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**THE EFFECTS OF INCOME AND EDUCATION ON ETHNIC DIFFERENCES
IN ORAL HEALTH: A STUDY IN USA ADULTS.**

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ABSTRACT

Background: Ethnic differences exist in oral health. However, the causes of the differences have not been adequately addressed. The objective of this study is to examine the effect of socioeconomic position on ethnic differences in oral health.

Methods: Data were from the Third National Health and Nutrition Examination Survey conducted in USA (1988-1994). The effects of income and education on ethnic differences in perceived oral health, gingival bleeding, periodontitis and tooth loss were analyzed using a series of regression models.

Results: The probabilities of poorer oral health were higher among African American, Mexican Americans and other ethnic groups than in White Americans. Adjusting for income and education resulted in a reduction in the odds ratios for having poorer perceived oral health (44%), tooth loss (29%), gingival bleeding (61%) and periodontitis (30%) among African Americans compared to White Americans. Similar reductions in risk were observed among Mexican Americans and other ethnic groups.

Conclusion: The results indicate that education and income play an important role in ethnic differences in oral health. Despite the major impact of socioeconomic position, the results imply that there are causes additional to socioeconomic position for ethnic differences in oral health.

INTRODUCTION

There are differences in oral health between ethnic groups (1-5). Several studies in the United States and the United Kingdom have shown a general trend for persons from ethnic minorities to have poorer oral health indicators than the predominant White population (1-11). Similar differences in general health and mortality rates exist between ethnic groups in the United States (12-19) and in the United Kingdom (20-25).

The causes of these ethnic differences in general health have been extensively examined. While some maintain that socioeconomic position plays no, or a minimum role in ethnic differences in health (26), others have suggested that socioeconomic position as well as cultural and genetic elements are also important (27,28). Others have considered that demographic location is responsible for ethnic differences in health (29). Whereas others have argued that socioeconomic inequalities explain most if not all the ethnic differences in health (24,30). Racial harassment and discrimination have also been suggested to be important explanatory factors of the health differences between ethnic groups (19,30-32). The different and overlapping reasons for ethnic differences in general health suggest that there are a number of underlying causes. In contrast, the causes of the ethnic differences in oral health have not been adequately explored. One study found that socioeconomic position explains a great part of the ethnic variations in untreated dental caries in the USA population (11).

There are similarities in the social determinants and underlying pathways for oral and general health (33,34). Hence, it is reasonable to assume that causes for ethnic

differences in general health also apply to oral health. Socioeconomic position is one of the most important and well established causes of ethnic differences in general health (24,30), therefore we set out to examine their role in ethnic differences in oral health. The hypothesis of this study is that indicators of socioeconomic position explain a significant part of the ethnic differences in oral health. The objective of this study is to assess the impact of education and income on ethnic differences in oral health, indicated by perceived oral health, gingival bleeding, periodontitis and tooth loss, in a nationally representative sample of the USA adult population.

METHODS

Data used are from the Third National Health and Nutrition Examination Survey (NHANES III) (35), a cross-sectional national survey conducted in the USA between 1988-1994. NHANES III used a stratified multistage probability sampling design with a sample representative of the non-institutionalized civilian American population. We used data for adults aged 17 years and older. The survey included a comprehensive dental examination which included periodontal examination and diagnosis of missing tooth due to a disease (periodontal disease or dental caries). Periodontal measures were assessed on randomly assigned half-mouths, one upper quadrant and one lower quadrant, selected at the beginning of the examination, according to the [National Institute of Dental and Craniofacial Research](#) protocol (36). In addition, NHANES III included a question about participants' perception of the status of their natural teeth. Furthermore, the survey included comprehensive demographic and socioeconomic data including years of education, poverty-income ratio, race-ethnicity, dental insurance and smoking. Details of the survey were described in other papers (1,2,33).

Oral health status was indicated by moderate periodontitis, gingival bleeding, tooth loss and perceived oral health. For perceived oral health, participants were asked to classify the status of their natural teeth as excellent, very good, good, fair, or poor. Perceived oral health was categorized into two groups: (1) poor/fair or (2) good/very good/excellent. Moderate periodontitis was defined by the presence of 2 or more inter-proximal sites with loss of attachment of 4mm or more (not on same tooth) or 2 or more inter-proximal sites with pocket depth 5mm or more (not on same tooth) (37). Gingival bleeding was

categorised into two groups indicating the presence of gingival bleeding in at least one site versus no gingival bleeding. Tooth loss was categorised into two groups indicating one missing tooth or more due to disease (dental caries or periodontal disease) versus no missing teeth.

NHANES III included a variable on race-ethnicity which was reported for four groups: Non-Hispanic white, Non-Hispanic black, Mexican-American and other ethnicities. In this document the terms White Americans and African Americans were used to refer to Non-Hispanic white and Non-Hispanic black, respectively.

Years of education and poverty-income ratio were both used as indicators of socioeconomic position. The poverty-income ratio was computed as a ratio of two components, family income and poverty threshold, in the calendar year in which the family was interviewed. Poverty threshold values (in USA dollars) are produced annually by the Census Bureau and are adjusted for changes caused by inflation between calendar years. Other covariates included age, sex, having dental insurance, and smoking (current smoker, non-smoker, non-respondent).

First, we assessed the prevalence of the variables indicating perceived poorer oral health, gingival bleeding, periodontitis and tooth loss within ethnic groups. Thereafter, two logistic regression models were constructed for each oral health outcome. The first model adjusted for ethnicity, age, sex, smoking and dental insurance. The second model additionally adjusted for education and poverty-income ratio. The contribution of

socioeconomic position to ethnic differences in oral health was assessed by calculating the percentage reduction in the odds ratios for each ethnic groups “Percent reduction in odds ratio = (odds ratio_{ethnic group, controlling for age, sex, smoking and insurance} - odds ratio_{ethnic group additionally controlling for education and poverty-income ratio}) / (odds ratio_{ethnic group, controlling for age, sex, smoking and insurance} - 1) X 100”. This method was used in previous studies and considered appropriate for assessing the contribution of socioeconomic position to the variation in health (11,38). The analysis was conducted using survey command in STATA statistical package version 8 (39). The key STATA 8 commands used in this analysis were (*svytab, svymean, svylogit*). Final sample weights, total primary sample units and survey stratum were used to adjust for the sampling complexity (40). Weighted data were used throughout the analysis. The analysis was conducted for participants who had complete data for all the variables used in the analysis. Of those who had complete dental examination 3,908 (29%) were excluded because they had incomplete data for all explanatory variables used in the analysis.

RESULTS

A total of 9643 participants were included in the analysis. The mean age was 41 (95%CI 40, 43) years for White Americans, 37 (95%CI 36, 38) for African Americans, 35 (95%CI 34, 36) for Mexican Americans and 38 (95%CI 36, 40) for persons of other ethnicities. The means of years of education were 13 (95%CI 13, 14), 12 (95%CI 12, 13), 10 (95%CI 9, 11) and 13 (95%CI 12, 13) for White, African, Mexican Americans and other ethnicities, respectively. The mean values for poverty-income ratios were 3.6 (95%CI 3.4, 3.8), 2.4 (95%CI 2.3, 2.6), 2.1 (95%CI 1.9, 2.4) and 2.7 (95%CI 2.4, 3.0) for White, African, Mexican Americans and other ethnicities, respectively. Overall, 55% (95%CI 51, 59) of White Americans, 65% (95%CI 60, 70) of African Americans, 45% (95%CI 37, 54) of Mexican Americans and 53% (95%CI 44, 61) of persons belonging to other ethnicities were covered by dental insurance. The prevalence of current smokers was 29% (95%CI 26, 31), 30% (95%CI 27, 34), 22% (95%CI 20, 24), and 19% (95%CI 13, 26) for White, African, Mexican Americans and persons belonging to other ethnicities, respectively.

The prevalence of poorer oral health for most of the outcomes was generally higher among African Americans, Mexican Americans and those in other ethnic groups than in White Americans. The prevalence of perceived poorer oral health was highest among Mexican Americans (49%) and lowest among Whites (28%). The prevalence of tooth loss (one tooth or more) was highest among African American (67%) and lowest among Mexican Americans (48%). Gingival bleeding was most common among Mexican Americans (65%) and least common among Whites (51%). Moderate periodontitis was

most prevalent among African American (14%) and least prevalent among Whites (8%) (Table 1).

Table 1 Weighted distribution of oral health indicators by ethnic groups of USA adults (NHANES III 1988-1994) (N=9643).

	White Americans (N=4214)	African Americans (N=2608)	Mexican Americans (N=2493)	Other Ethnicities (N=328)
Perceived poorer oral health (95% CI)	27.6 % (25.5, 30.0)	41.7% (39.5, 43.9)	48.8% (44.1, 53.5)	34.7% (28.5, 41.4)
Tooth loss (one tooth or more) (95% CI)	49.4% (46.7, 52.2)	67.3% (64.2, 70.3)	48.4% (46.1, 50.8)	60.6% (54.0, 66.9)
Gingival bleeding (95% CI)	50.5% (45.3, 55.8)	58.1% (52.3, 63.7)	65.1% (59.8, 70.1)	64.6% (55.7, 72.6)
Moderate periodontitis (95% CI)	8.3% (7.0, 9.9)	13.7% (12.1, 15.5)	8.7% (7.3, 10.3)	9.5% (6.7, 13.4)

Regression models adjusting for ethnicity, sex, age, smoking and dental insurance confirmed the trend of higher probabilities of poorer oral health among ethnic groups compared to White Americans. African Americans had the highest probabilities of tooth loss and moderate periodontitis compared to White American with odds ratios 4.39 (95% CI 3.67, 5.25) and 2.71 (95% CI 2.11, 3.48), respectively. Mexican Americans had the highest probabilities of perceived poorer oral health compared to White American with odds ratio 3.04 (95% CI 2.43, 3.80) (Table 2).

After adjusting for education and poverty-income ratio, the probabilities of ethnic groups having poorer oral health, compared to White Americans, attenuated for all oral health outcomes. The greatest reduction was in the odds ratio for tooth loss among Mexican

Americans. In the initial model, Mexican Americans were 1.80 times more likely to have tooth loss of one or more tooth compared to White Americans. After adjusting for education and income, the odds ratio was 0.86, indicating that Mexican Americans were less likely to lose teeth than Whites. For all other oral health conditions the associations between ethnicity and oral health remained in the same direction, although the statistical significance were lost in the association between gingival bleeding and being African American, and between tooth loss, gingival bleeding, periodontitis, and being Mexican Americans. In the models pertaining to African Americans, there were consistent reductions in the odds ratios for having poorer oral health after controlling for education and income with reductions in the odds ratios of 44% (perceived poorer oral health), 29% (tooth loss), 61% (gingival bleeding) and 30% (periodontitis). The probabilities of poorer oral health for persons belonging to other ethnicities compared to White American also attenuated after adjusting for education and income. However, the magnitude of reduction in the odds ratios for 'other ethnicities' was generally smaller than that for African and Mexican Americans (Table 2).

Table 2 Effect of adjusting for income and education on the odds ratios for having poorer oral health for ethnic groups compared to White Americans (NHANES III 1988-1994) (N=9643).

		African Americans		Mexican Americans		Other ethnicities	
		Odds ratio (95%CI)	Percent reduction in odds ratio [†]	Odds ratio (95%CI)	Percent reduction in odds ratio [†]	Odds ratio (95%CI)	Percent reduction in odds ratio [†]
Perceived poorer oral health	Model 1	2.17 (1.85, 2.54)		3.04 (2.43, 3.80)		1.66 (1.20, 2.30)	
	Model 2	1.65 (1.40, 1.94)	44%	1.78 (1.44, 2.21)	62%	1.33 (0.97, 1.83)	50%
Tooth loss (one tooth or more)	Model 1	4.39 (3.67, 5.25)		1.80 (1.54, 2.11)		2.84 (1.91, 4.22)	
	Model 2	3.41 (2.81, 4.15)	29%	0.86 (0.66, 1.11)	118% [§]	2.24 (1.53, 3.28)	33%
Gingival bleeding	Model 1	1.41 (1.11, 1.79)		1.68 (1.29, 2.19)		1.73 (1.19, 2.50)	
	Model 2	1.16 (0.91, 1.49)	61%	1.23 (0.94, 1.60)	66%	1.50 (1.03, 2.17)	32%
Moderate periodontitis	Model 1	2.71 (2.11, 3.48)		1.91 (1.40, 2.59)		1.95 (1.18, 3.22)	
	Model 2	2.19 (1.65, 2.91)	30%	1.06 (0.69, 1.65)	93%	1.70 (0.99, 2.91)	26%

Model 1 Adjusted for ethnicity, sex, age, smoking and dental insurance.

Model 2 Additionally adjusted for education and poverty-income ratio.

[†] Percent reduction in odds ratio = $(\text{odds ratio}_{\text{ethnic group, controlling for age, sex, smoking and insurance}} - \text{odds ratio}_{\text{ethnic group additionally controlling for education and poverty-income ratio}}) / (\text{odds ratio}_{\text{ethnic group, controlling for age, sex, smoking and insurance}} - 1) \times 100$

[§] Adjusting for education and poverty income ratio changed the direction of association between Mexican Americans and tooth loss, making Mexican Americans less likely to lose teeth than White Americans.

DISCUSSION

African Americans, Mexican Americans and other ethnicities had a higher prevalence of all negative oral health outcomes examined in this study than White American, with the exception of tooth loss which was lower among Hispanics. The trends, by ethnic differences in oral health, observed in this study were also reported in several USA-based studies (2-10). The results indicate that ethnic differences in oral health are similar to those reported for general health and mortality. (12-25).

After adjusting for income and education, the probabilities of poorer oral health attenuated for all oral health outcomes, lost significance for the associations between gingival bleeding and being African Americans and for tooth loss, gingival bleeding, periodontitis and being Mexican Americans. Interestingly, adjusting for socioeconomic position changed the direction of the association between tooth loss and being Mexican Americans. These finding for oral health outcomes supports the theories on the importance of socioeconomic position in explaining much of the ethnic differences in health (24,30). The finding is also consistent with another study on oral health which demonstrated the effect of socioeconomic position on ethnic differences in dental caries (11). However, the current study has the advantage over previous studies of examining a number of clinical and subjective indicators of oral health, hence reflecting the objective measures defined by clinicians and the multidimensional aspect of perceived health (41). The changes in the probabilities of ethnic differences in oral health after adjusting for socioeconomic position is particularly important as the initial models already controlled for some important determinants of oral health, including dental insurance.

Adjusting for income and education eliminated the differences in all clinical indicators of oral health between Mexican Americans and White Americans. These findings highlight the importance of socioeconomic position in the health of Mexican Americans. Other studies on the health status of the Hispanic population in USA addressed the Hispanic paradox whereby poor Hispanics living in the USA have better health than expected for their status (42). That highlights the effects of diet, culture and emigration. Those factors could not be examined in the current study.

Despite the major reduction in ethnic differences in oral health, socioeconomic position did not fully explain all ethnic differences in oral health in most of the outcomes. This suggests that in addition to socioeconomic position, other factors, not addressed in this study, contribute to ethnic differences in oral health. Studies on ethnic differences in general health suggested that in addition to socioeconomic position, factors such as genetics, culture, neighbourhood characteristics, racial harassment, discrimination, ethnic density and acculturation contribute to ethnic differences in health (29,32,43,44). The same factors are likely to affect ethnic differences in oral health.

The lack of data on the aforementioned possible causes of ethnic differences in oral health is one of the limitations of this study, and should be addressed by future research. Another limitation of this study is the cross-sectional nature of the survey which does not support conclusions about causal relationships. The dichotomization of some of the variables used, such as tooth loss and gingival bleeding, reflects presence and absence of a condition, but does not particularly reflect clinical significance. However, this

dichotomization was essential to quantify the effect of income and education on ethnic differences in oral health. The lack of oral health-related behaviours such as tooth-brushing and the lack of other variables believed to influence ethnic differences in health, such as racism, harassment, and discrimination in NHANES, are other limitations of this analysis. It is possible that the aforementioned variables could have explained more ethnic variations in oral health. **It is inevitable that some participants will not have complete data in a large national survey such as NHANES. The exclusion of participants with incomplete data may have influenced the results, however the use of survey weights to some extent accounts for these exclusions.** Despite the limitations of the study, the results clearly demonstrated a consistent role for income and education in ethnic differences in oral health.

It is worth noting that in the UK, where dental services are included in the National Health Services, there are small differences in adults' oral health between ethnic minorities (45). It is, therefore, possible that the lack of universal dental insurance in the USA may have contributed to ethnic differences in oral health there. On the other hand, more African Americans had some form of dental insurance than White Americans in the examined population in this study. So, while dental insurance coverage may have a role in influencing ethnic differences in oral health, it is unlikely to have intensified them in our study. On a broader perspective, ethnic minorities do not have the same characteristics across countries, therefore ethnic differences in health between countries should be interpreted taking this into consideration.

This study is unique in examining some of the underlying factors affecting ethnic differences in both subjective and clinical indicators of oral health in a nationally representative sample of the American adult population. Identifying the distal causes of ethnic differences in oral health is important to plan strategies to reduce ethnic inequalities in oral health.

This study examined the effect of some indicators of socioeconomic position on ethnic differences in oral health in a nationally representative sample of USA adults. Socioeconomic position explained a large portion of ethnic differences in oral health. The role of socioeconomic position in ethnic differences in oral health appears to be consistent with their reported effect on ethnic differences in general health (24,30). Our findings indicate that there are other causes, in addition to the major contribution of socioeconomic position, for ethnic differences in oral health of adults.

What is already known

- There are ethnic differences in morbidity and mortality.
- There are ethnic differences in oral health.
- Socioeconomic and environmental factors explain most of the ethnic differences in general health

What this study adds

- Socioeconomic position, indicated by income and education, explains a large portion of ethnic differences in oral health in US adult population.
- The effect of socioeconomic position on ethnic differences in oral health is consistent with its effect on ethnic differences in general health.

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