

Health Literacy and Functional Health Status Among Older Adults

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Background: Individuals with limited health literacy have less health knowledge, worse self-management skills, lower use of preventive services, and higher hospitalization rates. We evaluated the association between health literacy, self-reported physical and mental health functioning, and health-related activity limitations among new Medicare managed care enrollees.

Methods: A cross-sectional survey of 2923 enrollees was conducted in Cleveland, Ohio; Houston, Tex; Tampa, Fla; and Fort Lauderdale–Miami, Fla. Health literacy was measured using the short form of the Test of Functional Health Literacy in Adults. We used outcome measures that included scores on the physical and mental health functioning subscales of the Medical Outcomes Study 36-Item Short-Form Health Survey, difficulties with instrumental activities of daily living and activities of daily living, and limitations because of physical health and pain.

Results: After adjusting for the prevalence of chronic conditions, health risk behaviors, and sociodemographic characteristics, individuals with inadequate health literacy had worse physical function (67.7 vs 78.0, $P < .001$) and mental health (76.2 vs 84.0, $P < .001$) than individuals with adequate health literacy. Individuals with inadequate health literacy were more likely to report difficulties with instrumental activities of daily living (odds ratio [OR], 2.25; 95% confidence interval [CI], 1.74–2.92) and activities of daily living (OR, 2.83; 95% CI, 1.62–4.96), limitations in activity because of physical health (OR, 1.79; 95% CI, 1.39–2.32), fewer accomplishments because of physical health (OR, 1.90; 95% CI, 1.48–2.45), and pain that interferes with normal work activities (OR, 2.01; 95% CI, 1.46–2.77).

Conclusion: Among community-dwelling older adults, inadequate health literacy was independently associated with poorer physical and mental health.

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DURING THE PAST DECADE, the magnitude and consequences of low health literacy on the health of individuals have received considerable attention, contributing a new perspective on the broader and more complicated relationship between education and health.¹⁻⁵ Limited health literacy has been linked to problems with the use of preventive services,⁶ delayed diagnoses,⁷ understanding of one's medical condition,^{8,9} adherence to medical instructions,¹⁰ and self-management skills.¹¹ Although estimates vary, low health literacy has been attributed to higher health care costs.¹²

The Institute of Medicine, reviewing the body of literature and data from the National Adult Literacy Survey, released a report stating that 48% of the adult population in the United States lack the reading and numeracy skills required to fully understand and act on health information.¹³⁻¹⁵ These cumulative findings have led to groundbreaking responses by national

organizations and federal agencies.^{13,15-17} The Agency for Healthcare Research and Quality, in a recently released report, calls for further research that more consistently and clearly documents the relationship between health literacy and health status and outcomes.¹⁷ The Agency for Healthcare Research and Quality report raises important questions about the characterization of the relationship between literacy and personal health. Although the body of literature has grown considerably within the past several years, few research

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studies^{11,18} have been published that directly link health literacy to the health status of individuals. The objective of this study was to investigate the relationship between health literacy and functional health status among a cohort of new Medicare managed care enrollees from 4 US cities.

STUDY POPULATION

We analyzed data gathered from a multisite, cross-sectional survey of new Medicare enrollees in health plans of a national managed care organization in 4 US metropolitan areas (Cleveland, Ohio; Houston, Tex; Tampa, Fla; and Fort Lauderdale–Miami, Fla). The recruitment plan has been previously described in detail.¹⁹ Individuals were excluded from the study if it was determined that they were not comfortable speaking English or Spanish, were blind or had a severe vision problem not correctable with glasses, or did not know the year they were born, their address, or the current month, year, and state they lived in.

INTERVIEW

Consenting individuals completed a 1-hour in-person interview in their home. Survey items assessed demographics, income, current and past smoking, current alcohol use, problem drinking (as measured by the CAGE questionnaire),²⁰ height and weight (for body mass index calculations), chronic conditions (hypertension, diabetes mellitus, coronary artery disease, heart failure [including enlarged heart and fluid on the lungs], chronic bronchitis or emphysema, asthma, arthritis, or cancer),¹² and self-rated physical and mental health functioning (measured by the Medical Outcomes Study 36-Item Short-Form Health Survey [SF-36] subscales).²¹ Individuals were classified as non-Hispanic white, non-Hispanic black, native English-speaking Hispanic, native Spanish-speaking Hispanic, or other.

The Mini-Mental State Examination²² was also administered. Individuals who were identified as having severe cognitive impairment were deemed ineligible for the study. Individuals who consented to the study and later were found to have had a previous stroke were also excluded from the analysis because of the likelihood of possible cognitive impairment.

LITERACY ASSESSMENT

The primary independent variable of interest was health literacy, defined by the Institute of Medicine expert panel as the degree to which individuals have the capacity to obtain, process, and understand basic information and services needed to make appropriate decisions regarding their health.^{13(p4)} Therefore, health literacy is a multifaceted concept requiring measurement of many domains for complete assessment. Reading ability is one of the most fundamental components of health literacy. We used the short version of the Test of Functional Health Literacy in Adults²³ as our measure of health literacy for this study. This test has items that measure the ability to read and understand prose passages (prose literacy), appointment slips (document literacy), and prescription bottles containing numerical information (quantitative literacy). For simplicity, we refer to the construct assessed by the Test of Functional Health Literacy in Adults as health literacy, while recognizing that this test does not measure all domains of health literacy. An individual's ability to read, comprehend, and take action based on health-related material is closely related to the ability to read, comprehend, and take action based on other types of materials (ie, general literacy). However, reading comprehension varies with an individual's familiarity with the content of the text.²⁴ Therefore, health literacy is probably more predictive of health care use, health risk behaviors, and health outcomes than general literacy.

χ^2 Tests were used to examine bivariate associations between health literacy (adequate, marginal, or inadequate) and binary variables (yes or no), including all self-reported *chronic conditions* (hypertension, diabetes mellitus, coronary artery disease, heart failure [enlarged heart or fluid on the lungs], chronic bronchitis or emphysema, asthma, arthritis, and cancer) and *activity limitations* (instrumental activities of daily living, activities of daily living, limited activities because of physical health [in the past 4 weeks], accomplishing less than wanted because of physical health [in the last 4 weeks], and pain that interfered with normal work activities [none to moderately vs quite a bit to extremely, in the last 4 weeks]), as measured by individual items from the SF-36 subscale.²¹ Logistic regression models were then used to estimate the independent relationship between health literacy and each of the medical conditions and activity limitation variables, while adjusting for sociodemographic variables (age, sex, race/ethnicity, education, and annual income), health risk behaviors (smoking habit [never, former, or current] and alcohol use [none, light to moderate, or heavy]), and body mass index, calculated as weight in kilograms divided by the square of height in meters (<18.5, 18.5–24.9, 25.0–29.9, and ≥ 30.0). Models were run with and without the variable of education included as a covariate to present a conservative estimate of the effect of health literacy on various outcomes. The presence of depressive symptoms was excluded in multivariate models as a covariate because a prior study²⁵ found no relationship between depression and health literacy.

Linear regression models were used to estimate the relationship between health literacy and SF-36 physical and mental health functioning status measures while adjusting for the covariates already listed. In addition, each of the chronic conditions was included by adding separate indicator variables. Site was included in all of the models to adjust for differences that potentially might exist between study locations. The model fit for multivariate linear regression models was assessed by the proportion of the variance explained (adjusted r^2) by the overall model and by F statistics. The model fit for logistic regression models was assessed by C statistics from the receiver operating characteristic curves and from Hosmer-Lemeshow goodness-of-fit χ^2 tests. Analyses were performed using Stata version 8.0 (StataCorp LP, College Station, Tex).

RESULTS

In all, 7471 enrollees were contacted via telephone 3 months after enrollment in the managed care plan. Of those contacted, 3247 refused to participate, and no questions could be asked to determine eligibility. Of the 4224 interviewees, 737 did not meet eligibility criteria and were excluded. Of the 3487 people who were eligible and agreed to participate, 143 did not show up for their interview. Using the American Association for Public Opinion Research guidelines for calculating participation rates,²⁶ we estimate that 54.2% of all enrollees who were eligible for the study participated in the interview. Eighty-four people had vision difficulties that prevented them from completing the literacy testing, yielding 3260 participants with complete data on health status and literacy. We also excluded 337 participants with medical conditions that could affect their literacy, including 282 people with a previous stroke and 55 people with severe cognitive impairment (Mini-Mental

Table 1. Respondent Characteristics by Health Literacy Level*

Characteristic	Adequate (n = 1944)	Marginal (n = 330)	Inadequate (n = 649)	P Value
Age, y				<.001
65-69	44.3	29.4	24.5	
70-74	28.2	26.1	25.6	
75-79	17.3	23.9	22.5	
80-84	8.0	15.2	16.6	
≥85	2.2	5.6	10.8	
Female sex	58.4	53.6	59.0	.22
Race/ethnicity				<.001
White	83.6	66.1	57.1	
African American	6.5	13.0	25.6	
Hispanic, English-speaking	1.8	2.7	2.6	
Hispanic, Spanish-speaking	7.0	17.9	13.8	
Other	1.1	0.3	0.9	
Annual income, \$				<.001
<10 000	11.8	24.6	32.7	
10 000-14 999	20.1	22.2	22.1	
15 000-24 999	29.3	22.8	17.9	
25 000-34 999	10.6	8.5	4.4	
≥35 000	14.5	3.0	3.1	
Years of school completed				<.001
Grades 1-8	7.3	24.7	41.8	
Grades 9-11	14.2	25.0	23.9	
High school or general equivalency diploma	39.0	29.8	22.1	
>High school	39.5	20.4	12.2	
Smoking				.01
Never	38.6	42.1	46.7	
Former	49.0	44.9	41.6	
Current	12.4	13.0	11.7	
Current alcohol use				<.001
None	57.9	64.2	75.6	
Light to moderate	38.0	33.9	22.9	
Heavy	4.1	1.8	1.5	
Body mass index†				.04
<18.5	4.3	4.0	7.5	
18.5-24.9	56.8	56.2	56.3	
25.0-29.9	26.8	25.5	25.0	
≥30.0	12.1	14.3	11.2	

*Data are given as percentages unless otherwise indicated.

†Calculated as weight in kilograms divided by the square of height in meters.

State Examination score, <18). This left a final total of 2923 participants.

The mean age of the respondents was 71 years. Non-respondents had a slightly higher mean age, were more likely to be male, and lived in ZIP code areas with a higher socioeconomic status than respondents (27.8% of nonrespondents lived in neighborhoods with a median annual per capita income >\$17 842 vs 10.7% of respondents).

Approximately one third of the respondents had marginal (11.3%) or inadequate (22.2%) health literacy. Respondents with marginal or inadequate health literacy were more likely to be older, African American, or Hispanic (Spanish or English speaking) and more likely to have a lower annual income and fewer years of education (**Table 1**). Individuals with lower health literacy were more likely to have never smoked and more likely

to abstain from alcohol compared with individuals with adequate health literacy.

PREVALENCE OF CHRONIC CONDITIONS

Respondents with inadequate health literacy had significantly higher rates of certain chronic conditions compared with those with adequate skills (**Table 2**). Individuals with inadequate health literacy had significantly higher rates of hypertension (49.9% vs 43.3%, $P=.05$), diabetes mellitus (18.7% vs 12.8%, $P<.001$), heart failure (6.1% vs 3.8%, $P=.05$), and arthritis (57.3% vs 50.1%, $P=.01$). These individuals were also less likely to report having chronic bronchitis or emphysema than respondents with adequate health literacy (9.7% vs 13.5%, $P=.05$), which was consistent with their lower rate of smoking (Table 1). However, in multivariate analysis (**Table 3**), inadequate health literacy was only a significant independent predictor of having diabetes mellitus (odds ratio [OR], 1.48; 95% confidence interval [CI], 1.09-2.02) and heart failure (OR, 1.69; 95% CI, 1.02-2.80).

PHYSICAL AND MENTAL HEALTH

Individuals with inadequate health literacy reported significantly lower mean physical function (67.7 vs 78.0, $P<.001$) and mental health (76.2 vs 84.0, $P<.001$) scores on the SF-36 subscales compared with those with adequate and marginal health literacy (**Table 4**). Health literacy was significantly related to respondents' self-reported physical function and mental health after adjusting for relevant covariates, including chronic conditions. In the multivariate regression model predicting physical function, the β coefficient for inadequate health literacy was -6.0 (95% CI, -8.4 to -3.5); for mental health, the β coefficient for inadequate health literacy was -4.9 (95% CI, -6.7 to -3.1). A second multivariate model was analyzed for physical function, including mental health as a covariate. Inadequate health literacy remained a significant independent predictor of poorer physical health, although the relationship was reduced by 42% (β , -3.5; 95% CI, -5.8 to -0.9). Models were reanalyzed with education removed as a covariate; the relationship between inadequate health literacy and poorer physical health increased by 16.7% (β , -7.0; 95% CI, -8.8 to -5.3) for physical function and by 44.9% (β , -7.1; 95% CI, -8.7 to -5.3) for mental health.

ACTIVITY LIMITATIONS

Respondents with marginal and inadequate health literacy were significantly more likely to report activity limitations (**Table 5**). In multivariate models, inadequate health literacy was significantly associated with limitations in instrumental activities of daily living (OR, 2.25; 95% CI, 1.74-2.92) and activities of daily living (OR, 2.83; 95% CI, 1.62-4.96), limitations in activity because of physical health (OR, 1.79; 95% CI, 1.39-2.32), fewer accomplishments because of physical health (OR, 1.90; 95% CI, 1.48-2.45), and pain that "quite a bit" or "extremely" interfered with normal work activities (OR, 2.01; 95% CI, 1.46-2.77). Each model was reanalyzed with edu-

Table 2. Prevalence of Self-reported Chronic Conditions by Health Literacy Level*

Chronic Condition	Adequate (n = 1943)	Marginal (n = 329)	Inadequate (n = 649)	P Value
Hypertension	43.3	46.2	49.9	.05
Diabetes mellitus	12.8	15.2	18.7	<.001
Coronary artery disease	7.6	6.7	5.6	.21
Heart failure	3.8	3.7	6.1	.05
Bronchitis or emphysema	13.5	9.7	9.7	.05
Asthma	7.3	8.2	6.6	.66
Arthritis	50.1	56.5	57.3	.01
Cancer	6.0	7.0	4.2	.13

*Data are given as percentages unless otherwise indicated.

cation removed as a covariate, and the adjusted ORs for literacy increased slightly.

COMMENT

To our knowledge, this study is the first population-based study to explore the relationship between health literacy and self-reported physical and mental health functioning. After controlling for sociodemographic characteristics, health risk behaviors, and chronic conditions, individuals with inadequate health literacy reported significantly poorer physical and mental health functioning and greater limitations in routine activities. The magnitudes of these associations were large and clinically important. In our multivariate models, the magnitude of the association between inadequate health literacy and physical function was comparable to that of having a diagnosis of cancer (β , -6.4) and was more than twice that of having a diagnosis of heart failure (β , -2.4). Based on national data for these 2 SF-36 subscales, the magnitude of the association between inadequate health literacy and health outcomes was approximately equivalent to having a diagnosis of chronic obstructive pulmonary disease on physical function (β , -5.9) and mental health (β , -4.4).²⁷

Our finding that inadequate health literacy is independently associated with worse health is consistent with the results of previous cross-sectional studies^{11,18,28,29} of highly selected patient populations. Because our study was population based, it should be less subject to selection bias than previous studies that enrolled people at the time they were seeking medical care. Our findings are also consistent with prospective studies^{30,31} showing that health literacy is an independent predictor of hospitalizations.

An earlier study²⁵ found that inadequate health literacy was not independently associated with depression. In that study, depression was measured using the Geriatric Depression Scale,³² which has questions and established cutoffs designed to identify patients with a high likelihood of having major depressive disorder. In contrast, the present analysis found that inadequate health literacy was significantly associated with worse functioning on the mental health subscale. The present study used the mental health subscale of the SF-36, which is more general and less specific for depression compared with the Geriatric Depression Scale. Nevertheless, inad-

Table 3. Adjusted Odds Ratios (ORs) for Prevalence of Self-reported Chronic Conditions by Health Literacy Level*

Chronic Condition	Marginal (n = 330)	Inadequate (n = 649)
Hypertension	1.03 (0.80-1.34)	1.20 (0.95-1.50)
Diabetes mellitus	1.10 (0.75-1.59)	1.48 (1.09-2.02)
Coronary artery disease	0.85 (0.51-1.43)	0.93 (0.59-1.47)
Heart failure	0.97 (0.49-1.90)	1.69 (1.02-2.80)
Bronchitis or emphysema	0.81 (0.53-1.22)	0.75 (0.53-1.08)
Asthma	1.26 (0.79-2.01)	0.96 (0.62-1.37)
Arthritis	1.11 (0.85-1.44)	0.98 (0.78-1.23)
Cancer	1.38 (0.84-2.27)	0.91 (0.54-1.52)

*Data are given as OR (95% confidence interval), adjusted for patient age, sex, race/ethnicity, annual income, education, smoking status, alcohol use, body mass index, and site.

equately literacy was independently associated with all 5 individual items in the subscale, and the magnitude of the associations did not differ for the questions that more directly addressed symptoms of anxiety and those directed at depressive symptoms (data not shown). There are 2 likely explanations for the differences between these results and those of the previous study. First, the Geriatric Depression Scale has dichotomous questions as opposed to the 5-item Likert scale response options in the mental health subscale. Second, the previous analysis focused on whether individuals with inadequate literacy were more likely to have a total Geriatric Depression Scale score likely to indicate the presence of a major depressive disorder. We analyzed mental health as a continuous variable; therefore, the present analysis may have been more sensitive for detecting an association between health literacy and symptoms of depression and anxiety. Our results suggest that inadequate health literacy is associated with worse mental health, although findings of the previous study suggest that inadequate health literacy is not an independent predictor of clinical major depressive disorder.

Marginal health literacy was not independently associated with worse physical and mental health. However, marginal health literacy independently predicted activity limitations, although the association was only half that seen for inadequate health literacy. Previous studies^{18,29,33,34} found that marginal health literacy is more

Table 4. Crude and Adjusted Differences in Self-reported Physical and Mental Health by Health Literacy Level*

Measure	Adequate (n = 1944)	Marginal (n = 330)	Inadequate (n = 649)†
Physical function, mean ± SD	78.0 ± 24.6	73.7 ± 27.5	67.7 ± 29.7
Crude difference	...	-1.8 (-4.8 to 1.3)	-10.2 (-12.5 to -7.9)
Adjusted difference	...	-1.1 (-3.9 to 1.8)	-6.0 (-8.4 to -3.5)
Adjusted difference, without education	...	-2.1 (-4.2 to -0.1)‡	-7.0 (-8.8 to -5.3)
Mental health, mean ± SD	84.0 ± 16.1	81.8 ± 18.6	76.2 ± 20.9
Crude difference	...	-0.3 (-2.3 to 1.8)	-7.8 (-9.3 to -6.2)
Adjusted difference	...	-0.9 (-2.9 to 1.2)	-4.9 (-6.7 to -3.1)
Adjusted difference, without education	...	-2.1 (-4.0 to -0.1)‡	-7.1 (-8.7 to -5.3)

*Data are given as β coefficient (95% confidence interval) unless otherwise indicated. Differences are adjusted for patient age, sex, race/ethnicity, annual income, education, smoking status, alcohol use, chronic conditions, and site. The model fit statistics are $F_{37,2719} = 27.5$, $P < .001$, and adjusted $r^2 = 0.23$ for physical function; and $F_{38,2717} = 15.9$, $P < .001$, and adjusted $r^2 = 0.17$ for mental health.

† $P < .001$ for all differences.

‡ $P < .05$.

Table 5. Adjusted Odds Ratios (ORs) for Prevalence of Self-reported Activity Limitations by Health Literacy Level*

Activity Limitation	Marginal (n = 330)	Inadequate (n = 649)
Instrumental activities of daily living†		
Crude OR	1.41 (1.11-1.81)	2.31 (1.92-2.77)
Adjusted OR	1.65 (1.22-2.24)	2.25 (1.74-2.92)
Adjusted OR, without education	1.73 (1.28-2.33)	2.32 (1.79-2.94)
Activities of daily living‡		
Crude OR	1.68 (0.99-2.87)	2.99 (1.99-4.50)
Adjusted OR	2.05 (1.06-3.97)	2.83 (1.62-4.96)
Adjusted OR, without education	2.32 (1.23-4.37)	2.91 (1.71-4.94)
Limitations in activity because of physical health§		
Crude OR	1.29 (1.01-1.66)	1.78 (1.48-2.15)
Adjusted OR	1.35 (1.00-1.84)	1.79 (1.39-2.32)
Adjusted OR, without education	1.49 (1.11-2.00)	1.84 (1.45-2.36)
Fewer accomplishments because of physical health		
Crude OR	1.31 (1.02-1.69)	1.97 (1.63-2.37)
Adjusted OR	1.46 (1.08-1.97)	1.90 (1.48-2.45)
Adjusted OR, without education	1.58 (1.18-2.12)	1.96 (1.54-2.49)
Pain that interfered with normal work activities¶		
Crude OR	1.19 (0.94-1.58)	1.61 (1.32-1.96)
Adjusted OR	1.23 (0.83-1.82)	2.01 (1.46-2.77)
Adjusted OR, without education	1.32 (0.97-1.79)	2.07 (1.61-2.65)

*Data are given as OR (95% confidence interval). ORs are adjusted for patient age, sex, race/ethnicity, annual income, education, smoking status, alcohol use, chronic conditions, and site.

†The model fit statistics are Hosmer-Lemeshow $P = .19$, $C = 0.77$.

‡The model fit statistics are Hosmer-Lemeshow $P = .02$, $C = 0.79$.

§The model fit statistics are Hosmer-Lemeshow $P = .76$, $C = 0.71$.

||The model fit statistics are Hosmer-Lemeshow $P = .97$, $C = 0.71$.

¶The model fit statistics are Hosmer-Lemeshow $P = .51$, $C = 0.75$.

weakly associated with chronic disease knowledge, self-management behaviors, and self-reported overall health than inadequate health literacy. One study³⁰ found that

marginal literacy was not predictive of hospitalization, while another study³¹ found that the magnitude of the association between marginal literacy and hospitalization was similar to that seen for inadequate literacy. It is likely that the relationship between health literacy and health outcomes is not linear. There may be a threshold, which may vary across different health outcomes studied, at which low health literacy poses enough of a problem that it has a substantial effect on health care use, quality of care, self-management behaviors, and health.

Although patients with inadequate health literacy appear to have worse risk-adjusted physical and mental health, the causal pathways leading to this are unclear. Prior studies^{18,35} found that lower health literacy does not adversely affect the use of outpatient physician services or a regular source of care. However, Scott and colleagues⁶ noted that patients with inadequate health literacy were less likely to use preventive health care services. Inadequate health literacy is linked to worse knowledge of proper health behaviors and, possibly, to lower adherence to medical instructions.⁸⁻¹¹ Individuals with lower health literacy may not lack access to health care services, yet the quality of their experience may be compromised because of ineffective communication within the medical encounter, compounded by a lack of accessible health information resources. For instance, it has been noted previously that physicians often do not communicate at a level that is understood by patients with lower health literacy.³⁶⁻³⁸ In addition, most patient education materials that are distributed in physicians' offices may be too complex, written on too high a level, or not organized from the patient's perspective.³⁹⁻⁴² Over time, these factors could contribute to the worse health status seen among the older patients with low health literacy in this study.

The various limitations to our study should be noted. Although our study recruited a large number of participants from multiple sites, findings reflect cross-sectional data only. A causal relationship between inadequate health literacy and physical and mental health functioning cannot be established. This sample also represents Medicare-eligible older adults from 4 urban areas, and our findings may not be generalizable to younger

populations. We also measured the presence of chronic conditions through self-report, and we were unable at the time of the study to confirm diagnoses through a medical record review or via medical claims records. However, prior studies⁴³⁻⁴⁷ have demonstrated high levels of agreement between patient self-report of chronic conditions, including stroke, cancer, heart failure, hypertension, and diabetes mellitus, and the medical record. Although it is possible that individuals with inadequate health literacy may be more likely to lack knowledge of a previously determined medical diagnosis, a recent study by Simpson and colleagues⁴⁷ found no association between education and the validity of self-reported chronic conditions. Within our data, the validity of the respondents' self-report is supported through our finding that patients with inadequate literacy had significantly lower rates of current or former smoking and had a correspondingly lower prevalence of chronic bronchitis or emphysema compared with respondents with adequate health literacy.

In addition, our baseline models included education as a covariate. Health literacy and education probably have bidirectional causal relationships, and both may operate in the same causal pathway for health outcomes. Therefore, including health literacy and education in the same model may overadjust and lead to an underestimate of the association. When education was removed from the models (Tables 4 and 5), the association between health literacy and our health status measures increased substantially. Therefore, the results of our baseline models probably represent conservative estimates of the association between health literacy and health outcomes.

Although the causal pathways between low health literacy and disease-specific health outcomes remain unclear, this study provides further evidence of the likelihood that inadequate health literacy detrimentally affects health. To develop appropriate and responsive interventions, future studies should discern how adults with lower health literacy recognize health issues, and they should identify barriers to seeking out appropriate health care services. In addition, interventions are needed that can help physicians and other health care professionals recognize and address the special needs of patients with limited health literacy.

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REFERENCES

- Feldman JJ, Maroc DM, Kleinman JC, Cornoni-Huntley J. National trends in educational differences in mortality. *Am J Epidemiol*. 1989;129:919-933.
- Desai S, Alva S. Maternal education and child health: is there a strong causal relationship? *Demography*. 1998;35:71-81.
- Elo IT, Preston SH. Educational differentials in mortality: United States, 1979-85. *Soc Sci Med*. 1996;42:47-57.
- Kitagawa EM, Hauser PM. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology*. Cambridge, England: Harvard University Press; 1973.
- Yen IH, Moss N. Unbundling education: a critical discussion of what education confers and how it lowers risk for disease and death. *Ann N Y Acad Sci*. 1999; 896:350-351.
- Scott TL, Gazmararian JA, Williams MV, Baker DW. Health literacy and preventive health care use among Medicare enrollees in a managed care organization. *Med Care*. 2002;40:395-404.
- Bennett CL, Ferreira MR, Davis TC, et al. Relation between literacy, race, and stage of presentation among low-income patients with prostate cancer. *J Clin Oncol*. 1998;16:3101-3104.
- Gazmararian JA, Williams MV, Peel J, Baker DW. Health literacy and knowledge of chronic disease. *Patient Educ Couns*. 2003;51:267-275.
- Wolf MS, Davis TC, Cross JT, Tomori C, Green KM, Bennett CL. Health literacy and patient knowledge in a Southern HIV clinic. *Int J STD AIDS*. 2004;15:747-752.
- Kalichman SC, Ramachandran B, Catz S. Adherence to combination antiretroviral therapies in HIV patients of low health literacy. *J Gen Intern Med*. 1999; 14:267-273.
- Schillinger D, Grumbach K, Piette J, et al. Association of health literacy with diabetes outcomes. *JAMA*. 2002;288:475-482.
- Weiss BD, Palmer R. Relationship between health care costs and very low literacy skills in a medically needy and indigent Medicaid population. *J Am Board Fam Pract*. 2004;17:44-47.
- Institute of Medicine. *Health Literacy: A Prescription to End Confusion*. Washington, DC: National Academies Press; March 2004.
- Kirsh I, Jungeblut A, Jenkins L. *Adult Literacy in America: A First Look at the Results of the National Adult Literacy Survey*. Washington, DC: US Dept of Education; 1993.
- Ad Hoc Committee on Health Literacy; American Medical Association Council on Scientific Affairs. Health literacy: report of the Council on Scientific Affairs. *JAMA*. 1999;281:552-557.
- US Department of Health and Human Services. Health communication: understanding and improving health and objectives for improving health. In: *Healthy People 2010*. 2nd ed. Washington, DC: US Dept of Health and Human Services; 2000.
- Berkman N, Pignone MP, DeWalt DA, Sheridan S. *Evidence Report/Technology Assessment: Health Literacy: Impact on Health Outcomes*. Rockville, Md: Agency for Healthcare Research and Quality; 2004.
- Baker DW, Parker RM, Williams MV, Clark WS, Scott T, Nurss J. The relationship of patient reading ability to self-reported health and use of health services. *Am J Public Health*. 1997;87:1027-1030.
- Gazmararian JA, Baker DW, Williams MV, et al. Health literacy among Medicare enrollees in a managed care organization. *JAMA*. 1999;281:545-551.
- Mayfield D, McLeod G, Hall P. The CAGE questionnaire: validation of a new alcoholism screening instrument. *Am J Psychiatry*. 1974;131:1121-1123.
- Ware JE. The MOS 36-Item Short-Form Health Survey (SF-36). In: Sederer LI, Dickey B, eds. *Outcomes Assessment in Clinical Practice*. Baltimore, Md: Williams & Wilkins; 1996:61-64.
- 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.
- Baker DW, Williams MV, Parker RM, Gazmararian JA, Nurss J. Development of a brief test to measure functional health literacy. *Patient Educ Couns*. 1999; 38:33-42.
- Rudd RE, Renzulli D, Pereira A, Daltroy L. Literacy demands in health care settings: the patient perspective. In: Schwartzberg JG, VanGeest JB, Wang CC, eds. *Understanding Health Literacy: Implications for Medicine and Public Health*. Chicago, Ill: AMA Press; 2004:69-84.
- Gazmararian J, Baker D, Parker R, Blazer DG. A multivariate analysis of factors associated with depression: evaluating the role of health literacy as a potential contributor. *Arch Intern Med*. 2000;160:3307-3314.
- American Association for Public Opinion Research. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*. 3rd ed. Lenexa, Kan: American Association for Public Opinion Research; 2004.
- Ware JE, Kosinski M, Keller SD. *SF-36 Physical and Mental Health Summary Scales: A User's Manual*. 3rd ed. Boston, Mass: Health Institute, New England Medical Center; December 1994.
- Kalichman SC, Rompa D. Functional health literacy is associated with health status and health-related knowledge in people living with HIV-AIDS. *J Acquir Immune Defic Syndr*. 2000;25:337-344.
- DeWalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. Literacy and health

- outcomes: a systematic review of the literature. *J Gen Intern Med.* 2004;19:1228-1239.
30. Baker DW, Gazmararian JA, Williams MV, et al. Functional health literacy and the risk of hospital admission among Medicare enrollees. *Am J Public Health.* 2002;92:1278-1283.
 31. Baker DW, Parker RM, Williams MV, Clark WS. Health literacy and the risk of hospital admission. *J Gen Intern Med.* 1998;13:791-798.
 32. Sheikh JI, Yesavage JA. Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. *Clin Gerontol.* 1986;5:165-172.
 33. Williams MV, Baker DW, Parker RM, Nurss JR. Relationship of functional health literacy to patients' knowledge of their chronic disease: a study of patients with hypertension and diabetes. *Arch Intern Med.* 1998;158:166-172.
 34. Williams MV, Baker DW, Honig EG, Lee TM, Nowlan A. Inadequate literacy is a barrier to asthma knowledge and self-care. *Chest.* 1998;114:1008-1015.
 35. Baker DW, Gazmararian JA, Williams MV, et al. Health literacy and use of outpatient physician services by Medicare managed care enrollees. *J Gen Intern Med.* 2004;19:215-220.
 36. Davis TC, Williams MV, Branch WT Jr, Green KW. Explaining illness to patients with limited literacy. In: Whaley BB, ed. *Explaining Illness: Research, Theory, and Strategies.* Mahwah, NJ: Lawrence A Erlbaum Associates; 2000:123-146.
 37. National Work Group on Literacy and Health. Communicating with patients who have limited literacy skills: report of the National Work Group on Literacy and Health. *J Fam Pract.* 1998;46:168-176.
 38. Lindau S, Tomori C, McCarville BA, Bennett CL. Improving rates of cervical cancer and Pap smear follow-up for low-income women with limited health literacy. *Cancer Invest.* 2001;19:316-323.
 39. Hearsh-Holmes M, Murphy PW, Davis TC, et al. Literacy in patients with a chronic disease: systemic lupus erythematosus and the reading level of patient education materials. *J Rheumatol.* 1997;24:2335-2339.
 40. Zion AB, Aiman J. Level of reading difficulty in the American College of Obstetricians and Gynecologists patient education pamphlets. *Obstet Gynecol.* 1989;74:955-959.
 41. Davis TC, Bocchini JA Jr, Fredrickson D, et al. Parent comprehension of polio vaccine information pamphlets. *Pediatrics.* 1996;97:804-810.
 42. Davis TC, Mayeaux EJ, Fredrickson D, Bocchini JA Jr, Jackson RH, Murphy PW. Reading ability of parents compared with reading level of pediatric patient education materials. *Pediatrics.* 1994;93:460-468.
 43. Bush TL, Miller SR, Golden AL, Hale WE. Self-report and medical record report agreement of selected medical conditions in the elderly. *Am J Public Health.* 1989;79:1554-1556.
 44. Giles WH, Croft JB, Keenan NL, Lane MJ, Wheeler FC. The validity of self-reported hypertension and correlates of hypertension awareness among blacks and whites within the stroke belt. *Am J Prev Med.* 1995;11:163-169.
 45. Kriegsman DM, Pennix BW, van Eijks JT, et al. Self-reports and general practitioner information on the presence of chronic diseases in community-dwelling elderly: a study on the accuracy of patients' self-reports and on determinants of inaccuracy. *J Clin Epidemiol.* 1996;49:1407-1417.
 46. Bergmann M, Byers T, Freedman DS, et al. Validity of self-reported diagnoses leading to hospitalization: a comparison of self-reports with hospital records in a prospective study of American adults. *Am J Epidemiol.* 1998;147:969-977.
 47. Simpson CF, Boyd CM, Carlson MC, Griswold ME, Guralnik JM, Fried LP. Agreement between self-report of disease diagnoses and medical record validation in disabled older women: factors that modify agreement. *J Am Geriatr Soc.* 2004;52:123-127.