Sabbah et al. 2011). Gradients in income and education pertaining to periodontal disease were observed, but were not affected by controlling for social network or social support (Sabbah et al. 2011).

Tooth count may also be used an indicator of oral health status. Wu, Liang, Plassman, Remle and Bai used NHANES (1999-2004) respondent data for persons 60 and over to study racial disparities as they relate to edentulism (Wu, Liang, Plassman, Remle, and Bai 2011). Considering only the descriptive statistics, they found that African Americans were missing a mean value of 3.5 more teeth than Whites and 4.3 more than Mexican-Americans (Wu et al. 2011). Edentulism was also more common in African Americans (28.6%) than in Whites (24.5%) and Mexican Americans (18.1%) (Wu et al. 2011). After controlling for other variables, the authors found that in the dentate subsample, African Americans had 1.23 times more teeth missing than Whites (7 Wu et al. 2011). On the other hand, Mexican Americans were shown to have 20 percent fewer missing teeth than Whites (Wu et al. 2011). In contrast to the findings from the descriptive statistics above, the authors noted that in the age 60 and above sample "racial/ethnic variations in oral health were confounded by a number of variables. In particular, blacks and Mexican Americans were less likely to be edentulous than whites after controlling for SES, health behavior, dental care utilization, and other covariates" (Wu et al. 2011). Likewise, Sabbah et al. saw similar results in their study of NHANES III respondents 17 years old and above (Sabbah et al. 2009). African Americans showed the highest probability of loss of at least one tooth (67%), while Mexican Americans had the lowest probability (48%) (Sabbah et al. 2009). Compared to Whites and controlling for ethnicity, sex, age, smoking and dental insurance, African Americans had an odds ratio of 4.39 for tooth loss (Sabbah et al. 2009). Before controlling for education and poverty-income ratio, Mexican Americans had an odds ratio of 1.80 for tooth loss compared to Whites, but once these variables were adjusted for the odds ratio changed to 0.86 (Sabbah et al. 2009). In other words, Mexican Americans were not as likely as Whites to lose teeth (Sabbah et al. 2009). These studies show some variation in the degree to

which different racial groups exhibit tooth loss, but an overall trend appears to be that Mexican Americans have a higher probability of keeping their teeth.

Yet another indicator of oral health status is the basic presence of dental decay or caries. Wu et al. found that although Mexican Americans had the lowest prevalence of edentulism compared to Whites and African Americans, they had the greatest amount of decayed teeth (Wu et al. 2011). After controlling for ethnicity, sociodemographic variables, social support, health behaviors, health status, and dental care, it was seen that African Americans and Mexican Americans still had significantly more predicted decayed teeth compared to Whites (Wu et al. 2011). African Americans had 1.92 times more decayed teeth and Mexican Americans had 1.57 times more decayed teeth than Whites (Wu et al. 2011). Also, African Americans and Mexican Americans were shown to have lower predicted numbers of filled teeth than Whites even after adjusting for other variables (Wu et al. 2011). Being female, married and having more education and income were associated with having more filled teeth (Wu et al. 2011). Dental decay in children has also been studied by researchers Vargas, Crall, and Schneider using NHANES III (1988-1994) respondent data (Vargas, Crall, and Schneider 1998). For children aged 2 to 5, particularly in households with lower income levels, they found that Mexican Americans had a greater probability of having at least one decayed primary tooth than African Americans and Whites of a comparable group (Vargas, Crall, and Schneider 1998). African American and Mexican American children at 6-14 and 15-18 years of age have almost twice the presence of decay in at least on tooth (Vargas, Crall, and Schneider 1998). In these two respective age groups, the percentages of decay in at least one tooth were 18.0% and 36.1% for African Americans, 16.9% and 35.8% for Mexican Americans, and only 8.5% and 17.8% for Whites (Vargas, Crall, and Schneider 1998). Additionally, there were higher percentages of untreated

teeth with caries in those who were from households at or below 200% of the federal poverty line (Vargas, Crall, and Schneider 1998). By dividing the data into ethnic groups and dentition, it was seen that more children from households with incomes at or below 200% of the federal poverty line had teeth with untreated caries in comparison to those of an equivalent group of households with incomes above 200% (Vargas, Crall, and Schneider 1998). However, this was not true for African Americans because the percentage of children with untreated caries was higher in those above 200% of the federal poverty line, meaning greater income did not lessen the numbers of untreated caries in this case (Vargas, Crall, and Schneider 1998).

Scholars have noted clear disparities in oral health across races and socioeconomic statuses. Interestingly, these trends often remain even after controlling for other variables. Their research often highlights these disparities and notes that culture, health and behavior may be important factors. This study examines the differences in oral health between racial groups and offers an explanation for the reasons behind their existence.

Methods

Data were obtained from the National Health and Nutrition Examination Survey (NHANES) 2007-2008. The NHANES survey includes both an interview and examination component. Respondents represent civilian, non-institutionalized United States citizens of all ages. Participant selection is based on the survey's multistage, probability sampling design. In this study, only those respondents 20 years of age and older were included in the analysis. This was done to simplify possible levels of education. Respondents first complete a questionnaire given by an interviewer in their own home. Usually one to weeks later the examination occurs. The physical examination takes place in Mobile Examination Centers (MEC) for standardization

purposes. During the exam, respondents also complete further survey questionnaires given by an interviewer. Interviewer-administered questionnaires are given with the assistance of Computer-Assisted Personal Interview (CAPI) technology both in the home and in the Mobile Examination Centers.

The aim of the oral health section is to evaluate the occurrence of diseases and conditions concerning oral health. The examination focuses on status of oral health, decay, restorations, sealants, dentures, tooth count and occlusal contacts ("how many of the teeth oppose each other and can function properly when eating"). In addition, the in-house interview asks questions dealing with oral health quality of life and how the respondent perceives his or her oral health. The interview includes sociodemographic questions.

The outcome variables used in this study include tooth count, self-rated condition of teeth, possession of dentures and presence of dental decay. Each tooth position was examined for presence or absence of the tooth or if the dental root fragment was present. This was modified in the analysis so that the presence of a root fragment was grouped with the "tooth not present" option. There were 32 possible tooth positions, but only 28 were included in this study (third molars were excluded). The variable regarding the condition of the teeth was included in the questionnaire component. Respondents could choose to describe their teeth as "excellent," "very good," "good," "fair," "poor," or "don't know." These responses were transformed into an ordinal scale with from 1 to 5 with 1 being "poor," 2 being "fair," 3 being "good," 4 being "very good," and 5 being "excellent." Respondents were also asked if they have an upper removable partial or full denture and another similar question about a lower removable partial or full denture. These two variables were combined in the analysis. The denture variable then became whether or not the participant owned at least one denture (upper and/or lower) or none at all.

Lastly, the examination includes a variable of whether or not the participant has at least one tooth with untreated decay which is marked by "a 'cavity' in a tooth that appears as a darkened fracture (hole) with irregular breakdown of the enamel surface of the tooth. The area may appear soft-spongy in texture."

Demographic variables included in this analysis were age, gender, race/ethnicity, education and annual family income. Age was a range of values in years and gender was either male or female. Female was coded higher. Options for race/ethnicity were "Mexican American," "other Hispanic," "non-Hispanic White," "non-Hispanic Black," and "other race--including multi-racial." Education represented the highest level completed by the respondent which could be "less than 9^{th} grade," "$9\text{-}11^{th}$ grade (includes 12^{th} grade with no diploma)," "high school grad/GED or equivalent," "some college or AA degree," or "college graduate or above." Annual family income was a range of dollar values that increased incrementally from "$0-$4,999" to "$100,000 and over."

Ordinary least squares linear regression was performed separately on the tooth count and condition of teeth variables. Binary logistic regression was performed separately on the denture and decay variables. This was done such that other races were in reference to Whites. The demographic variables of age, gender, education, and annual family income were controlled for in these tests.

Results

Descriptive Statistics

Table 1 shows the descriptive statistics of the sample. The total sample consisted of 5,935 non-institutionalized individuals age 20 and above, most of whom were White (46.5%). African Americans comprised 20.7 percent of the sample and Mexican Americans 17.4 percent

of the sample. Other Hispanics made up 11.2 percent and other races including multi-racial made up 4.2 percent of the sample. The mean age of the sample was 50.77 (0.233 Standard Error) and the sexes were nearly equally represented.

Of the total sample, most respondents fell into the category of some college/associate's degree (25.4%) or high school degree/GED equivalent (24.7%). College graduates or above made up 18.6 percent of the sample, those who had less than a 9th grade education made up 13.7 percent of the sample, and those who had some high school experience (9-11th grade) with no diploma made up 17.7 percent of the sample. There was a noticeable difference between the percentages of Whites who had less than a 9th grade education (6.8%) and Mexican Americans (32.3%). In other words, almost five times as many Mexican Americans of the sample lacked a 9th grade education compared to Whites.

The U.S. Census Bureau reported that the median income of all households in 2008 was $50,303 (U.S. Census Bureau 2009). Eight percent of the total sample fell into this median category ($45,000-54,999), while 59.7 percent of the sample fell below this median amount ($0-44,999), and 32.3 percent of the sample fell above this amount ($55,000-100,000+). The most marked difference between Whites, Mexican Americans and African Americans was in the $100,000 and above income category. The percentage of Whites earning $100,000 or more (15.9%) was 1.66 times greater than for African Americans (9.6%) and 2.27 times for Mexican Americans (7.0%).

The disparities across racial categories in the oral health outcomes were investigated. The average tooth count of the sample prior to controlling for any other variables was 19.58 (0.121 SE) (see Table 1). When examining the sample by race, Mexican Americans had the greatest average number of teeth (22.71, 0.205 SE) and African Americans had the fewest average

number (18.47, 0.290 SE). The average self-rating condition of teeth for the sample was 2.86 out of 5 (5 being the best score). In the overall sample, 24.3 percent had decay in at least one tooth. Whites had the lowest percentage (18.8%), and Mexican Americans (32.3%) and African Americans (32.0%) had the highest percentage of decay in at least one tooth. The last outcome variable analyzed was ownership of dentures. In the overall sample, 26.0 percent owned dentures. The proportion of White Americans to own dentures (27.1%) was almost double that of Mexican Americans (13.9%). African Americans, on the other hand, had a higher percent of owning dentures (31.1%) compared to Whites.

Tooth Count

The relationship of Mexican Americans having the greatest and African Americans having the fewest average number of teeth remained even after controlling for other variables using linear regression. The predicted tooth count for Mexican Americans was 22.47 when other variables in the model (race, gender, age, education and income) were set to their respective means. The predicted number was 18.94 for Whites and 18.11 for African Americans (see Figure 1). Table 2 shows the predicted values for each of the variables for Model 1 (controlling for race, age and gender) and for Model 2 (additionally controlling for education and income)[1]. Age had the strongest effect of all the variables on tooth count in both models. The predicted tooth count for Mexican Americans compared to Whites was 1.730 (0.288 SE) more teeth in Model 1 and 3.531 (0.299 SE) more teeth in Model 2. The predicted tooth count for African Americans compared to Whites was 1.435 (0.270 SE) fewer teeth in Model 1 and 0.829 fewer teeth (0.267

[1] Other variables were additionally added to all regression models for a third model. Variables such as recent tobacco/nicotine use, body mass index, self-rated health of diet, and past 30 day milk consumption were added. However, these variables scarcely altered the predicted values and odds ratios and caused complications within the models due to missing cases.

SE) fewer teeth in Model 2. Although African Americans still had fewer average teeth compared to Whites after controlling for income and education, the number improved (0.8 fewer teeth in Model 2, compared to 1.5 fewer teeth in Model 1), but the level of significance was not as strong. Education was the second strongest variable that affected tooth count in Model 2. With each category increase in education, there was an average of 1.345 more teeth net of other variables. Higher income also indicated an increase in tooth count. With each category increase in income, there was an average of 0.341 more teeth net of other variables.

Self-Rated Condition of Teeth

Linear regression was also performed on the self-rated condition of teeth variables (see Table 2). When using predicted values from Model 2 (i.e., when all other variables were set to their respective means), the self-rating was 3.06 for Whites, 2.69 for Mexican Americans, and 2.74 for African Americans. Mexican Americans had the highest predicted tooth count (22.47), yet the lowest predicted self-rating (2.69) compared to all other races (see Figure 2). This was reversed for Whites who had the second fewest predicted number of teeth (18.94), yet the highest predicted self-rating (3.06). African Americans had relatively low predicted values for both. They had the fewest predicted number of teeth (18.11) and second lowest predicted self-rating (2.74) compared to all other races. After additionally controlling for education and income in Model 2, each of the variables still remained significant. Once adjusted for education and income, the predicted value for Mexican Americans compared to Whites decreased by over 40 percent, but remained significant ($p < 0.001$). In Model 1, both Mexican Americans and African Americans had predicted scores less than Whites. In Model 2, the predicted scores improved but remained less than the predicted score of Whites. With each category increase in education and

income, the predicted average self-rating score net of all other variables increased by .155 (0.014 SE) for education and .058 (0.005 SE) for income. Income and education were the two strongest variables in the model that had an effect on the outcome based on standardized coefficients.

Decay in At Least One Tooth

The presence of tooth decay in at least one tooth was analyzed using binary logistic regression (see Table 3). Controlling for age and gender, Mexican Americans had 88.8 percent greater odds of having decay in at least one tooth compared to Whites. After additionally controlling for education and income, this odds ratio dropped by more than half (39.3%). African Americans showed an even greater likelihood of having decay in at least one tooth compared to Whites. After controlling for age and gender, they were almost twice as likely as Whites to have decay in at least one tooth (odds ratio 1.970, 0.085 SE). After additionally controlling for education and income, African Americans had 80.8 percent greater odds of having decay in at least one tooth. The odds ratio decreased but remained significant. By controlling for education and income, the odds of Mexican Americans having at least one decayed tooth compared to Whites decreased by nearly 50 percent, but the odds for African Americans decreased by only 16.2 percent. Net of all other variables, with each category increase in education the odds of having decay in at least one tooth decreased by 27.2 percent. With each category increase in income, the odds of having decay in at least one tooth decreased by 11.2 percent.

Ownership of Dentures

Binary logistic regression was performed on the denture variable (see Table 3). Once again, the models were adjusted for race, age, gender, education and income. The odds ratios for

Mexican Americans and African Americans decreased in Model 2 compared to Model 1, but remained significant. In Model 1, Mexican Americans were shown to have 48.6 percent lower odds and African Americans 71.0 percent higher odds of owning dentures compared to Whites. After additionally controlling for education and income in Model 2, it was seen that for every single Mexican American that owns dentures, there are 2.42 Whites who do. On the other hand, for every White person who owns dentures, there are 1.47 African Americans who do (when controlling for all variables in Model 2). Higher levels of education and income were also shown to decrease the odds of owning dentures. With each category increase in education the odds of owning dentures decreased by 36.6 percent. With each category increase in income, the odds of owning dentures decreased by 7.9 percent.

Mexican American Subsample

The paradoxical findings related to Mexican Americans prompted further investigation of the Mexican American subsample (see Table 4). Within this subsample, those born in the U.S. had a lower frequency of decay (26.4%) than those born in Mexico (36.5%). This relationship was similar for citizenship status, with the frequency of decay in at least one tooth at 24.0 percent for U.S. citizens by birth or naturalization and almost double (43.6%) for non U.S. citizens. Owning dentures was more frequent in those born in Mexico (14.9%) versus those born in the United States (12.2%). Also, a higher percentage of U.S. citizens owned dentures (14.8%) compared to non-citizens (12.7%). Country of birth showed less of an effect on tooth count than citizenship status. The average tooth count for those born in the U.S. was 22.58 (0.307 SE) and was 22.78 (0.275 SE) for those born in Mexico. For citizens the average tooth count was 22.18 (0.280 SE) and for non-citizens it was a higher value of 23.43 (0.295 SE).

	Percentage/Mean (Standard Error)					
	Total Sample (N=5935)	**Mexican American (N=1033)**	**Other Hispanic (N=666)**	**White (N=2761)**	**African American (N=1227)**	**Other Race/Multiracial (N=248)**
Sociodemographics						
Age	50.77(.233)	45.47(.518)	49.60(.666)	53.82(.351)	49.57(.491)	47.98(1.069)
Male	49.0	48.5	44.4	50.5	47.9	52.4
Female	51.0	51.5	55.6	49.5	52.1	47.6
Education						
Less than 9th Grade	13.7	32.3	26.2	6.8	7.4	10.5
9-11th Grade	17.7	21.2	19.1	13.5	24.6	12.6
H.S. Grade/GED	24.7	20.0	20.6	28.3	23.7	19.4
Some college/AA Deg.	25.4	17.6	21.1	28.3	28.3	22.3
College Grad. or Above	18.6	8.9	13.0	23.2	16.0	35.2
Income						
$0-$4,999	2.9	3.0	3.0	2.5	3.5	2.7
$5,000-9,999	5.7	5.2	8.3	4.1	8.1	6.4
$10,000-14,999	9.0	10.8	6.7	8.8	8.2	13.7
$15,000-19,999	9.1	9.4	10.1	9.1	8.7	6.8
$20,000-24,999	9.8	11.4	13.1	9.6	8.0	6.8
$25,000-34,999	13.4	14.6	14.8	12.6	13.5	12.3
$35,000-44,999	9.8	11.7	9.2	9.2	10.0	8.7
$45,000-54,999	8.0	9.1	8.7	7.2	8.6	6.8
$55,000-64,999	5.9	5.9	7.4	5.6	6.1	4.6
$65,000-74,999	5.2	4.6	5.7	5.2	6.0	3.2
$75,000-99,999	8.7	7.2	5.5	9.9	9.6	3.7
$100,000 and Over	12.5	7.0	7.6	15.9	9.6	24.2
Clinical Oral Health Measures						
Tooth Count(0-28)	19.5814(.12058)	22.7085(.20452)	19.2306(.35690)	18.8648(.18120)	18.4685(.28972)	21.2146(.53649)
Decay in At Least One Tooth	24.3	32.3	22.4	18.8	32.0	22.8
Owns Dentures	26.0	13.9	31.8	27.1	31.1	23.5
Self- Rated Oral Health Measure						
Condition of Teeth	2.8630(.01602)	2.5411(.03541)	2.6682(.04722)	3.0948(.02335)	2.7138(.03530)	2.8902(.07920)
Clinical Health Measure						
Body Mass Index						
Underweight(<18.5)	20.0	19.1	20.8	20.2	19.3	22.0
Normal (18.5-24.9)	29.7	28.1	32.3	29.4	29.7	33.2
Overweight (25.0-29.9)	24.9	27.0	21.1	25.9	24.4	17.3
Obese (30.0 and above)	25.4	25.8	25.8	24.4	26.5	27.6
Self-Rated Health Measures						
Tobacco/Nicotine Past 5 Days	24.5	25.1	25.5	24.4	24.3	20.4
Diet Behavior						
How Healthy is Diet	3.0639(.01314)	2.8440(.02879)	2.9759(.03667)	3.1771(.01920)	2.9967(.03083)	3.2874(.06422)
Past 30 Day Milk Consump.						
Never	18.2	18.1	20.6	14.9	22.4	28.6
Rarely(Less Once/Wk.)	14.0	15.8	14.4	12.0	17.2	11.8
Sometimes	27.7	28.7	20.7	27.5	31.9	24.1
Often (Once/day or more)	40.1	37.5	44.3	45.7	28.5	35.5

Table 1. Sample Characteristics

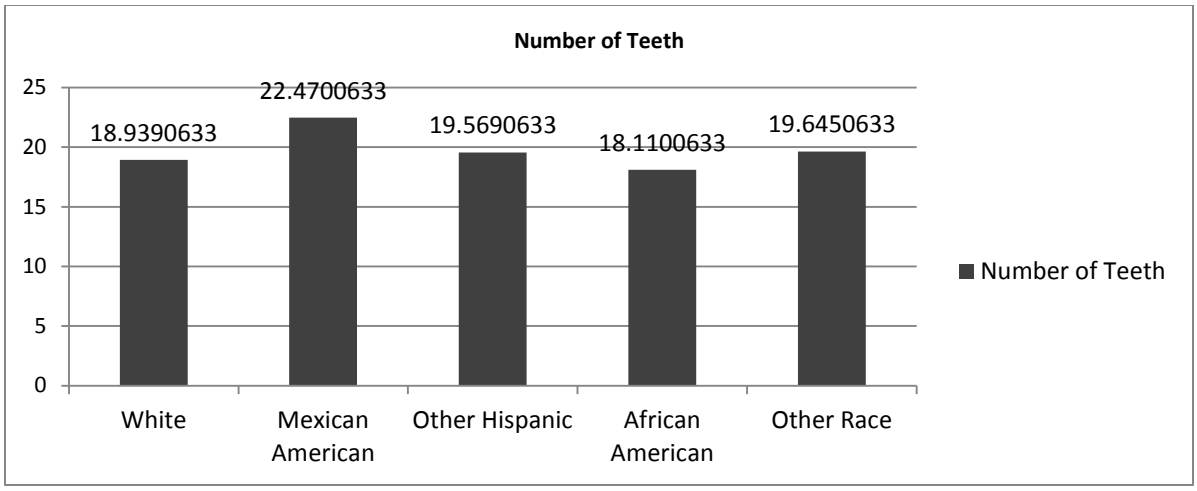

Figure 1. Predicted Values By Race When Other Variables Set to Respective Means.

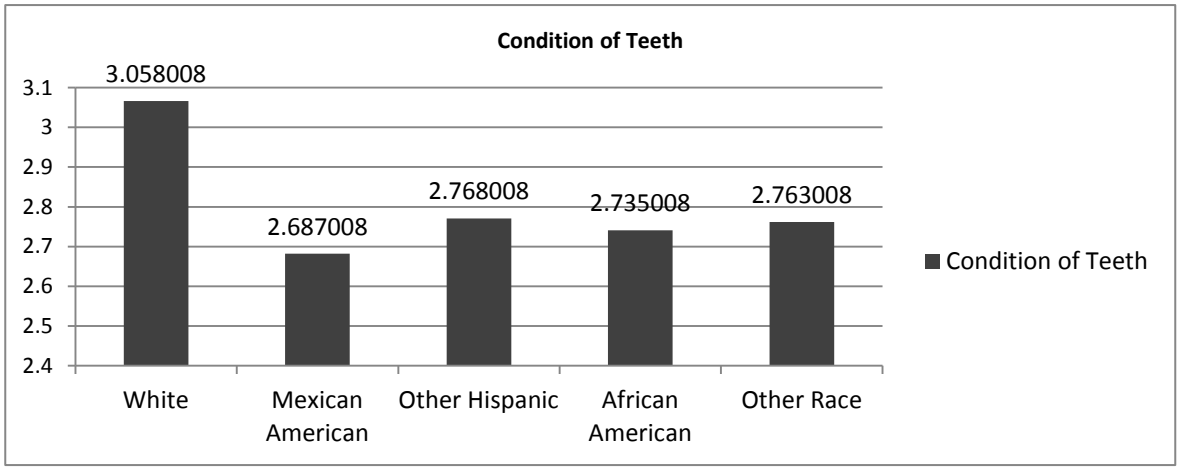

Figure 2. Predicted Values By Race When Other Variables Set to Respective Means.

Table 2. Linear Regression Results

	Predicted Values (Standard Error)			
	Tooth Count		Condition of Teeth	
	Model 1	Model 2	Model 1	Model 2
Constant	32.757(.355)**	24.216(.498)**	3.364(.055)**	2.268(.079)**
Mexican American	1.730(.288)**	3.531(.299)**	-.602(.045)**	-.371(.048)**
Other Hispanic	-.796(.341)*	.630(.350)	-.454(.052)**	-.290(.055)**
African American	-1.435(.270)**	-.829(.267)*	-.407(.042)**	-.323(.042)**
Other Race Including Multiracial	.751(.527)	.706(.520)	-.237(.081)*	-.295(.082)**
Age	-.254(.006)**	-.231(.006)**	-.006(.001)**	-.003(.001)**
Gender	-.439(.202)*	-.485(.201)*	.066(.031)*	.073(.032)*
Education Level		1.345(.089)**		.155(.014)**
Family Income		.341(.031)**		.058(.005)**

Model 1 adjusted for race, age, and gender.
Model 2 additionally adjusted for education and family income.
*P<0.05, **P<0.001

Table 3. Binary Logistic Regression Results

	Odds Ratios (Standard Error)			
	Decay		Owns Dentures	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Constant	.563(.114)**	3.323(.174)**	.004(.190)**	.026(.235)**
Mexican American	1.888(.090)**	1.393(.102)*	.673(.124)*	.414(.143)**
Other Hispanic	1.209(.115)	1.012(.126)	1.833(.121)**	1.265(.136)
African American	1.970(.085)**	1.808(.092)**	1.710(.096)**	1.473(.104)**
Other Race Including Multiracial	1.155(.176)	1.246(.187)	1.293(.201)	1.188(.218)
Age	.987(.002)**	.983(.002)**	1.077(.003)**	1.070(.003)**
Gender	.639(.067)**	.612(.072)**	1.357(.075)**	1.380(.081)**
Education Level		.786(.032)**		.732(.036)**
Family Income		.899(.011)**		.927(.013)**

Model 1 adjusted for race, age, and gender.
Model 2 additionally adjusted for education and family income.
*P<0.05, **P<0.001

Table 4. Mexican American Subsample

	Mean(Standard Error)		Percentage	
	Tooth Count	**Condition of Teeth**	**Decay**	**Owns Dentures**
Country of Birth				
U.S (50 States/ D.C.)	22.5840(.30726)	2.8321(.05764)	26.4	12.2
Mexico	22.7780(.27479)	2.3415(.04307)	36.5	14.9
Length of Time in U.S.				
Less than 1 yr.	24.5000(.86906)	2.5200(.15406)	55.0	0
1 yr., less than 5 yrs.	25.5357(.30997)	2.4219(.11314)	42.9	2.7
5 yrs., less than 10 yrs.	24.3736(.49556)	2.3178(.09990)	41.8	5.2
10 yrs., less than 15 yrs.	23.4286(.90068)	2.4833(.13960)	32.7	10.6
15 yrs., less than 20 yrs.	23.7746(.58938)	2.4568(.13269)	32.4	14.5
20 yrs., less than 30 yrs.	22.5862(.68289)	2.2963(.09233)	37.9	18.8
30 yrs., less than 40 yrs.	21.4921(.84056)	2.1842(.13728)	30.2	18.8
40 yrs., less than 50 yrs.	16.5278(1.45323)	2.1000(.19871)	27.8	33.3
50 yrs. or more	19.3793(1.44216)	2.5455(.18510)	31.0	31.0
Citizenship Status				
Citizen by birth/natural.	22.1772(.28012)	2.7162(.04908)	24.0	14.8
Not a citizen of U.S.	23.4305(.29485)	2.3124(.04875)	43.6	12.7

Discussion

The findings show the existence of racial/ethnic disparities in oral health. Race, education, and income were all significant predictors of the outcomes of tooth count, self-rated condition of teeth, decay in at least one tooth, and ownership of dentures. The addition of education and income together in the regression models had varying effects on the significance and the values of predicted numbers and odds ratios for races within each oral health category. The additional variables attenuated the levels of significance in some cases. Their addition affected the predicted values or odds ratios for each independent variable differently. The racial/ethnic categories of "other Hispanics" and "other race including multiracial" were included in the regression models, but Mexican Americans, African Americans, and Whites were the focus of the analysis.

The results of the tooth count analyses were surprising. Mexican Americans had the highest predicted number of teeth (22.47), while African Americans had the lowest (18.11) when education and income were included in the analysis. Whites were in between the two with 18.94 predicted teeth.Tooth count taken alone may not be an adequate indicator of oral health. A high number of teeth may be the result of maintaining healthy teeth or not having the proper dental care to remove unhealthy teeth. In the same way, a low number of teeth could be the result of seeking dental care to remove unhealthy teeth or the result of loss of teeth on their own. Reid, Hyman, and Macek (2004) stated that missing teeth could be "a proxy for material factors" as well as "a proxy for health-seeking behaviors." However, they explained that a wealthier person generally has more teeth than a poorer person, which was not necessarily supported by this study.

Although tooth count could have various meanings, the results still showed the effects of education and income. By additionally controlling for income and education, the number of predicted teeth for Mexican Americans compared to Whites jumped from 1.73 to 3.53. It appears that controlling for education and income had more of an impact on Mexican Americans' tooth count. The model ranked education as the second strongest predictor for tooth count behind age. This becomes especially interesting when considering that Mexican Americans in the sample had much lower levels of education compared to Whites. A mere 6.8 percent of Whites had less than a 9^{th} grade education, while a striking 32.3 percent of Mexican Americans fell into this category. The proportion of college grads or higher also differed with 23.2 percent of Whites compared to 8.9 percent of Mexican Americans in this education category. The percentages for African Americans were more similar to Whites than to Mexican Americans. Higher levels of education were shown to increase tooth count, but Mexican Americans still showed the highest predicted tooth count in the absence of relatively high education levels. Although African Americans did not have such noticeable differences in education levels compared to Whites, their education levels were still lower as were their predicted number of teeth. Income also plays a role. In fact, many other unknown variables must play a role considering that the R^2 value reflected that an estimated 30.0 percent of the variance in tooth count was explained by the model.

While the results from the tooth count model may not be completely clear cut, they are consistent with the findings related to dentures. The predicted tooth counts were highest for Mexican Americans and lowest for African Americans. At the same time, African Americans had the greatest likelihood of owning dentures compared to the other two races. Mexican Americans had the lowest odds. At the very least, there is an indication of receiving dental

treatment in the form of dentures; although this may not be the ideal form of treatment, and is obviously not as good as one's natural healthy teeth.

Increased levels of education and income were shown to decrease the odds of owning dentures. This is reversed from what was seen in the tooth count model, but is logical when taken from the perspective that higher education frequently translates into higher income. This could then allow for better access to care and guidance toward preventative oral health treatments as well as being able to afford costly procedures that retain the natural teeth. But, once again, this is only one possible interpretation. Dentures do not always mean lack of proper oral care. For some people, dentures may be the best possible treatment in their cases.

In contrast to tooth count and ownership of dentures, the presence of decay in at least one tooth can be analyzed from only one reasonable perspective. The presence of decay is a straightforward negative indicator of oral health status. African Americans had especially greater odds of decay (80.8%) compared to Whites when controlling for education and income. Mexican Americans were also 39.3 percent more likely to have decay compared to Whites in the second model. Levels of education and income greatly influence Mexican Americans' chances of having decay compared to Whites, but not for African Americans. That African Americans still had an 81 percent greater likelihood of having decay compared to Whites even after controlling for education and income indicates that oral health disparities for African Americans likely reflect systemic, rather than superficial social influences. Further support for the idea that the cause of decay goes beyond the independent variables included in the models is that the R^2 value for model 2 was only 12.6 percent.

Unlike the other dependent variables discussed, the condition of teeth variable was self-rated. Wu et al., (2011: 283) state that the "perception of health is socially constructed" (see also

Kaplan & Baron-Epel, 2003 regarding factors that influence subjective health). As Wu et al. explain, "Factors such as differences in cultural perception and interpretation of overall health, and perceived needs of dental care, could contribute to the differences in self-rated oral health" (2011: 283).

Although self-ratings may not always be consistent across cultures and individuals, the self-ratings of this study shed some additional light onto the earlier puzzling findings related to tooth count. As mentioned earlier, a high tooth count does not necessarily mean healthy teeth and good oral health. The low predicted self-ratings of Mexican Americans support this idea. Likewise, the high predicted self-ratings of Whites revealed greater satisfaction with their oral health despite having lower predicted numbers of teeth. The self-ratings of African Americans should also be taken into consideration. Their predicted value was only 0.05 units higher than Mexican Americans, who had the lowest predicted rating. It appears that the best way to understand self-ratings is to contextualize them by examining them in connection to other oral health indicators.

The variables examined in this study explained a portion of the differences in oral health across races. Interestingly, when health behavior variables (recent tobacco/nicotine use, BMI, self-rated health of diet, and past 30 day milk consumption) were added to the models, the results did not change much and were compromised by missing cases. This was not expected, but is similar to the findings of Reid, Hyman, and Macek (2004), who found that behavioral factors such as obesity, tobacco use, alcohol use, marital status, and social support had no effects on untreated dental caries disparities, but material factors such as dental insurance, education, and employment did.

Other variables not included in regression analysis but of interest related to the Mexican American subsample. Within the Mexican American subsample, those born in the United States compared to Mexico had, on average, a lower tooth count, higher condition of teeth self-rating, less prevalence of decay in at least one tooth, and a lower percentage who owned dentures. The biggest difference was seen in the decay variable as 26.4 percent born in the U.S. had decay in at least one tooth, but the percentage was 36.5 percent for those born in Mexico. Improved access to care and fluoridation of water are possible explanations for this finding. There was also a noticeable difference in the prevalence of decay in at least one tooth between U.S. citizens and non-citizens. Of non-citizens, 43.6 percent had decay in at least one tooth while this was 24 percent for citizens. Not being a citizen of the United States yet residing in the country may limit access to dental care.

The explanations for the causes of racial oral health disparities are complex. Mouradian, Wehr, and Crall (2000: 2629) noted that the "separation of medical and dental systems" that"occurs at the level of professional training, clinical care and continuing education, and in scholarly journals, research agendas, and financing and delivery mechanisms" plays a huge role in the disparities that exist in children's oral health and their ability to get care. This marginalization of oral health and dental care may also apply to the findings of this study even though it examined adults rather than children. Another explanation for the disparities may be an "environmental or contextual effect." As Borrell et al. (2000:99) explain, "The proposed contextual effect might be the physical features of the area shared by individuals; the availability of a healthy or an unhealthy environment; services provided, privately or publicly, to support people in their daily living; the sociocultural features of a neighborhood; and the reputation of a neighborhood." The authors also state that the effect of the environment, or context, can be

involved with what dental services are available, access to the care, and "culture-sensitive providers" (Borrell et al. 2001: 99).

The oral health status of African Americans may be the result of residential segregation, discrimination, and racism. Borrell et al. find that, "Residential segregation acts similarly to the contextual effect by limiting access to care, better schools, employment opportunities, hazardous environmental exposures, and poor-quality housing" (2001:99). The authors also link racial discrimination to stress, which has been shown to be related to periodontal disease even in a nearly all-White population (Borrell et al. 2001). Therefore, the stress caused by racism and discrimination experienced by African Americans may be even more likely to impact their periodontal health (Borrell et al. 2001). This idea could likely also apply to the oral health outcomes measured in this study. Since education and income could not fully explain the disparities, especially in the case of African Americans, it is likely that the subordinated status of African Americans produces adverse effects on their oral health. Also, Wu et al. note that their findings of disparities in oral health between racial/ethnic groups could be attributed to a "historical lack of access to dental care for racial /ethnic minorities" and "differential treatment as a result of limited dental coverage and inadequate participation of dentists in the Medicaid program" (2011: 7).

The results indicate that there are oral health disparities across racial/ethnic groups that go beyond social class differences. This may be related to dental insurance coverage. According to the U.S. Census Bureau, in 2010, 11.7 percent of non-Hispanic Whites were without health insurance coverage (U.S Census Bureau 2011). The percentages were higher for racial/ethnic minorities. The percentage of African Americans without health insurance coverage in 2010 was 20.8 percent (U.S. Census Bureau 2011). The percentage of Hispanics (any race) without health

insurance coverage in 2010 was 30.7 percent (U.S. Census Bureau 2011). It is likely that these percentages would be even higher for dental insurance coverage (the ADA does not publish comparable information on dental insurance statistics on their website).

Differences in health insurance coverage by race/ethnicity indicate differences in access to care. "However," as stated by Williams and Rucker (2000: 80), "efforts to ensure equitable access to care must go beyond the elimination of financial barriers" to remove "system barriers such as long waiting time, complex bureaucratic procedures, and the failure to treat patients with dignity and respect." Racial minorities are often seen as undesirable patients (Williams and Rucker 2000). Poor quality of treatment can direct patients away from health care systems and toward isolation (Williams and Rucker 2000). Eduardo Bonilla-Silva claimed, "Blacks and dark-skinned racial minorities lag well behind whites in virtually every area of social life" (2010:2). Thus, medicine is another example area where discrimination is likely to be widespread (Williams and Rucker 2000: 79). Racial discrimination in healthcare may not be intentional; instead, it is the indirect result of a lack of concern and awareness for minority patients' health compared to the care, concern, and awareness extended to white patients (Williams and Rucker 2000). Combating institutional discrimination in medicine will require data systems that monitor discrimination, stronger regulations, and training that raises the awareness and sensitivity of medical professionals (Williams and Rucker 2000). The racial discrimination that occurs in medicine is likely to follow a parallel pattern in dentistry, and similar steps should be taken to eradicate the discrimination in oral health care.

Limitations of the study

Although evidence of racial disparities in oral health was found, there were some limitations to the study that restricted what could be said about the nature and causes of these differences. The set of variables provided in the 2007-2008 NHANES survey, for example, were neither comprehensive nor consistent with previous NHANES waves. Comparing the available information of this NHANES wave to others, it appears that the 2007-2008 survey contained fewer detailed oral health questions.The decay variable of this wave did not give a tooth by tooth estimation of decay, but only the presence or absence of decay in at least one tooth. There was also a lack of "explanatory variables" (Reid, Hyman, and Macek 2004). Reid, Hyman, and Macek critiqued the NHANES dataset for omitting "the contribution of factors such as attitudes toward healthcare, access to oral-health-care services, and bacterial counts" (2004: 334). Other variables such as distance to the nearest dental office and regular dental checkups would be beneficial if included. In addition, this study was limited in that it only focused on Mexican Americans, African Americans, and Whites. Further research should aim to explain the causes of the disparities beyond socioeconomic status and behavior. It should also discuss how other races/ ethnicities such as Asian-Americans fit into the patterns of inequality seen in the current study.

Conclusion

The aim of this study was to explore some of the oral health inequalities that exist among different racial/ethnic groups in the United States. The oral health outcomes of tooth count, self-rated condition of teeth, presence of decay in at least one tooth, and ownership of dentures were examined in a nationally representative study of U.S. adults age 20 and above. The independent variables of age, gender, education, and family income were included in the analysis to

determine their respective impacts on each of the outcome variables. The study indicated that there are obvious yet complex disparities. The disparities between races varied in each outcome meaning there was not a particular race that consistently had the most positive or negative results. This may be due in part to the idea that some oral health measures like tooth count or ownership of dentures could be the result of either proper dental attention or lack of adequate care. More attention needs to be given to the status of U.S. citizens' oral health in order to tackle the disparities that were highlighted in both this study and others similar to it. For Mexican Americans, this may mean improving education levels which could improve oral health indicators although this should not be the only solution since differences persist beyond education. For African Americans, the policy concerns must go beyond education and income, and need to confront the issues of residential segregation and discrimination. As the percentage of Whites drops in relation to the percentages of other racial/ethnic groups in years to come, this issue will become increasingly important to ensure that the country is not in a situation in which only half the population is receiving proper dental care.

References

American Dental Association. (n.d.). Disease, Gum (Periodontal Disease). Retrieved from http://www.ada.org/3603.aspx

Bonilla-Silva, E. (2010). *Racism without racists: Color-blind racism and the persistence of racial inequality in the United States.* Lanham: Rowman and Littlefield Publishers.

Borrell, L.N., Burt, B.A., Gillespie, B.W., Lynch, J. and Neighbors, H. (2002). Periodontis in the United States: Beyond Black and White. *Journal of Public Health Dentistry*. 62(2), 92-101.

Kaplan, G., & Baron-Epel, O. (2003). What lies behind the subjective evaluation of health status? *Social Science & Medicine*, 56, 1669-1976.

Mouradian, W., Wehr, E., and Crall, J. (2000). Disparities in Children's Oral Health and Access to Dental Care. *Journal of the American Medical Association*. 284 (20), 2625-2631.

Seirawan, H., Sundaresan, S., Mulligan, R. (2011). Oral health-related quality of life and perceived dental needs in the United States. *Journal of Public Health Dentistry*. 71, 194-201.

Reid, B., Hyman, J., and Macek, M. (2004). Race/ethnicity and untreated dental caries: the impact of material and behavioral factors. *Community Dentistry and Oral Epidemiology*. 32, 329-336.

Sabbah, W., Tsakos, G., Chandola, T., Newton, T., Kawachi, I., Sheiham, A., Marmot, M.G. and Watt, R.G. (2011). The relationship between social network, social support and period ntal disease among older Americans. *Journal of Clinical Periodontology*. 38, 547-552.

Sabbah, W., Tsakos, G., Chandola, T., Sheiham, A. and Watt, R.G. (2007). Social gradients in oral and general health. *Journal of Dental Research.* 86, 992-996.

Sabbah, W., Tsakos, G., Sheiham, A. and Watt, R.G. (2009). The effects of income and education on ethnic differences in oral health: a study in USA adults. *Journal of Epidemiology and Community Health.* 63, 516-520.

U.S. Census Bureau. (2011, September). *U.S. Census Bureau. Income, Poverty, and Health Coverage: 2010*. Retrieved April 9, 2012, from http://www.census.gov/hhes/www/hlthins/data/incpovhlth/2010/table8.pdf.

U.S. Census Bureau. (2009, September). U.S. Census Bureau. Income, Poverty, and Health Coverage in the United States: 2008. Retrieved February 26, 2012, from http://www.census.gov/prod/2009pubs/p60-236.pdf.

Vargas, C.M., Crall, J.J. and Schneider D.A. (1998). Sociodemographic distribution of pediatric dental caries: NHANES III, 1988-1994. *The Journal of the American Dental Association*. 129, 1229-1238.

Williams, D. and Rucker, T. (2000). Understanding and addressing racial disparities in health care. *Health Care Financing Review*, 21, 75-90.

Wu, B., Liang, J., Plassman, B.L., Remle, C., and Bai, L. (2011). Oral health among white, black, and Mexican-American elders: an examination of edentulism and dental caries. *Journal of Public Health Dentistry.*71, 308-317.

Wu, B., Plassman, B.L., Liang, J., Remle, R.C., Bai, L, and Crout, R.J. (2011). Differences in self-reported oral health among community-dwelling black, Hispanic, and white elders. *Journal of Aging and Health*. 23(2), 267-288.