Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

J Aging Health. Author manuscript; available in PMC 2016 April 09.

Published in final edited form as:

J Aging Health. 2016 February ; 28(1): 68–94. doi:10.1177/0898264315585505.

Racial/Ethnic and Socioeconomic Disparities in Hearing Health Care Among Older Americans

Carrie L. Nieman, MD, MPH[1,2], **Nicole Marrone, PhD, CCC-A**[3], **Sarah L. Szanton, PhD, ANP**[4,5,6], **Roland J. Thorpe Jr., PhD**[4,6], and **Frank R. Lin, MD, PhD**[1,4,6]

[1]Johns Hopkins School of Medicine, Baltimore, MD, USA

[2]The Johns Hopkins Center on Aging and Health, Baltimore, MD, USA

[3]Johns Hopkins Medical Institutions, Baltimore, MD, USA

[4]University of Arizona, Tucson, USA

[5]Johns Hopkins School of Nursing, Baltimore, MD, USA

[6]Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Abstract

Objective—Hearing impairment is highly prevalent, but little is known about hearing health care among older minority adults.

Method—We analyzed nationally representative, cross-sectional data from 1,544 older adults ≥70 years with audiometry and hearing care data from the 2005-2006 and 2009-2010 National Health and Nutritional Examination Surveys.

Results—After adjusting for age and speech frequency pure tone average, Blacks (odds ratio [OR] = 1.68, vs. Whites) and those with greater education (OR = 1.63, ≥college vs. <high school) were more likely to report recent hearing testing, while White older adults and those with greater socioeconomic status were more likely to report regular hearing aid use (all *p*s < .05). Based on a multivariate analysis, Blacks were not more likely than Whites to use hearing aids despite being more likely to have had recent hearing testing.

Discussion—Racial/ethnic and socioeconomic disparities exist in hearing health care and represent critical areas for research and intervention.

Keywords

hearing health care; minority health; health care disparities; hearing loss; older adults

Reprints and permissions: sagepub.com/journalsPermissions.nav

Corresponding Author: Frank R. Lin, Johns Hopkins Center on Aging and Health, Johns Hopkins Medical Institutions, 2024 E. Monument Street, Suite 2-700, Baltimore, MD 21205, USA. flin1@jhmi.edu.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Introduction

Age-related hearing impairment is highly prevalent and increases with age; more than two thirds of adults 75 years and older have a clinically significant hearing impairment (Lin, Thorpe, Gordon-Salant, & Ferrucci, 2011). Hearing impairment impacts the social, cognitive, and physical functioning of older adults in ways that are substantial and often underestimated and underappreciated. Hearing impairment is independently associated with depression (Cacciatore et al., 1999; Jones, Victor, & Vetter, 1984; Mulrow et al., 1990), anxiety (Jones et al., 1984), communication difficulties (Gopinath et al., 2012; Mulrow et al., 1990), social isolation (Pronk et al., 2011; Pronk et al., 2014), increased caregiver burden (Kuzuya & Hirakawa, 2009), use of community support (Schneider et al., 2010), poorer cognitive functioning (Cacciatore et al., 1999; Lin, Ferrucci, et al., 2011), accelerated cognitive decline (Lin et al., 2013), incident dementia (Lin et al., 2013), poorer physical functioning (Dalton et al., 2003), and increased falls (Viljanen et al., 2009). The mechanistic pathways potentially underlying these associations (e.g., poor verbal communication, cognitive load, social withdrawal) may be amenable to hearing loss treatment (Parham, Lin, Coelho, Sataloff, & Gates, 2013). Hearing aids, along with adequate counseling and education, generally form the foundation of a comprehensive approach to hearing health care, which have been associated with sustained improvements in social, emotional, and communicative function (Mulrow et al., 1990; Mulrow, Tuley, & Aguilar, 1992).

Hearing assessment is essential to the provision of hearing health care, yet currently there are no national guidelines for hearing testing among older adults (Moyer & U.S. Preventive Services Task Force, 2012). Consequently, only 15% of older adults receive hearing screening (Kochkin, 2009). Even when hearing impairment is identified, there is evidence of inadequate access to intervention services, such as counseling and hearing aids. Fewer than 20% of older adults with audiometrically confirmed hearing impairment use hearing aids (Gates, Cooper, Kannel, & Miller, 1990; Kochkin, 2009; Lin, Thorpe, et al., 2011; Popelka et al., 1998). Multiple factors have been suggested to account for low rates of hearing aid use, including the time- and resource-intensive process of assessment and fitting, the large financial investments to purchase devices without the assistance of insurance, including Medicare (Knudsen, Oberg, Nielsen, Naylor, & Kramer, 2010), a lack of public awareness and education about how to cope with the effects of hearing impairment (Carson & Pichora-Fuller, 1997; Knudsen et al., 2010), stigma (Wallhagen, 2010), low self-efficacy for use and care of hearing aids (Kricos, 2000), and inadequate and limited management of hearing impairment as part of general health care provision for older adults (Meyer & Hickson, 2012; Schneider et al., 2010). Furthermore, hearing loss and the use of hearing health care are best characterized in the literature among non-Hispanic Whites, with less research devoted to understanding patterns of hearing health care among underserved and minority populations (Cruickshanks et al., 1998; Gates et al., 1990; Nash et al., 2013).

Although well-documented disparities exist in health care based on race/ethnicity and socioeconomic status (SES; Agency for Healthcare Research and Quality, 2014; Centers for Disease Control and Prevention [CDC], 2013; Institute of Medicine, 2003, 2012), few studies explore the impact of race/ethnicity and SES on hearing health care and whether associated disparities exist in hearing testing and hearing aid use (Bainbridge &

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Ramachandran, 2014; Lee, Carlson, Lee, Ray, & Markides, 1991; Tomita, Mann, & Welch, 2001). Of the few studies that consider race/ethnicity, the authors demonstrate significant differences in rates of hearing aid use between minority and White older adults (10%-17.1% of minorities vs. 28.6%-35.4% of Whites), but the authors focus on hearing aid use, only one aspect of hearing health care, and do not examine the potential differential effects of socioeconomic factors on hearing health care by race/ethnicity (Bainbridge & Ramachandran, 2014; Lee et al., 1991; Tomita et al., 2001). Similarly, only a small number of studies examine SES, primarily defined by years of education and income level, and found inconsistent associations with hearing health care (Bainbridge & Ramachandran, 2014; Knudsen et al., 2010; Meyer & Hickson, 2012).

The objective of this study was to examine hearing health care disparities, specifically, recent hearing testing and regular hearing aid use, among older adults using nationally representative data and to explore whether the associations differ by race/ethnicity. Understanding the current state of knowledge surrounding diverse older adults' hearing health care will enable us to meet the National Institute on Deafness and Other Communication Disorders (NIDCD) and Healthy People 2020 objectives to improve hearing aid adoption rates and health equity through accessibility and affordability (Donahue, Dubno, & Beck, 2010; Healthy People, 2014).

Method

Study Cohort

The cohort included in this study was drawn from the 2005-2006 and 2009-2010 cycles of the National Health and Nutritional Examination Surveys (NHANES) during which audiometric testing was performed in all adults 70 years and older. NHANES is a nationally representative, cross-sectional study of Americans that measures a range of health, functional, and laboratory measures through interviews and physical examinations (Johnson et al., 2013). Sampling occurs through a multistage probability sample design that includes selective oversampling for underrepresented subgroups, such as ethnic minorities, low-income individuals, and adults 70 years and older. Survey weights allow for participant data to be generalized to the U.S. population (Johnson et al., 2013).

Audiometric Assessment

Trained technicians performed otoscopy and audiometry, including pure tone air conduction hearing thresholds, according to NHANES protocols using a mobile sound booth, an Interacoustics AD226 audiometer, supra-aural headphones (TDH-39P), and an automated test procedure (modified Hughson-Westlake procedure; *NHANES Audiometry*, 2006). Participants with hearing aids were asked to remove them and were tested without the assistance of their hearing aids (*NHANES Audiometry*, 2006). A manual test procedure was utilized when participants were unable to use the response switch or follow the automated protocol, had a high false positive response rate, or thresholds exceeded 100 dB (*NHANES Audiometry*, 2006). Insert earphones (EARtone 3A) were employed with suspected ear canal collapse or large differences in pure tone thresholds between ears (*NHANES Audiometry*, 2006). Equipment underwent routine calibration, and ambient noise was

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

monitored regularly to ensure acceptable standards for interpretation (*NHANES Audiometry*, 2006). Participant reliability was monitored through the use of a test–retest protocol at 1,000 Hz threshold (*NHANES Audiometry*, 2006). Pure tone thresholds were obtained from 0.5 to 8,000 Hz, starting at 1,000 Hz and integrated manual re-test thresholds when appropriate (*NHANES Audiometry*, 2006). The better hearing ear speech frequency pure tone average (PTA) from 0.5 to 4 kHz was used to define hearing. All hearing thresholds are reported as decibels Hearing Level (dBHL) (ANSI S3.6-2004), and classifications of hearing loss severity were based on the better hearing ear and American Speech-Language-Hearing Association guidelines but collapsed into fewer categories to assist with analysis (normal hearing ≤25 dB HL, mild loss >25 dB HL and ≤40 dB HL, moderate loss >40 dB HL and ≤70 dB HL, and severe loss >70 dB HL; (ANSI S3.6-2004) ; Clark, 1981).

Hearing Health Care Measures

The two primary outcomes were defined as recent hearing testing and, for those with hearing loss, regular hearing aid use. Recent hearing testing was defined by the participant reporting whether he or she had hearing testing within the past 4 years. Regular hearing aid use was defined by reported use of a hearing aid ≥5 hr a week in the past 12 months.

Variables Associated With Health Care Disparities

Demographic characteristics, insurance status, general health condition, and health care utilization were collected through interviews. Race/ethnicity was divided into non-Hispanic White (White), non-Hispanic Black (Black), and Mexican American. Given differences in oversampling between Hispanic subgroups across the 2005-2006 and 2009-2010 cycles, only Mexican Americans were included per National Center for Health Statistics (NCHS) recommendations (Johnson et al., 2013). Marital status was collapsed into a four-level variable (married/living with partner, widowed, divorced/separated, never married). Poverty income ratio (PIR) takes into account household size and was divided based on Supplemental Nutrition Assistance Program (SNAP) cut-off of 130% or 1.3 of the poverty line and used in place of household income (SNAP, 2013). Private insurance, Medicare, and Medicaid status were coded as binary variables. Medicare and Medicaid are publicly funded health insurance programs that provide coverage for older adults, 65 years and older, and low-income adults and children, respectively. Health care utilization was defined as the frequency of health care utilization in the past year and was re-coded as a four-level variable (none, 1-3, 4-9, 10 or more visits per year). Self-report general health was categorized as a five-level variable (excellent, very good, good, fair, or poor).

We also included data on noise exposure history and utilization of hearing protection into analyses given that these variables may markedly affect hearing thresholds and hearing health care. These variables include firearm use (“Have you ever used firearms for target shooting, hunting, or for any other purposes?”), occupational noise exposure (“Have you ever had a job where you were exposed to loud noise 5 or more hours a week?”), recreational noise exposure (“Outside of a job, have you ever been exposed to steady loud noise or music for 5 or more hours a week?”), and frequency of hearing protection use

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

("How often do you wear hearing protection devices when exposed to loud sounds or noise?"; *NHANES Audiometry Questionnaire*, 2009).

Statistical Analysis

Sampling weights were applied to all analyses according to NCHS guidelines, including Table 1, which represents the weighted demographic characteristics of the study cohort (Johnson et al., 2013). Differences in socioeconomic, health care, and hearing variables across racial/ethnic groups were investigated with the use of chi-square tests. Demographic variables along with variables related to SES, health care, and hearing were explored in association with the two primary outcomes, recent hearing testing and regular hearing aid use, through logistic regression models. For hearing aid analyses, only those individuals with better ear PTA > 25 dB were included in the analytic cohort.

A series of crude regression models were first explored, not only examining the association between each predictor variable (e.g., race/ethnicity, education, income) with the primary outcome (recent hearing testing or regular hearing aid use) but also adjusting for age and degree of hearing impairment (PTA) in all models (because these variables are known to be highly correlated with both outcomes). Age was adjusted for as an ordinal variable (70-74, 75-79, 80+) and could not be adjusted for as a continuous variable because individuals in the 2009-2010 cycle who were >80 years were coded as being 80 years for privacy reasons (*NHANES 2009-2010 Data Documentation*, 2011). We next performed a multivariate logistic regression that included age, hearing impairment, and all predictor variables from the crude logistic regression models that had two-tailed $p \leq .1$.

Last, crude and multivariate models of the primary outcome, recent hearing testing, were stratified by race/ethnicity to assess potential differential factors between White, Black, and Mexican American older adults. Similar to the approach used for variable selection in the multivariate models involving the cohort as a whole, variables in the stratified models were selected based on whether the individual predictor approached statistical significance in the crude models (two-tailed $p \leq .1$). Multivariate logistic regression models, stratified by race/ethnicity, included age, PTA, and all variables with two-tailed $p \leq .1$ in the crude models. Following NCHS guidelines, we utilized the Taylor Series Linearization method (Johnson et al., 2013). All analyses were conducted using SAS 9.3 (SAS, Cary, North Carolina). Statistical significance was defined as two-tailed $p < .05$.

Results

Study Cohort

Characteristics of adults 70 years or older in the United States who are White, Black, or Mexican American are presented in Table 1. Whites, Blacks, and Mexican Americans differed across socioeconomic, health care–, and hearing-related variables. Compared with Whites, the minority groups were generally younger, a larger proportion were widowed, had less education, lower income levels, lower PIR, lower rates of private insurance coverage, and worse reported general health. Of note, greater than 60% of Mexican Americans had a less than high school education, and almost half of Blacks and Mexican Americans had less

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

than US$25,000 in annual household income. Black older adults had a lower better ear speech PTA compared with White and Mexican American older adults, but there was no significant difference in reported rates of occupational or recreational noise exposure by race/ethnicity.

Recent Hearing Testing

In the crude models, adjusted for age and hearing thresholds, recent hearing testing was more common among Blacks (odds ratio [OR] = 1.68, 95% CI [1.21, 2.33], relative to Whites) and individuals with higher education (some college or associate degree, OR = 1.85, 95% CI [1.26, 2.72]; college graduate or higher, OR = 1.63, 95% CI [1.05, 2.52], relative to individuals with less than a high school education). Older adults with poorer self-reported health had a lower odds of reporting recent hearing testing (OR = 0.62, 95% CI [0.35, 1.07]; Table 2). In the multivariate model controlling for age, degree of hearing impairment, marital status, and self-report health condition, recent hearing testing remained associated with race/ethnicity (Blacks OR = 2.09, 95% CI [1.45, 3.00]; Mexican Americans OR = 1.56, 95% CI [0.93, 2.63], compared with Whites) and higher education (Table 2).

Regular Hearing Aid Use

Among adults of similar age and with the same hearing, individuals who were Black (OR = 0.42, 95% CI [0.19, 0.91]) or Mexican American (OR = 0.22, 95% CI [0.06, 0.74]) had a lower odds, on average, of using hearing aids than Whites (Table 2). In these same crude models, adjusted for age and hearing, regular hearing aid use was significantly associated with higher education, higher PIR, and being privately insured. Older adults with recreational noise exposure (OR = 2.07, 95% CI [1.25, 3.42]) and those who more frequently utilized hearing protection had a greater odds of using hearing aids regularly. In the multivariate model accounting for age, hearing loss, PIR, insurance status, health condition, firearm use, recreational noise exposure, and frequency of hearing protection use, education remained significantly associated with regular hearing aid use (high school graduate: OR = 2.41, 95% CI [1.05, 5.52]; some college or associate degree: OR = 2.64, 95% CI [1.15, 6.06]; college graduate or higher: OR = 2.77, 95% CI [0.90, 8.51], compared with those with less than a high school education). In the same multivariate model, race was not associated with hearing aid use (Blacks: OR = 0.77, 95% CI [0.31, 1.90]; Mexican Americans: OR = 0.37, 95% CI [0.10, 1.36], compared with Whites).

Hearing Health Care Behaviors by Race/Ethnicity

To understand factors that may uniquely contribute to hearing health care behaviors within different racial/ethnic groups, analyses of hearing testing were stratified by racial/ethnic group (race/ethnicity-stratified analyses for hearing aid use were not possible because of the limited number of individuals reporting hearing aid use in Blacks and Mexican Americans; Table 3). In multivariate models stratified by race/ethnicity, factors significantly associated with hearing testing use differed among Whites, Blacks, and Mexican Americans. On average, we observed that among Whites, marital status and higher education were positively and significantly associated with hearing testing, similar to the group analysis. Among Blacks, receiving Medicaid and reporting lower general health were negatively associated with hearing testing, while high rates of health care utilization were positively

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

associated. For Mexican Americans, higher education and receiving Medicare were positively associated with recent hearing testing (Table 3).

Discussion

In this nationally representative study of older Americans, Black older adults were more likely than Whites to report recent hearing testing. On average, we observed that Blacks were twice as likely to report recent hearing testing than Whites based on a multivariate model, controlling for age, hearing loss, marital status, education, and self-report health. This finding is in contrast to documented disparities in preventive health services among older adults based on race/ethnicity (Chen, Diamant, Pourat, & Kagawa-Singer, 2005; Lees, Wortley, & Coughlin, 2005). However, despite higher rates of recent hearing testing, we found that minority older adults were less likely to use hearing aids than Whites. Among older Americans with hearing loss, Black older adults were 58% and Mexican American older adults were 78% less likely than White older adults to report regular hearing aid use after controlling for age and degree of hearing impairment. These findings highlight a discrepancy between diagnostic testing and treatment in the provision of hearing health care services to minority older adults.

A surprising and unanticipated finding in our results is that Blacks were more likely than Whites to have had recent hearing testing. The basis of this observation is unknown and will require further confirmation given the relatively small sample size of minorities in the present cohort. Speculatively, there are several possible explanations for this observation. One possibility is that Medicare coverage is almost universal among older Americans and includes coverage of audiometric testing. Medicare attenuates disparities in health care utilization for services covered by Medicare by minimizing the effect of economic access variables (e.g., education, income, wealth, health insurance; Dunlop, Manheim, Song, & Chang, 2002; Shih, Zhao, & Elting, 2006; also Dunlop et al., 2002; Shih et al., 2006). For example, rates of vision care, which is similar to hearing testing in its coverage by Medicare, do not differ among older adults by race/ethnicity (Chou et al., 2012). Another explanation may be differences in physician referral rates by race/ethnicity, which may affect referrals for a range of services, from preventive care to invasive procedures (Goulart et al., 2013; LaVeist, Morgan, Arthur, Plantholt, & Rubinstein, 2002).

Differential access to specialists due to geographic access may also account for differences in recent hearing testing by race/ethnicity. Similar to hearing health care, access to oral health care relies on the ability of older adults to access specialists without the assistance of Medicare and differences in rates of oral health care between urban and rural older adults exist (Vargas, Yellowitz, & Hayes, 2003). The majority of Blacks live in metropolitan areas with potentially greater access to specialized care (Agency for Healthcare Research and Quality, 2014; McKinnon, 2003). An additional contributor to higher rates of hearing testing may be secondary to concentrated efforts to provide hearing testing through community- or occupation-based testing programs in underserved communities. Alternatively, Black older adults may be more likely to report recent hearing testing compared with Whites if they delayed hearing testing until after obtaining Medicare coverage. Among previously uninsured older adults, who are more likely to be a minority, have less education, and lower

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

income, Medicare coverage increases the use of covered services, number of doctor visits, hospitalizations, and total medical expenditures (McWilliams, Meara, Zaslavsky, & Ayanian, 2007; McWilliams, Zaslavsky, Meara, & Ayanian, 2003).

Finally, intrinsic factors, such as stigma, may also influence an individual's pursuit of hearing testing. African Americans may experience less stigma and more readily obtain hearing testing based on physician referral. Several studies have documented lower rates of stigma surrounding depression and willingness to seek care among African Americans compared with Whites, but the differential experience of stigma by race/ethnicity has not been fully explored around hearing testing (Diala et al., 2001; Givens, Katz, Bellamy, & Holmes, 2007; Wallhagen, 2010).

Our results also demonstrate that factors associated with recent hearing testing varied by race/ethnicity. For White older adults, higher education was associated with recent hearing testing, which is consistent with prior studies and other preventive services, such as vision care (Chou et al., 2012; Helvik, Wennberg, Jacobsen, & Hallberg, 2008; Popelka et al., 1998). Among Black older adults, recent hearing testing was associated with higher rates of health care utilization, which may reflect individuals who have greater access to care. However, Medicaid coverage was negatively associated with recent screening for Black older adults and reflects similar findings of lower rates of preventive health services among older adults covered by Medicaid compared with those covered by supplemental private insurance (Chen et al., 2005). This finding contrasts with prior studies that found older adults with Medicaid were almost twice as likely to make physician visits and use hospital services as compared with older adults without Medicaid (Lum & Chang, 1998). Among Mexican American older adults, higher education and Medicare coverage were associated with recent hearing testing. Medicare coverage may reflect a higher degree of acculturation and access to care given associated citizenship requirements for Medicare coverage. The differential factors associated with hearing testing by race/ethnicity emphasize the need to approach hearing health care with an understanding of the unique barriers and facilitators that affect older adults' use to hearing health care.

Besides race/ethnicity, regular hearing aid use was strongly associated with disparities-related variables (including education, PIR, and private insurance) and several hearing-related variables (recreational noise exposure and frequency of hearing protection use). Economic access factors significantly affect health care utilization for services not covered by Medicare, such as dental care and hearing aids, and perpetuate disparities in health care utilization among minority older adults (Dunlop et al., 2002). Several prior studies explored factors associated with help seeking and hearing aid uptake such as race/ethnicity, education, and income, and produced inconsistent results (Knudsen et al., 2010; Meyer & Hickson, 2012). A few studies demonstrated minority older adults are less likely than Whites to use hearing aids (Bainbridge & Ramachandran, 2014; Tomita et al., 2001). Popelka et al. showed a significant association between education beyond 12 years and hearing aid use among American adults, which Helvik et al. also demonstrated among Norwegian adults with greater than 13 years of education (Helvik et al., 2008; Popelka et al., 1998). Previous NHANES studies from the 1980s report lower income as a predictor of hearing aid use among Mexican Americans with no effect of education or insurance status, which may

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

reflect changes in Medicaid coverage of hearing aids (Lee, Gomez-Marin, & Lee, 1996). However, several other studies found education and income to have no effect on hearing aid uptake (Gussekloo et al., 2003; Humes, Wilson, & Humes, 2003; Knudsen et al., 2010; Kochkin, 2009; Meyer & Hickson, 2012). Overall, race/ethnicity has seldom been investigated as a factor in help seeking and hearing aid uptake, and, when SES was included, the concept was narrowly defined by education, income, and/or self-reported ability of income to meet needs. Furthermore, most prior studies primarily consist of White older adults (Cruickshanks et al., 1998; Gates et al., 1990; Nash et al., 2013).

When controlling for disparities-related variables (e.g., education, PIR) in the multivariate model, minority older adults were not significantly less likely to use hearing aids despite obtaining significant results when only age and hearing impairment were included in the crude model. However, such analyses must be interpreted with caution given the relatively small sample size of minority adults in NHANES. Combining the 2005-2006 and 2009-2010 cohorts, there were 152 Mexican American older adults and 227 Black older adults compared with 1,165 White older adults. The relatively small sample of minority adults limited analyses, particularly when stratifying by race/ethnicity. Although statistically significant, some estimates were unstable due to the small sample of Mexican American and Black older adults, as illustrated by insurance subtype. For analyses of regular hearing aid use, the sample size further decreased given the focus on hearing impaired older adults. For example, there were only 10 Black older adults and 11 Mexican American older adults who wore hearing aids regularly.

A more nuanced approach to investigating the association between race/ethnicity and SES is needed within the field of hearing health care. Race/ethnicity is confounded by SES, and small sample sizes, as seen in this study, preclude robust statistical inferences. Current approaches to disparities research also fail to capture racial segregation as a determinant of social and environmental risk exposures (Laveist, Thorpe, Mance, & Jackson, 2007). Multivariate modeling, as utilized in this study, is a commonly used approach to account for the effects of race/ethnicity and SES (Laveist et al., 2007; Thorpe, Brandon, & LaVeist, 2008) but may be insufficient to draw valid conclusions, given small sample sizes (n = 10-11 for regular hearing aid use among minority older adults) and the inability to account for residual confounding by factors associated with racial segregation (e.g., differences in infrastructure, living conditions, and life chances; LaVeist, 2003; Laveist et al., 2007).

The primary limitation of this study is the small sample size of minority older adults with hearing impairment, which limited analysis and the generalizability of results. Another potential limitation of this study is that recent hearing testing and regular hearing aid use are based on self-report. Subjective self-report could bias results by overestimating an individual's use of hearing aids given social desirability, but studies have documented that users may either overestimate or underestimate use (Maki-Torkko, Sorri, & Laukli, 2001; Taubman, Palmer, Durrant, & Pratt, 1999). Measures in NHANES also do not capture the effects of racial segregation, leaving social and environmental factors that may impact recent hearing testing and regular hearing aid use among minority older adults unaccounted for and unaddressed. This exclusion impacts our ability to measure the true effect of race/ethnicity on recent hearing testing and regular hearing aid use.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Conclusion

Our findings demonstrate that race/ethnicity and socioeconomic factors, such as education, PIR, and insurance status, are associated with hearing health care disparities among older adults. Further research to elucidate differences in hearing testing, help seeking, and hearing aid uptake based on race/ethnicity and SES is critical because of the growing populations of minority older adults. This study underscores the need for research on hearing health care that accounts for the effects of race/ethnicity and SES to inform the future development of tailored hearing health care interventions.

Acknowledgments

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention, sponsors the NHANES. The NHANES hearing data are funded through generous support from the National Institute on Deafness and Other Communication Disorders (including an interagency agreement with the National Institute for Occupational Safety and Health for training health technicians to perform audiometry), National Institute on Aging, and NCHS. The authors were supported by a Resident Research Grant from the American Academy of Otolaryngology–Head and Neck Surgery (C.L.N.), the National Institute on Deafness and Other Communication Disorders (T32 DC000027, C.L.N.; K23DC011279, F.R.L.; R21DC013681, N.M.), a Triological Society/American College of Surgeons Clinician Scientist Award (F.R.L.), and the Eleanor Schwartz Charitable Foundation (F.R.L.).

References

Agency for Healthcare Research and Quality. Priority Populations. Rockville, MD.: 2014. 2013 National Healthcare Disparities Report.. AHRQ Publication No. 14-0005

Bainbridge KE, Ramachandran V. Hearing aid use among older U.S. adults: The National Health and Nutrition Examination Survey, 2005-2006 and 2009-2010. Ear and Hearing. 2014; 35:289–294. doi: 10.1097/01.aud. 0000441036.40169.29. [PubMed: 24521924]

Cacciatore F, Napoli C, Abete P, Marciano E, Triassi M, Rengo F. Quality of life determinants and hearing function in an elderly population: Osservatorio geriatrico campano study group. Gerontology. 1999; 45:323–328. [PubMed: 10559650]

Carson AJ, Pichora-Fuller MK. Health promotion and audiology: The community-clinic. Journal of the Academy of Rehabilitation Audiology. 1997; 30:29–51.

Centers for Disease Control and Prevention. CDC Health Disparities and Inequalities Report—United States. MMWR Supplements. 2013; 62(Suppl. 3):1–187.

Chen JY, Diamant A, Pourat N, Kagawa-Singer M. Racial/ethnic disparities in the use of preventive services among the elderly. American Journal of Preventive Medicine. 2005; 29:388–395. [PubMed: 16376701]

Chou CF, Barker LE, Crews JE, Primo SA, Zhang X, Elliott AF, Saaddine JB. Disparities in eye care utilization among the United States adults with visual impairment: Findings from the behavioral risk factor surveil-lance system 2006-2009. American Journal of Ophthalmology. 2012; 154(6 Suppl.):S45–52. e1. doi:10.1016/j.ajo.2011.09.025. [PubMed: 23158223]

Clark JG. Uses and abuses of hearing loss classification. ASHA. 1981; 23:493–500. [PubMed: 7052898]

Cruickshanks KJ, Wiley TL, Tweed TS, Klein BEK, Klein R, Mares-Perlman J, Nondahl DM. Prevalence of hearing loss in older adults in Beaver Dam, Wisconsin: The epidemiology of hearing loss study. American Journal of Epidemiology. 1998; 148:879–886. [PubMed: 9801018]

Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl DM. The impact of hearing loss on quality of life in older adults. The Gerontologist. 2003; 43:661–668. [PubMed: 14570962]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Diala CC, Muntaner C, Walrath C, Nickerson K, LaVeist T, Leaf P. Racial/ethnic differences in attitudes toward seeking professional mental health services. American Journal of Public Health. 2001; 91:805–807. [PubMed: 11344893]

Donahue A, Dubno JR, Beck L. Guest editorial: Accessible and affordable hearing health care for adults with mild to moderate hearing loss. Ear and Hearing. 2010; 31:2–6. doi:10.1097/AUD.0b013e3181cbc783. [PubMed: 20040828]

Dunlop DD, Manheim LM, Song J, Chang RW. Gender and ethnic/ racial disparities in health care utilization among older adults. The Journals of Gerontology, Series B: Psychological Sciences & Social Sciences. 2002; 57:S221–S233.

Gates GA, Cooper JC Jr. Kannel WB, Miller NJ. Hearing in the elderly: The Framingham cohort, 1983-1985. Part I. basic audiometric test results. Ear and Hearing. 1990; 11:247–256. [PubMed: 2210098]

Givens JL, Katz IR, Bellamy S, Holmes WC. Stigma and the acceptability of depression treatments among African Americans and Whites. Journal of General Internal Medicine. 2007; 22:1292–1297. doi:10.1007/s11606-007-0276-3. [PubMed: 17610120]

Gopinath B, Hickson L, Schneider J, McMahon CM, Burlutsky G, Leeder SR, Mitchell P. Hearing-impaired adults are at increased risk of experiencing emotional distress and social engagement restrictions five years later. Age and Ageing. 2012; 41:618–623. doi:10.1093/ageing/afs058. [PubMed: 22591986]

Goulart BH, Reyes CM, Fedorenko CR, Mummy DG, Satram-Hoang S, Koepl LM, Ramsey SD. Referral and treatment patterns among patients with stages III and IV non-small-cell lung cancer. Journal of Oncology Practice. 2013; 9:42–50. doi:10.1200/JOP.2012.000640. [PubMed: 23633970]

Gussekloo J, de Bont LE, von Faber M, Eekhof JA, de Laat JA, Hulshof JH, Westendorp RG. Auditory rehabilitation of older people from the general population—The Leiden 85-plus study. The British Journal of General Practice: The Journal of the Royal College of General Practitioners. 2003; 53:536–540. [PubMed: 14694666]

Healthy People. Hearing and Other Sensory or Communication Disorders. 2014. Retrieved from http://healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=20

Helvik A, Wennberg S, Jacobsen G, Hallberg LR. Why do some individuals with objectively verified hearing loss reject hearing aids? Audiological Medicine. 2008; 6:141–148. doi:10.1080/16513860802178692.

Humes LE, Wilson DL, Humes AC. Examination of differences between successful and unsuccessful elderly hearing aid candidates matched for age, hearing loss and gender. International Journal of Audiology. 2003; 42:432–441. [PubMed: 14582640]

Institute of Medicine. Unequal treatment: Confronting racial and ethnic disparities in health Care. The National Academies Press; Washington, DC: 2003.

Institute of Medicine. How far have we come in reducing health disparities? Progress since 2000: Workshop summary. The National Academies Press; Washington, DC: 2012.

Johnson CL, Paulose-Ram R, Ogden CL, Carroll MD, Kruszon-Moran D, Dohrmann SM, Curtin LR. National health and nutrition examination survey: Analytic guidelines, 1999-2010. Vital and Health Statistics. Series 2, Data Evaluation and Methods Research. 2013; 161:1–24.

Jones DA, Victor CR, Vetter NJ. Hearing difficulty and its psychological implications for the elderly. Journal of Epidemiology & Community Health. 1984; 38:75–78. [PubMed: 6231351]

Knudsen LV, Oberg M, Nielsen C, Naylor G, Kramer SE. Factors influencing help seeking, hearing aid uptake, hearing aid use and satisfaction with hearing aids: A review of the literature. Trends in Amplification. 2010; 14:127–154. doi:10.1177/1084713810385712. [PubMed: 21109549]

Kochkin S. MarkeTrak VIII: 25 year trends in the hearing health market. The Hearing Review. 2009; 16:12–31.

Kricos PB. The influence of nonaudiological variables on audiological rehabilitation outcomes. Ear and Hearing. 2000; 21(4 Suppl.):7S–14S. [PubMed: 10981590]

Kuzuya M, Hirakawa Y. Increased caregiver burden associated with hearing impairment but not vision impairment in disabled community-dwelling older people in Japan. Journal of the American

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Geriatrics Society. 2009; 57:357–358. doi:10.1111/j.1532-5415.2009.02116.x. [PubMed: 19207154]

LaVeist TA. Racial segregation and longevity among African Americans: An individual-level analysis. Health Services Research. 2003; 38(6, Pt. 2):1719–1733. [PubMed: 14727794]

LaVeist TA, Morgan A, Arthur M, Plantholt S, Rubinstein M. Physician referral patterns and race differences in receipt of coronary angiography. Health Services Research. 2002; 37:949–962. [PubMed: 12236392]

Laveist TA, Thorpe RJ Jr. Mance GA, Jackson J. Overcoming confounding of race with socio-economic status and segregation to explore race disparities in smoking. Addiction. 2007; 102(Suppl. 2):65–70. [PubMed: 17850615]

Lee DJ, Carlson DL, Lee HM, Ray LA, Markides KS. Hearing loss and hearing aid use in Hispanic adults: Results from the Hispanic health and nutrition examination survey. American Journal of Public Health. 1991; 81:1471–1474. [PubMed: 1951805]

Lee DJ, Gomez-Marin O, Lee HM. Sociodemographic correlates of hearing loss and hearing aid use in Hispanic adults. Epidemiology. 1996; 7:443–446. [PubMed: 8793375]

Lees KA, Wortley PM, Coughlin SS. Comparison of racial/ethnic disparities in adult immunization and cancer screening. American Journal of Preventive Medicine. 2005; 29:404–411. [PubMed: 16376703]

Lin FR, Ferrucci L, Metter EJ, An Y, Zonderman AB, Resnick SM. Hearing loss and cognition in the Baltimore longitudinal study of aging. Neuropsychology. 2011; 25:763–770. doi:10.1037/a0024238. [PubMed: 21728425]

Lin FR, Thorpe R, Gordon-Salant S, Ferrucci L. Hearing loss prevalence and risk factors among older adults in the United States. The Journals of Gerontology, Series A: Biological Sciences & Medical Sciences. 2011; 66:582–590. doi:10.1093/gerona/glr002.

Lin FR, Yaffe K, Xia J, Xue QL, Harris TB, Purchase-Helzner E, Simonsick EM. Hearing loss and cognitive decline in older adults. JAMA Internal Medicine. 2013; 173:293–299. doi:10.1001/jamainternmed.2013.1868. [PubMed: 23337978]

Lum Y, Chang H. The effect of Medicaid coverage on use of health services by low-income elderly people. Social Work Research. 1998; 22(1):31–43.

Maki-Torkko EM, Sorri MJ, Laukli E. Objective assessment of hearing aid use. Scandinavian Audiology. 2001; 30:81–82. doi:10.1080/010503901300007146. [PubMed: 11318492]

McKinnon, J. The Black population in the United States: March 2002 (Current Population Reports No. P20-541). U.S. Census Bureau; Washington, DC: 2003.

McWilliams JM, Meara E, Zaslavsky AM, Ayanian JZ. Use of health services by previously uninsured Medicare beneficiaries. The New England Journal of Medicine. 2007; 357:143–153. [PubMed: 17625126]

McWilliams JM, Zaslavsky AM, Meara E, Ayanian JZ. Impact of Medicare coverage on basic clinical services for previously uninsured adults. The Journal of the American Medical Association. 2003; 290:757–764. doi:10.1001/jama.290.6.757. [PubMed: 12915428]

Meyer C, Hickson L. What factors influence help-seeking for hearing impairment and hearing aid adoption in older adults? International Journal of Audiology. 2012; 51:66–74. doi:10.3109/14992027.2011.611178. [PubMed: 22256793]

Moyer VA, U.S. Preventive Services Task Force. Screening for hearing loss in older adults: U.S. preventive services task force recommendation statement. Annals of Internal Medicine. 2012; 157:655–661. [PubMed: 22893115]

Mulrow CD, Aguilar C, Endicott JE, Tuley MR, Velez R, Charlip WS, DeNino LA. Quality-of-life changes and hearing impairment. A randomized trial. Annals of Internal Medicine. 1990; 113:188–194. [PubMed: 2197909]

Mulrow CD, Tuley MR, Aguilar C. Sustained benefits of hearing aids. Journal of Speech and Hearing Research. 1992; 35:1402–1405. [PubMed: 1494282]

Nash SD, Cruickshanks KJ, Huang GH, Klein BE, Klein R, Nieto FJ, Tweed TS. Unmet hearing health care needs: The Beaver Dam off-spring study. American Journal of Public Health. 2013; 103:1134–1139. doi:10.2105/ AJPH.2012.301031. [PubMed: 23597370]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

National Health and Nutrition Examination Survey (NHANES). Audiometry Procedures Manual. CDC/National Center for Health Statistics; Hyattsville, MD: 2006. Retrieved from http://www.cdc.gov/nchs/data/nhanes/nhanes_05_06/AU.pdf

National Health and Nutrition Examination Survey 2005-2006 Data Documentation, Codebook, and Frequencies. Audiometry Questionnaire. 2009. Retrieved from http://www.cdc.gov/nchs/nhanes/nhanes2005-2006/AUQ_D.htm

National Health and Nutrition Examination Survey 2009-2010 Data Documentation, Codebook, and Frequencies. Demographic Variables and Sample Weights. 2011. Retrieved from http://wwwn.cdc.gov/nchs/nhanes/2009-2010/DEMO_F.htm#Analytic_Notes

Parham K, Lin FR, Coelho DH, Sataloff RT, Gates GA. Comprehensive management of presbycusis: Central and peripheral. Otolaryngology-Head and Neck Surgery: Official Journal of American Academy of Otolaryngology-Head and Neck Surgery. 2013; 148:537–539. doi:10.1177/0194599813477596. [PubMed: 23396589]

Popelka MM, Cruickshanks KJ, Wiley TL, Tweed TS, Klein BE, Klein R. Low prevalence of hearing aid use among older adults with hearing loss: The epidemiology of hearing loss study. Journal of the American Geriatrics Society. 1998; 46:1075–1078. [PubMed: 9736098]

Pronk M, Deeg DJ, Smits C, Twisk JW, van Tilburg TG, Festen JM, Kramer SE. Hearing loss in older persons: Does the rate of decline affect psychosocial health? Journal of Aging and Health. 2014; 26:703–723. [PubMed: 24788715]

Pronk M, Deeg DJ, Smits C, van Tilburg TG, Kuik DJ, Festen JM, Kramer SE. Prospective effects of hearing status on loneliness and depression in older persons: Identification of subgroups. International Journal of Audiology. 2011; 50:887–896. doi:10.3109/14992027.2011.599871. [PubMed: 21929374]

Schneider J, Gopinath B, Karpa MJ, McMahon CM, Rochtchina E, Leeder SR, Mitchell P. Hearing loss impacts on the use of community and informal supports. Age and Ageing. 2010; 39:458–464. doi:10.1093/ageing/afq051. [PubMed: 20516258]

Shih YC, Zhao L, Elting LS. Does Medicare coverage of colonoscopy reduce racial/ethnic disparities in cancer screening among the elderly? Health Affairs (Project Hope). 2006; 25:1153–1162. [PubMed: 16835198]

Taubman LB, Palmer CV, Durrant JD, Pratt S. Accuracy of hearing aid use time as reported by experienced hearing aid wearers. Ear and Hearing. 1999; 20:299–305. [PubMed: 10466566]

Thorpe RJ Jr. Brandon DT, LaVeist TA. Social context as an explanation for race disparities in hypertension: Findings from the Exploring Health Disparities in Integrated Communities (EHDIC) study. Social Science & Medicine. 2008; 67:1604–1611. doi:10.1016/j.socscimed.2008.07.002. [PubMed: 18701200]

Tomita M, Mann WC, Welch TR. Use of assistive devices to address hearing impairment by older persons with disabilities. International Journal of Rehabilitation Research. 2001; 24(4):279–290. [PubMed: 11775032]

Department of Agriculture, US. Supplemental Nutrition Assistance Program (SNAP): Eligibility. 2013. Retrieved from http://www.fns.usda.gov/snap/eligibility

Vargas CM, Yellowitz JA, Hayes KL. Oral health status of older rural adults in the United States. Journal of the American Dental Association. 2003; 134:479–486. [PubMed: 12733783]

Viljanen A, Kaprio J, Pyykkö I, Sorri M, Pajala S, Kauppinen M, Rantanen T. Hearing as a predictor of falls and postural balance in older female twins. The Journals of Gerontology, Series A: Biological Sciences & Medical Sciences. 2009; 64A:312–317.

Wallhagen MI. The stigma of hearing loss. The Gerontologist. 2010; 50:66–75. doi:10.1093/geront/gnp107. [PubMed: 19592638]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

J Aging Health. Author manuscript; available in PMC 2016 April 09.

Table 1

Population Characteristics by Race/Ethnicity of Americans 70 Years of Age and Older (n = 1,544).

	Overall (n = 1,544)	**White (n = 1,165)**	**Black (n = 227)**	**Mexican American (n = 152)**	***p***
Demographics	%	%	%	%	
Age, mean years [CI]	76.08 [75.82, 76.35]	76.20 [75.91, 76.49]	75.24 [74.72, 75.75]	75.18 [74.50, 75.86]	<.001
Age categories, years					<.001
70 to 74	38.14	36.92	46.34	49.69	
75 to 79	27.18	26.97	31.95	22.52	
80+	34.67	36.11	21.71	27.79	
Sex, n (%)					.79
Female	58.03	57.83	59.87	58.72	
Marital status					<.001
Married/living with partner	57.08	59.45	36.71	43.70	
Widowed	32.87	31.57	41.00	46.19	
Divorced/separated	8.14	7.09	20.27	7.83	
Never married	1.91	1.88	2.03	2.28	
Education					
Less than high school	11.79	9.06	18.41	60.69	<.001
Some high school	15.73	14.64	30.20	11.49	
High school graduate	29.36	30.56	24.22	12.29	
Some college or associates degree	23.68	24.52	20.30	11.42	
College graduate or above	19.44	21.22	6.87	4.11	
Annual household income					<.001
<US$25,000	32.93	31.12	45.44	49.57	
US$25,000 to <US$55,000	37.88	38.40	36.05	29.57	
US$55,000 and above	21.59	22.90	12.47	9.60	
Don't know/refused	7.60	7.58	6.04	11.27	
Poverty income ratio					<.001
<1.30	18.38	15.81	31.27	52.12	
1.30 to 1.99	20.44	20.16	24.21	19.04	
2.00 to 3.99	38.25	39.33	34.59	20.43	

Author Manuscript
Author Manuscript
Author Manuscript
Author Manuscript

	Overall (*n* = 1,544)	White (*n* = 1,165)	Black (*n* = 227)	Mexican American (*n* = 152)	*p*
4.00 and greater	22.93	24.70	9.94	8.40	
Health care					
Insurance					
Privately insured	63.28	66.62	41.85	30.05	<.001
Medicare recipient	96.94	97.58	96.92	82.41	<.001
Medicaid recipient	4.42	3.19	15.82	9.78	<.001
Health care utilization (no. of visits/year)					.17
None	2.44	2.20	3.63	5.51	
1 to 3	37.59	38.09	31.73	37.84	
4 to 9	37.60	37.22	42.86	35.71	
10 or more	22.37	22.49	21.78	20.94	
Self-report general health condition					<.001
Excellent	11.85	12.43	7.05	8.31	
Very good	28.49	30.47	13.87	12.69	
Good	34.93	35.33	31.45	32.94	
Fair	18.88	16.61	37.71	32.88	
Poor	5.85	5.17	9.92	13.18	
Hearing health care					
Mean PTA (dB HL)[a]	32.54 [31.38, 33.71]	33.04 [31.77, 34.30]	26.86 [24.75, 28.98]	32.60 [30.12, 35.08]	<.001
Hearing loss category (better ear speech PTA)					<.001
Normal	36.07	34.43	53.63	38.29	
Mild	36.06	36.62	30.63	34.20	
Moderate	26.64	27.74	14.81	25.14	
Severe	1.23	1.21	0.94	2.36	
Recent hearing testing[b]					.41
Yes	39.49	39.06	43.30	41.50	
Regular hearing aid use[c]					.002
Yes	19.50	20.50	9.53	10.22	
Firearm use					<.001
Ever used firearms	37.50	39.19	24.05	25.76	

Author Manuscript
Author Manuscript
Author Manuscript
Author Manuscript

	Overall (*n* = 1,544)	White (*n* = 1,165)	Black (*n* = 227)	Mexican American (*n* = 152)	*p*
Occupational noise exposure					.68
Yes	31.98	32.20	31.47	27.91	
Recreational noise exposure					.75
Yes	11.88	12.06	10.96	9.54	
Frequency of hearing protection use					.004
Most of the time	7.35	7.70	5.17	3.52	
Sometimes	10.88	11.32	8.57	5.54	
Rarely/seldom	7.75	8.16	4.13	5.69	
Never	74.02	72.82	82.13	85.25	

Note. CI = confidence interval; PTA = pure tone average.

[a]Mean speech pure tone average in better hearing ear.

[b]Hearing testing in the last 4 years.

[c]Only individuals with hearing loss were included in analysis as defined as speech frequency PTA > 25 dB in better hearing ear.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 2

Association of Disparities-Related Variables With Hearing Health Care Behaviors.

	Recent hearing testing		Regular hearing aid use[a]	
	Crude model[b]	Multivariate model[c]	Crude model[b]	Multivariate model[c]
Demographics				
Sex				
Male	Ref		Ref	
Female	1.11 [0.92, 1.34]		0.86 [0.58, 1.28]	
Race				
White	Ref	Ref	Ref	Ref
Black	1.68 [1.21, 2.33]**	2.09 [1.45, 3.00]***	0.42 [0.19, 0.91]*	0.77 [0.31, 1.90]
Mexican American	1.11 [0.69, 1.76]	1.56 [0.93, 2.63]†	0.22 [0.06, 0.74]*	0.37 [0.10, 1.36]
Marital status				
Married/living with partner	Ref	Ref	Ref	
Widowed	1.33 [1.03, 1.71]*	1.34 [1.03, 1.74]*	0.92 [0.54, 1.59]	
Divorced/separated	0.85 [0.56, 1.31]	0.82 [0.52, 1.31]	0.41 [0.11, 1.54]	
Never married	0.81 [0.37, 1.77]	0.82 [0.35, 1.90]	1.78 [0.43, 7.47]	
Education				
Less than HS	Ref	Ref	Ref	Ref
Some HS	1.38 [0.92, 2.09]	1.38 [0.89, 2.14]	2.09 [1.05, 4.18]*	2.02 [0.86, 4.78]
HS/GED	1.37 [0.93, 2.02]	1.44 [0.94, 2.22]†	2.91 [1.56, 5.43]***	2.41 [1.05, 5.52]*
Some college or associate degree	1.85 [1.26, 2.72]**	1.95 [1.29, 2.96]**	3.46 [1.73, 6.89]***	2.64 [1.15, 6.06]*
College grad and above	1.63 [1.05, 2.52]*	1.79 [1.09, 2.92]*	5.54 [2.75, 11.17]***	2.77 [0.90, 8.51]†
Poverty income ratio				
<1.30	Ref		Ref	Ref
1.30 to 1.99	1.09 [0.74, 1.60]		2.32 [1.00, 5.37]*	2.04 [0.85, 4.88]
2.00 to 3.99	1.25 [0.87, 1.79]		3.55 [1.81, 6.95]***	2.34 [1.09, 5.02]*
4.00+	1.32 [0.88, 1.97]		5.71 [2.72, 11.99]***	3.92 [1.60, 9.61]**

J Aging Health. Author manuscript; available in PMC 2016 April 09.

	Recent hearing testing		Regular hearing aid use[a]	
	Crude model[b]	Multivariate model[c]	Crude model[b]	Multivariate model[c]
Health care				
Private insurance				
Not privately insured	Ref		Ref	Ref
Privately insured	1.07 [0.84, 1.35]		1.80 [1.10, 2.95][*]	1.28 [0.76, 2.15]
Medicare				
Not receiving Medicare	Ref		Ref	
Medicare recipient	1.49 [0.65, 3.39]		5.13 [0.13, 201.45]	
Medicaid				
Not receiving Medicaid	Ref		Ref	
Medicaid recipient	0.90 [0.53, 1.56]		0.41 [0.08, 2.10]	
Health care utilization (# of visits/year)				
None	Ref		Ref	
1-3	1.25 [0.60, 2.59]		1.49 [0.42, 5.33]	
4-9	1.45 [0.68, 3.11]		1.57 [0.49, 5.09]	
10 or more	1.30 [0.66, 2.56]		1.64 [0.49, 5.50]	
Self-report health				
Excellent	Ref	Ref	Ref	Ref
Very good	1.09 [0.74, 1.61]	1.13 [0.74, 1.72]	1.83 [1.09, 3.07][*]	1.63 [0.83, 3.20]
Good	1.11 [0.81, 1.50]	1.10 [0.79, 1.53]	1.31 [0.71, 2.43]	1.38 [0.65, 2.93]
Fair	0.73 [0.47, 1.13]	0.71 [0.45, 1.12]	0.66 [0.33, 1.29]	0.85 [0.39, 1.85]
Poor	0.62 [0.35, 1.07][†]	0.63 [0.35, 1.12]	1.23 [0.53, 2.87]	2.33 [0.85, 6.34][†]
Hearing health care				
Firearm use				
No	Ref		Ref	Ref
Yes	1.11 [0.89, 1.40]		1.43 [0.97, 2.10][†]	1.05 [0.69, 1.58]
Occupational noise exposure				
No	Ref		Ref	
Yes	0.89 [0.70, 1.13]		1.06 [0.72, 1.57]	

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

	Recent hearing testing		Regular hearing aid use[a]	
	Crude model[b]	Multivariate model[c]	Crude model[b]	Multivariate model[c]
Recreational noise exposure				
No	Ref		Ref	Ref
Yes	1.33 [0.89, 2.00]		2.07 [1.25, 3.42]**	2.28 [1.39, 3.74]**
Frequency of hearing protection use				
Never	Ref		Ref	Ref
Rarely/seldom	1.06 [0.60, 1.89]		1.19 [0.63, 2.23]	0.89 [0.49, 1.63]
Sometimes	1.38 [0.93, 2.04]		2.52 [1.58, 4.01]***	2.10 [1.04, 4.24]*
Most of the time	1.25 [0.72, 2.17]		1.73 [0.78, 3.83]	1.50 [0.62, 3.59]

Note. PTA = pure tone average; HS/GED = High School or General Educational Development Test.

[a] Only individuals with hearing loss were included in analysis as defined as speech frequency PTA > 25 dB in better hearing ear.

[b] Crude models include the predictor variable of interest and are adjusted for age and degree of hearing impairment.

[c] The multivariate model includes all predictor variables with $p \leq .1$ from the crude models and are also adjusted for age and degree of hearing impairment.

† $p \leq .1$.

* $p < .05$.

** $p \leq .01$.

*** $p \leq .001$.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 3

Association of Disparities-Related Variables With Recent Hearing Testing, by Race/Ethnicity.

	White (*n* = 1,165)		Black (*n* = 227)		Mexican American (*n* = 152)	
	Crude model[a]	Multivariate model[b]	Crude model[a]	Multivariate model[b]	Crude model[a]	Multivariate model[b]
Demographics						
Sex						
Male	Ref		Ref		Ref	
Female	1.20 [0.95, 1.51]		0.69 [0.38, 1.26]		0.96 [0.52, 1.77]	
Marital status						
Married/living with partner	Ref	Ref	Ref	Ref	Ref	
Widowed	1.36 [1.02, 1.80] *	1.44 [1.09, 1.89] **	0.80 [0.42, 1.53]	1.17 [0.47, 2.94]	0.77 [0.40, 1.46]	
Divorced/separated	0.89 [0.53, 1.48]	0.92 [0.53, 1.60]	0.49 [0.25, 0.95] *	0.67 [0.25, 1.81]	0.77 [0.17, 3.46]	
Never married	0.70 [0.27, 1.82]	0.74 [0.27, 2.04]	6.32 [2.28, 17.54] ***	L	1.02 [0.20, 5.30]	
Education						
Less than HS	Ref	Ref	Ref		Ref	Ref
Some HS	1.65 [0.93, 2.95] †	1.50 [0.81, 2.77]	0.81 [0.40, 1.64]		1.90 [0.68, 5.35]	1.50 [0.57, 3.95]
HS/GED	1.72 [0.93, 3.17] †	1.56 [0.82, 2.95]	1.40 [0.72, 2.71]		1.25 [0.28, 5.53]	1.01 [0.23, 4.46]
Some college/AA	2.50 [1.39, 4.51] **	2.31 [1.24, 4.28] **	0.84 [0.37, 1.89]		0.99 [0.29, 3.40]	0.67 [0.18, 2.40]
College grad and above	2.21 [1.18, 4.14] **	2.05 [1.07, 3.92] *	1.09 [0.27, 4.36]		2.52 [1.34, 4.74] **	2.89 [0.94, 8.82] †
Poverty income ratio						
<1.30	Ref		Ref	Ref	Ref	
1.30 to 1.99	1.14 [0.73, 1.77]		1.88 [0.76, 4.63]	1.37 [0.57, 3.26]	0.41 [0.13, 1.32]	
2.00 to 3.99	1.29 [0.82, 2.02]		2.74 [1.45, 5.18] **	1.31 [0.46, 3.73]	0.79 [0.41, 1.51]	
4.00+	1.52 [0.91, 2.54]		0.84 [0.36, 1.98]	0.21 [0.01, 6.31]	0.87 [0.33, 2.30]	
Health care						
Medicare						
Not receiving Medicare	Ref		Ref		Ref	Ref
Medicare recipient	0.98 [0.41, 2.37]		L		2.62 [0.90, 7.68] †	3.05 [1.07, 8.71] *

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

	White (n = 1,165)		Black (n = 227)		Mexican American (n = 152)	
	Crude model[a]	Multivariate model[b]	Crude model[a]	Multivariate model[b]	Crude model[a]	Multivariate model[b]
Private insurance						
Not privately insured	Ref		Ref		Ref	
Privately insured	1.12 [0.85, 1.48]		1.24 [0.80, 1.94]		0.85 [0.48, 1.50]	
Medicaid						
Not receiving Medicaid	Ref		Ref	Ref	Ref	
Medicaid recipient	1.10 [0.51, 2.38]		0.35 [0.14, 0.86]*	0.39 [0.17, 0.86]*	0.95 [0.30, 3.06]	
Health care utilization (no. of visits/year)						
None	Ref		Ref	Ref	Ref	
1 to 3	1.14 [0.45, 2.89]		3.30 [0.73, 14.94]	2.70 [0.80, 9.13]	1.36 [0.51, 3.56]	
4 to 9	1.34 [0.51, 3.47]		2.78 [0.47, 16.34]	2.73 [0.62, 11.95]	2.26 [0.62, 8.32]	
10 or more	1.16 [0.51, 2.65]		4.42 [0.80, 24.49]†	4.54 [1.18, 17.44]*	1.68 [0.48, 5.90]	
Self-report health						
Excellent	Ref	Ref	Ref	Ref	Ref	
Very good	1.16 [0.74, 1.81]	1.20 [0.75, 1.92]	0.35 [0.08, 1.52]	0.26 [0.05, 1.50]	1.39 [0.27, 7.14]	
Good	1.17 [0.80, 1.70]	1.19 [0.80, 1.77]	0.33 [0.10, 1.09]†	0.31 [0.08, 1.18]†	1.07 [0.33, 3.47]	
Fair	0.63 [0.36, 1.09]†	0.67 [0.39, 1.17]	0.28 [0.08, 1.00]†	0.33 [0.07, 1.53]	1.51 [0.39, 5.87]	
Poor	0.56 [0.26, 1.20]	0.63 [0.29, 1.36]	0.17 [0.04, 0.65]**	0.23 [0.05, 1.15]†	2.60 [0.51, 13.26]	
Hearing health care						
Firearm use						
No	Ref		Ref		Ref	
Yes	1.12 [0.86, 1.45]		1.17 [0.72, 1.92]		1.26 [0.65, 2.46]	
Occupational noise exposure						
No	Ref		Ref		Ref	
Yes	0.82 [0.63, 1.06]		1.26 [0.63, 2.55]		1.11 [0.60, 2.03]	
Recreational noise exposure						
No	Ref		Ref		Ref	
Yes	1.38 [0.89, 2.14]		0.95 [0.47, 1.91]		2.16 [0.57, 8.21]	
Frequency of hearing protection use						

J Aging Health. Author manuscript; available in PMC 2016 April 09.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

	White (n = 1,165)		Black (n = 227)		Mexican American (n = 152)	
	Crude model[a]	**Multivariate model[b]**	**Crude model[a]**	**Multivariate model[b]**	**Crude model[a]**	**Multivariate model[b]**
Never	Ref		Ref		Ref	Ref
Rarely/seldom	1.07 [0.58, 1.96]		1.80 [0.45, 7.31]		0.41 [0.18, 0.92]*	0.29 [0.11, 0.75]*
Sometimes	1.39 [0.91, 2.12]		1.64 [0.74, 3.67]		0.69 [0.15, 3.30]	1.04 [0.20, 5.44]
Most of the time	1.21 [0.62, 2.33]		1.96 [0.49, 7.87]		1.92 [0.41, 9.03]	1.90 [0.22, 16.60]

Note. L = “Too few in category to obtain meaningful estimates.

[a]Crude models include the predictor variable of interest and are adjusted for age and degree of hearing impairment.

[b]The multivariate model includes all predictor variables with $p \leq .1$ from the crude models and are also adjusted for age and degree of hearing impairment.

† $p \leq .1$.

* $p < .05$.

** $p \leq .01$.

*** $p \leq .001$.

J Aging Health. Author manuscript; available in PMC 2016 April 09.