July 2018

Factors Related to Hearing Aid Use among Older Adults from Hispanic/Latino Backgrounds: Findings from the Hispanic Community Health Study/Study of Latinos

Michelle L. Arnold
University of South Florida, mlarnold@usf.edu

Factors Related to Hearing Aid Use among Older Adults from Hispanic/Latino Backgrounds: Findings from the Hispanic Community Health Study/Study of Latinos

by

Michelle L. Arnold

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
with a concentration in Aging Studies
School of Aging Studies
College of Behavioral and Community Sciences
University of South Florida

Major Professor: Kathryn Hyer, Ph.D., M.P.P.

Date of Approval:
May 25, 2018

Keywords: hearing loss, aging, minority health

Table of Contents

List of Tables

List of Figures

Abstract

The purpose of this dissertation was to understand perceived hearing loss and hearing health care use among older adults from Hispanic/Latino backgrounds using the Andersen model of health care utilization as a framework. A cross sectional analysis of audiometric and survey data from the Hispanic Community Health Study/Study of Latinos was used to estimate factors that characterize perceived hearing handicap and hearing aid use, and to determine hearing aid use rates in a large group of older Hispanic/Latino adults. Data came from 6970 adults aged 45 to 76. Results revealed that self-perceived hearing handicap is significantly correlated to measured hearing levels, and is characterized by health insurance status, age, sex, pure tone average, and language acculturation. Reported hearing aid use was characterized by poorer measured pure tone average of the better ear, higher Hearing Handicap Inventory – Screening scores, and current health insurance. Overall hearing aid uptake rate among included individuals was 3.7%. Hearing aid uptake rates among included individuals were low compared to rates of clinically significant hearing loss. The primary variable associated with underutilization of hearing aid uptake for those who could pose to benefit was a lack of health insurance.

Chapter 1: Background and Literature Review

Hearing Loss Prevalence in the US

Hearing loss is a chronic condition with high prevalence among older adults in the US. Overall, approximately 25% of adults over the age of 65 and over 50% of adults over the age of 75 have significant hearing loss (National Institute on Deafness and Other Communication Disorders, 2016). Included in this growing aging demographic are older adults from Hispanic/Latino backgrounds. It is projected that by the year 2050 over 102.6 million Hispanic/Latinos (21.5 million aged 65 years or older) will reside in the US, roughly equivalent to a quarter of the total population (U.S. Census Bureau, 2006; U.S. Department of Health and Human Services, 2015). As hearing loss is a known disabling chronic health condition that is common among older adults, it is important for researchers in the area of communication disorders and health care to study factors related to hearing aid use in older adults from Hispanic/Latino backgrounds given the growth trajectory of this population.

Recent estimates of hearing loss prevalence among older adults from Hispanic/Latino backgrounds demonstrated similar prevalence rates to Whites (Cruickshanks et al., 2015; Lin, Thorpe, Gordon-Salant, & Ferrucci, 2011). Yet older adults from Hispanic/Latino backgrounds are less likely to report having a hearing test or using hearing aids (Nieman, Marrone, Szanton, Thorpe, & Lin, 2016; Torre, Moyer, & Haro, 2006). Untreated hearing loss negatively impacts quality of life and is linked to increased risk for dementia, depression, anxiety, and reduced social contacts in older

adults (Dalton et al., 2003; Kramer, Kapteyn, Kuik, & Deeg, 2002; Lin, Ferrucci, et al., 2011). Individuals from Hispanic/Latino backgrounds may be at a higher risk for these adverse health outcomes if they are less likely to recognize or seek help for a hearing loss. Understanding more about hearing loss perception and use of hearing aids among adults from Hispanic/Latino backgrounds is a first step towards addressing low treatment uptake rates in this population.

Hearing Aid Use in the US

Hearing aids are an effective treatment option for most cases of age related hearing loss (ARHL). However, previous research indicates that while hearing aids significantly improve symptoms of hearing loss and quality of life in users (Chisolm et al., 2007; Ferguson et al., 2017), the proportion of individuals who pose to benefit from the use of hearing aids is much smaller than those who actually adopt them. Very few older adults with hearing loss report uptake of hearing aids (Bainbridge & Ramachandran, 2014; Gopinath et al., 2011; Lin, Thorpe, et al., 2011; Popelka et al., 1998), particularly those individuals with mild yet clinically-significant losses (Lin, Thorpe, et al., 2011). Several studies exist that attempt to explain decisions related to hearing aid use or nonuse, but little is known or understood regarding whether differences in culture or ethnic background impact hearing aid uptake.

Recent reviews of the literature on help-seeking and hearing loss suggest over 20 potential factors related to hearing aid uptake and regular use. Some of the most common factors include socioeconomic variables (such as income and education) and perceived need (such as degree of hearing impairment and related disability) (Bainbridge & Wallhagen, 2014; Knudsen, Öberg, Nielsen, Naylor, & Kramer, 2010;

Meyer & Hickson, 2012). Although other factors may contribute to hearing aid use among older adults, research from US populations suggests that the abovementioned variables may be important to consider for persons from Hispanic/Latino or other minority backgrounds. However, research evaluating the influence of income and hearing aid cost, education, and perceived need on hearing aid use among adults from Hispanic/Latino backgrounds is limited. Studies that address these factors among this population are described in the sections that follow.

Income and hearing aid cost. In the 2008 MarkeTrak survey, Kochkin (2009) reported that the average price per hearing aid was approximately $1600 ($3200 for a set), with costs reaching up to $6000 for a set of premium digital hearing aids. Like any electronic device, hearing aids require replacement; the average lifespan of a hearing aid ranges between four to six years. If replaced every five years, an adult diagnosed with hearing loss at age 55 might expect to pay between $12,000 and $24,000 on hearing aids by the time s/he reaches the age of 75. For retired persons on a fixed income, these costs may pose a significant barrier to obtaining hearing aids. Nearly 40% of adults surveyed by Kochkin reported assistance from their health care insurance provider (including the Veterans Administration) towards their hearing aids. Excluding the VA respondents, approximately 30% of individuals reported assistance from Medicare, Medicaid, or some other third-party payer (2009). While promising, this represents a minority of individuals with significant hearing loss; remaining are those who have little or no outside help for managing the high out-of-pocket costs associated with obtaining hearing aids. It is not surprising then, that hearing aid cost and lower

income levels are frequently reported by patients as barriers to hearing aid uptake (Franks & Beckmann, 1985; Wallhagen, 2014).

Overall, findings from studies that investigate cost and income as determinants of hearing aid uptake are mixed. Several studies that include income as a predictor reveal no relationships between income and hearing aid use (Fischer et al., 2011; Knudsen et al., 2010; Lin, Thorpe, et al., 2011; Nash et al., 2013; Popelka et al., 1998) or note trends towards significance, with participants who report higher levels of income being more likely to also report using hearing aids (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Lin, Thorpe, et al., 2011; Nieman et al., 2016). While some larger analyses have shown little or no relationship between income and hearing aid use, significant relationships between concerns related to cost and hearing aid use have been demonstrated in other studies (Garstecki & Erler, 1998; Gopinath et al., 2011). Much of the previous research investigating cost and income as factors related to hearing aid use are limited to primarily White samples. Findings from the few studies that address income as a correlate of hearing aid use in Hispanic/Latino populations are discussed below.

Lee, Gomez-Marin, and Lee (1996) used data from the Hispanic Health and Nutrition Examination Survey (HHANES), conducted between the years 1982 – 1984, to evaluate trends in hearing instrument use in a nationally representative adult sample of Mexican-, Cuban-, and Puerto-Rican- Americans. Hearing aid use and demographic variables, including poverty status, were determined through a series of interview questions. Mexican Americans living below the poverty line were over nine times more likely to report hearing aid use, but were not compared to other Hispanic/Latino groups

due to lack of hearing aid usage reported. No other significant findings were revealed for any other demographic variable of interest. These results are in contrast to findings from other studies that suggest positive relationships between hearing aid use and income. The authors proposed that a reason for this outcome was the availability of Medicaid for individuals living below the poverty level. In many states, Medicaid will provide at least one hearing aid to adults who meet certain criteria for hearing loss, but much variability for coverage exists between states (Arnold, Hyer, & Chisolm, 2017). However, results from the Lee et al. (1996) study demonstrated that only seven Mexican Americans reported any hearing aid use over the course of their lives, thus limiting the generalizability of their findings. An additional limitation of this research is that it did not directly compare Hispanic/Latinos with other groups, such as Whites or Blacks. Generalizations about differences in hearing aid uptake and outcomes between groups cannot be drawn based on the results.

More recently, Bainbridge and Ramachandran (2014) and Nieman et al. (2016) investigated racial and ethnic socioeconomic differences related to hearing aid use using data from the 2005-2006 and 2009-2010 waves of the NHANES. Bainbridge and Ramachandran (2014) found that hearing aid use among non-Hispanic/Latino Whites (35.4%) was more than two times greater than that among adults from Hispanic/Latino backgrounds, non-Hispanic/Latino Blacks, or other backgrounds (17.1%) ($p < .05$). The strongest predictor of hearing aid use was family income, with individuals in the lowest income-to-poverty quintile being 66% less likely to report hearing aid use compared to the highest quintile. A limitation of this study is that the authors did not perform any further discrete analyses to compare differences between Whites versus non-Whites;

therefore, it is difficult to draw conclusions based on background between individuals included in the non-White group. Nieman et al. (2016) also reported a significant relationship between income, background/race, and hearing aid uptake, with Whites being less likely to report lower income-to-poverty ratios than Blacks or Mexican Americans and more likely to report hearing aid use. Further, while both Blacks and Mexican Americans were found to be more likely to report recent hearing testing, they were significantly less likely than Whites to be hearing aid users. Taken together, these results suggest that disparities exist for hearing aid access between Whites and non-Whites. While Nieman et al. (2016) utilized a larger sample than the one used by Lee et al. (1996), their study was still limited by small sample sizes of Blacks and Hispanic/Latinos who reported hearing aid use, and their Hispanic/Latino sample was limited to Mexican Americans. This makes generalizations difficult, particularly to adults from Hispanic/Latino backgrounds who identify as being part of a different cultural group (for example, Cuban or Puerto-Rican).

In sum, cost and factors related to cost, such as income and poverty level, appear to be determinants of hearing aid use among older adults. There is a wide range of cost involved with hearing aid assessment and use, but little financial assistance is available for older adults who wish to obtain hearing aids. Some insurance coverage does exist, and both Medicare Part C and private third-party payer reimbursement for hearing aids is steadily increasing (Kochkin, 2009). However, given the number of studies that fail to demonstrate relationships between cost, income, and hearing aid use, other factors, such as education and perceived need should be considered.

Education. Education is a widely cited as a factor related to hearing aid uptake and use. Unlike cost and income, most studies demonstrate significant relationships between years of education and obtaining hearing aids. Simply stated, findings show that individuals with hearing loss who are more educated are more likely to obtain and use hearing aids. The majority of the research relating hearing aid use to education includes analysis of large data sets (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Lee et al., 1996; Lin, Thorpe, et al., 2011; Nieman et al., 2016; Popelka et al., 1998). However, the relationship between education and hearing aid use is also evident in prospective randomized controlled trials and cohort studies (Garstecki & Erler, 1998; Knudsen et al., 2010; Meyer & Hickson, 2012).

Again, when applying these findings to older adults from Hispanic/Latino backgrounds or other minority populations, findings relating education and hearing aid use should be interpreted with caution: Little evidence is available that specifically investigates this factor using large groups of minorities in the samples, if at all. Few studies do exist which incorporate those from Hispanic/Latino backgrounds and/or other minority groups in their analyses of education and hearing aid use. Unlike findings derived from primarily White populations, the findings of studies which include Hispanic/Latino and other minority populations are mixed. Lin, Thorpe, et al. (2011) included both Blacks and Hispanic/Latinos (majority Mexican Americans) in an analysis of hearing loss prevalence and hearing aid use using NHANES data. Education was identified as a significant predictor, with individuals reporting “Some college or more” being approximately two times more likely to also report hearing aid use. In contrast to these results, Lee et al. (1996) showed that years of education was inversely related to

hearing aid use among Hispanic/Latino adults who were included in the HHANES. In other words, individuals reporting lower levels of education were significantly *more* likely to report hearing aid use. Important limitations of both of these studies should be noted: First, the findings relating education to hearing aid use reported by Lin, Thorpe, et al. (2011) are not stratified by background or race. Second, the findings reported by Lee et al. (1996) do not take into account non-Hispanic/Latino outcomes and the sample size of those reporting hearing aid use (n=7) is prohibitively small and includes only Mexican American respondents.

Recent studies that include different populations in the analyses also demonstrate mixed findings regarding the relationship between hearing aid use and education (Bainbridge & Ramachandran, 2014; Nieman et al., 2016). Using NHANES data, Bainbridge and Ramachandran (2014) found that education was not associated with hearing aid use after adjusting for family income, however the authors limit their comparisons to White versus non-White (i.e., Black, Hispanic/Latino, and other backgrounds) study groups. Conversely, Nieman et al. (2016) demonstrated a strong association between education and hearing aid use using the same waves of NHANES data, showing significant differences in education between races as well as significant differences between hearing aid use based on amount of education obtained. The authors did not Hispanic/Latino groups other than Mexican Americans in their analyses, and therefore results lack generalizability to the Hispanic/Latino population in the US as a whole. To summarize, while the majority of research suggests that education is a determinant of hearing aid use among older adults, the literature focusing on individuals from Hispanic/Latino backgrounds is mixed and is lacking in number and scope.

Further, conflicting results are evident even when using the same waves of the same data set, suggesting the need for study replication using multiple indicators of socioeconomic status to understand the relationships between race, ethnic background and hearing aid use.

Perceived need. Perceived need is a factor identified in the majority of studies that address hearing aid use among older adults. “Need” may manifest in one of many ways. One such way is need based on objective hearing loss *(“I need a hearing aid because the audiologist told me I have a hearing loss”*). A second way is need based on self-perceived hearing loss *(“I need a hearing aid because I am noticing that my hearing is getting worse”),* or need based on the degree of disability experienced due to hearing loss *(“I need a hearing loss because I no longer enjoy going out to eat due to the difficulties I have understanding conversations in crowds”)*. A third way is need based on attitudes and expectations about hearing loss and hearing aids *(“I need a hearing aid because I am older, my hearing is getting worse, and hearing aids are helpful”)*. The next section of this review will consider these three different definitions of “need”, with focus on individuals from Hispanic/Latino or other minority populations.

1. Need based on objective hearing loss. Objective hearing loss is determined primarily through measuring hearing thresholds using pure tone audiometry. Most studies that investigated hearing aid use in older adults demonstrated significant relationships between hearing loss severity and hearing aid use. Specifically, the more hearing loss an individual presents with, the more likely it is that the individual is also a hearing aid user (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Garstecki & Erler, 1998; Gopinath et al., 2011; Knudsen et al., 2010; Kochkin, 2009; Lin, Thorpe, et

al., 2011; Meyer & Hickson, 2012; Nash et al., 2013; Popelka et al., 1998). It is unclear whether hearing loss severity is related to hearing aid use in older adults from Hispanic/Latino or other minority backgrounds. Regardless, the overall uptake of hearing aids among older adults with significant measured hearing loss remains roughly between 3-33% (Bainbridge & Ramachandran, 2014; Lin, Thorpe, et al., 2011). If perceived need is significantly related to hearing aid use, it is clear that degree of measured hearing loss does not fully explain why some individuals exhibit more perceived need for hearing aids than others do.

2. Need Based on Perceived Hearing Loss and Degree of Associated Disability Experienced. Perceived hearing loss is primarily determined through self-report measures. A wide variety of standardized measures exists for the purposes of estimating self-perceived hearing difficulties. The most commonly used standardized measure of perceived hearing loss and associated disability is the Hearing Handicap Inventory for the Elderly (HHIE) and adults (HHIA) (Ventry & Weinstein, 1982) including the Screening version (HHI-S) (Lichtenstein, Bess, & Logan, 1988; Ventry & Weinstein, 1983). The HHI-S is a 10-item self-report questionnaire that screens for perceived hearing impairment and has demonstrated sensitivity between 53 to 72% and specificity between 70 to 84% for different hearing loss severities. Scores greater than an eight are generally consistent with a significant self-perceived hearing handicap, with higher scores indicating greater degrees of impairment (Lichtenstein et al., 1988).

Other methods of determining self-perceived hearing difficulties and need for hearing aids include open-ended and semi-structured interviews (Johnson, 2012; Salas-Provence, Erickson, & Reed, 2002) as well as yes/no questions asking about self-

perceived hearing problems (i.e., *"Do you feel you have a hearing problem?")* (Kochkin, 2009; Lee, Gomez-Marin, Lam, & Zheng, 2004; Torre et al., 2006). Yes/no questions demonstrate relatively good accuracy when compared to measured hearing thresholds in adults, (Clark, Sowers, Wallace, & Anderson, 1991; Kamil, Genther, & Lin, 2015; Nondahl et al., 1998), including adults from Hispanic/Latino backgrounds (Torre et al., 2006) and are frequently used in large-scale population surveys.

Unlike the factors of cost and education, findings regarding perceived need and hearing aid use are largely unanimous: Individuals who self-report hearing difficulties and associated disability are more likely to also report hearing aid use (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Garstecki & Erler, 1998; Gopinath et al., 2011; Knudsen et al., 2010; Kochkin, 2009; Lin, Thorpe, et al., 2011; Meyer & Hickson, 2012; Nash et al., 2013; Popelka et al., 1998). What is less clear, however, is whether there are differences in the *perception* of need between Whites and individuals from Hispanic/Latino or other minority populations. While very few studies examine differences in hearing aid uptake and use between race and ethnic groups, even fewer attempt to investigate potential differences in attitudes and beliefs related to hearing loss and associated disability. A single study found that older Blacks and Hispanic/Latinos were significantly less accurate at gauging their hearing loss compared to age-matched Whites (Kamil, Genther, & Lin, 2015) which suggests that perhaps these participants did not experience the same degree of hearing loss-related disability. However, the reasons why self-perceptions of hearing ability were different among individuals included in the analysis were not apparent.

Interviews conducted with Hispanic/Latino and Black older adults have revealed several important themes to consider related to the perceived need for hearing aids. These include general beliefs about the health care system (for example, distrust of providers), self-efficacy, accepting hearing loss as part of aging, lack of culturally-congruent health care providers, negative experiences and expectations of audiologists and hearing aids, and stigma (Johnson, 2012; Salas-Provence et al., 2002). Factors specific to Spanish-speakers, such as US residential status (documented versus undocumented), language barriers, and a lack of linguistically appropriate assessment and educational materials about hearing aids and hearing loss are also significant themes (Johnson, 2012; Salas-Provence et al., 2002). These areas all need further exploration to understand fully the complex relationships between race and ethnicity, perceived need, and hearing aid use.

3. Need Based on Attitudes about Hearing Loss and Hearing Aids. Attitudes about hearing loss treatment are largely negative due to the stigma related to hearing aid use. Negative attitudes affect uptake, and have been widely reported (Johnson, 2012; Knudsen et al., 2010; Meyer & Hickson, 2012; Salas-Provence et al., 2002). While a comprehensive discussion of the stigma associated with hearing loss and hearing aid use is outside the scope of this dissertation, understanding differences in attitudes about hearing treatment in Hispanic/Latino or other minority groups is worthwhile.

Unfortunately, very few studies report on beliefs and attitudes older adults have towards hearing loss treatment or hearing aids in minority populations. However, results from a series of interviews with 40 members of the same Hispanic/Latino family (Mexico

via Spain), spanning four generations revealed beliefs related to both "folk" and "medical" solutions for hearing problems (Salas-Provence et al., 2002). When asked about possible remedies for hearing problems, younger family members tended to give medical responses (i.e., use a hearing aid, see an ENT, etc.) whereas older family members tended to give folk responses (i.e., use volcanic oil, seek help from a *Curandero*(*a*), perform ear candling, etc.). These results demonstrate the role that culture might play in influencing some older Hispanic/Latino adults' medical and health belief systems. The clinical implications of these findings point to awareness on the part of the health care professional that certain folk remedies may be an integral part of a patient's belief system, and understanding and respecting these beliefs are necessary for building a trustworthy relationship between patient and provider.

To summarize, hearing loss among older adults, including those who are from Hispanic/Latino and other minority backgrounds, is a significant problem that will continue to grow with the aging of the population. Currently, the most efficacious treatment for hearing loss is hearing aids. Comprehensive reviews of the literature examining randomized controlled trials or cohort studies (Knudsen et al., 2010; Meyer & Hickson, 2012) and large-scale data analyses (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Lee et al., 1991; Lee et al., 1996; Lin, Thorpe, et al., 2011; Nash et al., 2013; Nieman et al., 2016; Popelka et al., 1998) have identified numerous factors related to hearing aid use among older adults. These most common factors revealed by these studies include income and the cost of hearing aids, education, and perceived need.

Mixed findings are evident when comparing hearing aid use between populations, with a lack of literature available that addresses determinants of hearing aid use in minority populations. While hearing aid cost, income, and education appear to have conflicting results, with only some studies showing significant relationships (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Lin, Thorpe, et al., 2011; Nieman et al., 2016), perceived need tends to be a robust predictor for hearing aid use, regardless of whether a person is from a minority population (Knudsen et al., 2010; Meyer & Hickson, 2012).

Upon examination of the available literature addressing hearing loss and hearing aid use among adults from Hispanic/Latino backgrounds, several gaps in the literature are apparent. In particular, questions arise as to whether the common factors reported in the literature for non-Hispanic/Latino populations in the US (income/cost, education, and perceived need) are indeed factors that influence hearing aid use for older Hispanic/Latino adults. The use of a robust theoretical framework can assist in guiding research to identify these factors. Hearing health care researchers have begun investigating hearing aid use and behavior change in the context of health psychology models. The next portion of this dissertation will review some of this work, and will discuss a possible framework for researching hearing aid use in the Hispanic/Latino population.

Chapter 2: Theoretical Framework

Numerous health behavior frameworks exist that attempt to explain which decisional factors influence an individual's choice whether to address a chronic health issue, or engage in recommended treatment from a health care provider. In the area of hearing loss, studies focused on the utility of questionnaires rooted in health behavior frameworks attempt to reveal attitudes, beliefs, and behaviors related to use or non-use of hearing health care. Saunders, Frederick, Silverman, and Papesh (2013) developed the Hearing Beliefs Questionnaire using the health belief model as a guide. Briefly, the health belief model attempts to explain or predict health related behaviors with regard to perceived susceptibility, severity, benefits, barriers, self-efficacy, and cues to action related to a specific health condition. Saunders et al. (2013) conducted a principal components analysis and reliability analyses to validate the Hearing Beliefs Questionnaire, and found robust components relating to the underlying theoretical constructs of the model. Further, their instrument correctly classified 59 – 100% of participants' hearing help-seeking behaviors.

In a similar study, Laplante-Lévesque, Hickson, and Worrall (2013) investigated the constructs of the transtheoretical model of behavioral change in an adult hearing-impaired population through the use of the University of Rhode Island Change Assessment (URICA). The transtheoretical model (Prochaska & DiClemente, 1983) suggests that individuals cycle through discrete stages of behavioral change, and has been utilized widely in the areas of smoking cessation and diet. A principal components

analysis of responses from those with hearing loss indicated that four constructs from the transtheoretical model (precontemplation, contemplation, preparation, and action) were apparent. Further, a cluster analysis revealed that individuals tended to identify with multiple stages of change concurrently. The authors concluded that while the instrument was successful in predicting treatment uptake, with lower scores in precomtemplation and higher scores in action related to uptake, treatment adherence was unable to be predicted based on URICA scores.

Both Saunders et al. (2013) and Laplante-Lévesque et al. (2013) recommended using health care utilization models to best identify barriers to hearing help-seeking and treatment adherence. The behavioral model of health services utilization (Aday & Andersen, 1974; Andersen, 2008; Andersen & Newman, 2005) is a robust and widely used framework that seeks to parse out and explain characteristics related to health behaviors and outcomes. However, the theory has not been thoroughly tested or applied in the area of hearing loss.

The next section of this dissertation describes the constructs of the Andersen model and applies the model to older adults' use of hearing health care. Additionally, I will address how the model applies to Hispanic/Latino older adults' use of hearing health care in the US. Finally, limitations of the model will be discussed.

Andersen's Behavioral Model of Health Services Utilization

The initial version of Andersen's model of health services utilization did not fully address measures of access nor did it take into account how the differential effects of a person's larger environment versus their individual characteristics affect health service use. However, later versions of the model emerged between the 1970s and late 2000s

in which environmental characteristics (such as the policies, resources, and organization of health care systems) were treated as separate from individual characteristics in terms of the effects these factors have on health service use. The Andersen model was conceived in the 1960s as a framework for examining the health care use of families (Aday & Andersen, 1974; Andersen, 1995). The initial model included a causal chain of three primary constructs: Predisposing characteristics, enabling resources, and need. *Predisposing characteristics*, such as demographics, the social structure of the environment, and how these factors influenced health beliefs were thought to in turn influence *enabling resources*, such as personal or family income and support as well as insurance policy and status, which were in turn thought to influence an individual's *need* for health services, either their self-perceived need or some outside evaluation of need. Once need is established based on both predisposing and enabling characteristics, a person will then use health services.

Another primary goal of Andersen's model was to examine facilitators and barriers of access to health services use. Andersen defines three types of access, including *potential access*, or the presence of resources (i.e., is there a clinic that delivers the type of service(s) needed within a reasonable geographic distance?). A second type of access defined is *realized access*, or persons making use of available services. A third type of access defined is *equitable or inequitable access*; in other words, does need for the service explain differences in use (equitable access) or do demographic variables such as ethnicity or income explain differences in use (inequitable access) (Aday & Andersen, 1974; Andersen, 1995; Andersen & Newman, 2005).

Health behaviors and outcomes were added as constructs thought to influence the process of health services use in ways that were not addressed in the initial model of the 1960s. These later versions of the model included dynamic relationships between all of the constructs as opposed to a causal chain of events (i.e., predisposing characteristics → enabling variables → need → health service use). In sum, Andersen's model has undergone a series of evolutions that mirror the changes in US health policy. These updates reflect the current complexities between predisposing, enabling, and need variables and health care utilization outcomes, with specific attention paid to the differential effects of the individual and contextual determinants of access and use (Andersen, 1995, 2008). I discuss the constructs of the most current version of the model in the section that follows.

Constructs of the Andersen model.

Contextual characteristics. In the framework of the Andersen model, contextual characteristics are variables related to the structure of one's society, such as health care systems and organization, legislature related to health policy, and the larger surrounding community's demographics, norms, and beliefs (Andersen, 1995, 2008). Contextual characteristics disassemble down to predisposing, enabling, and need variables. Predisposing contextual variables include demographic and social factors, such as the age, sex, race, and socio-economic makeup of a society. Predisposing contextual variables also include beliefs and norms, influenced by both demographic and social inputs. Predisposing variables affect enabling variables, such as overall health systems (policies, financing, organization, and public health efforts). Contextual need variables include those factors that suggest the necessity of certain health

services, such as prevalence and incidence of disability or disease, or mortality rates due to a specific condition. In sum, contextual characteristics include the demographic makeup of a society that influence social norms and beliefs, including those beliefs about the need for health care. These predisposing variables in turn influence the policies that enable access and use of health services. Finally, policies and public health efforts as well as population health indices reflect the society's need for a particular health service. Taken together, contextual characteristics of health service utilization directly influence individual characteristics.

Individual Characteristics. The Anderson model disaggregates individual characteristics into predisposing, enabling, and need variables (Aday & Andersen, 1974; Andersen, 1995, 2008). Predisposing variables include the demographic and social identity of an individual and how this identity shapes one's beliefs. Individual demographic determinants of health service use are varied and include age, race, socioeconomic status, and education, among others (Andersen & Newman, 2005). Predisposing variables directly relate to enabling variables such as personal finances, health insurance status, and social or family support. Finally, need variables reflect both a person's self-perceived need (symptoms, general health state) as well as evaluated need from some outside source, such as a family member. Both contextual and individual characteristics influence personal health behaviors and outcomes. The need variables of both of these constructs are perhaps the most highly influential with regard to actual health behaviors, including health service use (Aday & Andersen, 1974; Andersen, 1995, 2008; Andersen & Newman, 2005).

Health behaviors. Andersen defines personal health behaviors as consisting of personal health practices, the process of medical care, and the realized access of personal health services (Andersen, 1995, 2008; Andersen & Newman, 2005). Personal health practices include diet, exercise, hygiene, and other lifestyle variables related to health. The process of medical care incorporates how providers interact with patients in a health care setting into the larger picture of health behaviors, for example, in terms of an individual's adherence to treatment recommendations or follow-up appointments. Realized access of personal health services is actual health service use, such as visits to a hospital or appointments with a physician or specialist. Contextual characteristics, individual characteristics, and health behaviors collectively affect outcomes (Andersen, 1995, 2008; Andersen & Newman, 2005).

Outcomes. The Andersen model identifies both perceived and evaluated health status as well as consumer satisfaction as outcomes to be measured for determining access and use of health services (Andersen, 1995, 2008). *Perceived health status* includes a person's appraisal of his or her own condition. *Evaluated health status* includes both subjective and objective appraisals by both professionals and society of the health of the population as well as the health of a particular individual. Finally, *consumer satisfaction* takes into account beliefs and expectations about a health condition as well as experience with the health care system. Consumer satisfaction also influences future health care utilization; in other words, positive appraisals lead to increased health service use whereas negative appraisals lead to decreased use. Further, there are dynamic relationships that exist between all of the factors and sub-factors within the Andersen model. These relationships represent the cyclical nature of

health service use and its dependence on both contextual and individual determinants of utilization. See Figure 1 for a diagram depicting the constructs and relationships between variables of the Andersen model.

Mutable versus immutable variables. Aday and Andersen delineate the constructs of the behavioral model into mutable versus immutable variables, and modern interpretations of the model carry this delineation through (Aday & Andersen, 1974; Andersen, 1995, 2008; Andersen & Newman, 2005; Gelberg, Andersen, & Leake, 2000). *Mutable variables* are defined as independent variables that can be affected or altered by policy, such as contextual and individual beliefs (predisposing variables), or insurance status and community supports (enabling variables). *Immutable variables* are defined as control variables that can be either minimally or not at all altered by policy, such as the age, race, and sex structure of a population (predisposing demographic variables) (Aday & Andersen, 1974). The concept of mutability is important to consider when implementing interventions designed to improve access to health services. In other words, it is not practical attempt to redefine the demographic makeup of a community; however, targeting public health efforts to reshape beliefs about a particular health problem may be feasible.

Andersen's Model Applied to Hearing Health Care. Given its comprehensive nature and well-defined constructs, the Andersen model has potential use for investigating the hearing health care utilization of both older adults in general and Hispanic/Latino older adults in the US. Several studies exist which seek to explain factors related to hearing health care use, primarily in the area of hearing aid uptake (Fischer et al., 2011; Garstecki & Erler, 1998; Gopinath et al., 2011; Knudsen, Öberg,

Nielsen, Naylor, & Kramer, 2010; Meyer & Hickson, 2012; Nash et al., 2013; Saunders, Frederick, Silverman, & Papesh, 2013). However, with some notable exceptions (Garstecki & Erler, 1998; Meyer & Hickson, 2012; Saunders et al., 2013), very few attempt to explain hearing health care utilization within a broader robust framework. Further, the Andersen model is particularly suited to examine hearing health care use in the US due to its inclusion of predisposing and enabling contextual factors and process of medical care factors. These factors can specifically focus on barriers and facilitators to use of hearing health care services and hearing aid uptake in the context of current US demographics, norms, beliefs, and health policies. The next portion of this dissertation will address how the Andersen model might be effective in exploring relationships factors known to influence to hearing aid uptake.

Cost. Within the framework of the Andersen model, "hearing aid cost" is a mutable access variable that affects several constructs, particularly enabling characteristics at both the contextual and individual levels (Andersen, 1995; Andersen & Newman, 2005). For example, at the broader contextual level, the extent of insurance coverage enables or impedes hearing aid access. Health policy related to hearing loss has the potential for change, which in turn might increase access to hearing aids. At the individual level, one's own finances and insurance status are the limiting or enabling factors with regard to hearing aid cost. Again, personal enabling resources such as insurance status is mutable; however, a person's income is likely less so. In other words, it is probably more feasible to alter policy related to insurance access for hearing aids rather than attempt to raise a person's income to address the barrier of cost.

Education. Within the framework of the Andersen model, similar to cost, education is also considered both a contextual and individual predisposing characteristic that may influence hearing health care use. In terms of a contextual factor, education at the level of the larger society includes the quality of the education and whether hearing health care is promoted. For example, there are numerous public health efforts which attempt to increase awareness of the dangers of hearing loss for children and adolescents, and education about the risks of hearing loss are required for occupations that expose workers to potentially hazardous noise (Rawool, 2012). At the individual level, the number of years of education as well as the type of education (high school, vocational school, or college) may influence whether or not a person ultimately uses hearing aids.

Perceived need. Interestingly, unlike cost or education, perceived need appears to be a universal predictor for hearing aid use, which is in line with the Andersen model (Aday & Andersen, 1974; Andersen, 1995, 2008; Andersen & Newman, 2005). In Andersen and Newman's (2005) own words, "Illness level represents the most immediate cause of health service use" (p. 16). The more a health condition negatively affects a person, the more likely they are to utilize health services. The fact that the perception of hearing ability is strongly related to hearing aid use confirms the potential strength of the Andersen model in identifying which contextual and individual factors impact health behaviors related to hearing aid use.

A question arises then about the individual appraisal of "need" with respect to hearing aids. If we are to consider the concept of need in the broader context of the Andersen model, then we know that need is influenced by an individual's predisposing

and enabling characteristics, including race and ethnic background. What we do not know is whether race/ethnicity, with its associated social factors, norms, and beliefs, differentially affects hearing aid use. A major limitation of previous studies is that collectively they include very little about the racial and ethnic makeup of their study populations. Most studies related to hearing aid use have been conducted with primarily White samples (Knudsen et al., 2010; Meyer & Hickson, 2012; Nash et al., 2013; Popelka et al., 1998), do not report the racial or ethnic breakdown of their samples (Kochkin, 2005, 2009; Saunders et al., 2013), or only include Black or Mexican-American outcomes in their analyses of diverse populations (Bainbridge & Ramachandran, 2014; Lin, Thorpe, et al., 2011; Pugh & Crandell, 2002). Few studies specifically examine the relationship between being of Hispanic/Latino background and hearing health care use in the US. I address how to apply the Andersen model to investigate hearing aid use among older adults from Hispanic/Latino backgrounds in the next section of this dissertation.

Applying the Andersen model to hearing aid use in Hispanic/Latino adults

Possible cultural differences between countries of origin could explain inconsistencies in hearing aid use seen between studies. In her dissertation, Johnson (2012) proposes a sociocultural model for appraisal of acquired hearing loss. The constructs identified in this model easily translate into Andersen's model of health service utilization. Through constructivist grounded theory, Johnson described differences in hearing health care beliefs, attitudes, and behaviors between African American, Hispanic/Latina, and White older adults. Johnson’s model identified three major themes that may help understand some of the racial/ethnic differences for hearing

health care behaviors: (1) general health care beliefs associated with quality of life can influence hearing health care behaviors; (2) perceptions specific to hearing health care can influence behaviors; and (3) structural/ environmental context can either facilitate or impede a person's ability to use hearing health care resources (for persons from Hispanic/Latino backgrounds in particular, language access and legal barriers such as an undocumented status were frequently noted as barriers to use). Other themes that Johnson's model uncovered related to lack of patient education or information materials that participants culturally identified with and lack of racially/ethnically congruent health care providers - particularly audiologists. Johnson noted that monolingual adults from Hispanic/Latino backgrounds had extreme difficulty in accessing audiologists or any hearing health care providers who spoke Spanish or used translators (2012).

These themes suggest the potential for introduction of a negative feedback cycle when considering the most recent evolution of Andersen's behavioral model. Elements from the constructs of health behaviors (such as process of medical care and use of personal health services) or outcomes (such as consumer satisfaction) influence future predisposing characteristics (beliefs). If patients have a negative appraisal of their hearing health care experience due to the barriers described by Johnson's participants, the likelihood of seeking help for hearing loss in the future, or if symptoms worsen, may be reduced.

Limitations of the Andersen Model

There are notable limitations to the Andersen model in terms of its utility in examining the hearing health care use of older adults. First, the model is quite complex, and to fully test the model one needs to incorporate equally complex study designs with

advanced statistical analyses, such as tests of conditional indirect effects or other forms of moderated regression (Baron & Kenny, 1986; McClelland & Judd, 1993; Preacher, Rucker, & Hayes, 2007). This requires not only ample sample sizes but also ideally longitudinal data from which causal chains between the constructs of the model can be established. Currently there is a large-scale study underway: the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), which includes over 15,000 adults from Hispanic backgrounds, stratified by Hispanic group. A detailed description of the HCHS/SOL appears later in this dissertation. There are also several statistical software packages available that can process complex survey data, such as SAS and SUDAAN.

An additional limitation to the application of the Andersen model for older adults hearing health care use is that frequently, generic outcomes of perceived and evaluated health status have been insensitive to changes in quality of life based on hearing intervention (Chisolm et al., 2007). However, a recent Cochrane review demonstrated both disease-specific and general quality of life improvements in adult hearing aid users with mild to moderate hearing losses (Ferguson et al., 2017). Further, disease-specific outcomes in the domain of hearing loss have been shown to be sensitive to changes; therefore, in an application of the Andersen model with regard to hearing aid use, a hearing-specific outcome is preferred to determine what effects, if any, hearing aid use among older Hispanic adults has on self-perceived hearing disability.

Another limitation of the Andersen model in terms of applying it to hearing aid use in older adults is that frequently one's own self-efficacy determines whether or not a person will engage in any behavior, health-related or otherwise (Azjen, 2002). While the Andersen model is complex and incorporates several factors in an attempt to predict

health care utilization, it does not explicitly take into account self-efficacy, which is included in other widely used models of health behaviors.

Chapter 3: Research Objectives

Aims

Whether help seeking for hearing loss or hearing aid use is different among adults from Hispanic/Latino backgrounds is not fully understood. The Andersen model is particularly suited to examine hearing health care use among adults from Hispanic/Latino backgrounds due to its inclusion of predisposing and enabling factors, which incorporate demographic variables as well as acculturation as potential predictors of health care use (Aday & Andersen, 1974; Andersen, 1995, 2008). Application of this model may allow the identification of novel barriers and facilitators to hearing health care use among older adults from Hispanic/Latino backgrounds. Understanding determinants of hearing aid use in the rapidly growing Hispanic/Latino population will guide patient education programs and interventions to address the needs of older Hispanic/Latino adults living with hearing loss in the US. Further, the results of this work may influence audiological services for older Hispanic/Latino adults in clinical settings by increasing the cultural competence of providers.

The overall purpose of this dissertation is to describe the relationships between hearing loss, hearing difficulties, and hearing aid use among older Hispanic/Latino adults. The specific aims of this dissertation are as follows:

- To understand relationships between subjective hearing difficulties, perceived need, and objectively measured hearing sensitivity

- To describe hearing aid uptake and use among a large group of adults from different Hispanic/Latino backgrounds
- To identify factors related to hearing aid uptake in adults from Hispanic/Latino backgrounds aged 45 years and older with at least a mild hearing loss in either ear

Using the Andersen framework as a guide, I address the specific aims of the dissertation in two studies, which ask the following research questions.

Study 1 Research Questions

- What is the relationship between objectively measured hearing loss, perceived hearing loss, and perceived need among older adults from Hispanic/Latino backgrounds?
    a. *Hypothesis*: Individuals with poorer objectively measured hearing loss will report greater perception of hearing loss.
    b. *Hypothesis*: Individuals with poorer objectively measured hearing loss will report greater perceived need.
- Among older adults from Hispanic/Latino backgrounds, are demographic and acculturation variables related to perceived need?
    a. *Hypothesis*: Older age, female sex, and higher acculturation will be associated with greater perceived need, independent of objectively measured hearing loss.

Study 2 Research Questions

- What is the prevalence of hearing aid uptake among older adults from Hispanic/Latino backgrounds?
    a. *Hypothesis:* Hearing aid use will not be more prevalent among older adults from Hispanic/Latino backgrounds than currently published estimates.
- Among older adults from Hispanic/Latino backgrounds, what factors predict hearing aid use?
    a. *Hypothesis*: Poorer objectively measured hearing loss, greater perceived hearing loss, greater perceived need, older age, female sex, and higher acculturation will be associated with increased hearing aid use.
    b. *Hypothesis:* Perceived need and hearing aid use will vary by degree of acculturation.

Figure 2 displays the variables and outcomes included in these two studies within the framework of the Andersen model. The dissertation research questions will be answered through completing large data analysis, using survey data collected as part of the Hispanic Community Health Study(HCHS)/Study of Latinos (SOL) (LaVange et al., 2010). The next chapter describes the study design, sampling methodology, and cohort selection of the HCHS/SOL in detail. A chapter follows the two studies that reviews the findings, relates them to the current body of literature on hearing health care use, and discusses implications for research, clinical practice, and education.

Chapter 4: The Hispanic Community Health Study/Study of Latinos

Background and Sampling Design

The HCHS/SOL is a community based prospective cohort study of 16,415 Hispanic/Latino persons aged 18-74 years at screening from randomly selected households in four U.S. field centers (Chicago, IL; Miami, FL; Bronx, NY; San Diego, CA) with baseline examination (2008 to 2011) and yearly telephone follow-up assessment for at least three years. The HCHS/SOL cohort includes participants who self-identified as having Hispanic/Latino background, the largest groups being Central American (n=1,732), Cuban (n=2,348), Dominican (n=1,473), Mexican (n=6,472), Puerto-Rican (n=2,728), and South American (n=1,072). The goals of the HCHS/SOL are to describe the prevalence of risk and protective factors for chronic conditions (e.g. cardiovascular disease (CVD), diabetes and pulmonary disease), and to quantify all-cause mortality, fatal and non-fatal CVD and pulmonary disease, and pulmonary disease exacerbation over time. The baseline clinical examination (Sorlie et al., 2010) included comprehensive biological (e.g., anthropometrics, blood draw, oral glucose tolerance test, ankle brachial pressure index, electrocardiogram), behavioral (e.g. dietary intake assessed with two 24-hour recalls, physical activity assessment by accelerometer and self-report, overnight sleep exam for apneic events, tobacco and alcohol assessed by self-report), and socio-demographic (e.g., socioeconomic status, migration history) assessments. The HCHS/SOL is particularly suited to addressing questions related to hearing loss and hearing health care use among older adults from

Hispanic/Latino backgrounds, as it includes a full audiometric test battery, a comprehensive hearing health questionnaire, and information on hearing aid use for all included participants.

The sample design and cohort selection has been previously described (LaVange et al, 2010). Briefly, a stratified two-stage area probability sample of household addresses was selected in each of the four field centers. The first sampling stage randomly selected census block groups with stratification based on Hispanic/Latino concentration and proportion of high/low socio-economic status. The second sampling stage randomly selected households, with stratification, from US Postal Service registries that covered the randomly selected census block groups. Both stages oversampled certain strata to increase the likelihood that a selected address yielded a Hispanic/Latino household. After households were sampled, in-person or telephone contacts were made to screen eligible households and to roster its members. Lastly, the study oversampled the 45-74 age group (n=9,714, 59.2%) to facilitate examination of target outcomes. As a result, participants included in HCHS/SOL cohort were selected with unequal probabilities of selection, and these probabilities need to be taken into account during data analysis to appropriately represent the target population. HCHS/SOL sampling weights are the product of a “base weight” (reciprocal of the probability of selection) and three adjustments: 1) non-response adjustments made relative to the sampling frame, 2) trimming to handle extreme values (to avoid a few weights with extreme values being overly influential in the analyses), and 3) calibration of weights to the 2010 U.S. Census according to age, sex and Hispanic background.

HCHS/SOL target population

The HCHS/SOL target population is defined as all non-institutionalized Hispanic/Latino adults aged 18-74 years and residing in the defined geographical areas (census block groups) across the four participating field centers. The choice of the census block groups was designed to provide diversity among cohort participants with regard to socioeconomic status and national origin or background. HCHS/SOL participants were selected using a probability sampling design within these areas to provide a representative sample of the target population. In order to recruit Spanish or English speaking individuals who self-identify with belonging to a Hispanic/Latino background, participants were asked the following question during screening: “Do you consider yourself to be Hispanic/Latino?”

Chapter 5: Study 1 – Objective versus subjective ratings of hearing ability in older adults from Hispanic/Latino backgrounds: Findings from the Hispanic Community Health Study/Study of Latinos

Abstract

Objective. To understand the relationships between objectively measured hearing and subjectively measured hearing difficulties among older Hispanic/Latino adults, and to determine if acculturation variables are associated with subjective hearing loss. ***Design***. A cross sectional analysis of audiometric and survey data. ***Study sample***. Data came from 6970 adults aged 45 to 74 years from various Hispanic/Latino backgrounds included in the Hispanic Community Health Study/Study of Latinos. ***Results***. Significant correlations were found between measured pure tone averages (500, 1000, 2000, and 4000 Hz) and self-reported hearing loss as well as Hearing Handicap Inventory – Screening results. Higher Hearing Handicap Inventory – Screening results were characterized by younger age, poorer measured pure tone averages, male sex, lack of health insurance, and higher Short Acculturation Scale for Hispanics language subtest scores (tending more towards English). ***Conclusions*****.** Similar to other populations, adults from Hispanic/Latino backgrounds are more likely to report perceived hearing difficulties if measured hearing is poorer. A tendency towards English as measured by the Short Acculturation Scale for Hispanics characterized subjective hearing loss, but not social acculturation or Hispanic/Latino background.

Introduction

Examining the relationships between hearing loss, perceived hearing difficulties, and demographic variables among adults from Hispanic/Latino backgrounds is a first step towards understanding hearing health care use in this population. Greater perceived hearing difficulty is significantly related to hearing aid use (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Garstecki & Erler, 1998; Gopinath et al., 2011; Knudsen et al., 2010), but studies investigating this relationship do not include enough participants from Hispanic/Latino backgrounds to draw conclusions about this population. While we know that older age, female sex, and poorer measured hearing are associated with greater perceived hearing difficulty in White, non-Hispanic/Latino populations, we must examine these relationships in people from Hispanic/Latino backgrounds before we can understand the hearing health care use of this population. Further, research on health care utilization among adults from Hispanic/Latino backgrounds suggests that language and culture may influence health care use (Lara, Gamboa, Kahramanian, Morales, & Hayes Bautista, 2005; Leclere, Jensen, & Biddlecom, 1994; Shaw, Huebner, Armin, Orzech, & Vivian, 2009; Solis, Marks, Garcia, & Shelton, 1990; Wells, Golding, Hough, Burman, & Karno, 1989; Zambrana & Carter-Pokras, 2010).

The concept of “acculturation” originates from a sociological context; stemming from the idea that immigrant ethnic groups undergo an inevitable and unidirectional process as they assimilate to the new “host” or “core” culture (Lara et al., 2005). Those who fully assimilate, thus abandoning their native culture, are then accepted to the core society. In the area of health, acculturation is largely viewed as a bidirectional process.

In other words, individuals do not abandon their native cultural identity; instead, acculturation occurs along a continuum, with most individuals maintaining some aspects of their cultural identity (Lara et al., 2005).

Studies of acculturation demonstrate that it is difficult to measure, and much individual variability exists (Lara et al., 2005). The majority of acculturation measures include language factors as primary indicators, which Solis et al. (1990) argue is related to language access; differences in health care use are not necessarily due to cultural differences. Other studies cite language access as a significant barrier to health care use in adults from Hispanic/Latino backgrounds (Fiscella, Franks, Doescher, & Saver, 2002; Leclere et al., 1994). Given the difficulty in measurement, and the high degree of variability, much of the literature concerning acculturation is mixed; however, two major trends are evident: (1) higher acculturation leads to poorer health outcomes with regard to lifestyle (e.g., nutrition, exercise, substance abuse); and (2) higher acculturation is related to improved access to health care (e.g., higher rates of insurance coverage) and use of preventative health services (e.g., cancer screenings) (Lara et al., 2005; Wells et al., 1989; Zambrana & Carter-Pokras, 2010). In light of these mixed findings, Lara et al. (2005) suggest the use of acculturation measures in research, to gain a better understanding of the relationships between language, culture, access, health care use, and health care outcomes.

In sum, numerous gaps exist in the current knowledge about hearing health care use among older adults from Hispanic/Latino backgrounds. To address these gaps, Study 1 will examine the relationships between age, sex, hearing loss severity,

language and culture, and perceived need, by focusing on the following research questions:

- What is the relationship between objectively measured hearing loss, perceived hearing loss, and perceived need among older adults from Hispanic/Latino backgrounds?
    a. *Hypothesis*: Individuals with poorer objectively measured hearing loss will report greater perception of hearing loss.
    b. *Hypothesis*: Individuals with poorer objectively measured hearing loss will report greater perceived need.
- Are demographic and acculturation variables related to perceived need among older adults from Hispanic/Latino backgrounds?
    a. *Hypothesis*: Older age, female sex, and higher acculturation will be associated with greater perceived need.

Method

Data Set

HCHS/SOL baseline data collected at the four test centers from 2008 – 2011 was analyzed as part of this study (described in detail in Chapter 4).

Participants

See Chapter 4 for a detailed description of sampling strategy and participants included in the HCHS/SOL. Study 1 analysis and results are from 6970 adults.

***Inclusion criteria for the current study*.** For Study 1, specific inclusion criteria were individuals between 45 and 74 years of age from the following Hispanic groups: Central American, Cuban, Dominican, Mexican, Puerto-Rican, South American, and

Mixed/Other. Only individuals who underwent hearing testing with appropriate use of insert earphones and masking were included. Individuals with profound hearing losses (PTA > 90 dB HL) or history of acoustic neuroma, Meniere's disease, cholesteatoma, or otosclerosis were excluded.

Measures

Hearing measures. All HCHS/SOL participants underwent a full audiometric test battery and completed a hearing health history questionnaire at the time of the baseline visit. Participants additionally completed the Hearing Handicap Inventory-Screening (HHI-S) questionnaire (Lichtenstein et al., 1988; Ventry & Weinstein, 1982). The following hearing measures were included in Study 1:

***Objectively measured hearing loss*.** To obtain thresholds, participants were tested in a sound-treated booth using a Grason-Stradler Instruments 61 clinical audiometer and TDH-50 supra-aural headphones. E-A-R 3A insert earphones were used as needed. Pure tone air conduction thresholds were measured at octaves between 500 and 8000 Hz. Pure tone bone conduction thresholds were measured at 500, 2000, and 4000 Hz. Masking was used as needed. Better-ear pure tone averages (PTA) at 500, 1000, 2000, and 4000 Hz were used for the current study.

Perceived hearing loss. Perceived hearing loss was measured in participants by asking a single self-report yes/no question during the hearing health history intake, "*Do you feel you have a hearing loss?"* Perceived hearing loss was a primary outcome measure of Study 1. Previous research demonstrated that in Hispanic/Latino adults, sensitivity and specificity for the question, "Do you feel you have a hearing loss?" was

75.7% and 72.7%, respectively. Accuracy of this question compared to pure tone audiometry results was 74.6%..

Perceived need. Perceived need was operationalized using results from the HHI-S (Lichtenstein et al., 1988; Ventry & Weinstein, 1982). The HHI-S is a highly reliable (r = .97) 10-item questionnaire that measures perceived hearing impairment. HHI-S scores can range from 0 to 40 with higher scores indicating greater self-perceived handicap. A cutoff score of 10 is suggestive of clinically-significant hearing problems (American Speech-Language-Hearing Association, 1997). A separate version for adults and elderly were administered based on age (adults aged 65 and older received the elderly version. The adult and elderly version differ on one item, with the adult version asking about hearing difficulties in the workplace and the elderly version asking about difficulties hearing a whispered voice). HCHS/SOL participants who preferred Spanish as a primary language received the cross-culturally adapted version of the HHI-S (Lichtenstein & Hazuda, 1998). The Spanish-language HHI-S has demonstrated high correlation (r = .89) and test equivalence with the English-language version (Lichtenstein & Hazuda, 1998). HHI-S score was a primary outcome measure of Study 1.

Demographic variables. In addition to age in years and sex, the following demographic measures were included as covariates in Study 1:

Hispanic/Latino group. HCHS/SOL self-identified with one of seven different Hispanic/Latino groups: Dominican, Central American, Cuban, Mexican, Puerto-Rican, South American, or Mixed/Other.

Education level. A three-level variable was used to represent education: (1) Less than high school; (2) high school or equivalent; or (3) greater than high school or equivalent.

Health insurance status. Health insurance status for the current study was measured as (1) insured or (2) not insured.

Annual household income. A five-level variable represented annual income: (1) less than $10,000; (2) $10,001 to $20,000; (3) $20,001 to $40,000; (4) $40,001 to $75,000; or (5) more than $75,000.

State of residence. Test center was used as a proxy for state of residence. Four test centers were located in the following cities: (1) Chicago, IL; (2) Miami, FL; (3) Bronx, NY; and (4) San Diego, CA.

Language and culture variables. The HCHS/SOL contains variables addressing language and culture, and two measures of acculturation from the Short Acculturation Scale for Hispanics (SASH) (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). The SASH is one of the most widely used measures of acculturation and assesses language use, media, and ethnic/social relations (Thomson & Hoffman-Goetz, 2009). The SASH is a 12-item scale with an overall test reliability of $r = .92$ (Ellison, Jandorf, & Duhamel, 2011; Thomson & Hoffman-Goetz, 2009) that distinguishes Hispanic/Latinos from non-Hispanic/Latinos (Thomson & Hoffman-Goetz, 2009). Items are scored on a 5-point Likert scale ranging from “Only Spanish” to “Only English” or “Very Latino/Hispanic” to “Very American”, and higher scores suggest greater degrees of acculturation. Further, the SASH does not rely on sociodemographic proxies as estimates of acculturation, making it a preferred tool for measurement (Lara

et al., 2005). For the current study, we used the SASH language and social subtest scores to address the contributions of language and culture to the relationships between hearing loss, other demographic variables, and perceived need. The SASH language subtest consists of five items measuring proficiency and preferences for speaking Spanish versus English in a variety of environments, and the SASH social subtest consists of four items measuring the preferred ethnicity of friends, visitors, and other acquaintances of the respondent (Marin et al., 1987). The test reliability of the SASH language and social subtests are r = .90 and r = .78, respectively (Marin et al., 1987).

Statistical analysis

Prior to any analyses, an examination of normality among the included continuous variables and missing data patterns was completed. Continuous variables (age and pure tone average of the better ear) were examined for normality. Using criteria for sample sizes > 300 defined by Kim (2013), neither age nor pure tone average of the better ear demonstrated absolute skewness values >2. A visual inspection of QQ plots for each continuous variable depicted no specific patterns of deviation. An examination of the correlation matrix for the variables of interest revealed primarily low, but no greater than a moderate correlation between any of the variables. An assessment of variance inflation and tolerance revealed no evidence of multicollinearity between any of the variables of interest. Evaluation of missing data revealed a non-monotonic missing pattern of greater than 5% of the total sample. Multiple imputation was performed for variables used in the analysis models. A three-step imputation procedure was completed. First, the imputation model (including the outcome variables and the main variables of interest) was fit to generate ten complete

data sets using a discriminant analysis method to account for the categorical variables in the model (Horton & Lipsitz, 2001). Second, the analysis models were run using the imputed data sets. Finally, the results of the ten separate analyses for each model were combined using Rubin's rule (2004) to account for imputation uncertainty and to generate appropriate standard errors and confidence limits.

Following the examination of normality and addressing missing data, statistical analysis included calculation of correlations to determine relationships between the variables of interest, and multiple linear regression modeling estimating of variables associated with HHI-S scores. Age-adjusted means for the target population of Hispanic/Latinos in the four HCHS/SOL communities were calculated using survey linear regression weighted least squares, adjusting each subgroup to the age distribution of the target population (age 45 years and older). All the analyses were performed using SAS 9.4 software (SAS Institute, Cary, NC).

Results

Demographics

Table 1.1 displays the unweighted descriptive characteristics of included study individuals. The final analytic sample consisted of 6970 individuals. The number of individuals within each Hispanic/Latino group ranged from 155 – 2578, with the most identifying as Mexican and the least identifying as Mixed/Other. Among included individuals, 64% were female and the average age was about 56. The majority of the sample (63.1%) had an average reported income of between $10,001 and $40,000, and reported having some form of health insurance coverage (57%). Most included individuals reported either less than high school education (39%) or more than high

school education or equivalent (39%). The average SASH Language and Social subscales score for all individuals were 1.76 and 2.14, respectively, consistent with the average scores of first-generation US residents Hispanic/Latino backgrounds in previous research (Marin et al., 1987), suggesting that those included in the current study tend towards thinking and speaking in Spanish and prefer social contacts from Hispanic/Latino backgrounds.

The distribution of included individuals was fairly even across the four test sites (range 22.8% - 29.2%), with the most sampled from Miami, FL (*n* = 2035). The Bronx, NY sample consisted primarily of those identifying as Dominican (*n* = 505) and Puerto-Rican (*n* = 811), the Chicago, IL sample consisted primarily of those identifying as Puerto-Rican (*n* = 352) and Mexican (*n* = 861), the Miami, FL sample consisted primarily of those identifying as Cuban (*n* = 1219), and the San Diego, CA sample consisted of those identifying as Mexican (*n* = 1666). Results do not generalize to the entire US Hispanic/Latino population but rather to those living in the four metropolitan areas had they followed the same age-distribution as from the US 2010 Census.

Relationships between Objectively Measured Hearing Loss, Perceived Hearing Loss, and Perceived Need

To address our first research question, we examined the relationships between (a) measured hearing loss and perceived hearing loss, and (b) measured hearing loss and perceived need. We hypothesized that adults with poorer measured hearing would be more likely to self-report a hearing loss and greater perceived need. A point-biserial correlation was conducted between the objectively measured pure tone average of the better ear and responses (no/yes) to the question, "*Do you feel you have a hearing*

loss?" Of the 6970 included individuals, 1866 (approximately 26%) responded "yes" to this item. A weak positive correlation was found, $r_{pb}(6968) = .07$, $p < .001$. In line with our hypothesis, poorer measured pure tone average was related to perceived hearing difficulty.

A Pearson correlation was conducted to examine the relationship between objectively measured pure ton average of the better ear and perceived need (as measured by the HHI-S total score) in adults with at least a mild hearing loss (PTA of 25 dB or greater) in either ear ($n = 1601$). A weak positive correlation was found, $r^2(1599) = .28$, $p < .001$. Further confirming our hypotheses, greater perceived need reported on the HHI-S was related to poorer measured pure tone averages. Table 1.2 displays mean HHI-S scores by Hispanic/Latino group for included individuals with at least a mild hearing loss in one ear.

Relationship between Demographic Variables and Perceived Need

To address our second research question, we explored how perceived need, as measured by HHI-S total scores, was influenced by objectively measured pure tone hearing, demographic variables, and language and culture variables (SASH Language and Social subscores). We hypothesized that poorer hearing, older age, female sex, and higher SASH scores would be associated with higher HHI-S scores. To determine this, we fit a multiple regression model including measured PTA of the better ear, age in years, sex, education, income, health insurance status, city of residence, SASH Language and Social subscales, and self-reported Hispanic/Latino background. The model results revealed that measured hearing loss, age, sex, health insurance status, and SASH language scores were significantly associated with higher perceived need,

accounting for approximately 10 percent of the overall variance. Specifically, the results confirmed our hypotheses in that poorer hearing and higher SASH language scores were significantly associated with higher HHI-S scores. However, in contrast to our hypothesis, male sex and younger age also significantly characterized higher HHI-S scores. While we did not specifically hypothesize how other demographic variables would contribute to the overall solution, a self-report of no current health insurance was associated with higher HHI-S scores. Further, residence in Chicago, IL was significantly related to lower HHI-S scores compared to the reference category of San Diego, CA. Detailed results from the fit model are displayed in Table 1.3.

Discussion

The first step in investigating hearing aid use of older adults from Hispanic/Latino backgrounds is understanding the relationships between factors known to influence hearing aid uptake in other populations. As discussed in Chapter 1, a large body of literature suggests robust associations between measured hearing loss and perception of hearing loss, and measured hearing loss and perception of need (Agrawal, Platz, & Niparko, 2008; Fischer et al., 2011; Garstecki & Erler, 1998; Gopinath et al., 2011; Kamil et al., 2015; Knudsen et al., 2010; Meyer & Hickson, 2012; Pugh & Crandell, 2002). These three variables, as well as cost/income (Bainbridge & Ramachandran, 2014; Garstecki & Erler, 1998; Gopinath et al., 2011; Nieman et al., 2016) and education (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Garstecki & Erler, 1998; Knudsen et al., 2010; Lin, Thorpe, et al., 2011; Meyer & Hickson, 2012; Popelka et al., 1998), are additionally associated with hearing aid use, but the majority of studies investigating these relationships focus on White, non-Hispanic/Latino samples. Before

examining variables related to the occurrence of hearing aid use among adults from Hispanic/Latino backgrounds, we sought to determine if relationships between objectively measured hearing loss, perceived hearing loss, and perceived need were similar to those of other populations reported in the literature. We further sought to determine whether demographic (including acculturation) variables were related to perceived need.

The Andersen model (Figures 1 and 3) drove our hypotheses, which were largely confirmed by the results. We found significant correlations between measured PTA and a single-item self-report of hearing loss and HHI-S scores. Further, relationships between demographic variables, measured PTA, and HHI-S scores were as expected: adults from Hispanic/Latino backgrounds with poorer objectively measured hearing, and higher degrees of acculturation as measured by the SASH Language subtest reported higher perceived need as measured by the HHI-S. In contrast to our hypothesis, male sex and younger age in years were significantly associated with higher HHI-S scores. It is possible that males in this group were more likely to have occupations that involved noise exposure, and were more attuned to long-term hearing problems. Regarding age, middle aged to older adults from Hispanic/Latino backgrounds may be more sensitive to hearing difficulties than old-older adults. This finding is consistent with recent studies suggesting that while younger age is associated with better hearing, it is also associated with greater perceived hearing loss, with younger participants being more likely to overestimate their hearing problems (Kamil et al., 2015), and more likely seek out a hearing test due to perceived hearing difficulties (Arnold et al., under review; Torre et al., 2006).

We did not hypothesize about the influence of health insurance status or city of residence, but these variables were also associated with higher perceived need (HHI-S scores). According to the Andersen model, enabling factors such as health insurance, can influence an individual's symptom appraisal (Andersen & Newman, 2005). A lack of health coverage, and thus the inability to seek out help for hearing difficulties could result in appraisal differences, since individuals without coverage are unable to have their needs addressed. The model also recognizes the contribution of social structure and community on symptom appraisal, and our results suggest that differences in structure and community between Chicago and San Diego account for part of the variability in HHI-S scores between individuals living in these cities. A discussion of the access factors that may contribute to this difference is beyond the scope of Study 1; however, Study 2 will investigate this relationship further with regard to hearing aid uptake. Taken together, the results of Study 1 do suggest the Andersen model is an appropriate framework for explaining a small, yet significant proportion of the variance for HHI-S results among the current included sample.

Compared to previous studies, we found similar patterns of scores on the HHI-S based on measured hearing loss (Lichtenstein et al., 1988; Newman, Weinstein, Jacobson, & Hug, 1991), but overall lower scores for Hispanics/Latinos compared to Whites. Newman et al. (1991) reported a total HHI-S score of 13.7 among older participants (race/ethnicity not reported) with hearing loss (mean PTA: better ear = 24 dB HL; worse ear = 29 dB HL). In a study investigating the use of the HHI-S as a screening tool for detecting hearing loss among older adults included in the Framingham Heart Study, Gates, Murphy, Rees, and Fraher (2003) reported a mean

HHI-S score of 8.65 for older adults (race/ethnicity not reported) with hearing loss. The current study revealed a mean total HHI-S score of 5.3 for participants with hearing loss (mean PTA: better ear = 29 dB HL; worse ear = 35 dB HL. These contrasting results suggest differences in perceived hearing disability for those with hearing loss between previously studied populations and the current included sample from the HCHS/SOL. Future studies comparing HHI-S responses from different populations are recommended to further explore these discrepancies.

Finally, the variables of interest accounted for a small percentage (10%) of the overall variance; and while the relationships revealed between demographics, measured hearing loss, and HHI-S scores were similar to other populations reported in the literature, there is still much left to learn. SASH Language subtest scores and health insurance contributed significantly to the solution. Higher scores on the HHI-S (more perceived need) was associated higher levels of acculturation for language. This result is consistent with findings from previous studies that demonstrated better use of preventative and screening services, suggesting that perhaps individuals who have higher English proficiency may be able to better express health care needs to providers and receive necessary referrals (DuBard & Gizlice, 2008; Fiscella et al., 2002; Lara et al., 2005; Solis et al., 1990). A lack of health insurance was also associated with higher HHI-S scores; however, lack of health coverage is an access and not an acculturation issue. Although language is commonly interpreted as an acculturation factor, some authors argue that language alone is more of an access factor (Jacobs, Chen, Karliner, Agger-Gupta, & Mutha, 2006; Solis et al., 1990). Taken together, these results suggest differences in access may contribute to differences in understanding and reporting

symptoms of hearing loss. We plan to further examine these access variables and their relationship with hearing aid use in Study 2.

Study 1 Tables and Figures

Table 1. Demographic Characteristics of Included HCHS/SOL Individuals

Measure	Hispanic/Latino Background															
	Dominican (n=552)		Central American (n=740)		Cuban (n=1245)		Mexican (n=2578)		Puerto Rican (n=1222)		South American (n=478)		Mixed/ Other (n=155)		Total (n=6970)	
	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)
Age	55.2	0.49	55.3	0.45	58.0	0.33	54.7	0.28	56.8	0.42	55.6	0.54	55.4	1.11	56.17	0.17
Sex (female)	(385)	(70.0)	(500)	(67.6)	(696)	(56.0)	(1744)	(68.0)	(762)	(62.3)	(309)	(64.6)	(95)	(61.2)	(4491)	(64.4)
Education																
Less than HS	(271)	(48.8)	(314)	(41.0)	(320)	(28.2)	(1321)	(48.3)	(524)	(41.9)	(131)	(24.8)	(44)	(23.2)	(2925)	(38.9)
HS or equivalent	(96)	(16.9)	(142)	(18.6)	(331)	(25.4)	(479)	(17.7)	(300)	(22.3)	(110)	(26.2)	(21)	(25.3)	(1497)	(21.4)
Greater than HS	(185)	(34.3)	(283)	(40.4)	(594)	(46.4)	(770)	(34.0)	(397)	(35.8)	(237)	(49.0)	(79)	(51.5)	(2545)	(39.7)
Missing															(21)	(0.01)
Health insured	(429)	(77.1)	(267)	(40.2)	(493)	(46.9)	(1277)	(52.2)	(1016)	(83.2)	(185)	(43.9)	(83)	(62.0)	(3750)	(57.2)
Missing															(39)	(1.0)
Annual income																
Less than $10K	(112)	(21.8)	(108)	(15.2)	(262)	(24.3)	(299)	(13.3)	(245)	(21.6)	(66)	(15.1)	(23)	(13.2)	(1115)	(18.8)
$10,001 – 20,000	(180)	(35.4)	(260)	(41.7)	(384)	(36.7)	(713)	(27.4)	(364)	(31.3)	(153)	(31.6)	(33)	(23.0)	(2087)	(32.4)
$20,001 – 40,000	(160)	(32.0)	(202)	(30.1)	(307)	(26.8)	(905)	(33.7)	(293)	(28.1)	(155)	(34.9)	(46)	(42.4)	(2068)	(30.7)
$40,001 – 75,000	(50)	(10.0)	(66)	(10.0)	(81)	(8.6)	(362)	(16.9)	(154)	(12.3)	(62)	(14.5)	(23)	(13.7)	(798)	(12.5)
Greater than $75K	(4)	(0.8)	(16)	(3.0)	(33)	(3.6)	(110)	(8.7)	(69)	(6.7)	(12)	(3.9)	(9)	(7.7)	(253)	(5.6)
Missing															(649)	(0.1)
State of residence																
Bronx, NY	(505)	(91.5)	(88)	(12.0)	(15)	(1.2)	(37)	(1.4)	(811)	(66.4)	(87)	(18.2)	(47)	(30.3)	(1590)	(22.8)
Chicago, IL	(11)	(2.0)	(172)	(23.2)	(10)	(0.07)	(861)	(33.4)	(352)	(28.8)	(142)	(29.7)	(26)	(16.8)	(1574)	(22.6)
Miami, FL	(35)	(6.0)	(449)	(60.7)	(1219)	(98.0)	(14)	(0.6)	(41)	(3.3)	(231)	(48.3)	(46)	(29.7)	(2035)	(29.2)
San Diego, CA	(1)	(.05)	(31)	(4.2)	(1)	(0.01)	(1666)	(64.6)	(18)	(1.5)	(18)	(3.8)	(36)	(23.2)	(1771)	(25.4)
SASH language	1.46	0.03	1.43	0.05	1.36	0.02	1.74	0.04	2.74	0.07	1.54	0.04	1.98	0.16	1.76	0.03
Missing															(16)	(0.1)
SASH social	2.12	-.03	2.04	0.03	1.93	0.02	2.11	0.02	2.51	0.03	2.19	0.04	2.31	0.10	2.14	0.02
Missing															(350)	(0.5)

Note. Table 1 depicts unweighted sample statistics of the target population. For columns designating Hispanic/Latino classification groups, numbers in parentheses reflect within-group percentages and *n*. HCHS/SOL = Hispanic Community Health Study/Study of Latinos; HS = High school; NY = New York; IL = Illinois; FL = Florida; CA = California; SASH = Short Acculturation Scale for Hispanics. Source: Authors' analysis of HCHS/SOL baseline data. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

Table 2. Mean HHI-S Scores of Older Adults by Hispanic/Latino Background

Group	Mean	SE
Dominican	3.8	0.80
Central American	5.6	1.27
Cuban	4.4	0.57
Mexican	7.1	0.88
Puerto-Rican	5.3	0.69
South American	5.6	1.35
Mixed/Other	4.2	2.54
Total	5.3	0.34

Note. Table 2 depicts HHI-S total mean scores and standard errors across Hispanic/Latino backgrounds. (*n* = 1601). HHI-S = Hearing Handicap Inventory – Screening questionnaire. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

Table 3. Summary of Multiple Linear Regression Analysis Characterizing HHI-S Scores

Variable	*B*	95% CI
PTAB	0.20**	[0.17, 0.24]
Age	-.0.04*	[-0.01, -0.07]
Sex	0.92**	[0.47, 1.37]
Education		
Less than high school	0.48	[-0.04, 1.01]
High school or equivalent	-0.32	[-0.79, 0.15]
Greater than high school or equivalent	Reference	Reference
Annual Income		
Less than $10,000	0.67	[-0.26, 1.61]
$10,001 - $20,000	0.36	[-0.46, 1.18]
$20,001 - $40,000	0.22	[-0.63, 1.07]
$40,001 - $75,000	0.30	[-0.61, 1.21]
Greater than $75,000	Reference	Reference
Health Insured	-0.63*	[-1.12, -0.14]
City of Residence		
Bronx, NY	-0.51	[-1.44, 0.42]
Chicago, IL	-0.68*	[-1.29, -0.07]
Miami, FL	-0.45	[-1.39, 0.50]
San Diego, CA	Reference	Reference
SASH Language	0.67**	[0.37, 0.98]
SASH Social	-0.42	[-0.93, 0.10]
Hispanic/Latino Background		
Dominican	-0.76	[-1.91, 0.39]
Central American	0.18	[-1.09, 1.45]
Cuban	-0.86	[-2.12, 0.41]
Mexican	-0.37	[-1.52, 0.79]
Puerto-Rican	-0.43	[-1.59, 0.73]
South American	0.12	[-1.14, 1.38]
Mixed/Other	Reference	Reference

Note. Table 3 displays variables that characterize HHI-S total scores from survey regression analysis. *p < .01; **p < .001. HHI-S = Hearing Handicap Inventory – Screening questionnaire; PTAB = pure tone average, better ear; SASH = Short Acculturation Scale for Hispanics. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

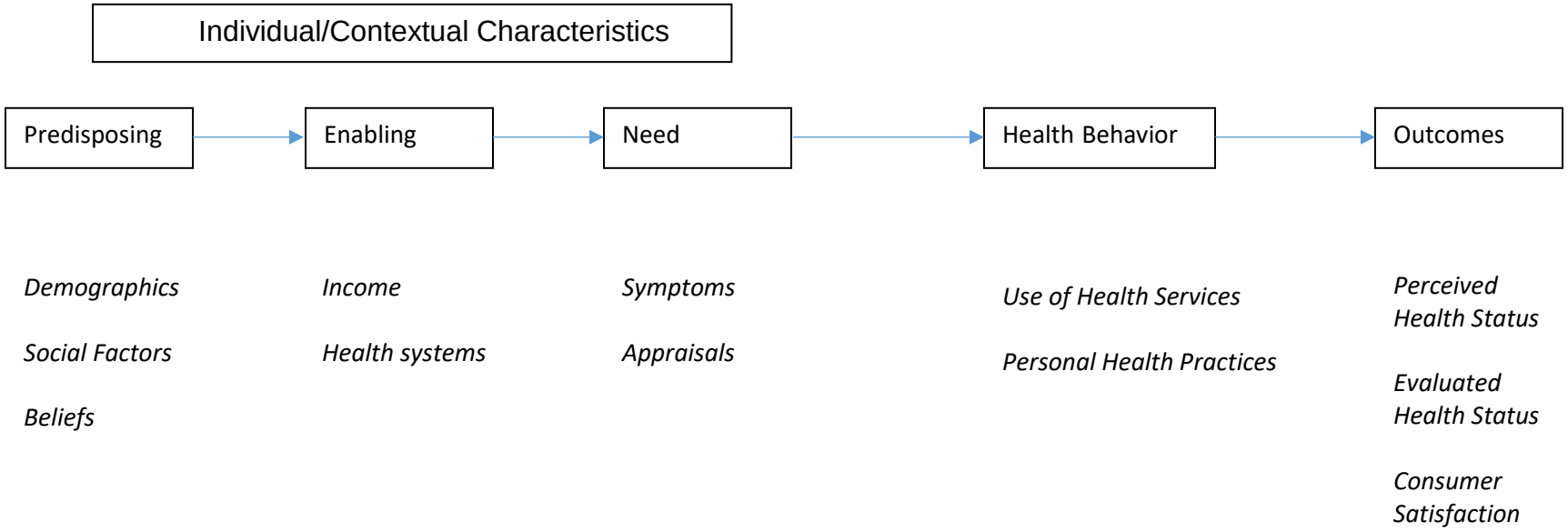

Figure 1. The Andersen Model of Health Services Utilization

Note. Figure 1 displays a schematic representation of the Andersen model of health services utilization. So
adaptation of Andersen (1995).

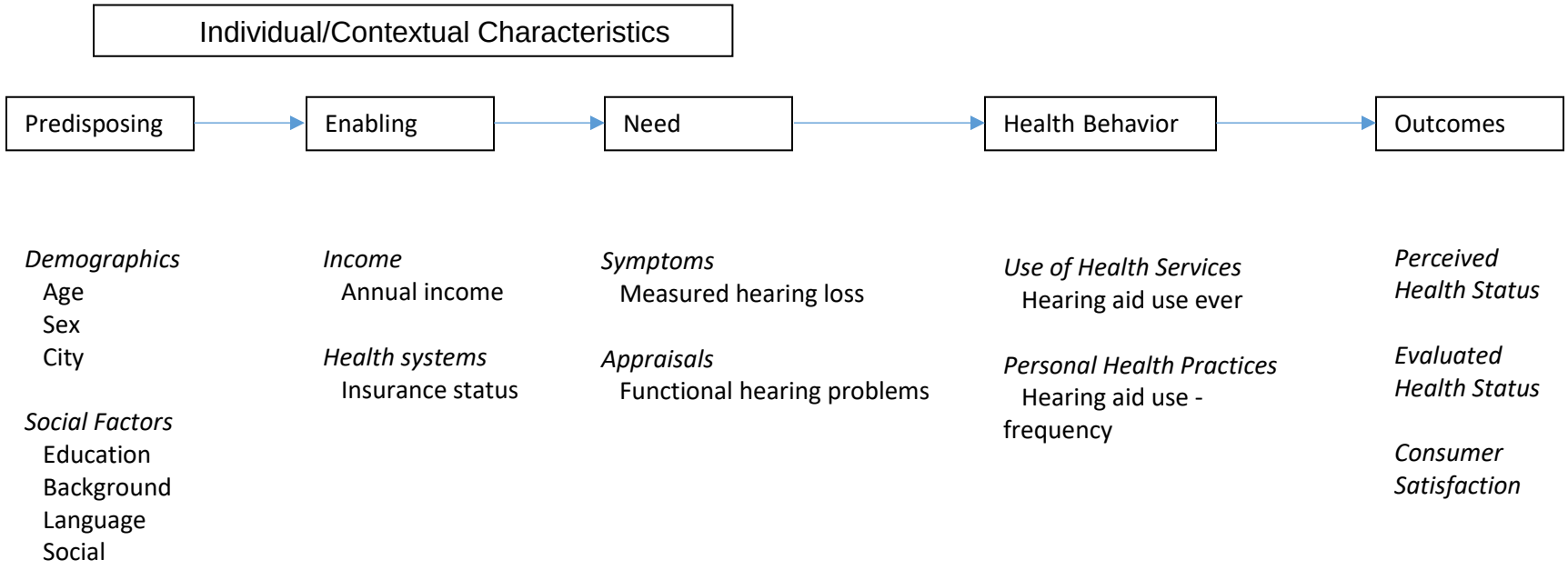

Figure 2. Predisposing, Enabling, and Need Variables and Health Behavior Outcomes for Investigating Hearing Aid Use among Adults from Hispanic/Latino Backgrounds within the Andersen Framework of Health Service Utilization

Note. Figure 1 displays a schematic representation of the Andersen model of health services utilization and different variables of interest related to hearing health care use among Hispanic/Latino adults as they fit within the framework. Source: Author's adaptation of Andersen (1995).

Chapter 6: Study 2 – Factors related to hearing aid use in adults from Hispanic/Latino backgrounds: Findings from the Hispanic Community Health Study/Study of Latinos

Abstract

Objective. To describe hearing aid uptake rates and identify factors that characterize reported hearing aid use among older Hispanic/Latino adults. ***Design***. A cross sectional analysis of audiometric and survey data. ***Study sample***. Data came from 2241 adults aged 45 to 74 with clinically significant hearing loss included in the Hispanic Community Health Study/Study of Latinos. ***Results***. Overall hearing aid uptake rate among included individuals was 3.7%. Reported hearing aid use was characterized by poorer measured pure tone average (500, 1000, 2000, and 4000 Hz) of the better ear, higher Hearing Handicap Inventory – Screening scores, and current health insurance. ***Conclusions*.** Hearing aid uptake rates among included individuals were low compared to rates of clinically significant hearing loss. The primary variable associated with underutilization of hearing aid uptake for those who could pose to benefit was a lack of health insurance.

Introduction

Hearing loss prevalence among over the age of 70, including those from Hispanic/Latino backgrounds, is approximately 63% in the US (Lin, Thorpe, Gordon-Salant, & Ferrucci, 2011). The hearing health care needs of a growing and diverse population are impending: the number of individuals with hearing loss in the US is

expected to grow from 44.11 million in 2020 to 73.5 million in 2060 (Goman, Reed, & Lin, 2017). Negative outcomes related to untreated hearing loss include increased risks for cognitive decline (Lin, Ferrucci, et al., 2011; Lin, Metter, et al., 2011; Lin et al., 2013; Loughrey, Kelly, Brennan, & Lawlor, 2018), falls (Lin & Ferrucci, 2012), and hospitalization (Genther, Frick, Chen, Betz, & Lin, 2013). Hearing loss is also significantly associated with psychosocial adjustment issues and social isolation (Kramer et al., 2002; Weinstein & Ventry, 1982). Considering the costs associated with these outcomes, untreated hearing loss poses a significant public health issue that deserves attention as the aging population in the US grows. Currently, the most efficacious management option for the majority of hearing loss cases is hearing aids, which can improve communication and general health-related quality of life in users (Chisolm et al., 2007; Ferguson et al., 2017). However, hearing aid uptake is relatively low among older adults who could benefit from amplification, with estimates ranging between 14.2 and 33.1 % for those from non-Hispanic/Latino backgrounds (Bainbridge & Ramachandran, 2014; Chien & Lin, 2012; Nash et al., 2013; Popelka et al., 1998).

As discussed in Chapter 1, numerous factors influence hearing aid use. The most commonly identified factors are family income, education, perceived need, and the cost of hearing aids (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Gopinath et al., 2011; Knudsen et al., 2010; Lin, Thorpe, et al., 2011; Meyer & Hickson, 2012; Popelka et al., 1998). However, the majority of available literature focuses on largely White, non-Hispanic/Latino samples. There is a gap in our knowledge of whether help seeking for hearing loss or hearing aid use varies for individuals from minority backgrounds. In particular, few studies have examined acculturation (see Chapter 5 for

a review), such as country of origin, ethnicity, or preferred spoken language and the associations with hearing aid use.

Of the few studies focused on hearing aid use among older adults from Hispanic/Latino backgrounds, findings are mixed. As noted in Chapter 1, data from the HHANES revealed hearing aid use in less than 12% of participants, although hearing loss prevalence ranged from 24 to 48% among adults between the ages of 55 – 74 (Lee et al., 1991; Lee, Gomez-Marin, Lam, & Zheng, 2004). In a follow-up study, Lee et al. (1996) found that Mexican Americans living below the poverty line were over nine times more likely to report hearing aid use. These results are in contrast to other studies that demonstrated relationships between hearing aid uptake to higher levels of income (Bainbridge & Ramachandran, 2014; Garstecki & Erler, 1998; Nieman et al., 2016). The authors suggested the introduction of Medicaid for individuals living below the poverty level as a potential factor influencing hearing aid uptake rates in this study (Lee et al., 1996). Enrollment in Medicare or Medicaid is a potential indicator of greater acculturation among Mexican-American adults given the citizenship requirements necessary to access these programs (Nieman et al., 2016). The findings of Lee et al. (1996) therefore suggest that acculturation may be associated with hearing aid use among adults from Hispanic/Latino backgrounds.

Recent data suggest that hearing aid use among Hispanic/Latino adults is essentially unchanged since the HHANES reports (Lee et al., 1991; Lee et al., 1996). Only 13% (n = 81) of U.S. Hispanic/Latino (primarily from Mexican American backgrounds) older adults report hearing aid use despite a hearing loss prevalence estimated to be 65% (Lin, Thorpe, et al., 2011), and older adults from Mexican

American backgrounds included in the NHANES were 78% less likely to use hearing aids than Non-Hispanic whites (Nieman et al., 2016). However, small numbers of individuals from Hispanic/Latino backgrounds who report hearing aid use was a limitation of these studies. Further, there is poor representation for individuals from Hispanic/Latino backgrounds other than Mexican American.

The purpose of the Study 2 is to describe rates and identify variables that characterize reported hearing aid use among older adults from Hispanic/Latino backgrounds included in the HCHS/SOL (Sorlie et al., 2010). We frame our analysis using Andersen's model of health service utilization for vulnerable populations (Gelberg et al., 2000). The model (Chapter 2) is particularly suited to examine hearing aid use among adults from Hispanic/Latino backgrounds due to its inclusion of predisposing and enabling factors, which incorporate acculturation as a potential predictor of health care use (Andersen, 1995, 2008; Andersen & Newman, 2005; Gelberg et al., 2000). Application of this model may allow the identification of novel barriers and facilitators to hearing aid use among older adults from Hispanic/Latino backgrounds given the current context of demographics and health policies. Understanding determinants of hearing aid use in the rapidly growing Hispanic/Latino population will guide patient education programs and interventions to address the needs of older adults from Hispanic/Latino backgrounds living with hearing loss in the US. Further, the results of this work may influence audiological services for older adults from Hispanic/Latino backgrounds in clinical settings by increasing cultural awareness and competence of providers. We will answer the following research questions as part of Study 2:

- What are the rates of reported hearing aid uptake among older adults from Hispanic/Latino backgrounds?
    a. *Hypothesis:* Hearing aid uptake rates among older adults from Hispanic/Latino backgrounds will not be higher than currently published estimates.
- Among older adults from Hispanic/Latino backgrounds, what factors characterize reported hearing aid use?
    a. *Hypothesis*: Poorer objectively measured hearing loss, greater perceived need, older age, female sex, and higher acculturation will be associated with increased hearing aid use.
    b. *Hypothesis:* Perceived need and hearing aid use will vary by degree of acculturation.

Method

Data Set

HCHS/SOL baseline data collected from 2008 – 2011 was analyzed as part of this study (described in detail in Chapter 4).

Participants

Chapter 4 provides a detailed description of the sampling strategy and participants included in the overall HCHS/SOL. Study 2 analysis and results are from 2241 adults.

***Inclusion criteria for the current study*.** Study 2 included HCHS/SOL participants between 45 and 74 years of age from the following self-identified Hispanic/Latino backgrounds: Dominican, Central American, Mexican, Cuban, Puerto-

Rican, South American, and Mixed/Other. Participants underwent hearing testing at the baseline evaluation, and had at least a mild hearing loss ($\geq$ 25 dB HL) in either ear as measured by the 500, 1000, 2000, or 4000 Hz PTA. The current study focused on hearing aid use among those with likely age-related hearing loss. Therefore, we excluded individuals with profound hearing losses (PTA > 90 dB HL) or history of acoustic neuroma, Meniere's disease, cholesteatoma, otosclerosis, or bilateral conductive hearing losses (as measured by an air-bone gap $\geq$ 15 dB at two or more frequencies in both ears).

Measures

Study 2 utilized the same hearing and demographic measures as Study 1 (Chapter 5), described briefly below.

Hearing measures. All HCHS/SOL participants completed a full audiometric test battery, answered questions related to their hearing health history, and completed the Hearing Handicap Inventory-Screening (HHI-S) questionnaire (Lichtenstein et al., 1988; Lichtenstein & Hazuda, 1998; Ventry & Weinstein, 1982) in their preferred language. See Study 1 (Chapter 5) for a description of measures of objectively measured hearing loss, perceived hearing loss, and perceived hearing need.

***Demographics*.** The following variables were included in Study 2: age in years, sex, self-identified Hispanic/Latino background, education level, health insurance status, annual household income, state of residence, and SASH language and social subtest scores. Study 1 (Chapter 5) provides a description to the measurement of these variables.

***Hearing aid use*.** Four items addressed hearing aid use at the HCHS/SOL baseline examination as part of the hearing health history questions. The yes/no item "*Have you ever worn a hearing aid?*" was the primary dependent variable for the current study. The second item asked, *"In the past 12 months, have you worn a hearing aid?*" with a response of Yes/No. The third item, asked only to participants who responded "Yes" to wearing a hearing aid in the past 12 months, was *"How long have you used a hearing aid?"* Possible responses to the third item ranged from "*less than 6 weeks*" to "*15 years or more*". The fourth hearing aid item, also asked only to those who reported hearing aid use within the past 12 months, was *"In the past 12 months how often did you use a hearing aid?*" Likert responses for the fourth item were on a five-point scale, and were (1) *Always*; (2) *Usually*; (3) *About half the time*; (4) *Seldom*; or (5) *Never*.

Statistical Analysis

We conducted an initial estimation of reported hearing aid rates among included adults, defined by the item *"Have you ever worn a hearing aid?"* Following this step, descriptive statistics were calculated for the remaining three hearing-aid related items.

Prior to performing any further analyses, an evaluation of missing data was performed, revealing a non-monotonic missing pattern of greater than 5% of the total sample. Multiple imputation was performed for variables used in the analysis models. A three-step imputation procedure was completed. First, the imputation model (including the outcome variables and the main variables of interest) was fit to generate ten complete data sets using a discriminant analysis method to account for the categorical variables in the model (Horton & Lipsitz, 2001). Second, the analysis models were run using the imputed data sets. Finally, the results of the ten separate analyses for each

model were combined using Rubin's rule (2004) to account for imputation uncertainty and to generate appropriate standard errors and confidence limits.

Statistical analysis included multiple regression modeling to estimate variables related to the occurrence of hearing aid use. For the categorical response of the item, "*Have you ever used a hearing aid?"* estimates for the target population of Hispanic/Latinos in the four HCHS/SOL communities were calculated using logistic regression, adjusting each subgroup to the age distribution of the target population. Odds ratios and corresponding 95% Wald confidence intervals were estimated by exponentiating the unstandardized beta coefficients and lower and upper confidence limits, respectively.

Results

Demographics

Table 4 displays the unweighted descriptive characteristics of the adults included in the current study. The analytic sample consisted of 2241 adults aged 45 to 74 years old. The number of individuals within each Hispanic/Latino group ranged from 50 – 732, with the most identifying as Mexican and the least identifying as Mixed/Other. Of those included, 50.3% were female and the average age was about 60 years old. The majority of included individuals reported annual income of either between $10,001 and $20,000 (31.7%) or between $20,001 and $40,000 (26.5%) and reported having some form of health insurance coverage (62.3%). Most included individuals reported less than high school education (51.7%). The average SASH language and social subtest score for all individuals were 1.69 and 2.11, respectively, consistent with the average scores of first-generation US residents from Hispanic/Latino backgrounds in previous research (Marin

et al., 1987), suggesting that those included in the current study tend towards thinking and speaking in Spanish and prefer social contacts from Hispanic/Latino backgrounds.

The distribution of included individuals was fairly even across the four test sites (range 21.4% - 28.6%), with the most sampled from Miami, FL (*n* = 640) and the Bronx, NY (*n* = 608). The Bronx, NY sample consisted primarily of persons identifying as Dominican (*n* = 161) and Puerto-Rican (*n* = 358), the Chicago, IL sample consisted primarily of those identifying as Puerto-Rican (*n* = 124) and Mexican (*n* = 262), the Miami, FL sample consisted primarily of those identifying as Cuban (*n* = 417), and the San Diego, CA sample consisted of those identifying as Mexican (*n* = 460). Results do not generalize to the entire U.S. Hispanic/Latino population but rather to those living in the four metropolitan areas had they followed the same age-distribution as from the US 2010 Census.

Hearing Aid Use Rates

To address the first research question of the current study regarding reported hearing aid rates among adults from Hispanic/Latino backgrounds, we estimated hearing aid uptake and use among included individuals using four questionnaire items from the HCHS/SOL baseline examination. Results from the four items that asked about hearing aid use ever and hearing aid use within the past year are below. For individuals who reported hearing aid use within the past year, further information is included regarding the duration and frequency of hearing aid use.

Hearing aid use ever. Among 2241 included individuals with at least a mild hearing loss in either ear, 82 (3.7%) reported ever using a hearing aid. Hearing aid use rates varied across Hispanic/Latino groups, with the smallest proportion of reported use

among those from Central American backgrounds (0.09 %) and the largest proportion of reported use among those from Puerto-Rican backgrounds (4.7 %). Table 5 displays results for self-report of ever using a hearing aid among included individuals.

***Hearing aid use within the past 12 months*.** Of the 82 individuals who reported ever using a hearing aid, the majority (64.6%) reported that they used a hearing aid within the past 12 months (Table 6).

Hearing aid use – how long? The range of possible responses to determine the length of time a hearing aid was used was as follows: (1) less than six weeks; (2) six weeks to eleven months; (3) one to two years; (4) three to four years; (5) five to nine years; (6) ten to fourteen years; (7) greater than 15 years; and (9) don't know. Figure 3 displays results for individuals who reported hearing aid use within the past 12 months (*n* = 53) in total and according to Hispanic/Latino background. The majority of individuals (66%) reported a short duration of hearing aid use (two years or less). Only one person reported hearing aid use of 15 years or greater.

Hearing aid use – how often? The range of possible responses to determine how often a hearing aid was used was as follows: (1) always; (2) usually; (3) about half the time; (4) seldom; (5) never; and (9) don't know. Figure 4 displays results for individuals who reported hearing aid use within the past 12 months (*n* = 53) in total and according to Hispanic/Latino background. The majority of individuals responded that they either always (36%) or seldom (36%) used their hearing aid. Only two individuals (approximately 4%) reported that they never use their hearing aid.

Factors related to hearing aid use

For our second research question, we hypothesized that poorer objectively measured hearing loss, greater perceived need, older age, female sex, and greater acculturation would be associated with a report of ever using a hearing aid. We additionally hypothesized that hearing aid use would be moderated by acculturation variables (SASH language and social subtest scores) and demographic variables (Hispanic/Latino background, hearing loss severity, HHI-S scores).

To determine what factors characterized hearing aid use, we fit a logistic regression model including measured PTA of the better ear, HHI-S score, age in years, sex, education, income, health insurance status, city of residence, SASH language and social subtest scores, and self-reported Hispanic/Latino background. To arrive at a converged model, binary dummy variables were created for annual household income (0 = less than $40,000; 1 = greater than $40,000), Hispanic/Latino background (0 = not from Mexican background; 1 = from Mexican background), and city of residence (0 = not San Diego; 1 = San Diego). Consistent with our hypothesis, results revealed that poorer objectively measured hearing (PTA of the better ear) and greater perceived need (higher HHI-S scores) were significantly related to an increased odds of self-reported hearing aid use – ever (*p*s < .0001). Further, health insurance status related to self-reported hearing aid use (*p* = .03). Included individuals with health insurance were 46% more likely to report hearing aid use – ever than those without insurance. No other demographic variables or measures of acculturation were associated with self-reported hearing aid use. Table 7 displays the odds ratios and 95% confidence intervals from the logistic regression analysis.

In order to test for moderating relationships between reported hearing aid use, perceived need, and acculturation, a simplified logistic regression model was run using interaction terms for SASH language subtest scores, SASH social subtest scores, language preference, and HHI-S scores. There were no significant interactions between any of the included variables (*p*s = .08, .24, and .22, respectively). To determine if moderating relationships existed between hearing aid use and acculturation among hearing aid users, moderated regression was conducted using the ordinal hearing aid questions (*"How long have you used a hearing aid?"* and *"How often did you use a hearing aid?"*), SASH language and social subtest scores, and HHI-S scores. No significant moderating relationships between any of the included variables were revealed.

Discussion

In Study 2, we sought to characterize hearing aid use among adults from Hispanic/Latino backgrounds, aged 45 to 75 years, with clinically significant hearing loss. Of 2,241 included adults who could potentially benefit from hearing aid use, only 82 (3.7%) reported ever doing so, and of those individuals, only 53 reported use within the past 12 months. Further, only about half (*n* = 25) of recent users reporting using hearing aids "Always" or "Usually". Overall, this finding reveals a striking underutilization of hearing health care in the form of hearing aid use among the included adults with hearing loss from Hispanic/Latino backgrounds. For the majority of Hispanic/Latino backgrounds, reported hearing aid use – ever was between 3% and 4%. However, people with hearing loss from Central American backgrounds were far less likely (less than 1%) and those from Puerto Rican backgrounds were slightly more likely (4.7%) to

report hearing aid use. It is difficult to draw conclusions based on Hispanic/Latino background given the small numbers of individuals from each group reporting hearing aid use. Indeed, when estimating factors that characterize hearing aid use in the logistic regression, we had to create a dummy variable for Hispanic/Latino background (Mexican vs. non-Mexican) so we could arrive at a converged solution.

Not surprisingly, measured hearing loss and HHI-S scores were significantly associated with reported hearing aid use. This finding is consistent with a large body of research (Bainbridge & Ramachandran, 2014; Fischer et al., 2011; Garstecki & Erler, 1998; Gopinath et al., 2011; Knudsen et al., 2010; Lin, Thorpe, et al., 2011; Meyer & Hickson, 2012; Popelka et al., 1998) including studies examining individuals from Hispanic/Latino backgrounds (Lee, Carlson, Lee, Ray, & Markides, 1991; Lin, Thorpe, et al., 2011; Nieman et al., 2016). Our findings add to this literature base by confirming that hearing aid use is also more likely in individuals from varied Hispanic/Latino backgrounds (including those other than Mexican) with poorer measured hearing and greater perceived need. An equally important finding related to hearing aid use in our included sample was that adults with clinically significant hearing loss who reported no health insurance were 64% less likely to report ever using a hearing aid. This suggests that access may be a barrier to hearing health care utilization among older adults from Hispanic/Latino backgrounds. The next chapter discusses these findings, together with the findings from Study 1, along with policy implications for research, clinical practice, and education.

Study 2 Tables and Figures

Table 4. Demographic Characteristics of Included HCHS/SOL Individuals

Measure	Hispanic/Latino Background															
	Dominican (*n*=174)		Central American (*n*=216)		Cuban (*n*=426)		Mexican (*n*=732)		Puerto Rican (*n*=510)		South American (*n*=133)		Mixed/ Other (*n*=50)		Total (*n*=2241)	
	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)	M (n)	SE(%)
Age	57.9	0.80	60.5	0.80	62.3	0.54	58.8	0.52	59.6	0.66	60.9	1.03	58.4	2.66	60.2	0.28
Sex (female)	(102)	(58.6)	(109)	(50.5)	(174)	(40.8)	(372)	(50.8)	(283)	(55.5)	(63)	(47.4)	(24)	(48.0)	(1127)	(50.3)
Education																
Less than HS	(102)	(58.6)	(111)	(51.4)	(146)	(34.3)	(452)	(61.7)	(278)	(54.5)	(51)	(38.4)	(19)	(38.0)	(1159)	(51.7)
HS or equivalent	(28)	(16.1)	(44)	(20.4)	(99)	(23.2)	(111)	(15.2)	(118)	(23.1)	(37)	(27.8)	(10)	(20.0)	(447)	(20.0)
Greater than HS	(44)	(25.3)	(60)	(27.8)	(181)	(42.5)	(166)	(22.7)	(114)	(22.4)	(45)	(33.8)	(12)	(24.0)	(622)	(27.8)
Missing			(1)	(0.4)			(3)	(0.4)					(9)	(18.0)	(13)	(0.5)
Health insured	(139)	(79.9)	(101)	(46.8)	(219)	(51.4)	(409)	(55.9)	(444)	(87.1)	(62)	(46.6)	(23)	(46.0)	(1397)	(62.3)
Missing	(1)	(0.6)	(1)	(0.4)	(3)	(0.7)	(1)	(0.1)	(6)	(1.1)			(4)	(8.0)	(16)	(0.8)
Annual income																
Less than $10K	(38)	(21.8)	(29)	(13.4)	(100)	(23.5)	(105)	(14.3)	(131)	(25.7)	(25)	(18.8)	(12)	(24.0)	(440)	(19.6)
$10,001 – 20,000	(61)	(35.1)	(81)	(37.5)	(137)	(32.1)	(225)	(30.7)	(146)	(28.6)	(52)	(39.1)	(8)	(16.0)	(710)	(31.7)
$20,001 – 40,000	(51)	(29.3)	(69)	(32.0)	(91)	(21.4)	(216)	(29.5)	(115)	(22.6)	(37)	(27.8)	(15)	(30.0)	(594)	(26.5)
$40,001 – 75,000	(4)	(2.3)	(13)	(6.0)	(28)	(6.6)	(88)	(12.0)	(56)	(11.0)	(10)	(7.5)	(3)	(6.0)	(202)	(9.0)
Greater than $75K	(1)	(0.5)	(4)	(1.8)	(7)	(1.6)	(25)	(3.4)	(17)	(3.3)	(2)	(1.5)	(0)	(0.0)	(56)	(2.5)
Missing	(19)	(11.0)	(20)	(9.3)	(63)	(14.8)	(73)	(10.1)	(45)	(8.8)	(7)	(5.3)	(12)	(24.0)	(239)	(10.7)
State of residence																
Bronx, NY	(161)	(92.5)	(27)	(12.5)	(5)	(1.2)	(8)	(1.1)	(358)	(70.2)	(28)	(21.1)	(21)	(42.0)	(608)	(27.1)
Chicago, IL	(4)	(2.3)	(63)	(29.2)	(4)	(0.9)	(262)	(35.8)	(124)	(24.3)	(42)	(31.6)	(14)	(28.0)	(513)	(22.9)
Miami, FL	(9)	(5.2)	(116)	(53.7)	(417)	(97.9)	(2)	(0.3)	(20)	(3.9)	(62)	(46.6)	(14)	(28.0)	(640)	(28.6)
San Diego, CA	(0)	(0.0)	(10)	(4.6)	(0)	(0.0)	(460)	(62.8)	(8)	(1.6)	(1)	(0.7)	(1)	(2.0)	(480)	(21.4)
SASH language	1.34	0.04	1.42	0.08	1.31	0.03	1.73	0.06	2.46	0.09	1.37	0.07	1.39	0.16	1.69	0.04
Missing															(8)	(0.04)
SASH social	2.13	0.05	1.94	0.07	1.90	0.03	2.11	0.04	2.44	0.07	2.06	0.06	2.03	0.15	2.11	0.03
Missing															(103)	(4.6)

Note. Table 4 depicts unweighted sample statistics of the target population. For columns designating Hispanic/Latino classification groups, numbers in parentheses reflect within-group percentages and *n*. HCHS/SOL = Hispanic Community Health Study/Study of Latinos; HS = High school; NY = New York; IL = Illinois; FL = Florida; CA = California; SASH = Short Acculturation Scale for Hispanics. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

Table 5. Self-Reported Hearing Aid Use – Ever

Hispanic/Latino Background	Hearing Aid Use Ever - Yes		Hearing Aid Use Ever - No	
	n	%	*n*	%
Dominican (*n* = 174)	7	4.0	167	96.0
Central America (*n* = 216)	2	0.09	214	99.1
Cuban (*n* = 426)	14	3.3	412	96.7
Mexican (*n* = 732)	29	4.0	703	96.0
Puerto-Rican (*n* = 510)	24	4.7	486	95.3
South American (*n* = 133)	4	3.0	129	97.0
Mixed/Other (*n* = 50)	2	4.0	48	96.0
Total (*n* = 2241)	**82**	**3.7**	**2159**	**96.3**

Note. Table 5 depicts unweighted sample statistics of included HCHS/SOL individuals with clinically significant hearing loss (PTA $\geq$ 25 dB HL). For rows designating Hispanic/Latino classification groups, values reflect within-group percentages and *n*. HCHS/SOL = Hispanic Community Health Study/Study of Latinos. PTA = pure tone average in either ear at 500, 1000, 2000, and 4000 Hz. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

Table 6. Self-Reported Hearing Aid Use within the Past 12 Months

Hispanic/Latino Background	Hearing Aid Use Ever – Past 12 Months	
	n	%
Dominican (*n* = 7)	4	57.1
Central America (*n* = 2)	2	100.0
Cuban (*n* = 14)	8	57.1
Mexican (*n* = 29)	18	62.1
Puerto-Rican (*n* = 24)	16	66.7
South American (*n* = 4)	3	75.0
Mixed/Other (*n* = 2)	2	100.0
Total (*n* = 82)	**53**	**64.6**

Note. Table 6 depicts self-reported hearing aid use among HCHS/SOL individuals with clinically significant hearing loss (PTA $\geq$ 25 dB HL). HCHS/SOL = Hispanic Community Health Study/Study of Latinos. PTA = pure tone average in either ear at 500, 1000, 2000, and 4000 Hz. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

Table 7. Adjusted Odds Ratios of Hearing Aid Use by Demographic or Other Factors

Characteristic	*OR*	95% CI
Language preference		
Spanish	1 [Reference]	1 [Reference]
English	1.87	[0.56, 6.21]
SASH Language subtest score	1.01	[0.59, 1.73]
SASH Social subtest score	0.96	[0.48, 1.95]
Hispanic/Latino background		
Mexican	1 [Reference]	1 [Reference]
Other background	1.60	[0.74, 3.47]
HHI-S score	1.05	[1.02, 1.08]
PTA better ear	1.06	[1.03, 1.10]
Age	1.02	[0.98, 1.07]
Sex		
Female	1 [Reference]	1 [Reference]
Male	0.92	[0.50, 1.69]
Education		
Greater than high school or equivalent	1 [Reference]	1 [Reference]
High school or equivalent	0.89	[0.49, 4.91]
Less than high school	0.41	[0.10, 1.06]
Annual income		
$40,000 or less	1 [Reference]	1 [Reference]
Greater than $40,000	1.05	[0.35, 3.12]
Health insurance status		
Not insured	1 [Reference]	1 [Reference]
Insured	0.46	[0.23, 0.92]
City		
San Diego	1 [Reference]	1 [Reference]
Not San Diego	0.43	[0.19, 1.01]

Note. Table 7 depicts sample statistics of the target population adjusted for age, sex, center, and Hispanic/Latino background. Included individuals were 2144 adults with clinically significant hearing loss as defined by a PTA of $\geq$ 25 dB HL. PTA = pure tone average; HCHS/SOL = Hispanic Community Health Study/Study of Latinos; dB HL = decibels hearing level; OR = odds ratio; CI = confidence interval; SASH = Short Acculturation Scale for Hispanics; HHI-S = Hearing Handicap Inventory – Screening. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

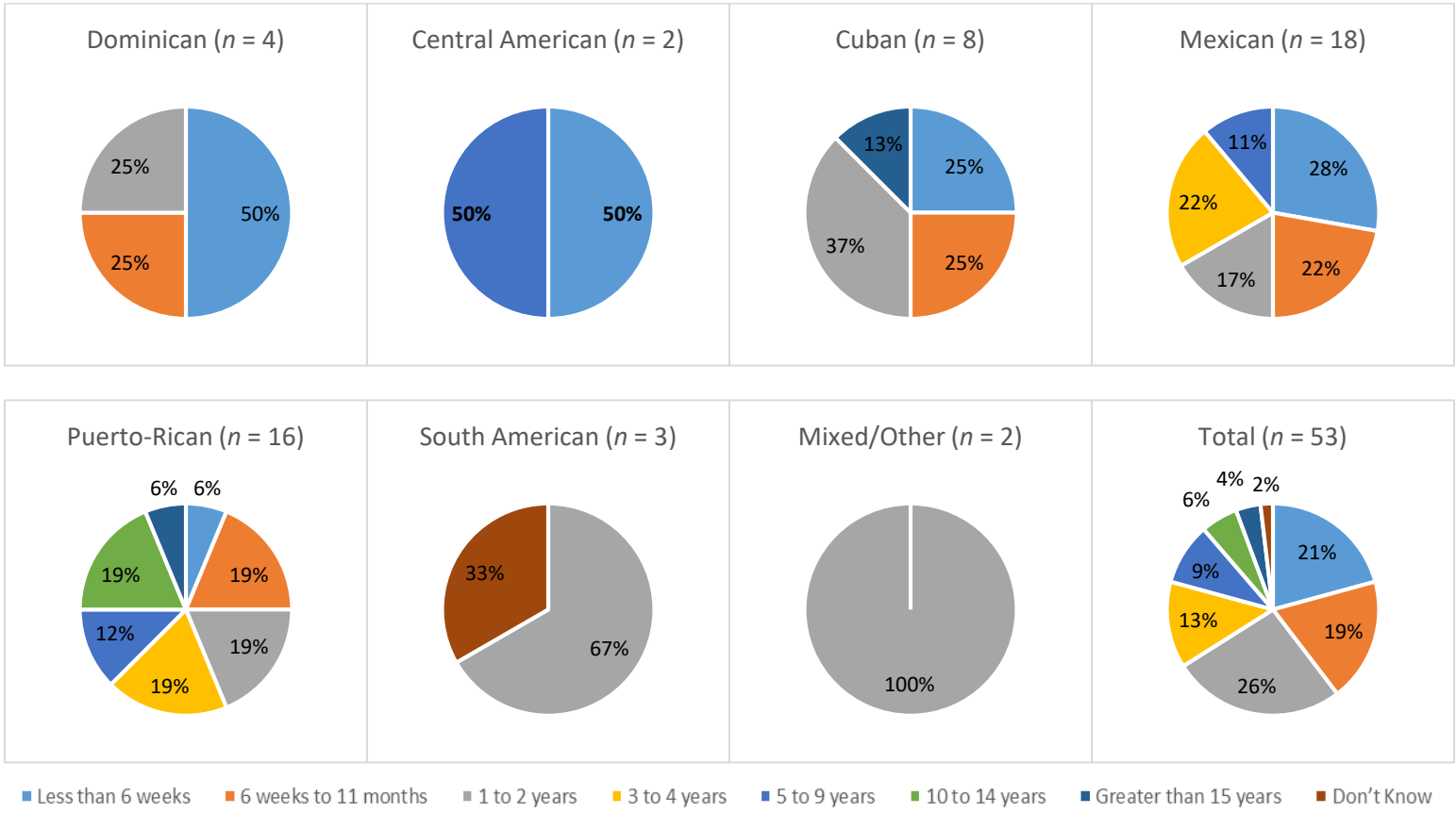

Figure 3. Length of Hearing Aid Use among Included HCHS/SOL Individuals

Note. Figure 3 depicts unweighted sample statistics of included individuals who Reported Hearing Aid Use within the Past 12 Months. For charts designating Hispanic/Latino classification groups, values reflect within-group percentages and *n*. HCHS/SOL = Hispanic Community Health Study/Study of Latinos. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

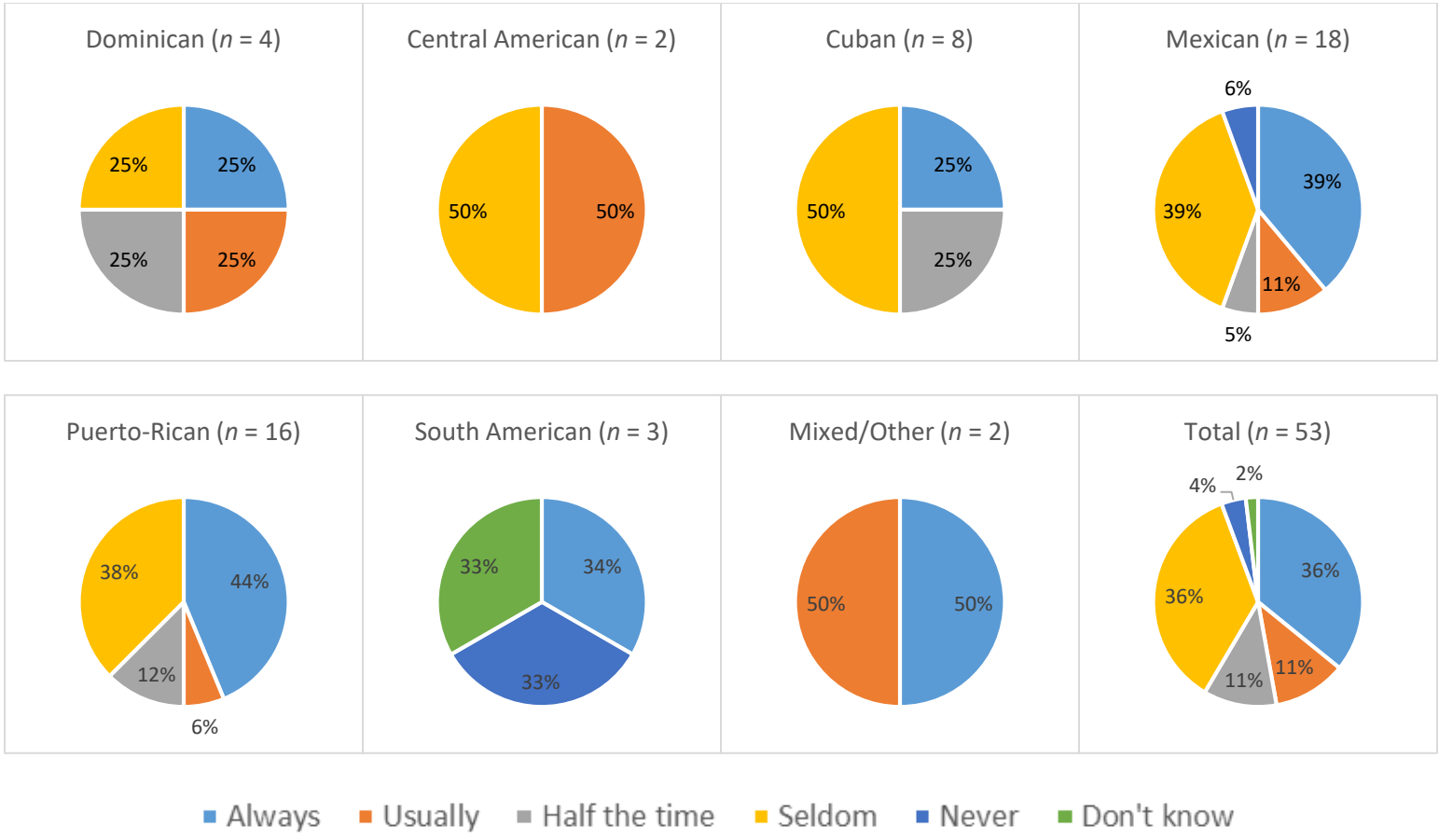

Figure 4. Frequency of Hearing Aid Use among Included HCHS/SOL Individuals

Note. Figure 4 depicts unweighted sample statistics of included individuals who reported hearing aid use within the past 12 months. For charts designating Hispanic/Latino classification groups, values reflect within-group percentages and *n*. HCHS/SOL = Hispanic Community Health Study/Study of Latinos. Source: Authors' analysis of HCHS/SOL baseline data collected from 2008 - 2011.

Chapter 7: Discussion – Policy Implications for Research, Clinical Practice, and Education

This series of studies aimed to understand the associations between hearing loss, demographics, acculturation, and hearing aid use among adults from Hispanic/Latino backgrounds using the Andersen model of health care utilization as a framework (Aday & Andersen, 1974; Gelberg et al., 2000). Study 1 examined the relationships between objective and subjective hearing loss, demographic variables, measures of acculturation, and perceived need. The main findings supported our hypotheses, revealing significant correlations between poorer hearing thresholds and self-reported hearing loss and higher HHI-S scores (indicating greater perceived hearing difficulties and need). These results are consistent with previous literature that demonstrate robust relationships between hearing loss severity, self-reported hearing loss, and HHI-S scores (Knudsen et al., 2010; Lichtenstein et al., 1988; Meyer & Hickson, 2012; Pugh & Crandell, 2002). Study 1 findings additionally revealed that younger age, male sex, city of residence, lack of health insurance, and higher acculturation scores on the SASH language subtest were associated with greater perceived need as measured by the HHI-S.

In Study 2, we sought to identify factors related to hearing aid use among adults from Hispanic/Latino backgrounds. The reported rates of hearing aid use among included individuals was strikingly low. Overall, only 3.7% (*n* = 82) of included individuals with clinically significant hearing loss reported ever using a hearing aid, with

64.6% (*n* = 53) of those hearing aid users reporting use within the past 12 months. Hearing aid users varied in self-reported length of use, with few reporting use longer than three years. This finding is not surprising, as the included individuals represent a relatively young-old sample, with the oldest at 76 years of age. In an attempt to focus on individuals with ARHL, we excluded persons with likely congenital hearing losses and losses not related to age from the current analyses (e.g., bilateral conductive losses, acoustic neuroma, or profound hearing losses). Hearing loss prevalence sharply increases among adults 70 years of age and older (Lin, Thorpe, et al., 2011); therefore, we would expect that the majority of users in the included sample would experience a short duration of hearing loss and thus report shorter durations of hearing aid use.

Taken together, our findings suggest patterns of relationships between predisposing, enabling and need variables and health utilization outcomes consistent with the Anderson model. In Study 1, we found that predisposing and enabling variables influenced need. Age, sex, city of residence (predisposing variables), and health insurance status (enabling variable) characterized HHI-S scores. Further, in accordance with findings from other studied populations (primarily White, non-Hispanic/Latino), need variables (measured hearing loss and appraisal of need/HHI-S scores) characterized reported hearing aid use among included adults from Hispanic/Latino backgrounds in Study 2.

Importantly, individuals that reported no health insurance coverage were more likely to have greater perceived need as measured by the HHI-S. Individuals without health insurance may be unable to have their hearing problems addressed by a health care provider, thus resulting in worse self-perceptions of hearing difficulties. Further,

findings from Study 2 showed that included adults with hearing loss but no health insurance had 64% lower odds of reporting ever using a hearing aid. Taken together, the results from these two studies indicate that lack of health insurance is a likely contributor to increased functional hearing difficulties and a significant barrier to treatment among adults from Hispanic/Latino backgrounds with hearing loss.

We were specifically interested as to whether acculturation (predisposing variables) related to need, and our Study 1 findings revealed that only SASH language subtest results characterized HHI-S scores. This is in contrast to better self-perceived health status for adults with higher acculturation reported in other studies (Lara et al., 2005). Perhaps the functional difficulties associated with hearing loss (e.g., communication, television and radio listening, and socialization) are more noticeable or bothersome than general health-related issues. Neither Hispanic/Latino background nor SASH social subtest results related to HHI-S scores. This finding is consistent with previous studies showing no differences in health care utilization based on Hispanic/Latino background (Solis et al., 1990) or race and ethnicity (Fiscella et al., 2002) when controlling for language preference.

We were also interested as to whether acculturation related to hearing aid uptake. Interestingly in Study 2, higher HHI-S scores resulted in higher odds of use, yet we did not see a relationship between SAS language subtest scores and reported use. Conversely, despite higher HHI-S scores among the uninsured seen in Study 1, lack of health insurance resulted in lower odds of hearing aid use in Study 2. One example illustrates this seemingly paradoxical finding. Among the different Hispanic/Latino groups, included individuals from Central American backgrounds had relatively low

SASH language subtest scores (group mean = 1.42), relatively high HHI-S scores (group mean = 5.6), and the lowest rate of reported health insurance (approximately 53% were uninsured). Individuals from Central American backgrounds also had the lowest prevalence of reported hearing aid use of all the included groups (less than 1%). Therefore, while included individuals from Central American backgrounds had higher HHI-S scores, low rates of insurance and lower English proficiency potentially posed as barriers to hearing aid uptake. As no other acculturation variables characterized HHI-S scores or hearing aid uptake, this complex pattern of findings suggests that access, and not culture, characterize hearing use. This is consistent with a growing body of work that shows that low English proficiency results in reduced health care utilization, such as visits to a regular primary care physician and seeking preventative care or specialty care (e.g., dental, mental health), when controlling for variables related to acculturation (DuBard & Gizlice, 2008; Fiscella et al., 2002; Solis et al., 1990). Taken together, our findings concerning language and access have important policy implications for research, clinical practice, and education.

Limitations

There were limitations to this series of studies. First, the data we analyzed is cross-sectional, so we were unable to infer causality based on the relationships revealed. Second, the HCHS/SOL is not a nationally representative data set, so results may not generalize to the broader U.S. population. All of the HCHS/SOL test sites are located in large metropolitan areas. There may be substantial differences in the predisposing, enabling, and need variables and subsequent hearing aid use outcomes of adults from Hispanic/Latino backgrounds living in rural areas. However, based on the

low hearing aid uptake rates revealed in areas where access to hearing health care is more likely, we would not expect higher rates in a rural setting. Finally, we were unable to detect any moderating relationships or interactions between variables of interest in Study 2, despite Study 1 results demonstrating significant relationships between SASH language subtest scores, HHI-S scores and health insurance status. Given the extremely low rates of hearing aid uptake in some of the Hispanic/Latino background groups, we were unable to test models that fully incorporated income, health insurance status (e.g., type of insurance), and Hispanic/Latino background. Further, we did not compare our sample to non-Hispanic/Latino groups, and it is possible that there was not enough variability in SASH language and culture subtest scores to detect differences between those who reported hearing aid use and those who did not.

Implications for research

The influence of language on perceived hearing handicap but not hearing aid uptake is complex, and deserves more attention in future studies. Our findings warrant further investigation into facilitators and barriers of hearing health care for adults from Hispanic/Latino backgrounds. A first step is better understanding the role of language access in general health care utilization and outcomes, as the current body of literature is small and shows mixed outcomes. As new waves of HCHS/SOL data become available, researchers should make efforts to design studies that model mediating and moderating relationships between Hispanic/Latino background, language preference, health insurance, and health care use. Further, as the HCHS/SOL cohorts age, follow-up hearing assessments should be performed, including questions regarding hearing aid use, as the odds of hearing loss is known to increase substantially after the age of

70. Studies examining overall access for hearing health care are additionally warranted, including those that take into account current health policies and factors known to affect true access, such as third-party service coverage and provider reimbursement.

Implications for clinical practice

The growing trajectory of aging adults from Hispanic/Latino backgrounds carries several implications for the future of audiology service provision. Our findings revealed significant relationships between language preferences and perceived hearing handicap, and remarkably low hearing aid uptake rates among adults with clinically significant hearing loss. Low English proficiency or a tendency towards speaking and thinking in Spanish and lack of health insurance represent potential barriers for hearing loss treatment. In an effort to increase access to hearing loss assessment and treatment among adults from Hispanic/Latino backgrounds, U.S. audiologists working with adults must be prepared to deliver culturally and linguistically appropriate services (CLAS).

An initial step to fostering CLAS in clinical practice is the facilitation of communication and language assistance for those with low English proficiency, or have preferences toward thinking and speaking in Spanish. According to the U.S. Department of Health and Human Services National Standards for CLAS in Health and Health Care (2013), delivery of appropriate communication and language services has four core components:

> 1.) *Offer language assistance to individuals who have limited English proficiency and/or other communication needs, at no cost to them, to facilitate timely access to all health care and services.*

2.) *Inform all individuals of the availability of language assistance services clearly and in their preferred language, verbally and in writing.*

3.) *Ensure the competence of individuals providing language assistance, recognizing that the use of untrained individuals and/or minors as interpreters should be avoided*.

4.) *Provide easy-to-understand print and multimedia materials and signage in the languages commonly used by the populations in the service area.* (p. 13).

One strategy to address these standards is to increase the availability of Spanish-speaking bilingual audiology service providers. In the most recent demographic profile of bilingual audiologists and speech language pathologists, the American Speech-Language-Hearing Association (ASHA) reported that of over 14,000 certified audiologists, only 726 (~5%) were bilingual (2016). Further, approximately half of all bilingual audiologists reported working in pediatric or educational settings, leaving only 2.5% of remaining ASHA-certified audiologists that work in adult settings. Several approaches could offset the lack of bilingual audiologists, thus increasing language access for older Spanish-speaking adults.

The availability of language interpretation should be increased in audiology practice settings. Use of trained bilingual staff is one way to accomplish this. In particular, the recruitment and training of bilingual audiology assistants has potential to not only provide better language access for clients with low English proficiency or other language preferences, but also increase productivity (Hamill & Andrews, 2016).

Professional interpreting services are another (more costly) option, and include in-person and phone/video services.

Another strategy for improving CLAS is the cross-cultural adaptation of hearing loss specific outcomes to better understand the perceptions adults from Hispanic/Latino backgrounds have on hearing-related disability, communication difficulties, and treatment outcomes. Currently, the only outcome measure validated for use with U.S. Spanish-speakers is the HHI-S (Lichtenstein & Hazuda, 1998). Finally, the development of Spanish language counseling materials addressing the needs, values, and goals of the target audience is necessary.

Implications for education

Increasing the lack of bilingual audiologists in the U.S. workforce will entail efforts in higher education. Doctor of Audiology (Au.D.) programs should more visibly align themselves with other Science, Technology, Engineering, and Mathematics (STEM) professions in an effort to recruit talented bilingual students. One innovative approach currently being investigated is the NSF-funded *STEM Mio* ("My STEM") project (Barab, et al.), a multimedia, game-based platform aimed at increasing the visibility of STEM careers for middle and high school students from Hispanic/Latino backgrounds. Active recruitment efforts from programs such as the Communication Sciences and Disorders/Spanish double major at LaSalle University is another way to increase bilingual student counts in Au.D. programs. Finally, implementing clinical and research programs such as the Hispanic Initiative at the University of South Carolina Speech and Hearing Research Center and *Oyendo Bien* ("Hearing Well") at the University of Arizona

can further attract competitive bilingual undergraduates interested in a STEM career to Au.D. programs.

Conclusion

Based on results from this series of studies, older adults from Hispanic/Latino backgrounds demonstrate similar patterns of predisposing variables, enabling variables and need variables with regard to hearing loss and hearing aid uptake as those from other backgrounds. For adults from Hispanic/Latino backgrounds, younger age, male sex, poorer objectively measured hearing loss, lack of health insurance status, and higher SASH language subtest scores characterize greater perceived need, as measured by the HHI-S. Hearing aid uptake among older adults from Hispanic/Latino backgrounds was low compared to the rates of clinically significant hearing loss. The most significant variable associated with underutilization of hearing aid uptake was lack of health insurance. It was unclear whether our results indicated cultural and linguistic barriers to treatment, access barriers treatment, or both.

These findings have implications for the service delivery needs of a growing population of older Spanish-speaking adults. There is currently a lack of Spanish/English bilingual service providers in the field of audiology, thus limiting access for those with low English proficiency or other language preferences. Efforts in the area of research, clinical practice, and education are necessary to increase the availability of CLAS in hearing health care in order to increase accessibility and reduce hearing health disparities for older adults with hearing loss from Hispanic/Latino backgrounds.

References

Aday, L. A., & Andersen, R. M. (1974). A framework for the study of access to medical care. *Health Services Research, 9*(3), 208-220.

Agrawal, Y., Platz, E. A., & Niparko, J. K. (2008). Prevalence of hearing loss and differences by demographic characteristics among US adults: Data from the National Health and Nutrition Examination Survey, 1999-2004. *A.M.A. Archives of Internal Medicine, 168*(14), 1522-1530. doi:10.1001/archinte.168.14.1522

American Speech-Language-Hearing Association. (1997). Guidelines for audiologic screening. Retrieved from asha.org/policy

American Speech-Language-Hearing Association. (2016). *Demographic profile of ASHA members providing bilingual services*. Retrieved from https://www.asha.org/uploadedFiles/Demographic-Profile-Bilingual-Spanish-Service-Members.pdf

Andersen, R. M. (1995). Revisiting the behavioral model and access to medical care: Does it matter? *Journal of Health and Social Behavior, 36*(1), 1-10. doi:10.2307/2137284

Andersen, R. M. (2008). National health surveys and the behavioral model of health services use. *Medical Care, 46*(7), 647-653. doi:10.1097/mlr.0b013e31817a835d

Andersen, R. M., & Newman, J. F. (2005). Societal and individual determinants of medical care utilization in the United States. *Milbank Memorial Fund Quarterly, 83*(4), 1-28. doi:10.1111/j.1468-0009.2005.00428.x

Arnold, M. L., Hyer, K., & Chisolm, T. H. (2017). Medicaid hearing aid coverage for older adult beneficiaries: A state-by-state comparison. *Health Affairs, 36*(8), 1476-1484. doi:10.1377/hlthaff.2016.1610

Arnold, M. L., Small, B., Hyer, K., Chisolm, T. H., Frederick, M., Silverman, S., & Saunders, G. H. (under review). Development of a Theory of Planned Behavior questionnaire for hearing health care. *International Journal of Audiology*.

Azjen, I. (2002). Perceived behavioral control, self efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology, 34*(4), 665-683. doi:10.1111/j.1559-1816.2002.tb00236.x

Bainbridge, K. E., & Ramachandran, V. (2014). Hearing aid use among older U.S. adults: The National Health and Nutrition Examination Survey, 2005-2006 and 2009-2010. *Ear and Hearing, 35*(3), 289-294. doi:10.1097/01.aud.0000441036.40169.29

Bainbridge, K. E., & Wallhagen, M. I. (2014). Hearing loss in an aging American population: Extent, impact, and management. *Annual Review of Public Health, 35*, 139-152. doi:10.1146/annurev-publhealth-032013-182510

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182. doi:10.1037/0022-3514.51.6.1173

Chien, W., & Lin, F. R. (2012). Prevalence of hearing aid use among older adults in the United States. *Archives of Internal Medicine (Chicago, Ill.: 1908), 172*(3), 292-293. doi:10.1001/archinternmed.2011.1408

Chisolm, T. H., Johnson, C. E., Danhauer, J. L., Portz, L. J. B., Abrams, H. B., Lesner, S., . . . Newman, C. W. (2007). A systematic review of health-related quality of life and hearing aids: Final report of the American Academy of Audiology Task Force on the Health-Related Quality of Life Benefits of

Amplification in Adults. *Journal of the American Academy of Audiology, 18*(2), 151-183. doi:10.3766/jaaa.18.2.7

Clark, K., Sowers, M. F., Wallace, R. B., & Anderson, C. (1991). The accuracy of self-reported hearing loss in women aged 60-85 years. *American Journal of Epidemiology, 134*(7), 704-708.

Cruickshanks, K. J., Dhar, S., Dinces, E., Fifer, R. C., Gonzalez, F., Heiss, G., . . . Tweed, T. S. (2015). Hearing impairment prevalence and associated risk factors in the Hispanic Community Health Survey/Study of Latinos. *JAMA Otolaryngology - Head & Neck Surgery, 141*(7), 641-648. doi:10.1001/jamaoto.2015.0889

Dalton, D. S., Cruickshanks, K. J., Klein, B. E. K., Klein, R., Wiley, T. L., & Nondahl, D. M. (2003). The impact of hearing loss on quality of life in older adults. *The Gerontologist, 43*(5), 661-668. doi:10.1093/geront/43.5.661

DuBard, C. A., & Gizlice, Z. (2008). Languages spoken and differences in health status, access to care, and receipt of preventative services among US Hispanics. *American Journal of Public Health and the Nations Health, 98*(11), 2021-2028.

Ellison, J., Jandorf, L., & Duhamel, K. (2011). Assessment of the Short Acculturation Scale for Hispanics (SASH) among low-income, immigrant Hipanics. *Journal of Cancer Education, 26*(3), 478-483. doi:10.1007/s13187-011-0233-z

Ferguson, M. A., Kitterick, P. T., Chong, L., Edmundson-Jones, M., Barker, F., & Hoare, D. J. (2017). Hearing aids for mild to moderate hearing loss in adults. *Cochrane Database of Systematic Reviews, 9*(CD012023). doi:10.1002/14651858.CD012023.pub2

Fiscella, K., Franks, P., Doescher, M. P., & Saver, B. G. (2002). Disparities in health care by race, ethnicity, and language among the insured: Findings from a national sample. *Medical Care, 40*(1), 52-59.

Fischer, M. E., Cruickshanks, K. J., Wiley, T. L., Klein, B. E. K., Klein, R., & Tweed, T. S. (2011). Determinants of hearing aid acquisition in older adults. *American Journal of Public Health and the Nations Health, 101*(8). doi:10.2105/AJPH.2010.300078

Franks, J. R., & Beckmann, N. J. (1985). Rejection of hearing aids: Attitudes of a geriatric sample. *Ear and Hearing, 6*, 161-166.

Garstecki, D. S., & Erler, S. F. (1998). Hearing loss, control, and demographic factors influencing hearing aid use among older adults. *Journal of Speech, Language, and Hearing Research, 41*(3), 527-237. doi:10.1044/jslhr.4103.527

Gates, G. A., Murphy, M., Rees, T. S., & Fraher, A. (2003). Screening for handicapping hearing loss in the elderly. *Journal of Family Practice, 52*(1), 56-62.

Gelberg, L., Andersen, R. M., & Leake, B. D. (2000). The behavioral model for vulnerable populations: Application to medical care use and outcomes for homeless people. *Health Services Research, 34*(6), 1273-1302.

Genther, D. J., Frick, K. D., Chen, D., Betz, J., & Lin, F. R. (2013). Association of hearing loss with hospitalization and burden of disease in older adults. *Journal of the American Medical Association, 22*, 2322-2324. doi:10.1001/jama.2013.5912

Goman, A. M., Reed, N. S., & Lin, F. R. (2017). Addressing estimated hearing loss in adults in 2060. *JAMA Otolaryngology - Head & Neck Surgery, published online March 2, 2017*. doi:10.1001/jamaoto.2016.4642

Gopinath, B., Schneider, J., Hartley, D., Teber, E., McMahon, C. M., Leeder, S. R., & Mitchell, P. (2011). Incidence and predictors of hearing aid use and ownership among older adults with hearing loss. *Annals of Epidemiology, 21*(7), 497-506. doi:10.1016/j.annepidem.2011.03.005

Hamill, T. A., & Andrews, J. P. (2016). Audiology assistants in private practice. *Seminars in Hearing, 37*(4), 348-358. doi:10.1055/s-0036-1593996

Horton, N. J., & Lipsitz, S. R. (2001). Multiple imputation in practice. *The American Statistician, 55*(3), 244-254. doi:10.1198/000313001317098266

Jacobs, E., Chen, H. M., Karliner, L. S., Agger-Gupta, N., & Mutha, S. (2006). The need for more research on language barriers in health care: A proposed research agenda. *Milbank Quarterly, 84*(1), 111-133. doi:doi.org/10.1111/j.1468-0009.2006.00440.x

Johnson, J. (2012). *Influence of culture on appraisal of acquired hearing impairment.* (Doctor of Philosophy dissertation), The University of Memphis, ProQuest Dissertations Publishing. (3497917)

Kamil, R. J., Genther, D. J., & Lin, F. R. (2015). Factors associated with the accuracy of subjective assessments of hearing impairment. *Ear and Hearing, 36*(1), 164-167. doi:10.1097/aud.0000000000000075

Kim, H.-Y. (2013). Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry, 38*(1), 52-54. doi:10.5395/rde.2013.38.1352

Knudsen, L. V., Öberg, M., Nielsen, K., Naylor, G., & Kramer, S. E. (2010). Factors influencing help-seeking, hearing aid uptake, hearing aid use and satisfaction with hearing aids: A review of the literature. *Trends in Amplification, 14*(3), 127-154. doi:10.1177/1084713810385712

Kochkin, S. (2009). MarkeTrak VIII: 25-year trends in the hearing health market. *Hearing Review, 16*(11), 12-31.

Kramer, S. E., Kapteyn, T. S., Kuik, D. J., & Deeg, D. J. H. (2002). The association of hearing impairment and chronic diseases with psychosocial health status in older age. *Journal of Aging and Health, 14*(1), 122-137. doi:10.1177/089826430201400107

Laplante-Lévesque, A., Hickson, L., & Worrall, L. (2013). Stages of change in adults with acquired hearing impairment seeking help for the first time: Application of the transtheoretical model in audiologic rehabilitation. *Ear and Hearing, 34*(4), 447-457. doi:10.1097/AUD.0b013e3182772c49

Lara, M., Gamboa, C., Kahramanian, M. I., Morales, L. S., & Hayes Bautista, D. E. (2005). Acculturation and Latino health in the United States: A review of the literature and its sociopolitical context. *Annual Review of Public Health, 26*(1), 367-397.

LaVange, L. M., Kalsbeek, W. D., Sorlie, P. D., Aviles-Santa, L. M., Kaplan, R. C., Barnhart, J., . . . Elder, J. P. (2010). Sample design and cohort selection in the Hispanic Community Health Survey/Study of Latinos. *Annals of Epidemiology, 20*(8), 642-649. doi:10.1016/j.annepidem.2010.05.006

Leclere, F. B., Jensen, L., & Biddlecom, A. E. (1994). Health care utilization, family context, and adaptation among immigrants to the United States. *Journal of Health and Social Behavior, 35*(4), 370-384. doi:10.2307/2137215

Lee, D. J., Carlson, D. L., Lee, H. M., Ray, L. A., & Markides, K. S. (1991). Hearing loss and hearing aid use in Hispanic adults: results from the Hispanic Health and Nutrition Examination Survey. *American Journal of Public Health, 81*(11), 1471-1474. doi:10.2105/ajph.81.11.1471

Lee, D. J., Gomez-Marin, O., Lam, B. L., & Zheng, D. D. (2004). Trends in hearing impairment in United States adults: The National Health Interview Survey, 1986-1995. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences, 59A*(11), 1186-1190. doi:10.1093/gerona/59.11.1186

Lee, D. J., Gomez-Marin, O., & Lee, H. M. (1996). Sociodemographic correlates of hearing loss and hearnig aid use in Hispanic adults. *Epidemiology, 7*(4), 443-446. doi:10.1097/00001648-199607000-00019

Lichtenstein, M. J., Bess, F. H., & Logan, S. A. (1988). Diagnostic performance of the Hearing Handicap Inventory for the Elderly (Screening Version) against differing definitions of hearing loss. *Ear and Hearing, 9*(4), 208-211. doi:10.1097/00003446-198808000-00006

Lichtenstein, M. J., & Hazuda, H. P. (1998). Cross-cultural adaptation of the Hearing Handicap Inventory for the Elderly-Screening Version (HHIE-S) for use with Spanish-speaking Mexican Americans. *Journal of the American Geriatrics Society, 46*(4), 492-498. doi:10.1111/j.1532-5415.1998.tb02473.x

Lin, F. R., & Ferrucci, L. (2012). Hearing loss and falls among older adults in the United States. *Archives of Internal Medicine (Chicago, Ill.: 1908), 172*(4), 369-371. doi:10.1001/archinternmed.2011.728

Lin, F. R., Ferrucci, L., Metter, J., An, Y., Zonderman, A. B., & Resnick, S. M. (2011). Hearing loss and cognition in the Baltimore Longitudinal Study of Aging. *Neuropsychology, 25*(6), 763-770. doi:10.1037/a0024238

Lin, F. R., Metter, J., O'Brien, R. J., Resnick, S. M., Zonderman, A. B., & Ferrucci, L. (2011). Hearing loss and incident dementia. *Archives of Neurology, 68*(2), 214-220. doi:10.1001/archneurol.2010.362

Lin, F. R., Thorpe, R., Gordon-Salant, S., & Ferrucci, L. (2011). Hearing loss prevalence and risk factors among older adults in the United States. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences, 66A*(5), 582-590. doi:10.1093/gerona/glr002

Lin, F. R., Yaffe, K., Xia, J., Xue, Q. L., Harris, T. B., Purchase-Helzner, E., . . . Simonsick, E. M. (2013). Hearing loss and cognitive decline in older adults. *JAMA Internal Medicine, 173*(4), 293-299. doi:10.1001/jamainternmed.2013.1868

Loughrey, D. G., Kelly, M. E., Brennan, S., & Lawlor, B. A. (2018). Association of age-related hearing loss with cognitive function, cognitive impairment, and dementia: A systematic review and meta-analysis. *JAMA Otolaryngology - Head & Neck Surgery, 144*(2), 115-126. doi:10.1001/jamaoto.2017.2513

Marin, G., Sabogal, F., Marin, B. V., Otero-Sabogal, R., & Perez-Stable, E. J. (1987). Development of a short acculturation scale for Hispanics. *Hispanic Journal of Behavioral Sciences, 9*(2), 183-205.

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological Bulletin, 114*(2), 376-390. doi:10.1037/0033-2909.114.2.376

Meyer, C., & Hickson, L. (2012). What factors influence help-seeking for hearing impairment and hearing aid adoption in older adults? *International Journal of Audiology, 51*(2), 66-74. doi:10.3109/14992027.2011.611178

Nash, S. D., Cruickshanks, K. J., Huang, G., Klein, B. E. K., Klein, R., Nieto, J., & Tweed, T. S. (2013). Unmet hearing health care needs: The Beaver Dam offspring study. *American Journal of Public Health and the Nations Health, 103*(6), 1134-1139. doi:10.2105/AJPH.2012.301031

National Institute on Deafness and Other Communication Disorders. (2016). Quick Statistics About Hearing. Retrieved from https://www.nidcd.nih.gov/health/statistics/quick-statistics-hearing#5

Newman, C. W., Weinstein, B. E., Jacobson, G. P., & Hug, G. A. (1991). Test retest reliability of the Hearing Handicap Inventory for Adults. *Ear and Hearing, 15*(5), 355-357.

Nieman, C. L., Marrone, N., Szanton, S. L., Thorpe, R., & Lin, F. R. (2016). Racial/ethnic and socioeconomic disparities in hearing health care among older Americans. *Journal of Aging and Health, 28*(1), 68-94. doi:10.1177/0898264315585505

Nondahl, D. M., Cruickshanks, K. J., Wiley, T. L., Tweed, T. S., Klein, R., & Klein, B. E. K. (1998). Accuracy of self-reported hearing loss. *Audiology, 37*, 295-301.

Popelka, M. M., Cruickshanks, K. J., Wiley, T. L., Tweed, T. S., Klein, B. E. K., & Klein, R. (1998). Low prevalence of hearing aid use among older adults: The Epidemiology of Hearing Loss Study. *Journal of the American Geriatrics Society, 46*(9), 1075-1078.

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research, 421*(1), 185-227. doi:10.1080/00273170701341316

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 51*(3), 390-395.

Pugh, K. C., & Crandell, C. C. (2002). Hearing loss, hearing handicap, and functional health status between African American and Caucasian American seniors. *Journal of the American Academy of Audiology, 13*(9), 493-502.

Rawool, V. W. (2012). *Hearing Conservation in Occupational, Recreational, Educational, and Home Settings*. New York, NY: Thieme.

Rubin, D. B. (2004). *Multiple imputation for nonresponse in surveys*. New York: John Wiley & Sons.

Salas-Provence, M., Erickson, J. G., & Reed, J. (2002). Disabilities as viewed by four generations of one Hispanic family. *American Journal of Speech-Language Pathology, 11*(2), 151-162. doi:10.1044/1058-0360(2002/015)

Saunders, G. H., Frederick, M. T., Silverman, S., & Papesh, M. (2013). Application of the health belief model: Development of the hearing beliefs questionnaire (HBQ) and its associations with hearing health behaviors. *International Journal of Audiology, 52*(8), 558-567. doi:10.3109/14992027.2013.791030

Shaw, S. J., Huebner, C., Armin, J., Orzech, K., & Vivian, J. (2009). The role of culture in health literacy and chronic disease screening and management. *Journal of Immigrant and Minority Health, 11*(6), 460-467. doi:10.1007/s10903-008-9149-z

Solis, J. M., Marks, G., Garcia, M., & Shelton, D. (1990). Acculturation, access to care, and use of preventive services by Hispanics: findings from HHANES 1982-84. *American Journal of Public Health and the Nations Health, 80*(Suppl.), 11-19. doi:10.2105/AJPH.80.Suppl.11

Sorlie, P. D., Avilés-Santa, L., Wassertheil-Smoller, S., Kaplan, R. C., Daviglus, M. L., Giachello, A., . . . Heiss, G. (2010). Design and implementation of the Hispanic Community Health Study/Study of Latinos. *Annals of Epidemiology, 20*(8), 629-641. doi:10.1016/j.annepidem.2010.03.015

Thomson, M. D., & Hoffman-Goetz, L. (2009). Defining and measuring acculturation: A systematic review of public health studies with Hispanic populations in the United States. *Social Science & Medicine. Part A: Medical Sociology, 69*, 983-991. doi:doi.org/10.1016/j.socscimed.2009.05.011

Torre, P. T., Moyer, C. J., & Haro, N. R. (2006). The accuracy of self-reported hearing loss in older Latino-American adults. *International Journal of Audiology, 45*, 559-562. doi:10.1080/14992020600860935

U.S. Census Bureau. (2006). Hispanics in the United States: 2006. Retrieved from http://www.census.gov/population/hispanic/publications/hispanics_2006.html

U.S. Department of Health and Human Services. (2013). *National standards for culturally and linguistically appropriate services in health and health care: A blueprint for advancing and sustaining CLAS policy and practice*. Retrieved from https://www.thinkculturalhealth.hhs.gov/assets/pdfs/EnhancedCLASStandardsBlueprint.pdf

U.S. Department of Health and Human Services. (2015). *A Statistical Profile of Older Hispanic Americans*. Retrieved from http://www.aoa.acl.gov/Aging_Statistics/minority_aging/DOCS/Statistical-Profile-Older-Hispanic-Ameri.pdf

Ventry, I. M., & Weinstein, B. E. (1982). The Hearing Handicap Inventory for the Elderly: A new tool. *Ear and Hearing, 3*(3), 128-134.

Ventry, I. M., & Weinstein, B. E. (1983). Idenification of elderly people with hearing problems. *ASHA, 25*, 37-42.

Wallhagen, M. I. (2014). Access to care for hearing loss. *Journal of Gerontological Nursing, 40*(3), 15-19. doi:10.3928/00989134-20140131-01

Weinstein, B. E., & Ventry, I. M. (1982). Hearing impairment and social isolation in the elderly. *Journal of Speech, Language, and Hearing Research, 25*, 593-599. doi:10.1044/jshr.2504.593

Wells, K. B., Golding, J. M., Hough, R. L., Burman, M. A., & Karno, M. (1989). Acculturation and the probability of health services use by Mexican Americans. *Health Services Research, 24*(2), 237-257.

Zambrana, R. E., & Carter-Pokras, O. (2010). Role of acculturation research in advancing science and practice in reducing health care disparities among Latinos. *American Journal of Public Health and the Nations Health, 100*(1), 18-23. doi:10.2105/AJPH.2008.138826