Health Literacy, Numeracy, and Graphical Literacy Among Veterans in Primary Care and Their Effect on Shared Decision Making and Trust in Physicians

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Studies reveal high levels of inadequate health literacy and numeracy in African Americans and older veterans. The authors aimed to investigate the distribution of health literacy, numeracy, and graph literacy in these populations. They conducted a cross-sectional survey of veterans receiving outpatient care and measured health literacy, numeracy, graph literacy, shared decision making, and trust in physicians. In addition, the authors compared subgroups of veterans using analyses of covariance. Participants were 502 veterans (22–82 years). Low, marginal, and adequate health literacy were found in, respectively, 29%, 26%, and 45% of the veterans. The authors found a significant main effect of race qualified by an age and race interaction. Inadequate health literacy was more common in African Americans than in Whites. Younger African Americans had lower health literacy ($p < .001$), graph literacy ($p < .001$), and numeracy ($p < .001$) than did Whites, even after the authors adjusted for covariates. Older and younger participants did not differ in health literacy, objective numeracy, or graph literacy after adjustment. The authors found no health literacy or age-related differences regarding preferences for shared decision making. African Americans expressed dissatisfaction with their current role in decision making ($p = .03$). Older participants trusted their physicians more than younger participants ($p = .01$). In conclusion, African Americans may be at a disadvantage when reviewing patient education materials, potentially affecting health care outcomes.

Health literacy is the capacity to obtain, process, and use basic health information and services needed to make health decisions (Nielsen-Bohlman, Panzer, & Kindig, 2004). Research indicates an association of inadequate health literacy with poor knowledge of disease (Osborn, Cavanaugh, Wallston, & Rothman, 2010), impaired patient–physician communication (Schillinger et al., 2003; Williams, Davis, Parker, & Weiss, 2002), lower adherence (Osborn, Paasche-Orlow, Davis, & Wolf, 2007), poor self-management skills (Kalichman, Ramachandran, & Catz, 1999), worse perceived health status (Baker et al., 2002), poor functional status (Wolf, Gazmararian, & Baker, 2005), worse clinical outcomes (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Estrada, Martin-Hryniewicz, Peek, Collins, & Byrd, 2004; Schillinger et al., 2002), diminished involvement in shared decision making (Naik, Street, Castillo, & Abraham, 2011), and higher health care utilization (Baker et al., 2002; Hardie, Kyanko, Busch, Losasso, & Levin, 2011).

Health literacy also encompasses two skills that only relatively recently have received greater attention: numeracy and graph literacy. Numeracy consists of a set of quantitative abilities needed for comprehending, managing, and manipulating numerical expressions of probability about health information (Peters, 2012; Rothman, Montori, Cherrington, & Pignone, 2008). Graph literacy, which has recently emerged as another important literacy skill in health care (Galesic, Garcia-Retamero, & Gigerenzer, 2009; Garcia-Retamero & Galesic, 2010), refers to the ability to understand basic graphical representations used to present quantitative health-related information.

Studies document higher levels of inadequate health literacy and numeracy among African Americans (Morrow et al., 2006; Osborn et al., 2007; Patel et al., 2011;

Waldrop-Valverde et al., 2010). Even after we controlled for socioeconomic status, education, and burden of disease, a significant association remained between race and inadequate health literacy (Chaudhry et al., 2011; Morrow et al., 2006; Osborn et al., 2007; Shea et al., 2004). Research also demonstrates a high prevalence of inadequate health literacy (Martin et al., 2009; Morrow et al., 2006; Peterson et al., 2011) and numeracy (Garcia-Retamero, Galesic, & Gigerenzer, 2010; Taha, Sharit, & Czaja, 2012) in older individuals. These age differences may stem from generational differences in levels of educational achievement and preservation of knowledge gains, multiple comorbidities, use of multiple medications, and cognitive and sensory impairments (Baker, Gazmararian, Sudano, & Patterson, 2000; Sentell & Halpin, 2006). It is important to note that after we controlled for cognitive ability, the association between age and health literacy disappears (Baker et al., 2000; Bostock & Steptoe, 2012; Morrow et al., 2006).

American military veterans constitute a patient population with a large pool of African American and older individuals. Veterans are predominantly older, have lower socioeconomic and educational status, have higher prevalence of chronic diseases, and are uninsured or unemployed (Agha, Lofgren, VanRuiswyk, & Layde, 2000; Kazis et al., 1998; Liu, Maciejewski, & Sales, 2005). Female veterans often had problems managing numerical information regarding the benefits of mammograms (Schwartz, Woloshin, Black, & Welch, 1997). Also, outpatient veterans showed lower numeracy scores than those at a University-based clinic (Fagerlin et al., 2007). Further, inadequate health literacy in primary care veterans was a predictor of worse satisfaction with health care after adjusting for patient sociodemographics (Shea et al., 2007). In contrast, another study conducted on veterans—96% of whom were White—showed higher levels of adequate literacy (Schapira et al., 2012). These studies, however, did not assess numeracy or graph literacy. The purpose of the present research was to determine levels of health literacy, numeracy, and graph literacy in a sample of veterans and to assess their association with two important aspects of the patient-physician relationship: trust in physicians and willingness to participate in decision making about their health. We were particularly interested in examining the associations of race and age with these potentially critical attributes of patient-physician dynamics.

Method

Design and Participants

We conducted a cross-sectional study from January through February 2012, on male veterans, aged 20 or older receiving outpatient care at the Bruce W. Carter VAMC. We recruited participants at outpatient clinics who met the following inclusion criteria: enrollment in a Veterans Affairs clinic, cognitively intact (Mini-Cog score greater than 3), nondepressed (Patient Health Questionnaire-2 score less than 3), and having a minimum education level of eighth grade. We did not include veterans with unstable illness or sensory impairment. Each participant received a US\$5 voucher. The survey took approximately 50 min to complete. We obtained full institutional review board approval from the Bruce W. Carter VAMC.

Measures

After completing the informed consent form participants completed a sociodemographics survey, as well as a series of instruments from which we obtained the following measures.

Health Literacy

We measured health literacy with the Newest Vital Sign (NVS; Weiss et al., 2005). It consists of a nutritional label and six associated questions. The cutoff for appropriate health literacy is four or more correct answers. The NVS takes approximately 3 minutes to complete. The instrument is reliable and has demonstrated internal consistency in a previous study (Cronbach's α of .76; Weiss et al., 2005). Cronbach's alpha coefficient in this study was .83.

Numeracy

We measured objective numeracy with a scale consisting of nine items developed by Schwartz and colleagues (Schwartz et al., 1997) and Lipkus and colleagues (Lipkus, Samsa, & Rimer, 2001) and the four items of the Berlin Numeracy Test (Cokely, Galesic, Schulz, Ghazal, & Garcia-Retamero, 2012). Cronbach's alpha coefficient in this study was .73. In addition, we used a subjective numeracy scale developed by Fagerlin and colleagues (2007). This scale is an eight-item self-report measure of the perceived ability to perform various mathematical tasks and preferences for use of numerical versus prose information. Cronbach's alpha coefficient in this study was .82 (Fagerlin et al., 2007).

Graph Literacy

We used the graph literacy scale developed by Galesic and Garcia-Retamero (2011), which consists of 13 items and measures three abilities: finding specific information in the graph, finding relationships in the data as shown on the graph, and making inferences and predictions from the data. The graph literacy scale underwent validation on probabilistic national samples in Germany and United States (Galesic & Garcia-Retamero, 2011). Cronbach's alpha coefficient in this study was .81.

Trust in Physicians

This scale consists of 11 items that assess participants' trust in their physicians in the domains of dependability, confidence, and confidentiality of information (Anderson & Dedrick, 1990). In a previous study that used this scale, investigators found a Cronbach's α of .85 (Anderson & Dedrick, 1990). Cronbach's alpha coefficient in this study was .94.

Shared Decision Making

This instrument consists of two questions: The first asks about the usual role participants play in their interactions with physicians. The second asks about the role they believe they should play. Both use a 5-point scale ranging from 1 "the doctor makes (should make) the decision" to 5 "I (should) make the decision" (Strull, Lo, & Charles, 1984). Higher scores imply more active involvement.

Data Analysis

We report descriptive statistics of age, education, marital status, ethnicity, race, perception of general health, number of medications, body mass index, Charlson Comorbidity Index, and self-reported mental health. We used the 5-Digit ZIP Code Tabulation Area and the median household income in the past 12 months (in 2011 inflation-adjusted dollars) by racial group from the U.S. Census Bureau, 2007–2011, American Community Survey (African American: B19013B, White: B19013A, Asian:

B19013D and American Indian/Alaska Native: B19013C) to determine differences in median household income. In the case of participants without race information, we considered the general median household income (B19013). We categorized usual and preferred role in shared decision-making responses as passive, collaborative, or active. We grouped the differences in responses between the usual and preferred roles into the following three categories: prefer a more passive role than the one they actually play (negative numbers), satisfied with current role (zero), or prefer a more active role than the one they actually play (positive numbers). We conducted multivariate analysis of variance with age (younger than 65 years vs. older than 65 years) and race (White vs. African American) as independent variables, and health literacy, graph literacy, objective numeracy, and subjective numeracy as dependent variables. We included education, median household income in the past 12 months, body mass index, marital status, number of medications, Charlson Comorbidity Index, trust in physicians, perception of general health, and number of mental health disorders as covariates in the analyses.

Results

Participant Characteristics

Table 1 presents the overall participant characteristics. We enrolled 502 veterans with a mean age of 57.12 years ($SD = 9.75$, range = 22–82 years). The ethnic makeup included Hispanic (19%), non-Hispanic (68%) and those who selected “do not want to answer” (13%), with race divided between African Americans (55%), Whites (34%), American Indian/Asian (3%), and those who selected “do not want to answer” or who did not provide a response (8%).

Health Literacy, Numeracy, and Graph Literacy

Low, marginal, and adequate levels of health literacy were present in 145 (29%), 131 (26%), and 226 (45%) participants, respectively. Table 1 contrasts demographic characteristics between participants with adequate and inadequate (low and marginal, respectively) health literacy. Compared with participants with adequate health literacy, those with inadequate health literacy were older, had lower household incomes, had lower education, had higher body mass indexes, took more medications, had more comorbidities, and had more mental disorders. More participants with inadequate health literacy perceived their health as “poor or fair” (63%) compared with those with adequate health literacy (37%). In contrast, more participants with adequate health literacy perceived their health as “very good or excellent” (55%) compared with those with inadequate health literacy (45%, $\chi^2(2, n = 500) = 9.66, p = .008$).

Table 2 provides comparisons of unadjusted health literacy, numeracy (subjective and objective), and graph literacy between participants with inadequate and adequate health literacy. Spearman Rho correlations between demographic variables and health literacy, numeracy, and graph literacy are shown in Table 3. The highest correlations occurred between health literacy and objective numeracy, health literacy and graph literacy, and graph literacy and objective numeracy. The remaining correlations were relatively weak.

Racial and Age Differences

Compared with Whites, African Americans were younger, and had lower household incomes, lower education, and higher body mass indexes (see Table 1). African

Table 1. Unadjusted comparisons of demographic characteristics of participants as a function of their health literacy, race, and age

Characteristic	Total $M \pm SD, (n)$	Inadequate health literacy $M \pm SD (n)$	Adequate health literacy $M \pm SD, (n)$	African American $M \pm SD, (n)$	Whites $M \pm SD, (n)$	Younger than 65 years $M \pm SD, (n)$	Older than 65 years $M \pm SD, (n)$	p
Age (years)	57.12 $\pm$ 9.75 (502)	58.37 $\pm$ 8.17 (276)	55.60 $\pm$ 11.22 (226)	.002* 56.23 $\pm$ 8.55 (278)	59.04 $\pm$ 11.21 (172)	.005* 54.04 $\pm$ 8.16 (402)	69.50 $\pm$ 4.25 (100)	<.001*
Household income	42,703 $\pm$ 21,519 (480)	40,703 $\pm$ 21,449 (267)	45,211 $\pm$ 21,394 (213)	.003* 37,421 $\pm$ 20,955 (268)	51,013 $\pm$ 20,233 (164)	<.001* 41,905 $\pm$ 22,426 (382)	45,814 $\pm$ 17,294 (98)	.11
Education (years)	12.94 $\pm$ 2.11 (493)	12.51 $\pm$ 1.76 (271)	13.47 $\pm$ 2.37 (222)	<.001* 12.68 $\pm$ 1.80 (272)	13.25 $\pm$ 2.40 (170)	.009* 12.89 $\pm$ 1.97 (396)	13.14 $\pm$ 2.61 (97)	.29
Body mass index	29.04 $\pm$ 5.90 (502)	29.54 $\pm$ 6.31 (276)	28.45 $\pm$ 5.31 (226)	.04* 29.90 $\pm$ 6.17 (278)	28.35 $\pm$ 5.36 (172)	.007* 29.19 $\pm$ 5.97 (402)	28.49 $\pm$ 5.61 (100)	.29
Medications (n)	5.90 $\pm$ 4.22 (502)	6.41 $\pm$ 4.44 (276)	5.28 $\pm$ 3.85 (226)	.003* 6.23 $\pm$ 4.32 (278)	5.40 $\pm$ 4.10 (172)	.04* 5.78 $\pm$ 4.19 (402)	6.39 $\pm$ 4.31 (100)	.19
Perceived health	3.22 $\pm$ 0.95 (502)	3.33 $\pm$.97 (276)	3.09 $\pm$.91 (226)	.005* 3.31 $\pm$.86 (278)	3.08 $\pm$ 1.02 (172)	.01* 3.23 $\pm$.94 (402)	3.18 $\pm$.99 (100)	.63
Charlson Comorbidity Index	3.43 $\pm$ 3.06 (488)	3.69 $\pm$ 3.08 (268)	3.13 $\pm$ 3.01 (220)	.04* 3.43 $\pm$ 3.17 (268)	3.70 $\pm$ 3.01 (168)	.37 3.09 $\pm$ 3.02 (388)	4.77 $\pm$ 2.83 (100)	<.001*
Mental health (n)	2.74 $\pm$ 2.20 (502)	2.93 $\pm$ 2.25 (276)	2.51 $\pm$ 2.11 (226)	.03* 2.80 $\pm$ 2.10 (278)	2.45 $\pm$ 2.20 (172)	.09 2.93 $\pm$ 2.17 (402)	1.99 $\pm$ 2.14 (100)	<.001*
Trust in physicians	63.32 $\pm$ 14.56 (502)	62.78 $\pm$ 5.45 (276)	63.99 $\pm$ 13.4 (226)	.35 63.91 $\pm$ 13.71 (278)	64.17 $\pm$ 14.12 (172)	.84 62.56 $\pm$ 14.37 (402)	66.40 $\pm$ 14.99 (100)	.01*

Note. Not all totals add up to 502 because of missing data.

* $p < .05$.

Table 2. Unadjusted comparisons of health literacy, numeracy, and graphical literacy characteristics of participants as a function of their health literacy, race, and age

Characteristic	Total $M \pm SD, (n)$	Inadequate health literacy		Adequate health literacy		African American		Whites		Younger than 65 years		Older than 65 years	
		$M \pm SD, (n)$	$M \pm SD, (n)$	$M \pm SD, (n)$	$M \pm SD, (n)$	$M \pm SD, (n)$	p	$M \pm SD, (n)$	p	$M \pm SD, (n)$	p	$M \pm SD, (n)$	p
Health literacy	3.04 $\pm$ 2.16 (502)	1.32 $\pm$ 1.14 (276)	5.15 $\pm$ 0.83 (226)	<.001*	2.45 $\pm$ 1.98 (278)	4.04 $\pm$ 2.09 (172)	<.001*	3.05 $\pm$ 2.14 (402)	<.001*	3.01 $\pm$ 2.25 (100)			.85
Subjective numeracy	34.17 $\pm$ 10.43 (502)	30.96 $\pm$ 9.42 (276)	38.12 $\pm$ 10.26 (226)	<.001*	32.35 $\pm$ 10.32 (278)	37.13 $\pm$ 9.76 (172)	<.001*	33.57 $\pm$ 10.62 (402)	<.001*	36.64 $\pm$ 9.23 (100)			.008*
Objective numeracy	5.39 $\pm$ 2.52 (502)	4.26 $\pm$ 2.01 (276)	6.77 $\pm$ 2.38 (226)	<.001*	4.75 $\pm$ 2.31 (278)	6.51 $\pm$ 2.47 (172)	<.001*	5.31 $\pm$ 2.47 (402)	<.001*	5.73 $\pm$ 2.68 (100)			.13
Graph literacy	7.16 $\pm$ 3.05 (502)	5.96 $\pm$ 2.90 (276)	8.64 $\pm$ 2.54 (226)	<.001*	6.43 $\pm$ 3.04 (278)	8.36 $\pm$ 2.67 (172)	<.001*	7.17 $\pm$ 2.95 (402)	<.001*	7.16 $\pm$ 3.43 (100)			.97

Note. Not all totals add up to 502 because of missing data.
* $p < .05$.

Table 3. Spearman rho correlations between participants' characteristics and health literacy, numeracy, and graph literacy

	1	2	3	4	5	6	7	8	9	10
1. Age	1.000	.060	.053	.172**	.409**	.046	-.131**	-.068	.043	-.142**
<i>p</i>	—	.186	.244	.000	.000	.306	.003	.128	.339	.001
<i>n</i>	502	493	480	450	488	502	502	502	502	502
2. Education	.060	1.000	.189**	.148**	.014	-.059	.250**	.286**	.313**	.291**
<i>p</i>	.186	—	.000	.002	.768	.191	.000	.000	.000	.000
<i>n</i>	493	493	472	442	479	493	493	493	493	493
3. Income	.053	.189**	1.000	.408**	-.084	-.005	.172**	.245**	.126**	.284**
<i>p</i>	.244	.000	—	.000	.070	.921	.000	.000	.006	.000
<i>n</i>	480	472	480	432	472	480	480	480	480	480
4. Race	.172**	.148**	.408**	1.000	.058	-.123**	.361**	.351**	.217**	.321**
<i>p</i>	.000	.002	.000	—	.225	.009	.000	.000	.000	.000
<i>n</i>	450	442	432	450	436	450	450	450	450	450
5. Charlson (adjusted)	.409**	.014	-.084	.058	1.000	.175**	-.050	-.172**	-.048	-.196**
<i>p</i>	.000	.768	.070	.225	—	.000	.271	.000	.286	.000
<i>n</i>	488	479	472	436	488	488	488	488	488	488
6. Perceived health	.046	-.059	-.005	-.123**	.175**	1.000	-.133**	-.062	-.142**	-.102*
<i>p</i>	.306	.191	.921	.009	.000	—	.003	.168	.001	.022
<i>n</i>	502	493	480	450	488	502	502	502	502	502
7. Health literacy	-.131**	.250**	.172**	.361**	-.050	-.133**	1.000	.505**	.360**	.510**
<i>p</i>	.003	.000	.000	.000	.271	.003	—	.000	.000	.000
<i>n</i>	502	493	480	450	488	502	502	502	502	502
8. Objective numeracy	-.068	.286**	.245**	.351**	-.172**	-.062	.505**	1.000	.478**	.664**
<i>p</i>	.128	.000	.000	.000	.000	.168	.000	.000	.000	.000
<i>n</i>	502	493	480	450	488	502	502	502	502	502
9. Subjective numeracy	.043	.313**	.126**	.217*	-.048	-.142**	.360**	.478**	1.000	.411**
<i>p</i>	.339	.000	.006	.000	.286	.001	.000	.000	—	.000
<i>n</i>	502	493	480	450	488	502	502	502	502	502
10. Graph literacy	-.142**	.291**	.284**	.321*	-.196**	-.102*	.510**	.664**	.411**	1.000
<i>p</i>	.001	.000	.000	.000	.000	.022	.000	.000	.000	.000
<i>n</i>	502	493	480	450	488	502	502	502	502	502

Note. All *p* values were two-tailed.

***p* = .01. **p* = .05.

Table 4. Post hoc comparisons of African American and White veterans in two age groups for adjusted mean scores of health literacy, objective numeracy, graph literacy, and subjective numeracy

				95% Confidence Interval		
Age and Literacy Construct	Race (<i>n</i>)	<i>M</i>	<i>SD</i>	Lower bound	Upper bound	<i>p</i>
<i>Younger than 65 years</i>						
Health literacy	African American (224)	2.513 ^a	.134	2.250	2.776	.000
	White (105)	4.162 ^a	.201	3.767	4.558	.000
Subjective numeracy	African American (224)	32.127 ^a	.648	30.853	33.401	.000
	White (105)	36.824 ^a	.973	34.910	38.737	.000
Objective numeracy	African American (224)	4.855 ^a	.151	4.557	5.153	.000
	White (105)	6.386 ^a	.227	5.938	6.833	.000
Graphical literacy	African American (224)	6.753 ^a	.180	6.399	7.106	.000
	White (105)	8.090 ^a	.270	7.559	8.620	.000
<i>Older than 65 years</i>						
Health literacy	African American (31)	2.664 ^b	.418	1.831	3.496	.169
	White (55)	3.408 ^b	.308	2.795	4.020	.169
Subjective numeracy	African American (31)	36.566 ^b	1.816	32.947	40.184	.862
	White (55)	36.972 ^b	1.337	34.309	39.635	.862
Objective numeracy	African American (31)	5.322 ^b	.443	4.440	6.204	.111
	White (55)	6.237 ^b	.326	5.588	6.886	.111
Graphical literacy	African American (31)	5.533 ^b	.545	4.448	6.618	.001
	White (55)	8.027 ^b	.401	7.228	8.825	.001

^aCovariates appearing in the model are evaluated at the following values: education = 12.82, median household income in the past 12 months = \$41,596.64, body mass index = 29.51, marital status = 2.49, number of medication = 6.07, Charlson Comorbidity Index = 2.38, trust in physicians = 63.23, perception of general health = 3.24, number of mental health conditions = 2.84.

^bCovariates appearing in the model are evaluated at the following values: education = 13.22, median household income in the past 12 months = \$47,490.70, body mass index = 28.90, marital status = 2.84, number of medication = 6.72, Charlson Comorbidity Index = 2.83, trust in physicians = 68.53, perception of general health = 3.20, number of mental health conditions = 2.05.

Americans also took more medications. More African Americans perceived their health to be “fair” or “poor” (67%) than did Whites (33%). In contrast, more Whites perceived their health as “very good” or “excellent” (53%) than did African Americans

(47%), $\chi^2(2, 450) = 10.87, p = .004$. African Americans did not differ from Whites in the number of comorbidities and mental disorders. Compared with older participants, younger participants had fewer comorbidities and more mental disorders. Younger participants were similar to their older counterparts in their perceptions of health and their median household incomes. African Americans had higher rates of low (NVS = 0–1; 79%) or marginal health literacy (NVS = 2–3; 70%) compared with Whites (21%; and 30%), respectively, $\chi^2(2, 450) = 41.91, p < .001$. In contrast, Whites had higher rates of adequate health literacy (54%) than did African Americans (46%).

Table 2 provides comparisons of unadjusted health literacy, numeracy (subjective and objective), and graph literacy between racial and age groups. African Americans had lower levels of health literacy, subjective and objective numeracy, and graph literacy than did Whites. Compared with younger participants, older participants had higher subjective numeracy. We did not find any unadjusted differences between the younger and older age groups in levels of levels of health literacy, objective numeracy, and graph literacy.

Multivariate analysis revealed a statistically significant effect of race, $F(4, 399) = 9.02, p < .001$; Wilks' $\lambda = .91$, partial $\eta^2 = .08$, which was qualified by an interaction between race and age, $F(4, 399) = 3.36, p = .01$; Wilks' $\lambda = .96$, partial $\eta^2 = .03$. Univariate tests of race showed significant differences, with lower scores for African Americans in health literacy, $\Delta M = 1.23, F(1, 402) = 21.88, p < .001$; partial $\eta^2 = .05$; graph literacy, $\Delta M = 1.85, F(1, 402) = 27.36, p < .001$; partial $\eta^2 = .06$; subjective numeracy, $\Delta M = 2.47, F(1, 402) = 3.90, p = 0.04$; partial $\eta^2 = .01$; and objective numeracy, $\Delta M = 1.24, F(1, 402) = 17.57, p < .001$; partial $\eta^2 = .04$. Multivariate tests also revealed a significant interaction between education, $F(4, 399) = 14.68, p < .001$; Wilks' $\lambda = .87$, partial $\eta^2 = .12$ and health literacy ($p < .001$), subjective numeracy ($p < .001$), objective numeracy ($p < .001$), and graphical literacy ($p < .001$); between Charlson Comorbidity index, $F(4, 399) = 4.06, p = .003$; Wilks' $\lambda = .96$, partial $\eta^2 = .03$ and objective numeracy ($p < .001$) and graphical literacy ($p = .005$); and between number of mental health disorders, $F(4, 399) = 2.64, p = .03$; Wilks' $\lambda = .97$, partial $\eta^2 = .02$ and health literacy ($p < .001$), subjective numeracy ($p = .01$), objective numeracy ($p = .005$), and graphical literacy ($p = .001$). We found no significant differences in multivariate tests on age ($p = .08$), income ($p = .13$), body mass index ($p = .09$) marital status ($p = .15$), medications ($p = .07$), trust in physicians ($p = .11$), and perceived health status ($p = .20$).

Table 4 shows adjusted differences between African Americans and Whites and between the younger and older participants in health literacy, subjective and objective numeracy, and graph literacy. Younger African Americans had lower levels of health literacy and subjective and objective numeracy than did younger Whites. In addition, older African Americans had lower levels of graph literacy than did older Whites. Older African Americans did not differ from Whites in levels of health literacy or in subjective and objective numeracy.

Shared Decision Making and Trust in Physicians

When asked about their usual role in health decisions, participants indicated that they often assumed a passive (51%) or a collaborative role (34%); relatively few participants indicated having assumed an active role (15%). However, most participants favored a collaborative role when asked about their preferred role (54%). A smaller proportion preferred a passive role (34%), whereas only a minority preferred an active role (12%). Participants with adequate health literacy did not differ from those with inadequate

health literacy in the role they usually assume in decision making, $\chi^2(2, n = 502) = 2.17$, $p = .33$, or in the role they would like to take on, $\chi^2(2, n = 502) = 2.01$, $p = .36$. Similarly, African Americans and Whites did not differ in the role they usually take on in health decisions ($\chi^2(2, n = 450) = 1.38$, $p = .50$) or in the role they would like to assume ($\chi^2(2, n = 450) = 5.63$, $p = .06$). Last, younger participants did not differ from older participants in the role they usually play in health decisions, $\chi^2(2, n = 502) = 2.26$, $p = .32$, or in the role they would like to take on, $\chi^2(2, n = 502) = 1.70$, $p = .42$. The analyses of the differences between preferred and actual roles revealed that many participants expressed satisfaction with their current role (50%), or preferred to assume a more active role (35%). Only a few participants preferred to assume a more passive role (15%). Participants with adequate and inadequate health literacy, and younger and older participants, showed similar differences between their preferred and actual roles, $\chi^2(2, n = 502) = .35$, $p = .83$, and $\chi^2(2, n = 502) = 1.85$, $p = .39$, respectively.

African Americans preferred to take on a more active role in decisions about their health (40%) than did Whites (28%, $p < .05$), $\chi^2(2, n = 450) = 6.78$, $p = .03$. In contrast, Whites (58%) expressed more satisfaction with their current role than did African Americans (46%, $p < .05$). A similar percentage of African Americans (14%) and Whites (14%) would prefer to play a more passive role in decision making.

Last, the results indicated that participants often trusted their physicians (average score = 63 out of 77 points; $SD = 15$, range = 0 to 77). Participants with adequate and inadequate health literacy, $t(500) = .92$, $p = .35$, and African Americans and Whites, $t(448) = .19$, $p = .84$, trusted their physicians to a similar extent. However, older participants trusted their physicians more than did younger participants, $t(500) = 2.37$, $p = .01$, $d = .26$.

Discussion

Levels of inadequate health literacy were significant in this population of veterans. Compared with participants with adequate health literacy, those with inadequate health literacy were older, poorer, less educated, more obese, and had more physical and mental comorbidities. We found a significant age by race interaction such that differences in literacy variables between African Americans and Whites were most evident for those who were younger than the age of 65 years. After adjusting for known prognostic factors (i.e., socioeconomic status, education, body mass index, number of medications, comorbidities), younger African Americans have higher levels of inadequate health literacy and lower levels of subjective and objective numeracy and graph literacy than younger Whites. In older African Americans, results showed lower graph literacy than for Whites, with no differences in health literacy and subjective and objective numeracy.

We did not find any age differences in health literacy, subjective and objective numeracy, and graph literacy after adjusting for known prognostic factors. Veterans with inadequate health literacy were less willing to participate in decision making about their health but did not differ in the extent to which they trusted their physicians. In addition, African Americans expressed less satisfaction than Whites with the role they played in decisions about their own health; specifically they would prefer more active involvement. However, African Americans and Whites did not differ in the extent to which they trusted their physicians. Last, older participants trusted their physicians more than younger participants.

In contrast with researchers of past studies, we used the NVS. Other investigators used the Test of Functional Health Literacy in Adults or the Rapid Estimate of

Adult Literacy in Medicine instruments, which may account for the different results (Chew et al., 2008; Griffin et al., 2010). The NVS consistently overestimates inadequate health literacy, especially in the elderly and in African Americans (Kirk et al., 2012; Murray, Johnson, Wolf, & Deary, 2011; Ozdemir, Alper, Uncu, & Bilgel, 2010; Patel et al., 2011; Weiss et al., 2005). These findings suggest that important differences exist between these instruments. In particular, the Rapid Estimate of Adult Literacy in Medicine is a word recognition test that mostly relates to education, and to health knowledge and experience (Davis et al., 1993), and thus may potentially underestimate inadequate health literacy (Chin et al., 2011; Murray et al., 2011). In contrast, we found a strong correlation between the NVS and the Test of Functional Health Literacy in Adults. Both tests are independent of the effects of education (Murray et al., 2011; Wolf et al., 2012), and assess reading ability and comprehension as well as numeracy (Parker, Baker, Williams, & Nurss, 1995; Weiss et al., 2005). These instruments also appear to meet ecological validity criteria (Parker et al., 1995; Weiss et al., 2005). The NVS's brevity and ability to discriminate among high scoring individuals may make it a preferred instrument for some (Murray et al., 2011).

In our study, participants with inadequate health literacy as measured by NVS were also more likely to have lower numeracy and graph literacy. Our sample may overrepresent groups known to display higher levels of inadequate health literacy, numeracy, and graph literacy.

The higher levels of inadequate health literacy, numeracy, and graph literacy in African Americans after adjusting for relevant covariates are significant and consistent with other studies (Chaudhry et al., 2011; Shea et al., 2004). We propose three explanations for this finding: poor educational experiences, health care professional bias, and testing effects. Research shows that number of years of schooling does not necessarily imply equal levels of educational achievement (Baker, Parker, Williams, Clark, & Nurss, 1997). Health care professional bias toward African Americans could also adversely impact such patient education strategies (Penner, Albrecht, Coleman, & Norton, 2007). Conceivably, professional bias alone may impact the quality of patient education, ultimately resulting in lower levels of health literacy. In addition, investigators have showed evidence of racial bias in testing of African Americans from infancy to adulthood (Jencks & Phillips, 1998). Recent evidence shows that when compared to Caucasians, African Americans experienced more difficulties completing the NVS (Kirk et al., 2012; Patel et al., 2011). Together, these factors could directly or indirectly affect health literacy in African Americans.

Other investigators have demonstrated an association between age and inadequate health literacy (Baker et al., 2000; Gazmararian et al., 1999; Murray et al., 2011; Williams et al., 1995). In contrast, studies such as ours, which control for cognitive impairment, typically fail to demonstrate associations of age with inadequate health literacy (Federman, Sano, Wolf, Siu, & Halm, 2009; Kaphingst et al., 2012; Levinthal, Morrow, Tu, Wu, & Murray, 2008; Morrow et al., 2006). Thus, clinicians need to be mindful of the increased incidence of cognitive impairment with aging and its interaction with health literacy (Federman et al., 2009).

As in previous Veterans Affairs studies, despite the preference for a majority of participants to assume a collaborative role (Naik et al., 2011), we found that most veterans actually played a passive role in decision making. However, in contrast with the other Veterans Affairs studies (DeWalt, Boone, & Pignone, 2007; Naik et al., 2011; Smith, Dixon, Trevena, Nutbeam, & McCaffery, 2009), participants with inadequate health literacy in our study did not differ from those with adequate health literacy in

their willingness to participate in health decision making, pointing to the need for further research to discern the contribution of health literacy to decision making.

African Americans in our study expressed more dissatisfaction with the role they played and often wanted more involvement. Physicians' biases, cultural differences, mistrust of White physicians, negative physicians' attitudes, and patients' perceptions of racism are all potential factors that may hinder African Americans' willingness to participate in decision making (Peek et al., 2010). Providers would likely need to adapt their approach toward interacting with patients to effectively manage the large number of patients possessing inadequate health literacy, and that are characterized by diverse racial and ethnic differences (King, Eckman, & Moulton, 2011; Peek et al., 2009). The lack of effect of health literacy on trust in physicians is encouraging as trust in physicians results in better acceptance of recommended care (Ayanian, Cleary, Weissman, & Epstein, 1999; Safran et al., 1998), satisfaction with care (Keating et al., 2002) and physicians (Kao, Green, Davis, Koplan, & Cleary, 1998), better perceived health (Kao et al., 1998; Safran et al., 1998), and adherence (Jacobs, Rolle, Ferrans, Whitaker, & Warnecke, 2006).

The strengths of this study include a relatively large sample of veterans, use of validated scales yielding a more comprehensive assessment of other health literacy domains, and the supplementary use of chart audit data. However, our study also has a number of limitations. We used a convenience instead of a randomly selected sample. Excluding participants with less than an eighth-grade education may have resulted in an overestimation of health literacy, numeracy, and graph literacy abilities. We measured socioeconomic status with residential zip codes and data from the 2010 U.S. Census; the lack of granularity in this data thus may not reflect the actual incomes of individuals. Also, we limited our study to veterans at one medical center, and ethnic, racial, educational, and socioeconomic composition may be different from other veterans' facilities in the United States.

Implications of this study for clinical practice are various. Clinicians need to be mindful of the diversity of patients within any population subgroup. To reduce the impact of inadequate health literacy, numeracy, and graph literacy on African Americans, health care providers need to make a concerted effort to increase the use of patient education strategies tailored to these deficits. Clinicians can empower African-American patients by speaking respectfully; using lay terminology, and checking for understanding with the teach-back method (Schillinger et al., 2003). Large integrated health care systems like the Veterans Affairs can foster interventions that address the needs of these patients. Such interventions can range from training providers to designing educational materials that are culturally relevant and written at a sixth-grade reading level. The use of well-designed pictures in educational materials can also potentially overcome some of these literacy limitations. Efforts to increase participation of African Americans in the design of educational materials can be an approach to address racial and cultural differences (Houts, Doak, Doak, & Loscalzo, 2006).

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