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Original Research Article

Associations Between Self-Reported Visual and Hearing Functioning and Cognitive Function Among Hispanics/ Latino: Hispanic Community Health Study

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Abstract

Background and Objectives: To investigate the associations between self-reported visual functioning (VF) and hearing functioning with cognition in the Hispanic/Latino population.

Research Design and Methods: We utilized data from the Miami Ocular Study of Latinos ancillary study to Hispanic Community Health Study/Study of Latinos with 1,056 participants aged 45 and older. The outcomes were cognitive performances assessed by the Digit Symbol Substitution Test (DSST), Word Fluency, Brief-Spanish English Verbal Learning Test-recall (B-SEVLT recall), words recalled over 3 trials, and the Six-Item Screener. VF was measured by National Eye Institute Visual Function Questionnaire (NEI-VFQ), and hearing function was measured by Hearing Handicap Inventory Screening Questionnaire for Adults and Elderly (HHIA/E-S). Multiple regressions were performed for each cognitive outcome while controlling for covariates and complex sampling design.

Results: NEI-VFQ was associated with 3 of the 5 cognitive outcomes. A 4-point NEI-VFQ score difference was associated with a 0.56-point difference in DSST (standard error [*SE*] = 0.27, $p < .001$), 0.17 in Word fluency (*SE* = 0.16, $p < .01$), and 0.08 in B-SEVLT-recall (*SE* = 0.07, $p < .01$). HHIA/E-S was not associated with any of the cognitive measures examined.

Discussion and Implications: These data suggest that impaired VF is associated with worse cognition in the Hispanic/Latino population. Although previous work in this cohort indicated hearing loss assessed by pure tone audiometry was associated with worse cognition, we found self-perceived hearing function was not associated with cognition, suggesting the potential limitation of self-reported hearing function as a proxy for hearing loss in epidemiological research in Hispanic/Latino populations. Results also imply impaired VF and hearing function may be linked to cognition differently in the Hispanic population, and more research is needed to better understand the underlying linking mechanisms. Visual and hearing impairments are common and treatable and represent important modifiable risk factors that can be treated to preserve cognitive function in Hispanics/Latinos.

Translational Significance: Epidemiological studies frequently rely on self-reported data. We found that self-reported visual functioning (VF) was associated with cognitive function in the Hispanic population, but not self-reported hearing functioning (HF), despite previous findings of HF assessed by pure tone audiometry associated with cognition in this cohort. Findings suggest the potential limitation of self-reported HF as a proxy for hearing in epidemiological research. Results imply impaired VF and HF may be linked to cognition differently in the Hispanic population. Visual and hearing impairments are common and treatable and represent important modifiable risk factors that can be treated to preserve cognitive function in Hispanics/Latinos.

Keywords: Cognitive impairment, Hearing loss, Visual functioning, Visual impairment

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Visual impairment (VI) and hearing impairment (HI) occur commonly among older adults and the risk increases with age (Lee et al., 2004; Swenor et al., 2013). Impaired visual and hearing functions have substantial health consequences. VI and HI diminish communication and can cause social isolation, reduced independence, and are associated with depression, cognitive impairment, and mortality (Karpa et al., 2010; Keller et al., 1999; Lee et al., 2002; Lin et al., 2011; Zheng et al., 2018).

Cognitive impairment is another serious health concern among older adults. In 2022, an estimated 6.5 million U.S. adults, age 65 years and older, had Alzheimer's disease and related dementias, and by 2050, this number is expected to increase to 13.8 million (Alzheimer's Association, 2022). Cognitive impairment is associated with decreased quality of life, increased disability and dependency on others (Lyketsos et al., 2002; Tabert et al., 2002), increased healthcare costs (Tabert et al., 2002), and early mortality (Schultz-Larsen et al., 2008).

The number of adults affected by VI, HI, and cognitive impairment will increase dramatically over the coming decades due to the rapid aging of the US population. Growing evidence indicates VI and HI are associated with cognitive decline in older adults not only cross-sectionally but also longitudinally (Lin et al., 2013; Vu et al., 2021; Zheng et al., 2018). However, these findings are drawn from studies that involved samples of mostly White and Black older adults with very few Hispanic participants. Hispanics/Latinos are the largest minority group in the United States comprising over 18% of the population with rapidly growing numbers and is estimated to become 24.3% by the year 2050. VI and HI are associated with lower socioeconomic status, diabetes mellitus, hypertension, smoking, and obesity, risk factors that may be more common among the Hispanic/Latino population (Agrawal et al., 2009; Bainbridge et al., 2008; Cruickshanks et al., 1998, 2015; Lee et al., 2005; Nash et al., 2011). Thus, Hispanic/Latinos may have a greater burden of VI and HI.

The NEI-Visual Function Questionnaire (NEI-VFQ) and the Hearing Handicap Inventory Screening Questionnaire for Adults/Elderly (HHIA/E-S) capture not only self-reported vision and hearing capabilities but also the impact of VI and hearing loss on communication ability in daily life and emotional well-being (Mangione et al., 2001; Newman et al., 1990; Ventry & Weinstein, 1982). To our knowledge, no studies have investigated joint associations between visual, hearing, and cognitive functioning measures in a large Hispanic/Latino population.

The objective of this study was to investigate the association between visual functioning measured by the NEI-VFQ and hearing functioning measured by the HHIA/E-S with cognitive functioning in a large representative multiethnic Hispanic/Latino population. Findings from this study will provide a deeper understanding of the role of visual and hearing functioning in Hispanic adults who may be at increased risk of cognitive impairment.

Method

Data Source

The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is a population-based cohort study of Hispanics conducted in four U.S. cities (Bronx, NY; Chicago, IL; Miami, FL; and San Diego, CA) and was designed to examine risk and protective factors for chronic diseases within Hispanic subgroups. This study was approved by the institutional review boards at each participating institution; written informed consent was obtained from all participants. Detailed descriptions of the sampling methods and baseline examination (2008–2011) have been published (LaVange et al., 2010; Sorlie et al., 2010). HCHS/SOL participants underwent cognitive functioning test, pure tone audiometry (PTA), and completed the HHIA/E-S at baseline. Participants at the Miami site also enrolled in an ancillary study—Ocular Study of Latinos (Ocular SOL) in 2011 which included a questionnaire on visual function (NEI-VFQ). Assessments were conducted in English or Spanish, as preferred by the participants. All assessment batteries were available in both English and Spanish and were administrated by bilingual staff. At the Miami site, 98% of participants preferred Spanish as the testing language. The cognitive assessments were administered to participants aged 45 years and older in HCHS/SOL; therefore, those aged 45 and above were included in this analysis. The current project utilized data from the Miami site who were enrolled in the Ocular SOL ancillary study (n = 1,056). Additional analyses were conducted using data from all four HCHS sites (n = 9,343) for a sensitivity analysis of hearing loss and cognitive impairment.

Visual Function

Visual function was assessed by NEI-VFQ-25 (Mangione et al., 2001). The VFQ-25 consists of 25 vision-targeted questions and represents 11 vision-related subscales such as global vision rating, difficulty with near-vision and distance-vision activities, limitations in social functioning, role limitations due to vision, dependency on others, mental health symptoms, driving difficulties, limitations with peripheral vision, limitation with color vision, and ocular pain. Items within each subscale were averaged together to create the subscale scores. The subscale scores were calculated based on the nonmissing items (McClure et al., 2016). The overall VFQ-25 composite score was calculated by averaging over the vision-targeted subscales excluding general health rating questions (Mangione et al., 2001). The NEI-VFQ composite scores range from 0 to 100 with 0 representing worst eye health and 100 representing best eye health. A 4-point difference in the NEI-VFQ score is considered minimum clinically meaningful (Submacular Surgery Trials Research Group, 2007). The VFQ-25 measures the influence of visual disability on general health, emotional well-being and social functioning, and daily visual functioning. Participants who preferred Spanish as a testing language received the Spanish version of the NEI-VFQ (Broman et al., 2001).

Hearing Function

Hearing function was measured by the Hearing Handicap Inventory Screening Questionnaire for Adults (HHIA-S; age 18–65 years; Newman et al., 1990) or the Hearing Handicap Inventory Screening Questionnaire for the Elderly (HHIE-S; age over 65 years; Ventry & Weinstein, 1982). The HHIA-S and HHIE-S questionnaires are identical except two questions were worded slightly differently so that they are more applicable to the age range. These 10-item questionnaires are designed to assess the emotional and social impact of perceived HI for adults of the two age ranges. In both questionnaires, each of the 10 questions was scored as No (0 points), Sometimes (2 points), and Yes (4 points). The total score is a sum of the 10 questions and ranges from 0 to 40, with higher scores indicating greater self-perceived hearing handicap. HHIA/E-S scores of 0–8 are considered to reflect no self-perceived hearing disability, 10–24 mild-to-moderate hearing disability, and 26–40 severe hearing disability. The HHIA/E-S score was primarily analyzed as a continuous variable. Participants who preferred Spanish as a testing language received the cross-culturally adapted Spanish version of the HHIA/E-S (Lichtenstein & Hazuda, 1998). In post hoc analyses, we also examined the correlations between the self-reported HHIA/E-S and Pure Tone Average at 0.5, 1, 2, and 4 kHz in the better hearing (PTAB) ear assessed at baseline examination (Cruickshanks et al., 2015).

Cognitive Functioning

The participant was asked if he/she used reading glasses or wore hearing aids. If so, these items were worn during cognitive testing. Five different cognitive functioning measures were administered in HCHS (González et al., 2015). The global cognitive functioning was measured by the Six-Item Screener (SIS). The SIS is similar to the Mini-Mental State Exam and is a brief screener that consists of three orientation questions and a three-word list learning and memory trial (Callahan et al., 2002). The sum of correctly answered SIS questions represents the SIS measure. The verbal learning and memory were assessed by the Brief-Spanish English Verbal Learning Test (B-SEVLT; González et al., 2001). The participant was presented with a list of 15 common words over three separate trials and asked to recall the words after each learning trial. The total correct number of words recalled over three trials was recorded (B-SEVLT 3 trials). A distracting word list was then presented to the participants and the participants repeated it back. The examinee was then asked to recall the first word list after the distracting word list was given (B-SEVLT recall). Verbal functioning was evaluated by a phonemic verbal fluency test Word Fluency. Participants were instructed to say as many words as possible that begin with the letter F within 60 s. This procedure was then repeated for the letter A. The sum of correctly generated words for both letters served as the verbal fluency score. The executive function/processing speed was assessed by the Digit Symbol Substitute Test (DSST). Participants were asked to translate numbers (1–9) to symbols using a key provided within 90 s. We used the original scale of the cognitive measures because comparison across cognitive tests is not the intention of this project.

Mental Well-Being and Social Connection

In post hoc analysis, we examined the relationship of VFQ and HHIA/E-S with individuals' mental well-being, specifically depression and anxiety. Depression was assessed by Center for Epidemiologic Studies—Depression Scale-10 (CESD-10; González et al., 2017). CESD-10 scores range from 0 to 30 with higher scores indicating worse depressive symptoms. Anxiety was assessed by 10-item State–Trait Anxiety Inventory summary score (STAI-10) and scores ranging from 0 to 40 with higher scores indicating worse anxiety (Spielberger et al., 1971).

The social connection measures utilized are the Interpersonal Support Evaluation List (ISEL; Cohen et al., 1985). ISEL assessed self-perceived availability of social support. Respondents indicated the extent to which statements describing the availability of different types of social support in their lives are true or false. The social network index (SNI) measures include the number of people in the social network, the number of high-contact role, and the number of embedded networks (Cohen et al., 1997). The social connection data were collected through the sociocultural ancillary study, which was planned for about one third of the HCHS parent study sample. The sociocultural ancillary study subsample is considered representative of the HCHS/SOL parent study cohort (Gallo et al., 2014). Social connection data are available for 43% (457 out of 1,056) of the study participants who had participated in the HCHS/SOL Sociocultural Ancillary Study (Gallo et al., 2014)

Covariates

The sociodemographic variables that were controlled in the statistical model included age (in years), sex (male vs female), Hispanic/Latino background (Mexican, Puerto Rican, Dominican, Central and South American vs Cuban), education level (high school graduate, above high school vs less than high school). Important confounders of cognitive impairment such as depressive symptoms and cardiovascular risk factors are also controlled in the model. The cardiovascular risk score was calculated as the number of conditions that participants reported including diabetes, hypertension, coronary artery disease, stroke/transient ischemic attack (Golub et al., 2020). Each condition reported was counted as 1 point, except for diabetes which was based on fasting glucose; 1 point was assigned for impaired glucose tolerance and 2 points for diabetes (Golub et al., 2020). Depressive symptoms assessed by CESD-10 were also controlled in the regression models when depressive symptoms were not the outcome.

Statistical Analysis

Descriptive statistics of sociodemographic variables, covariates, predictors, and outcome variables were calculated for the study sample (Miami site). Multiple linear regressions examining the relationship between NEI-VFQ and/or HHIA/E-S with cognitive function were performed for different domains of cognitive outcomes while controlling for confounders. Potential interaction between NEI-VFQ and HHIA/E-S was also examined. To account for multiple cognitive tests, a Bonferroni correction for five tests (the number of cognitive tests) was implemented, which gave us an adjusted α level of 0.01 (= 0.05/5). Regression coefficients, standard errors [*SE*s], and p values are reported. We reported the coefficients associated with a 4-point change in NEI-VFQ score which is considered minimum clinically meaningful (Submacular Surgery Trials Research Group, 2007). Correlation analyses were conducted to examine the consistency between self-reported HHIA/E-S and audiometry measure of PTAB.

The regression analyses accounted for the cluster sampling and the use of stratification in the sample selection of the HCHS/SOL study (Sorlie et al., 2010). As a sensitivity analysis, we also utilized data from all four HCHS sites for the hearing-related analyses because the hearing data were available in all HCHS sites. Post hoc analyses also included standardized regression analyses examining the relationship between VFQ and HHIA/E-S with the mental well-being and social connection variables. Analyses were conducted using SAS 9.4 (Cary, NC).

Results

A description of the study population is presented in Table 1. The analytic sample included 1,056 participants aged 45 years and older from Miami Ocular SOL ancillary study. The majority of the sample self-identified as being of Cuban descent (*n* = 644, 61%) with 32% identifying as being of Central or South American descent (*n* = 344). The average age of the study population was 55.6 (standard deviation [*SD*] 7.1) years, 61% were female, and 48% had above high school education. The average cardiovascular risk score was 1.47 (*SD* 1.1) and the average depressive symptom score was 7.79 (*SD* 6.7).

The mean SIS score was 5.43 (out of 6) indicating the cognitive status of this community-residing study sample was within normal limits. About 10.2% of participants reported SIS ≤ 4, which is considered cognitively impaired (Callahan et al., 2002). Both the NEI-VFQ and HHIA/E-S scores were skewed with a majority of participants reporting no impaired vision or hearing functioning. The mean NEI-VFQ score is 86.7, median 92.7, interquartile range 82.7–95.9. About 67.5% of participants reported VFQ score above 95 indicating minimal visual functioning impairment. The average HHIA/E-S score is 2.46 with a median of 0. Approximately 78% of participants had an HHIA/E-S score of 0 reporting no self-perceived impaired hearing functioning, whereas PTA showed 15% (157) participants had PTAB > 25 dB, which is considered clinically significant hearing loss (Table 1).

Table 1. Participant Characteristics for the Miami Ocular SOL Study (*N* = 1,056)

Characteristics	Mean (*SD*) or *n* (%)
Age, mean (*SD*)	55.6 (7.1)
Sex—female, *n* (%)	646 (61.2%)
Education, *n* (%)	
Less than high school	288 (27.3%)
High school graduate	256 (24.3%)
Above high school	510 (48.4%)
Ethnic background, *n* (%)	
Cuban	644 (61.0%)
Mexican	10 (1.0%)
Dominican and Puerto Rican	37 (3.5%)
Central and South American	344 (32.6%)
Other	21 (2.0%)
Cardiovascular disease score, mean (*SD*)	1.8 ± 1.1
Depression (CESD-10), mean (*SD*)	7.8 ± 6.7
Anxiety (STAI-10), mean (*SD*)	16.8 ± 5.8
Vision	
NEI-VFQ, mean	86.7
NEI-VFQ, medium	92.7
Hearing	
HHIA/E-S score, mean	2.46
HHIA/E-S score, medium	0
PTA better ear, mean (*SD*)	0.17 ± 0.43
Hearing loss—PTA > 25 dB better ear, n (%)	157 (15.1%)
Cognition, *m* (*SD*)	
Six-Item Screener score	5.4 ± 0.8
Digit Symbol Substitution Test score	33.4 ± 12.4
Word Fluency Test score	18.1 ± 7.1
B-SEVLT recall	8.2 ± 2.7
B-SEVLT 3 Trials	22.5 ± 5.6

Notes: B-SEVLT = Brief-Spanish English Verbal Learning Test; CESD-10 = Center for Epidemiologic Studies—Depression Scale-10; HHIA/E-S = Hearing Handicap Inventory Screening Questionnaire for Adults and Elderly; NEI-VFQ = National Eye Institute Visual Function Questionnaire; PTA = Pure Tone Audiometry; STAI-10 = State–Trait Anxiety Inventory.

Self-Reported Visual and Hearing Functioning and Cognition

The multiple regression examining the association between self-reported visual functioning (VFQ) and different measures of cognitive function indicated that VFQ was associated with three of the five cognitive outcomes (Table 2). A 4-point decrease in VFQ score was associated with a 0.56-point decrease in the DSST, which measures processing speed and executive function (β = 0.56, *SE* = 0.11, *p* < .001). A 4-point decrease in VFQ is also associated with a 0.17-point decrease in Word Fluency Test (verbal fluency, β = 0.17, *SE* = 0.07, *p* < .01), and 0.08-point decrease in B-SEVLT recall (episodic learning and memory, β = 0.08, *SE* = 0.03, *p* < .01). VFQ was not statistically significantly associated with B-SEVLT-three trials (β = 0.11, *SE* = 0.06, *p* = .053) or the SIS (β = 0.02, *SE* = 0.001, *p* = .068).

Similar regression analysis examining self-perceived hearing functioning and cognitive function indicated HHIA/E-S score was not associated with any of the cognitive functioning measures in the study sample (Table 3). HHIA/E-S was not statistically significantly associated with DSST (β=–0.068, *SE* = 0.045, *p* = .13); Word Fluency Test (β=–0.03, *SE* = 0.036, *p* = .4); B-SEVLT-recall (β = 0.007, *SE* = 0.014, *p* = .62), B-SEVLT-3 trials (β = 0.006, *SE* = 0.035, *p* = .98), or SIS (β = 0.002, *SE* = 0.035, *p* = .65).

We also examined the joint effect of VFQ and HHIA/E-S on cognition by including both items and their interaction in the regression while controlling for the covariates (Table 4). There was no statistically significant interaction effect between VFQ and HHIA/E-S for all cognitive outcomes after Bonferroni adjustment. Therefore, the interaction was excluded from the models. VFQ remained statistically significantly associated

Table 2. Multiple Regression of NEI-VFQ Score and Cognitive Functioning Measures

Cognitive outcome	Difference per 4-point NEI-VFQ[a]	*SE*	*p* Value
Six-item Screener	0.02	0.001	.068
Digital Symbol Substitute Test	0.56	0.11	<.001
Word frequency test	0.17	0.07	<.01
B-SEVLT Recall	0.08	0.03	<.01
B-SEVLT three trials	0.11	0.06	.053

Notes: B-SEVLT: Brief-Spanish English Verbal Learning Test; NEI-VFQ = National Eye Institute Visual Function Questionnaire; *SE* = standard error.
[a]Multiple regression model controlled for age, gender, education, Hispanic ethnicity background, cardiovascular risk score, and depression score. *p* Values <.01 were considered statistically significant (Bonferroni correction for five tests α = 0.05/5).

with the DSST (β = 0.56, *SE* = 0.11, $p < .001$) and B-SEVLT-recall (β = 0.09, *SE* = 0.03, $p < .01$), but was no longer statistically significantly associated with word fluency test (β = 0.17, *SE* = 0.07, $p = .01$) and SIS (β = 0.02, *SE* = 0.01, $p < .05$) after Bonferroni correction. VFQ was not associated with B-SEVLT-3 trials (β = 0.11, *SE* = 0.06, $p = .067$). HHIA/E-S was not significantly associated with any of the five cognitive outcomes. Therefore, VFQ remained a significant predictor of the cognitive outcomes with the presence of HHIA/E-S in the model.

As a sensitivity analysis, we repeated the multiple regression analysis for HHIA/E-S using data from all four HCHS sites because the HHIA/E-S data were available, unlike VFQ which was only available in the Miami site. HHIA/E-S was associated with one of the five cognitive outcomes when using data from all four sites (n = 9,343, Table 5). Each point increase in HHIA/E-S score was associated with a 0.03-point decrease of the B-SEVLT-3 trials (learning, β = −0.03, *SE* = 0.011, $p < .01$). HHIA/E were not statistically significantly associated with DSST (β = −0.011, *SE* = 0.023, $p = .63$), Word Fluency Test (β = −0.018, *SE* = 0.017, $p = .27$); B-SEVLT-recall (β = −0.01, *SE* = 0.005, $p = .057$) or SIS (β = 0.0001, *SE* = 0.002, $p = .97$). We also performed regression analyses treating HHIA/E-S as a categorical variable (no hearing disability, mild to moderate, and severe hearing disability) and similar results were observed.

Table 3. Multiple Regression of HHIA/E-S Score and Cognitive Functioning Measures

Cognitive outcome	Difference per HHIA/E-S point[a]	*SE*	P value
Six-item screener	0.002	0.004	0.65
Digital symbol substitute test	−0.068	0.045	0.13
Word frequency test	−0.03	0.036	0.4
B-SEVLT Recall	0.0066	0.014	0.62
B-SEVLT three trials	0.0006	0.035	0.98

Notes: B-SEVLT: Brief-Spanish English Verbal Learning Test; HHIA/E-S = Hearing Handicap Inventory Screening Questionnaire for Adults and Elderly; *SE* = standard error.
[a]Regression model controlled for age, gender, education, Hispanic background, cardiovascular risk factor, and depression score. p Values <.01 were considered statistically significant (Bonferroni correction for five tests α = 0.05/5).

Table 4. Multiple Regression of NEI-VFQ and HHIA/E-S and Cognitive Functioning in HCHS Population

Cognitive outcome	Difference per 4-point NEI-VFQ[a]	Standard error	p Value	Per HHIA/ E-S point	*SE*	p Value
Six-item Screener	0.02	0.01	.047	0.004	0.005	.34
Digital Symbol Substitute	0.56	0.11	<.001	−0.004	0.045	.94
Word Frequency Test	0.17	0.07	.01	−0.01	0.035	.76
B-SEVLT Recall	0.09	0.03	<.01	0.017	0.015	.26
B-SEVLT Three trials	0.11	0.06	.067	0.014	0.037	.72

Notes: B-SEVLT = Brief-Spanish English Verbal Learning Test; HCHS = Hispanic Community Health Study; HHIA/E-S = Hearing Handicap Inventory Screening Questionnaire for Adults and Elderly; NEI-VFQ = National Eye Institute Visual Function Questionnaire; *SE* = standard error.
[a]Regression model includes the NEI-VFQ and the HHIA/E with adjustment for age, gender, education, Hispanic ethnicity background, cardiovascular risk factor, and depression score. p Values <.01 were considered statistically significant (Bonferroni correction for five tests α = 0.05/5).

Self-Reported Visual/Hearing Functioning and Social Connection and Mental Well-Being

Post hoc analysis examining the relationship between VFQ and HHIA/E-S with depression and anxiety showed that both VFQ and HHIA/E-S were associated with these mental well-being measures. However, when comparing the standardized coefficients, which are in a common metric of *SD* unit and therefore comparable, the effect of VFQ on depression (standardized β = −0.312, *SE* = 0.035, $p < .001$) was larger compared to the effect of HHIA/E-S (standardized β = 0.165, *SE* = 0.033, $p < .001$). The standardized coefficient for VFQ on depression was about twice the size of HHIA-E/S. Similarly, the standardized coefficient for VFQ on anxiety (standardized β = −0.291, *SE* = 0.043, $p < .001$) was about three times the size of HHIA-E/S on anxiety (standardized β = 0.098, *SE* = 0.033, $p < .001$; Table 6).

Standardized regression examining VFQ and HHIA/E-S with social connection variables indicated both VFQ and HHIA/E-S were associated with ISEL to a similar degree. The standardized coefficient is 0.140 for VFQ (*SE* = 0.053, $p = .01$) and 0.115 for HHIA/E-S (*SE* = 0.043, $p = .01$). Neither VFQ nor HHIA/E-S was statistically significantly associated with the SNI variables in the adjusted models.

Discussion

Our study examined the relationship between self-reported visual and hearing functioning with cognitive function in a large multiethnic Hispanic/Latino population. Our results

Table 5. Sensitivity Analysis—Hearing Handicap Inventory Screening Questionnaire (HHIA/E-S) Score and Cognitive Functioning Measures in HCHS Population (Data From All 4 HCHS Sites, N = 9,343)

Cognitive outcome	HHIA/E-S score[a]	*SE*	p Value
Six-item screener	0.0001	0.002	.97
Digital symbol substitute test	−0.011	0.023	.63
Word frequency test	−0.018	0.017	.27
B-SEVLT Recall	−0.01	0.005	.057
B-SEVLT three trials	−0.03	0.011	.01

Notes: B-SEVLT: Brief-Spanish English Verbal Learning Test; HCHS = Hispanic Community Health Study; HHIA/E-S = Hearing Handicap Inventory Screening Questionnaire for Adults and Elderly; *SE* = standard error.
[a]Regression model controlled for age, gender, education, Hispanic background, cardiovascular risk factor, and depression score. p Values <.01 were considered statistically significant (Bonferroni correction for five tests α = 0.05/5).

Table 6. Standardized Regression of VFQ and HHIA/E-S With Mental Well-Being and Social Connection Measures

Outcome	NEI-VFQ	*SE*	*p* Value	HHIA/E-S	*SE*	*p* Value
ISEL	0.14[a]	0.054	.01	−0.115[a]	0.043	.01
CESD-10 (Depression)	−0.312[a]	0.035	<.001	0.165[a]	0.033	<.001
STAI-10 (Anxiety)	−0.291[a]	0.043	<.001	0.098[a]	0.033	<.001

Notes: CESD-10 = Center for Epidemiologic Studies—Depression Scale-10; HHIA/E-S = Hearing Handicap Inventory Screening Questionnaire for Adults and Elderly; ISEL = Interpersonal Support Evaluation List; NEI-VFQ = National Eye Institute Visual Function Questionnaire; STAI-10 = State–Trait Anxiety Inventory; VFQ = Visual Function Questionnaire.
[a]Standardized coefficient. Model controlled for age, gender, education, Hispanic background, and cardiovascular risk factor.

indicated self-reported impaired visual functioning was associated with worse cognitive functioning in three of the five cognitive function assessments. The three cognitive function assessments represent processing speed/executive functioning, verbal fluency, and episodic learning and memory. On the contrary, self-perceived impaired hearing functioning was not associated with any of the five cognitive functioning assessments.

Clinically measured visual functions, such as visual acuity and contrast sensitivity, have been demonstrated to be associated with multiple domains of cognitive function (Ehrlich et al., 2021; Swenor et al., 2019; Zheng et al., 2018). Our study further demonstrated that self-reported visual function measured by NEI-VFQ is associated with multiple domains of cognitive function in a multiethnic Hispanic/Latino population. Furthermore, self-reported visual functioning remained a significant predictor of cognitive function with the presence of self-perceived hearing functioning in the model. To our knowledge, this finding has not been reported previously.

Our finding that self-perceived hearing function was not associated with any of the cognitive assessments in our study sample was a surprise. Several studies reported the associations between HI and poor cognitive outcomes in older adults (Lin et al., 2013; Livingston et al., 2020). Golub and others demonstrated that hearing loss assessed via PTA was associated with poor cognitive performance in this cohort (Golub et al., 2020; Stickel et al., 2021). To uncover the causes of this discrepancy, we examined the correspondence between pure tone average of the better ear (PTAB) and self-perceived hearing function (HHIA/E-S) in our data. The correlation between PTAB and HHIA/E-S score was relatively low at 0.29 in the Miami site and 0.33 in the larger sample from four sites (both $p < .05$). For those participants with mild hearing loss (PTAB 25–40 dB HL), 77% reported having no self-perceived impaired hearing functioning (HHIA/E-S score 0–8). For those with severe hearing loss (PTAB > 40 dB HL), 48% reported no self-perceived impaired hearing functioning. Despite audiometric test results indicating hearing loss, a large percentage of participants reported no self-perceived impaired hearing functioning. A similar low correspondence between PTAB and HHIA/E-S was also found when using data from all four sites (n = 9,247). The disagreement between PTA and HHIA/E-S findings from this large community-based study appears to be worse than those reported by one smaller clinical study (Servidoni & Conterno, 2018). Other studies also revealed the low agreement between audiometric measures and self-perceived hearing functioning (Gopinath et al., 2012; Kamil et al., 2015). This discordance between self-perceived hearing functioning and PTA is one of the main reasons that our findings are divergent from those utilizing PTA to assess hearing loss and cognitive function in this Hispanic population (Golub et al., 2020; Stickel et al., 2021). This suggests the potential limitation of using self-reported hearing functioning difficulties as a proxy for hearing function/impairment in epidemiological research in the Hispanic population.

Hearing loss is likely subjected to stigma more than VI. A survey by The Hearing Review (2011) found 35% of people did not want to admit having hearing loss publicly, and 34% reported hearing aids are embarrassing to wear and would make them look disabled. One study found that stigma is the underlying factor in the denial of hearing loss and rejection of hearing assessment and treatment. Stigma around hearing loss has to do with altered self-perception and ageism (Wallhagen, 2010). It is unknown whether the stigma and denial around hearing loss are more prevalent in the Hispanic population. Of note, one study documented that Hispanic ethnicity and older age were associated with more discordance between self-reported hearing loss and audiometric measures (Kamil et al., 2015). Additionally, hearing loss develops slowly and many individuals may remain unaware of their hearing loss. The discrepancy between HHIA/E-S and PTA may be more prominent in the mid-age group than the older group.

It is worth noting that although NEI-VFQ and HHIA/E-S measure visual and hearing function, respectively, they are different in instrument length, range of issues captured, and the response options employed. The NEI-VFQ includes 25 questions comprising 11 subscales with 5 or 6 response options to each question and a complex scoring system (see Methods section). The NEI-VFQ captures the influence of visual disability on general health, emotional well-being and social functioning, and daily visual functioning. In contrast, HHIA/E-S includes only 10 questions each with 3 response options that assess the emotional and social impact of self-perceived hearing loss. These differences in instrument structure and complexity could contribute to NEI-VFQ and HHIA/E-S related to the cognitive measures differently in this study.

Several theories (Humes et al., 2013) have been proposed to explain the underlying mechanism in which VI and hearing loss affect cognition in aging adults. Sensory impairment may increase the cognitive load (Whitson et al., 2018), reduce older adults' ability to participate in activities and social engagement, or affect their mental well-being; these factors, in turn, become risk factors for cognitive decline and dementia (Joe Verghese et al., 2006). Alternatively, sensory impairment and cognitive decline could both be the result of a common underlying cause, such as brain neurodegeneration (Lindenberger & Ghisletta, 2009). Although sensory impairment likely influences cognition through multiple pathways, our findings that self-reported visual and hearing functioning are related to cognition differently may imply that the main linking mechanisms in which VI and hearing loss operate to affect cognition in aging adults could be different.

Our results indicate both self-reported impaired visual and hearing functioning were associated with decreased social connections in this Hispanic/Latino population as the VFQ and HHIA/E-S were designed to capture. Additionally, we found that the association of visual and hearing functioning with social connection was comparable. On the other hand, the impact of impaired visual functioning on individual's mental well-being appeared to be stronger than impaired hearing functioning in this Hispanic/Latino population, as indicated by the size of the standardized coefficients of VFQ on depression and anxiety being two to threefold larger than the HHIA/E-S associations, respectively. This suggests the underlying mechanisms that VI and hearing loss operate to affect cognitive function in middle-aged and old adults could be slightly different. Further research is warranted to better understand how impaired visual and hearing functions are connected to cognitive impairment in the Hispanic/Latino population, which will provide insight into strategies to reduce the risk of cognitive decline associated with these impairments.

The limitations of the study include the VFQ information only being available at one study site (Miami) where the subjects were predominantly of Cuban and Central or South American origin, and our findings are generalizable to these groups only. However, associations between self-reported hearing and visual functioning and cognition have never been reported in these subgroups, which can be considered a strength. Our sample was relatively young with a mean age of 55 years; the prevalence of impaired visual and hearing functioning as well as cognitive impairment was still relatively low in this population. We will likely observe more visual, hearing, and cognitive impairment and their functional impacts as the study continues and as the participants age. Additionally, because of the cross-sectional nature of these data, no temporal relationship or direction of the association can be drawn from our findings; future longitudinal assessment of both clinical and functional measures is needed. Nevertheless, our study utilized multiple cognitive measures assessing different domains of cognition and examined the effect of visual and hearing functioning on cognition simultaneously in a large multiethnic Hispanic population.

Conclusion

We demonstrated that self-reported impaired visual functioning was associated with worse cognition in a diverse Hispanic/Latino population. Although previous work in this cohort showed hearing loss assessed by PTA was associated with worse cognitive functioning in this population, we found self-reported impaired hearing functioning was largely not associated with cognitive performance, suggesting the potential limitation of self-reported hearing function as a proxy for hearing loss in sensory impairment and cognition research in Hispanics/Latinos. Additional research is needed to fully understand the underlying linking mechanisms between VI and hearing loss with cognitive function in Hispanics/Latinos.

Our results reinforce the importance of early detection and treatment to preserve visual and hearing function in the Hispanic population which shares a great burden of vision and HI. Treatments for cognitive decline, Alzheimer's diseases, and related dementia remain very limited. VI and hearing loss are prevalent conditions that are highly treatable and represent important modifiable risk factors for the preservation of cognitive function and therefore, improved quality of life.

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Conflict of Interest

None.

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