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Health Literacy and Cognitive Performance among Older Adults

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Abstract

Objectives—Specific cognitive abilities may explain the association of health literacy with health status. We studied the relationship between health literacy and memory and verbal fluency in older adults.

Design—Cross-sectional cohort.

Setting—Twenty senior centers and apartment buildings in New York City, NY.

Participants—Independently living, English and Spanish-speaking adults ages 60 and older (n=414).

Measurements—Health literacy was measured using the Short Test of Functional Health Literacy in Adults (S-TOFHLA). The associations of S-TOFHLA scores with immediate and delayed recall (Wechsler Memory Scale II), verbal fluency (Animal Naming), and global cognitive function (Mini Mental Status Exam, MMSE), were modeled with multivariable logistic and linear regression.

Results—Health literacy was inadequate in 24.3%. Impairment of immediate recall occurred in 20.4%; delayed recall, 15.0%; verbal fluency, 9.9%; and MMSE, 17.4%. Abnormal cognitive function was strongly associated with inadequate health literacy: immediate recall (AOR 3.44, 95% CI 1.71 to 6.94, p<.0001); delayed recall (AOR 3.48, 95% CI 1.58 to 7.67, p = .002); and

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verbal fluency (AOR 3.47, 95% CI 1.44 to 8.38, $p=.006$). These associations persisted in subgroups that excluded individuals with normal age-adjusted MMSE scores.

Conclusion—Memory and verbal fluency are strongly associated with health literacy, independently of education and health status, even among those with subtle cognitive dysfunction. Reducing the cognitive burden of health information might mitigate the detrimental effects of limited health literacy in older adults. Research that examines the impact of materials tailored to older adults' cognitive limitations on health literacy and health outcomes is needed.

Keywords

Health literacy; cognition; older adults

INTRODUCTION

Health literacy has been defined by the Institute of Medicine as “The degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.”(1) A rapidly growing body of research has documented the problems of low health literacy, including its high prevalence (1) and detrimental impact on health and health outcomes (2-4). Our understanding of health literacy has evolved, and it is increasingly apparent that deficits in health literacy result not just from problems with vocabulary and reading fluency, but from an interaction of several factors. Health literacy is influenced by the complexity of the presented information, basic reading and numeracy skills, contextual knowledge and prior experience, as well as fundamental cognitive abilities (5-7). However, the impact of cognition on health literacy, independent of education, has been less well studied, especially in the elderly. This topic is particularly germane to the elderly, who have relatively high rates of both cognitive impairment and low health literacy (8).

With increasing age, decline in cognitive performance often occurs in the absence of frank dementia—over 5 million adults over age 70 in the US have some form of cognitive impairment without dementia (9). The impact of these lesser forms of cognitive dysfunction can have a cumulative toll on one's ability to perform necessary health tasks. Mild Cognitive Impairment (MCI), which is characterized by measurable memory loss without functional impairment (10), affects 2 to 8 percent of community-dwelling older adults (11,12). Unfortunately, these subtle forms of cognitive impairment are difficult to detect; as a result many elderly individuals are not properly identified as in need of support within the healthcare system (13). Mild cognitive impairment is typically diagnosed using formal neuropsychiatric assessments (13). Verbal fluency is another important cognitive ability that is often impaired in non-demented older adults (14). It includes the processes necessary for deriving deeper meaning from text and oral communications; including access to a vocabulary store and making inferences based on information from long-term memory. Despite its importance, standard tests of verbal fluency or inferential reasoning are not routinely used in clinical settings.

Previous studies examining the relationship between cognitive function and health literacy have either used non-specific cognitive measures, such as the mini-mental status exam (MMSE) (5), or used homogeneous samples of patients with heart failure (7). We sought to define the relationship between health literacy and specific cognitive abilities that are commonly impaired in older adults, and to do so in a generalizable community-based sample of independently living older adults. We hypothesized that impairments of both memory and verbal fluency, in particular, would have strong and independent associations with limited health literacy.

METHODS

Subjects and Setting

We recruited independently living adults ages 60 years and older from 30 community-based settings in New York City, including senior centers and residential complexes. Senior centers, either free-standing or connected with naturally occurring retirement communities (NORC), were identified through listings maintained by the New York City Department for the Aging. Low-income housing facilities were identified through a listing of federal Housing and Urban Development-supported low-income housing facilities. We selected sites in zip code areas with median household incomes below \$50,000 and over-sampled men because they are outnumbered by women in these communities.

Individuals were recruited during site-sponsored meals or special events for a longitudinal study about health, health care use, and health insurance that provided \$20 for the baseline interview and \$10 for a follow-up interview (scheduled to occur 6-9 months later). Interviews were conducted with only a single member of a household and were conducted in English and Spanish on-site by trained bilingual interviewers. All interviews took place between June 1, 2007 and October 1, 2007. For the present analysis we only included individuals whose visual acuity was 20/50 or better as determined with a handheld Snellen chart, with or without use of corrective lenses. Written informed consent was obtained from all participants prior to interviews and the study was approved by the Mount Sinai School of Medicine Institutional Review Board.

Outcome Measures

The outcome, health literacy, was assessed with the Short Test of Functional Health Literacy in Adults (S-TOFHLA), one of the most widely used and validated instruments (15). Although health literacy is a complex concept and no existing instrument measures all of its pertinent domains, the S-TOFHLA is strongly correlated with other measures of health literacy (15), and as an education-independent association with other health-related measures including knowledge of chronic illness (16) and health outcomes (3).

The S-TOFHLA is a timed (7-minute) comprehension test composed of 2 clinically oriented reading passages. Thirty-six words are intermittently missing through the 2 passages and the respondent must select the 1 word among 4 choices to complete each sentence in a grammatically correct fashion. Scores range from 0-36 and are divided into 3 levels of health literacy: inadequate (range 0-16), marginal (range 17-22), and adequate (range 23-36). Individuals with inadequate health literacy struggle with basic medical information, such as reading prescription bottles. We examined S-TOFHLA scores as both a dichotomous variable, indicating inadequate health literacy, and as a continuous variable.

Independent Variables

We conducted 4 assessments of cognitive function: immediate and delayed recall (memory); verbal fluency; and global cognitive function. We assessed immediate and delayed recall using Story A of the Wechsler Memory Scale II (WMS) (17). Story A is a brief passage read by an interviewer, who asks the subject to recall as much as possible immediately after it is read (immediate recall task). The interviewer then asks them to remember the passage, saying that they will be asked to recall it again "later." The delayed recall is conducted 25-30 minutes later. The Animal Naming Test (14) was administered to assess semantic verbal fluency, an ability involving both language and executive functions (18). Because the test demonstrates less sensitivity to variations in education and English ability, it is suitable for ethnically diverse populations with wide ranging education levels (18). It requires subjects to name as many animals of any kind in one minute. The Mini Mental Status Exam,

a tool typically used to screen for dementia, was used to assess global cognitive function (19). Scores for the cognitive measures were used as dichotomous variables indicating abnormal scores and as continuous variables. The thresholds for normal for the dichotomous variables were set as 1.5 standard deviations or more below age-based norms (17,20-22).

Other variables having known associations with basic and health literacy were also included in our analyses. These were age, gender, race and ethnicity (non-Hispanic blacks, non-Hispanic whites, Latinos, and other), education level, English proficiency, income, and health and functional status (1,5-8,23). To determine English proficiency, study participants were asked: "How would you describe your ability to speak and understand English?" The 6 response options ranged from very poor to excellent. Our health status measures included the single-item general health measure from the SF-36 (24), total number of chronic diseases, and basic activities of daily living (ADL). Self-reported performance on 6 ADLs was documented (bathing or showering, walking, getting in or out of bed or chairs, eating, dressing, or using the toilet) (25). Study participants were considered to be impaired if they experienced difficulty with one or more tasks all of the time.

Analysis

We conducted 2 general sets of analyses. First, we compared inadequate health literacy with the 4 variables indicating abnormal cognitive function in both unadjusted (chi-square tests) and adjusted analyses (logistic regression). We further sought to determine whether memory and verbal fluency were associated with health literacy in the context of cognitive impairment without frank dementia. We therefore reran the main logistic regression models for the subgroup with normal MMSE scores (age-adjusted), as well as the combined subgroup with both normal MMSE scores and no ADL deficiencies.

Second, we compared the continuous S-TOFHLA score with the 4 continuous measures of cognitive function. For unadjusted analyses of the latter, we calculated Spearman correlation coefficients. We then used multivariable linear regression to model the relationships between S-TOFHLA scores and the continuous measures of cognitive function. Separate models were created to examine each cognitive measure individually. We report R^2 values for these models.

Most questions were missing data for fewer than 5% of study participants. However, 13.0% were missing data on income, consistent with other survey studies that collected data on self-reported income (26). We used multiple hot-deck imputation to replace missing observations for income in logistic regression analyses (27). Imputed data sets were created with STATA version 10 using the hotdeck command (Stata Corporation, College Station, TX). All analyses were conducted with SAS version 9.1 (SAS Institute, Inc., Cary, NC).

RESULTS

Sample Characteristics and Performance on the S-TOFHLA

Of the 451 individuals recruited for this study, 414 (92.0%) were administered the S-TOFHLA and were included in the analyses presented here. Ninety-two surveys (22.2%) were administered in Spanish. Overall, about half the respondents (44.7%) were 75 years or older and 37.6% were men (Table 1). The sample was evenly divided among blacks, whites, and Latinos, and 28.0% had not graduated high school. Other demographic and health status characteristics of the sample are shown in Table 1.

Of the 37 subjects who did not take the S-TOFHLA, 17 (47%) had a visual impairment, 17 (46%) refused, and 3 (8%) reported being unable to read. One-hundred and seven

participants (25.8%) did not complete the S-TOFHLA in the allotted time, and of these individuals 60.8% had inadequate health literacy.

Among those taking the S-TOFHLA, health literacy was adequate in two-thirds (66.5%), marginal for 9.2%, and inadequate for 24.3%. More than one-third of blacks (38.6%) and half of Latinos (53.5%) had inadequate health literacy compared with 3.9% of white study participants (Table 1). Inadequate health literacy was also significantly more common among those with lower English proficiency, education, income, and poorer general health and functional status.

Abnormal Cognition and Inadequate Health Literacy

The proportion of individuals with abnormal immediate recall was 20.4%, abnormal delayed recall, 15.0%, abnormal verbal fluency, 9.9%, and abnormal MMSE was 17.4% (Table 2). All measures of abnormal cognition were significantly associated with inadequate health literacy ($p < .0001$).

In multivariate logistic regression analyses, the associations between the cognitive measures and inadequate health literacy persisted after adjusting for education and other demographics and health status (Table 3). Individuals with abnormal immediate and delayed recall, verbal fluency, and MMSE scores had three to five fold greater adjusted odds of inadequate health literacy.

In the subgroup of individuals with normal age-adjusted MMSE scores, the proportion of those with abnormal immediate recall was 19.0%, abnormal delayed recall, 12.6%, and abnormal verbal fluency, 8.8%. These cognitive measures maintained their statistically significant associations with inadequate health literacy in the adjusted subgroup analyses: abnormal immediate recall (AOR 4.90, 95% CI 2.09 to 11.6, $p = .0003$); abnormal delayed recall (AOR 3.65, 95% CI 1.16 to 7.97, $p = .02$); abnormal verbal fluency (AOR 7.68, 95% CI 2.57 to 22.9, $p = .0003$). When the analyses were repeated for those with normal MMSE scores who also had no deficiencies in activities of daily living, similar and statistically significant results were obtained.

In the analyses of the continuous measures of cognitive function and health literacy, the correlation coefficients were, for immediate recall, 0.48; delayed recall, 0.40; word fluency, 0.48; and MMSE, 0.55 ($p < .0001$ for all 4 measures). Notably, the correlation coefficient for health literacy and the delayed recall task on the MMSE (recall of 3 words after a 3 minute delay) was lower than for the WMS delayed recall (0.32 vs. 0.52, respectively).

In linear regression models estimating S-TOFHLA scores the combination of one or more of the cognitive status measures with education explained half or nearly half of the variation in S-TOFHLA scores. The addition of other demographic factors (age, gender, race/ethnicity, English language proficiency, and household income) in most cases only increased the R^2 by 0.03 to 0.05. After adjusting for education and other demographic characteristics, and health status, all cognitive performance measures remained significantly associated with S-TOFHLA scores at the $p < .0001$ level, with the following R^2 values: immediate recall, 0.53; delayed recall, 0.54; word fluency, 0.52; and MMSE, 0.54.

DISCUSSION

In this study of 414 community-dwelling seniors, we found that impairment of memory and verbal fluency are strongly associated with inadequate health literacy. The odds of inadequate health literacy among individuals with impaired performance on tests of memory and verbal fluency were three to five times that of individuals with normal cognition after

accounting for education, income, and other variables. These associations were significant even after excluding individuals with abnormal cognition based on a commonly used screening tool, the mini-mental status exam. The data provide evidence of a major role of memory and verbal fluency in accounting for the functional health literacy skills of older adults, independent of education and other factors.

Previous research found that the delayed recall domain of the MMSE is associated with health literacy (5). Using the memory assessment from a dementia screening instrument, however, underestimates the association of memory impairment with inadequate health literacy. With the use of a specific and well validated measure of memory, we found a 40% greater association between memory and health literacy when comparing the R^2 value obtained using the Wechsler assessment compared with the delayed recall domain of the MMSE. Future health literacy research should involve assessments of specific cognitive abilities rather than relying on more crude, global screening tools.

Memory and verbal fluency explained 8% to 11% of the variance in models of S-TOFHLA scores beyond that contributed by education alone. However, their marginal contribution to explaining overall health literacy scores was small (4% to 8%) when the models included other socioeconomic and health status variables. These findings demonstrate that while recall and verbal fluency measures are independently associated with scores on the S-TOFHLA, additional work is needed to identify other latent cognitive and psychosocial factors contributing to variation in health literacy scores.

It is also important to recognize that the relationship between cognition and health literacy is likely to be bidirectional. Cognitive function has an obvious and direct impact on reading comprehension (7,28). However, the reverse is also true. Longitudinal studies of cognition suggest that higher literacy skills at baseline reduce the rate of cognitive decline in older adults (6). Indeed, in these studies literacy is consistently more predictive of cognitive decline than years of education. Regardless of the directionality, the association between cognitive impairment and inadequate health literacy provides evidence that conveying health and healthcare-related information to populations at risk for cognitive impairment, such as the elderly or chronically ill, must be designed to compensate for limited cognitive skills. Most policy and clinical initiatives for addressing health literacy have relied on simplifying vocabulary—a necessary but insufficient step toward improving information transfer. Health information targeted to older adults must go beyond vocabulary simplification and specifically incorporate ways to limit the demand on memory and verbal fluency more comprehensively. Strategies might incorporate suggested practices for using familiar language, testing for comprehension, contextualizing behaviors, and adequately following-up patients to reinforce learning. In the meantime, healthcare professionals need to consider the possibility of cognitive dysfunction in all their older patients, whether mild or moderate, and adapt their information giving accordingly.

LIMITATIONS

We note potential limitations of our study. First, we used convenience sampling which could lead to recruitment bias. However, performance on the cognitive and health literacy measures by participants of our study resembled that of similarly-aged adults in studies that employed a variety of recruitment strategies (5,22,29). Additionally, we had a highly diverse sample, socioeconomically and racially, enhancing the generalizability of our findings. Because our study was community-based, recruitment bias would most likely result in overrepresentation by higher functioning seniors, thereby underestimating rates of cognitive impairment in the community but not necessarily biasing the association between cognition and health literacy.

Second, although the S-TOFHLA is a widely used measure of health literacy, it is imperfect because health literacy is determined by a complex interaction between simple literacy and numeracy, scientific or health knowledge, and social and cultural awareness (1). The extent to which the S-TOFHLA taps into elements of health literacy other than simple literacy is unknown. Nonetheless, the S-TOFHLA is strongly associated with poor health outcomes and remains a credible measure of health literacy (3,30).

CONCLUSIONS

Using specific measures of memory and word fluency in a sample of independently living seniors, we have shown that cognitive impairment is strongly associated with low health literacy independently of education and other socioeconomic and health status measures, even among those with subtle cognitive dysfunction. The relationship between cognition and health literacy warrants more attention by clinicians and policymakers because they are pervasive problems, with both contributing to undesirable health outcomes. Given the strength of the associations we and others have observed, research in health literacy and cognition should now advance to assessments of written materials with varying levels of cognitive burden and that integrate evidence-based strategies to mitigate the problems of limited health literacy. In the meantime, physicians treating older patients need to limit the complexity of the written and oral information they provide to all patients, since even subtle cognitive deficiencies of cognition, including memory and word fluency, may impair patients' ability to understand important health information.

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REFERENCES

1. Institute of Medicine. Health Literacy: A Prescription to End Confusion. 2004. [cited March 21, 2008]; Available from: <http://www.iom.edu/CMS/3775/3827/19723.aspx>
2. Baker DW, Wolf MS, Feinglass J, et al. Health literacy and mortality among elderly persons. *Arch Intern Med*. 2007; 167:1503–1509. [PubMed: 17646604]
3. Schillinger D, Grumbach K, Piette J, et al. Association of health literacy with diabetes outcomes. *JAMA*. 2002; 288:475–482. [PubMed: 12132978]
4. Wolf MS, Gazmararian JA, Baker DW. Health literacy and functional health status among older adults. *Arch Intern Med*. 2005; 165:1946–1952. [PubMed: 16186463]
5. Baker DW, Gazmararian JA, Sudano J, et al. Health literacy and performance on the Mini-Mental State Examination. *Aging Ment Health*. 2002; 6:22–29. [PubMed: 11827619]
6. Manly JJ, Schupf N, Tang MX, et al. Cognitive decline and literacy among ethnically diverse elders. *J Geriatr Psychiatry Neurol*. 2005; 18:213–217. [PubMed: 16306242]
7. Morrow D, Clark D, Tu W, et al. Correlates of health literacy in patients with chronic heart failure. *Gerontologist*. 2006; 46:669–676. [PubMed: 17050758]
8. Paasche-Orlow MK, Parker RM, Gazmararian JA, et al. The prevalence of limited health literacy. *J Gen Intern Med*. 2005; 20:175–184. [PubMed: 15836552]

9. Plassman BL, Langa KM, Fisher GG, et al. Prevalence of cognitive impairment without dementia in the United States. *Ann Intern Med.* 2008; 148:427–434. [PubMed: 18347351]
10. Petersen RC. Mild cognitive impairment as a diagnostic entity. *J Intern Med.* 2004; 256:183–194. [PubMed: 15324362]
11. Ganguli M, Dodge HH, Shen C, et al. Mild cognitive impairment, amnesic type: an epidemiologic study. *Neurology.* 2004; 63:115–121. [PubMed: 15249620]
12. Manly JJ, Tang MX, Schupf N, et al. Frequency and course of mild cognitive impairment in a multiethnic community. *Ann Neurol.* 2008; 63:494–506. [PubMed: 18300306]
13. Petersen RC, Doody R, Kurz A, et al. Current concepts in mild cognitive impairment. *Arch Neurol.* 2001; 58:1985–1992. [PubMed: 11735772]
14. Rosen WG. Verbal fluency in aging and dementia. *J Clin Exp Neuropsychol.* 1980; 2:135–146.
15. Baker DW, Williams MV, Parker RM, et al. Development of a brief test to measure functional health literacy. *Patient Educ Couns.* 1999; 38:33–42. [PubMed: 14528569]
16. Gazmararian JA, Williams MV, Peel J, et al. Health literacy and knowledge of chronic disease. *Patient Educ Couns.* 2003; 51:267–275. [PubMed: 14630383]
17. Wechsler, D. Manual: Wechsler Memory Scale-III Abbreviated. 3rd Ed.. Harcourt Assessment; San Antonio: 2002.
18. Ardila A, Ostrosky-Solis F, Bernal B. Cognitive testing toward the future: the example of semantic verbal fluency (ANIMALS). *International Journal of Psychology.* 2006; 41:324–332.
19. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975; 12:189–198. [PubMed: 1202204]
20. Crum RM, Anthony JC, Bassett SS, et al. Population-based norms for the Mini-Mental State Examination by age and educational level. *JAMA.* 1993; 269:2386–2391. [PubMed: 8479064]
21. Grundman M, Petersen RC, Ferris SH, et al. Mild cognitive impairment can be distinguished from Alzheimer disease and normal aging for clinical trials. *Arch Neurol.* 2004; 61:59–66. [PubMed: 14732621]
22. Tombaugh TN, Kozak J, Rees L. Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. *Arch Clin Neuropsychol.* 1999; 14:167–177. [PubMed: 14590600]
23. Gazmararian JA, Baker DW, Williams MV, et al. Health literacy among Medicare enrollees in a managed care organization. *JAMA.* 1999; 281:545–551. [PubMed: 10022111]
24. DeSalvo KB, Fan VS, McDonnell MB, et al. Predicting mortality and healthcare utilization with a single question. *Health Serv Res.* 2005; 40:1234–1246. [PubMed: 16033502]
25. Linn MW, Linn BS. The rapid disability rating scale-2. *J Am Geriatr Soc.* 1982; 30:378–382. [PubMed: 7077018]
26. Kim S, Egerter S, Cubbin C, et al. Potential implications of missing income data in population-based surveys: An example from a postpartum survey in California. *Public Health Rep.* 2007; 122:753–763. [PubMed: 18051668]
27. Barzi F, Woodward M. Imputations of missing values in practice: results from imputations of serum cholesterol in 28 cohort studies. *Am J Epidemiol.* 2004; 160:34–45. [PubMed: 15229115]
28. Weiss BD, Reed R, Kligman EW, et al. Literacy and performance on the Mini-Mental State Examination. *J Am Geriatr Soc.* 1995; 43:807–810. [PubMed: 7602038]
29. Johnson AS, Flicker LJ, Lichtenberg PA. Reading ability mediates the relationship between education and executive function tasks. *J Int Neuropsychol Soc.* 2006; 12:64–71. [PubMed: 16433945]
30. Greene, J.; Hibbard, J.; Tusler, M. How much do health literacy and patient activation contribute to older adults' ability to manage their health?. 2005. [cited May 12, 2006]; Available from: http://assets.aarp.org/rgcenter/health/2005_05_literacy.pdf

Table 1

Characteristics of Study Participants, by Level of Health Literacy (n=414)

Variable	Total (%)	Health Literacy		p*
		Adequate (%)	Marginal (%)	Inadequate (%)
Overall	100	66.5	9.2	24.3
Age, mean (std)	73.6 (8.6)	72.8 (8.7)	75.1 (8.1)	75.1 (8.3)
60-64	18.1	21.1	10.5	12.9
65-69	19.1	21.1	23.7	11.9
70-74	18.1	17.5	10.5	22.8
75-79	20.1	17.1	31.6	23.8
80-84	11.8	10.6	10.5	15.8
≥ 85	12.8	12.7	13.2	12.9
Male	37.6	34.1	44.7	44.6
Race/Ethnicity				
White	30.8	42.3	18.4	3.9
Black	30.9	29.2	23.7	38.6
Latino	31.9	21.5	50.0	53.5
Other	6.3	6.9	7.9	3.9
English proficiency				
Very poor to fair	17.8	7.6	23.7	43.6
Education				
≥ 4 years college	28.2	38.0	10.5	7.9
1 to 3 years of college	20.5	26.8	21.1	2.9
High school degree/GED	23.4	25.0	18.4	20.8
Some high school	11.1	5.1	21.1	23.8
8th grade or less	16.9	5.1	28.9	44.6
Income (monthly)				
≥\$2,001	27.0	38.4	5.2	4.0

Variable	Total (%)	Health Literacy			P [*]
		Adequate (%)	Marginal (%)	Inadequate (%)	
\$1,351-\$2,000	17.2	15.1	31.6	17.2	
\$751-\$1,350	29.2	27.3	42.1	29.3	
≤\$750	26.7	19.2	21.1	49.5	
General health, poor-fair	39.5	32.6	55.3	52.5	.02
≥ 1 deficiency in ADLs	17.4	12.3	18.4	30.7	.0002

* Chi-square test. ADL indicates activities of daily living.

Table 2

Association of Age-Adjusted Abnormal Cognitive Function with Inadequate Health Literacy, n = 414

Cognitive Measure	Total Sample	Health Literacy			P*
		Adequate n = 275 (66.4%)	Marginal n = 38 (9.2%)	Inadequate n=101 (24.4%)	
Abnormal Immediate Recall, %	20.8	12.7	26.3	40.6	<.0001
Abnormal Delayed Recall, %	15.0	9.1	21.1	28.7	<.0001
Abnormal Verbal Fluency, %	9.9	5.8	10.5	20.8	<.0001
Abnormal MMSE, %	17.4	9.1	15.8	40.6	<.0001

Abnormal values for the cognitive measures were set as 1.5 standard deviations or more below age-based norms.

MMSE indicates mini-mental status exam.

* Chi-square test.

Table 3

Adjusted Association of Abnormal Cognition with Inadequate Health Literacy

Independent Variables	Adjusted Odds Ratio (95% CI)	P
Abnormal Immediate Recall	4.07 (2.45-6.76)	<.0001
+ education	3.12 (1.70-5.73)	<.0001
+ education + other SES *	3.36 (1.70-6.65)	<.0001
+ education + other SES * + health status [†]	3.44 (1.71-6.94)	<.0001
Abnormal Delayed Recall	3.42 (1.95-5.99)	<.0001
+ education	3.03 (1.51-6.10)	<.0001
+ education + other SES *	3.49 (1.60-7.60)	.002
+ education + other SES * + health status [†]	3.48 (1.58-7.67)	.002
Abnormal Verbal fluency	3.84 (1.99-7.44)	<.0001
+ education	3.16 (1.43-7.01)	.005
+ education + other SES *	3.55 (1.52-8.30)	.003
+ education + other SES * + health status [†]	3.47 (1.44-8.38)	.006
Abnormal Mini-Mental Status Exam	6.22 (3.61-10.7)	<.0001
+ education	4.68 (2.41-9.09)	<.0001
+ education + other SES *	5.62 (2.63-12.0)	<.0001
+ education + other SES * + health status [†]	5.64 (2.59-12.3)	<.0001

Logistic regression.

CI indicates confidence interval; SES, socioeconomic status variables.

* Other SES included age, gender, race/ethnicity (black, Latino vs. other), poor English language proficiency, and household income.

[†] Included self-reported general health and any deficiency in activities of daily living.