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## Socioeconomic and Racial/Ethnic Oral Health Disparities among U.S. Older Adults: Oral Health Quality of Life and Dentition

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### Abstract

**OBJECTIVE**—To examine if older adults living in poverty and from minority racial/ethnic groups experienced disproportionately high rates of poor oral health outcomes measured by oral health quality of life (OHQOL) and number of permanent teeth.

**METHODS**—Cross-sectional analysis of 2,745 community-dwelling adults aged ≥65 years from the National Health and Nutrition Examination Survey (NHANES) 2005–2008. Oral health outcomes were assessed by questionnaire using the NHANES-Oral Health Impact Profile for OHQOL and standardized examination for dentition. Logistic and linear regression analyses were used to determine the association between oral health outcomes and predictors of interest. All analyses were weighted to account for complex survey sampling methods.

**RESULTS**—Both poverty and minority race/ethnicity were significantly associated with poor oral health outcomes in OHQOL and number of permanent teeth. Distribution of scores for each OHQOL domain varied by minority racial/ethnic group.

**CONCLUSIONS**—Oral health disparities persist in older adults living in poverty and among those from minority racial/ethnic groups. The racial/ethnic variation in OHQOL domains should be further examined to develop interventions to improve the oral health of these groups.

### Keywords

health status disparities; older adults; oral health; quality of life; tooth loss; NHANES

### INTRODUCTION

Oral health disparities remain a major public health problem for U.S. older adults (1–3). Generally, oral health disparities arise from preventable conditions such as dental caries (1–3), periodontal disease (1, 2) and tooth loss (1–3). These conditions are reported to disproportionately affect individuals with lower socioeconomic status and minority racial/

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ethnic groups. For example, the overall prevalence of edentulism decreased among U.S. older adults from 1972 to 2001, but disparities by socioeconomic position persisted (4). Similarly, partial edentulism prevalence disparities decreased among non-poor older adults and white older adults from 1998 to 2004, but not among older adults living in poverty and minority racial/ethnic groups (2).

While studies have documented oral health disparities by income and race/ethnicity in the U.S. for the past decade, the magnitude of these disparities in the heterogeneous U.S. older adult populations is not well known. Moreover, oral health quality of life (OHQOL) is an important component of oral health that measures its psychosocial and functional impacts, but few studies have examined this critical outcome in the context of older adult populations and oral health disparities. This study builds upon the results from prior national studies (1, 3, 5) to improve understanding of oral health disparities among U.S. older adults. We hypothesized that living in poverty and minority race/ethnicity status are associated with lower OHQOL (subjective oral health) and fewer teeth (objective oral health) in older adults. This study addressed this combination of poverty and race/ethnicity by examining the association between OHQOL, number of teeth, poverty status and race/ethnicity in U.S. older adults (≥ 65 years) using National Health and Nutrition Examination Survey (NHANES) 2005–2008 data.

## METHODS

NHANES surveys a nationally representative sample of the non-institutionalized U.S. population to determine prevalence of certain chronic diseases and disease risk factors. Survey participants complete a detailed interview and examination. NHANES survey data is currently collected on a continuing basis in 2-year cycles (6). De-identified data is publicly available. This study was exempt from Institutional Review Board approval as we used publicly available data sets that do not contain identifiable or private data.

This study used cross-sectional data from NHANES 2005–2008. These years were used according to NHANES analytic guidelines to only combine oral health examination data for the 2005–2006 and 2007–2008 data cycles due to differences in the examination procedure from previous cycles (7). The current analyses were limited to older adults aged ≥ 65 years.

### Oral Health Outcomes/Dependent Variables: OHQOL and Number of Teeth

Oral health outcomes of interest were OHQOL (subjective oral health) and number of teeth (objective oral health). These two outcomes were chosen based on Patrick *et al.*'s proposed conceptual framework of contributing factors to oral health disparities, which included both oral health and OHQOL as measures of health and well-being (8). Further, it was previously reported that OHQOL and dentition are associated, though the degree of impairment may vary by individual perspective (9). The NHANES oral health questionnaire assessed OHQOL using: 1) a single question eliciting self-rated oral health, and 2) a modified Oral Health Impact Profile-14 (OHIP-14). Self-rated oral health responses were given on a 5-point Likert scale (excellent, very good, good, fair or poor). We derived a binary variable for self-rated oral health dividing responses into 0 = excellent, very good or good self-rated oral health, and 1 = fair or poor self-rated oral health. Self-rated oral health is typically reported

as binary variable (10). The modified NHANES-Oral Health Impact Profile (NHANES-OHIP) measured seven dimensions of oral health as measured by the OHIP-14: oral health-related functional limitation, physical pain, psychological discomfort, psychological disability, physical disability, social disability and handicap, and was previously validated (11). Questions were worded “How often during the last year have you [OHQOL item]...” with responses rated on a 5-point Likert scale (never, hardly ever, occasionally, fairly often and very often) (12). We derived a binary variable for each question dividing responses into 0 = never or hardly ever, and 1 = occasionally, fairly often or very often, as previously defined by Griffin *et al.* (1). A composite NHANES-OHIP score was calculated by summing participant responses to each question (0 = never to 4 = very often) for a total score range of 0–28, with higher scores indicating worse OHQOL (13).

Number of teeth was assessed by a tooth count performed by a health technologist during the study examination (7). We defined permanent teeth as present or not present; permanent dental root fragments were considered as teeth not present. Respondents were further classified with potential chewing difficulty if they had <20 permanent teeth (e.g., lack of “functional dentitions” (14)) (0 = 20 or more teeth, 1 = fewer than 20 teeth). The maximum possible number of permanent teeth was 32. Removable denture use was not included due to previously reported socioeconomic and racial/ethnic variations in denture prevalence and use (14–16). There are also reported socioeconomic variations in denture-related conditions (e.g., denture-related stomatitis), which may affect actually wearing removable dentures regularly (14). Additionally, OHQOL was previously reported to be decreased among edentulous adults with complete dentures (17).

### Independent Variables of Interest

The independent variables of interest were poverty status based on the ratio of family income to federal poverty level (FPL), and self-reported race/ethnicity. Respondents were classified as living in poverty if their family income was <100% FPL. Race/ethnicity categories were non-Hispanic white, non-Hispanic black and Hispanic (including Mexican-American ethnicity).

### Covariates

Demographic covariates were age, sex, marital status (married/living with partner or single/divorced/separated/widowed), education and health insurance status. A modified Charlson co-morbidity index score to account for overall health was calculated according to Quan *et al.* (18). Based on available survey interview data, we assigned respondents with self-reported congestive heart failure, chronic obstructive pulmonary disease, rheumatologic disease, liver disease and any cancer 1–2 points each for each condition toward the co-morbidity index score (possible range 0–10) (18). We were unable to account for dementia, diabetes with chronic complications other than retinopathy, hemiplegia or paraplegia, metastatic malignancy from a solid tumor, or HIV/AIDS as these conditions were not assessed in the NHANES survey.

## Statistical Analysis

Descriptive analyses of the above variables were stratified by poverty status and race/ethnicity. Two-sided *t*-tests, Chi-square tests and ANOVA were used to examine differences between reported OHQOL (measured by self-rated oral health and composite NHANES-OHIP score), number of permanent teeth, potential chewing difficulty, poverty and race/ethnicity using univariate and multivariate models. Logistic regression modeling was performed to determine the association between each NHANES-OHIP measure, potential chewing difficulty, poverty and race/ethnicity using univariate and multivariate models. Linear regression modeling was performed to examine the association between composite NHANES-OHIP score, number of teeth, poverty and race/ethnicity. Linear regression was used as the sample size approximates normal distribution by the Central Limit Theorem (19). All regression models included both poverty and race/ethnicity. Analyses were adjusted for age (continuous variable, top-coded at 85 years in 2005–2006 and 80 years in 2007–2008), sex, education, marital status, health insurance, smoking status (never/former/current) and modified Charlson co-morbidity index score. Bonferroni correction was used to determine adjusted *P*-values for multiple hypothesis testing. For comparisons of self-rated oral health, OHQOL measured by composite NHANES-OHIP score, number of teeth and potential chewing difficulty, the calculated significant *P*-value was <0.0125. For comparisons of individual NHANES-OHIP measures, the calculated significant *P*-value was <0.007. Interactions were tested to examine if race/ethnicity modified the association between poverty status and oral health. Interaction terms between poverty status (living in poverty versus not living in poverty) and race/ethnicity (white, black, and Hispanic) were included in the previously discussed regression models. The examination sample weight calculated according to NHANES analytic guidelines was used for all survey analyses to account for the NHANES complex sampling design (6). STATA 12 (StataCorp LP, College Station, TX) survey procedures were used for all analyses.

## RESULTS

Table 1 describes the distribution of demographic characteristics and potential risk factors affecting oral health. The majority of the respondents were female (57.5%). Approximately 9% of respondents reported income <100% FPL, 8.5% were non-Hispanic black race and 5.9% were other Hispanic or Mexican ethnicity. Demographic characteristics and potential risk factors stratified by poverty status and race/ethnicity are shown in Table 2. Blacks and Hispanics comprised a greater proportion of older adults living in poverty compared to older adults not living in poverty.

Table 3 compares OHQOL and number of teeth in older adults by poverty status and racial/ethnic group. Older adults living in poverty reported worse OHQOL measures and had fewer teeth on examination compared to older adults not living in poverty. All minority racial/ethnic groups reported worse OHQOL measures and had fewer teeth on examination compared to their non-Hispanic white counterparts.

### Association of Poverty with OHQOL and Number of Teeth

Table 4 shows results from the multivariate regression models. For subjective oral health outcomes, poverty was significantly associated with higher composite NHANES-OHIP score indicating worse reported OHQOL but not worse reported self-rated oral health. Additionally, poverty was significantly associated with four of the seven individual NHANES-OHIP measures: 1) taste affected because of problems with teeth, mouth or dentures (theoretical domain: functional limitation; OR = 1.95, 95% CI 1.24–3.09,  $P = 0.004$ ); 2) uncomfortable to eat because of problems with teeth, mouth or dentures (theoretical domain: physical pain; OR = 1.60, 95% CI 1.15–2.24,  $P = 0.006$ ); 3) painful aching anywhere in the mouth (theoretical domain: physical pain; OR = 1.91, 95% CI 1.33–2.74,  $P < 0.001$ ); and 4) life less satisfying because of problems with teeth, mouth or dentures (theoretical domain: handicap; OR = 1.90, 95% CI 1.30–2.78,  $P = 0.001$ ). Poverty was not significantly associated with feeling self-conscious or embarrassed because of problems with teeth, mouth or dentures (theoretical domains: psychological discomfort and psychological disability; OR = 1.37, 95% CI 0.95–2.01,  $P = 0.104$ ); avoided food because of problems with teeth, mouth or dentures (theoretical domain: physical disability; OR = 1.47, 95% CI 1.04–2.08,  $P = 0.029$ ); or difficulty with job because of problems with teeth, mouth or denture (theoretical domain: social disability; OR = 2.15, 95% CI 1.09–4.25,  $P = 0.028$ ). For objective oral health outcomes, poverty was significantly associated with fewer teeth but not potential chewing difficulty.

### Association of Race/Ethnicity with OHQOL and Number of Teeth

Black and Hispanic older adults were more likely to report worse self-rated oral health compared to white older adults (Table 4). There were no significant associations between black race and composite NHANES-OHIP score or individual measures. Hispanic ethnicity was significantly associated with a higher composite NHANES-OHIP score indicating worse reported OHQOL compared to whites. This included one of the seven NHANES-OHIP measures: uncomfortable to eat because of problems with teeth, mouth or dentures (theoretical domain: physical pain; OR = 1.80, 95% CI 1.29–2.50,  $P = 0.001$ ).

Table 4 shows associations between number of teeth and potential chewing difficulty for non-Hispanic blacks and Hispanics. Non-Hispanic black older adults had 2.73-fold increased odds of potential chewing difficulty compared to non-Hispanic whites ( $P < 0.001$ ). Hispanic older adults did not have significantly increased odds of potential chewing difficulty compared to non-Hispanic whites ( $P = 0.375$ ). Multivariate linear regression models showed that black race was significantly associated with fewer teeth ( $P < 0.001$ ). Hispanic ethnicity was not significantly associated with more teeth compared to whites, though the  $\beta$ -coefficient was positive ( $P = 0.026$ ).

### Poverty and Race/Ethnicity Interactions

The interaction between poverty and race/ethnicity was examined for all outcomes. Hispanic ethnicity modified the association between poverty and potential chewing difficulty compared to white race in the logistic regression interaction model ( $P = 0.042$ ); black race did not modify the association between poverty and potential chewing difficulty. Black race and Hispanic ethnicity modified the association between poverty and number of permanent

teeth compared to white race (interaction coefficient = 3.13, 95% CI 0.12–6.15,  $P = 0.041$ ; interaction coefficient = 4.68, 95% CI 1.28–8.08,  $P = 0.007$ , respectively). No other significant interactions between poverty and race/ethnicity were found for all other OHQOL outcomes.

## DISCUSSION

The results of this study show that U.S. older adults living in poverty from 2005–2008 experienced disparities in both subjective and objective oral health outcomes compared to older adults not living in poverty. This supports a prior U.S. study that reported a higher prevalence of worse OHQOL and fewer teeth among older adults living in poverty compared to those not living in poverty from 1999–2004 (1). Our study showed that poverty is an independent predictor of worse OHQOL among U.S. older adults, but not for self-rated oral health. Our findings are similar to a prior study that reported economic barriers to dental care were associated with worse OHQOL measured by the Oral Impact on Daily Performance questionnaire among a cohort of mid-life to older adults in Sweden (20). However, these findings are different from prior studies that reported worse self-perceived oral health associated with lower income among adults in Canada (21), and mid-life and older adults in the UK (22); as well as another study that reported no association between socioeconomic status and OHQOL measured by the Geriatric Oral Health Assessment Index among Brazilian older adults (23). Further, we found that poverty was significantly associated with oral health-related functional limitation, physical pain and handicap. This is one of the first studies to our knowledge to report these OHQOL disparities among U.S. older adults living in poverty.

Disparities in both subjective and objective oral health outcomes also persisted among minority racial/ethnic older adults. Our study found that both black and Hispanic older adults had increased risk of worse self-rated oral health compared to white older adults. This is consistent with a prior study of U.S. older adults from 1999–2004 by Wu *et al.* (5), but different from a prior study of mid-life and older adults in New York City by Northridge *et al.* that reported only non-Hispanic black race was significantly associated with worse self-rated oral health compared to whites (24). This variation in findings is likely due to differences in study populations: both our study and Wu *et al.*'s study used a nationally representative population of U.S. older adults (5), while Northridge *et al.*'s study included mid-life and older adults from a smaller geographic area (24). Additionally, we found racial/ethnic differences in overall OHQOL measured by the NHANES-OHIP, with Hispanic older adults reporting worse OHQOL and oral health-related physical pain compared to white older adults, but not among black older adults. Two NHANES-OHIP items also showed a trend toward statistical significance among Hispanic older adults: oral health-related physical disability and handicap. These particular OHQOL racial/ethnic disparities are not previously reported to our knowledge, and may provide further insight into factors contributing to self-rated oral health among minority older adults.

Our findings also demonstrated that number of teeth alone does not determine self-rated oral health among minority racial/ethnic groups. Hispanic older adults were found to have more teeth than black older adults (Table 3), but also had significantly increased risk of worse

self-rated oral health and oral health-related physical pain compared to their white counterparts as previously discussed. Worse self-rated oral health among Hispanic older adults in this study may be explained by prior studies that reported that this ethnic group had fewer missing teeth, but more decayed teeth and fewer filled teeth (2, 3). Among black older adults, it is possible that number of teeth is regarded as the most important factor contributing to their OHQOL.

The variation in OHQOL among minority racial/ethnic groups suggests cultural differences in expectation regarding oral health with aging. A prior study of community-dwelling older adults in the Seattle, Washington area reported that white and black older adults felt that appearance of teeth was most important as an indicator for good oral health, while Hispanic older adults felt that good oral health was “freedom from disease” (25). This variation should be further studied to better understand what factors contribute to OHQOL among different minority racial/ethnic groups in order to develop targeted interventions to improve their oral health.

In our study, black older adults had fewer teeth compared to white older adults. This finding is consistent with prior studies by Griffin *et al.* (1), Dye *et al.* (2), and Wu *et al.* (3). Collectively, these three studies plus our study document persistent disparities in objective oral health in U.S. black older adults from 1988 through 2008. This sustained dentition disparity for black older adults may result from differences in dental care access and dental visits. Blacks across all age groups were previously reported to be less likely to visit the dentist than non-Hispanic whites (26). It is also possible that variations in oral health beliefs (e.g., benefits of preventive dental care and attitudes toward tooth extraction) continue to contribute to disparities in dentition for black older adults, though these cultural beliefs are not well studied (27). In contrast, the difference in the number of teeth was not statistically significant between Hispanic and white older adults (Table 4), but trended toward more teeth among Hispanics compared to white older adults. This finding supports prior studies by Dye *et al.* (2) and Wu *et al.* (3), which showed that Mexican-American older adults were more likely to have fewer missing teeth from 1988 through 2004. Although our study included non-Mexican Hispanic older adults, the fact that number of teeth did not significantly differ between Hispanic and white older adults also suggests that disparity in dental care access plays a role. Hispanics across all age groups were previously reported as less likely to have a dental visit than non-Hispanic whites (26). This may explain why Dye *et al.* and Wu *et al.* previously reported that Mexican-American older adults had more decayed teeth and fewer filled teeth (2, 3); those who did not visit a dentist were less likely to have indicated tooth extractions. The contribution of oral health beliefs in the diverse U.S. Hispanic population is also not well known (27), and likely contributes to any dentition differences compared to white older adults.

Further studies are needed to establish the factors associated with disparities in oral health outcomes among older adults, particularly in those living in poverty and from minority racial/ethnic groups. Understanding these factors, especially social determinants of health, may help develop and allocate resources to promote healthy aging and improve oral health outcomes in these older adult sub-populations in the U.S. Since oral health in later life is impacted by health and lifestyle over the life span (14), public oral health initiatives to



promote healthy aging directed at higher-risk groups are urgently needed. Furthermore, reducing oral health disparities would require multiple changes in the current U.S. health care system, including expanding dental insurance coverage and dental care access. Medicare only provides very limited coverage for dental care (28): nearly 70% of U.S. older adults were reported to have no dental insurance coverage in 2004 (26). Integration of oral health care into medical care is another possible way to reduce oral health disparities.

Study limitations are primarily due to survey data limitations, the cross-sectional study design and possibility of type I error. We were unable to account for dental care, as the NHANES 2005–2008 oral health questionnaire did not assess recent dental care as in prior years, dental insurance status, or oral hygiene habits (12). These factors were previously reported to affect oral health (26, 29, 30). We were also unable to account for lifetime dental care, which would affect dentition and overall oral health. There are differences in the size of the compared respondent groups that potentially influenced the statistical significance of our findings: 91% of the cohort were not living in poverty while 9% were living in poverty. Similarly, non-Hispanic whites comprised 85.5% of the cohort, while 14.4% were non-Hispanic blacks and Hispanics. However, this cohort distribution approximates the U.S. older adult population during 2005–2008 (31–35).

Despite the above limitations, this study contributes new findings: First, we used a nationally representative sample of community-dwelling older adults. Second, we also evaluated both poverty and race/ethnicity in our regression models, along with other factors that may affect oral health outcomes. Third, few studies have described OHQOL in conjunction with objective oral health outcomes. Our study adds to our knowledge of OHQOL disparities in the U.S. older adult population.

In conclusion, oral health disparities exist for U.S. older adults living in poverty and from minority racial/ethnic groups. We found that poverty was associated with both worse OHQOL and fewer teeth. OHQOL measured by NHANES-OHIP association varied by racial/ethnic group. Additional studies are needed to determine factors that contribute to OHQOL, particularly among different racial/ethnic groups. This information is needed to help determine how to effectively develop potential interventions to reduce oral health disparities among older adults.

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**Table 1**

Demographics and Potential Risk Factors Affecting Oral Health in U.S. Older Adults Aged 65 Years (N=2,745) (NHANES 2005–2008, weighted).

| Characteristic                                      | Value           |
|---|-----------------|
| Age, mean $\pm$ SE (years)                          | 73.9 $\pm$ 0.1  |
| Female sex (%)                                      | 57.5            |
| Race/ethnicity (%)                                  |                 |
| Non-Hispanic White                                  | 85.5            |
| Non-Hispanic Black                                  | 8.5             |
| Other Hispanic and Mexican                          | 5.9             |
| Education <high school (%)                          | 28.4            |
| Widowed/divorced/separated/never married (%)        | 43.0            |
| <100% federal poverty level (%)                     | 9.0             |
| Lack of health insurance (%)                        | 1.6             |
| Smoking status (%)                                  |                 |
| Never   | 47.8            |
| Former  | 42.7            |
| Current   | 9.5             |
| Modified Charlson co-morbidity index, mean $\pm$ SE | 1.11 $\pm$ 0.03 |

SE = standard error

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**Table 2** Sociodemographic Characteristics of U.S. Older Adults Aged 65 Years Stratified by Poverty Status and Race/Ethnicity (NHANES 2005–2008).

| Characteristic                                  | Poverty     | Not in poverty | P-value | White       | Black       | Hispanic    | P-value |
|---|-------------|----------------|---------|-------------|-------------|-------------|---------|
| Age, mean ± SE (years)                          | 74.1 ± 0.4  | 73.9 ± 0.2     | 0.64    | 74.1 ± 0.2  | 73.3 ± 0.3  | 72.6 ± 0.4  | <0.001  |
| Female sex (%)                                  | 64.2        | 56.9           | 0.02    | 57.4        | 60.3        | 54.3        | 0.31    |
| Race/ethnicity (%)                              |             |                | <0.001  | --          | --          | --          | --      |
| Non-Hispanic White                              | 60.1        | 88.0           |         | --          | --          | --          | --      |
| Non-Hispanic Black                              | 21.4        | 7.3            |         | --          | --          | --          | --      |
| Other Hispanic and Mexican-American             | 18.5        | 4.7            |         | --          | --          | --          | --      |
| Education <high school (%)                      | 60.4        | 25.3           | <0.001  | 23.4        | 52.1        | 65.7        | <0.001  |
| Widowed/divorced/separated/never married (%)    | 69.6        | 40.4           | <0.001  | 40.4        | 62.6        | 46.8        | <0.001  |
| <100% federal poverty level (%)                 | --          | --             | --      | 6.2         | 22.1        | 27.4        | <0.001  |
| Lack of health insurance (%)                    | 6.3         | 1.2            | <0.001  | 1.0         | 1.9         | 11.3        | <0.001  |
| Modified Charlson co-morbidity index, mean ± SE | 0.91 ± 0.08 | 1.13 ± 0.04    | 0.008   | 1.15 ± 0.04 | 1.02 ± 0.06 | 0.74 ± 0.06 | <0.001  |

SE = standard error

**Table 3**

Comparison of Oral Health Quality of Life and Number of Permanent Teeth in U.S. Older Adults Aged 65 Years Stratified by Poverty Status and Race/Ethnicity (NHANES 2005–2008, weighted).

| Outcome   | Total      | Living in Poverty |            | P-value* | Race/Ethnicity |            |            | P-value <sup>†</sup> |
|---|------------|-------------------|------------|----------|----------------|------------|------------|----------------------|
|   |            | Yes               | No         |          | White          | Black      | Hispanic   |                      |
| Fair/poor self-rated oral health (%)  | 31.6       | 48.3              | 30.0       | <0.001   | 28.8           | 45.8       | 51.8       | <0.001               |
| NHANES-OHIP score, mean ± SE  | 2.5 ± 0.1  | 4.3 ± 0.4         | 2.4 ± 0.1  | <0.001   | 2.4 ± 0.1      | 3.1 ± 0.2  | 3.8 ± 0.3  | <0.001 <sup>‡</sup>  |
| Taste affected because of problems with teeth, mouth or dentures (%) <sup>‡</sup> [Theoretical domain: Functional limitation]   | 5.0        | 12.0              | 4.2        | <0.001   | 4.3            | 7.1        | 8.2        | 0.0028               |
| Painful aching anywhere in mouth (%) <sup>‡</sup> [Theoretical domain: Physical pain]   | 14.2       | 23.6              | 13.3       | <0.001   | 13.0           | 19.9       | 18.4       | 0.0017               |
| Uncomfortable to eat because of problems with teeth, mouth or dentures (%) <sup>‡</sup> [Theoretical domain: Physical pain]   | 15.9       | 27.4              | 14.8       | <0.001   | 14.7           | 19.3       | 25.9       | 0.0006               |
| Self-conscious or embarrassed because of problems with teeth, mouth or dentures (%) <sup>‡</sup> [Theoretical domain: Psychological discomfort; Psychological disability] | 10.9       | 19.8              | 10.0       | <0.001   | 9.8            | 16.7       | 15.7       | 0.001                |
| Avoided food because of problems with teeth, mouth or dentures (%) <sup>‡</sup> [Theoretical domain: Physical disability]   | 17.2       | 27.3              | 16.2       | <0.001   | 15.9           | 19.7       | 26.1       | 0.0003               |
| Difficulty with job because of problems with teeth, mouth or dentures (%) <sup>‡</sup> [Theoretical domain: Social disability]  | 3.1        | 7.8               | 2.6        | <0.001   | 2.5            | 3.7        | 6.5        | <0.001               |
| Life less satisfying because of problems with teeth, mouth or dentures (%) <sup>‡</sup> [Theoretical domain: Handicap]  | 9.9        | 19.2              | 9.0        | <0.001   | 8.9            | 14.1       | 16.5       | 0.0006               |
| Number of permanent teeth, mean ± SE  | 15.6 ± 0.3 | 10.1 ± 0.7        | 16.1 ± 0.3 | <0.001   | 16.2 ± 0.3     | 10.6 ± 0.5 | 15.1 ± 0.7 | <0.001 <sup>‡</sup>  |
| <20 permanent teeth (%)   | 53.8       | 76.3              | 51.6       | <0.001   | 50.8           | 78.7       | 59.4       | <0.001               |

SE = standard error

NHANES-OHIP: National Health and Nutrition Examination Survey–Oral Health Impact Profile

\* Two-sided *t*-test or Chi-square test

<sup>†</sup> Analysis of variance (ANOVA)

<sup>‡</sup> Positive NHANES-OHIP response: Occasionally/fairly often/very often in past year

<sup>‡</sup> Bonferroni corrected *P*-value

**Table 4**  
Oral Health Outcomes Associated with Poverty and Race/Ethnicity in U.S. Older Adults (NHANES 2005–2008).

|                          | Fair/Poor Self-Rated Oral Health |                     | NHANES-OHIP Score                          |                    | Potential Chewing Difficulty (<20 Teeth) |                     | Number of Permanent Teeth                  |                     |
|--------------------------|----------------------------------|---------------------|--|--------------------|--|---------------------|--|---------------------|
|                          | Odds Ratio* (OR) (95% CI)        | P-value             | $\beta$ -coefficient <sup>†</sup> (95% CI) | P-value            | Odds Ratio* (OR) (95% CI)                | P-value             | $\beta$ -coefficient <sup>‡</sup> (95% CI) | P-value             |
| <b>Living in Poverty</b> |                                  |                     |  |                    |  |                     |  |                     |
| No                       | Reference                        | --                  | Reference                                  | --                 | Reference                                | --                  | Reference                                  | --                  |
| Yes                      | 1.39 (1.02–1.88)                 | 0.037               | 1.38 (0.62–2.13)                           | <0.001             | 1.58 (1.06–2.36)                         | 0.024               | -2.21 (-3.67, -0.76)                       | 0.003               |
| <b>Race/Ethnicity</b>    |                                  |                     |  |                    |  |                     |  |                     |
| White                    | Reference                        | --                  | Reference                                  | --                 | Reference                                | --                  | Reference                                  | --                  |
| Black                    | 1.75 (1.36–2.23)                 | <0.001 <sup>‡</sup> | 0.24 (-0.29–0.77)                          | 0.738 <sup>‡</sup> | 2.73 (1.98–3.79)                         | <0.001 <sup>‡</sup> | -3.06 (-4.26, -1.86)                       | <0.001 <sup>‡</sup> |
| Hispanic                 | 2.07 (1.51–2.84)                 | <0.001 <sup>‡</sup> | 0.95 (0.34–1.56)                           | 0.005 <sup>‡</sup> | 0.76 (0.51–1.14)                         | 0.375 <sup>‡</sup>  | 2.10 (0.45–3.75)                           | 0.026 <sup>‡</sup>  |

Analyses adjusted for age, sex, marital status, education, health insurance, modified Charlson co-morbidity index and smoking status

NHANES-OHIP: National Health and Nutrition Examination Survey–Oral Health Impact Profile

\* Results from logistic regression analyses

<sup>†</sup> Results from linear trend analyses

<sup>‡</sup> Bonferroni corrected P-value