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Health literacy and current CD4 cell count in a multi-ethnic U.S. sample of adults living with HIV Infection

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Abstract

Background—Hispanic and Black adults are disproportionately affected by HIV and experience poorer HIV-related health outcomes relative to non-Hispanic White adults. The current study adopted Sørensen's (2012) Integrated Model to test the hypothesis that lower functional and critical health literacy competencies contribute to poorer HIV-related health and CD4 cell count for Hispanic and Black individuals.

Methods—Eighty-one non-Hispanic White, Hispanic, and Black HIV seropositive individuals from a large, Southwestern metropolitan area were administered measures of health literacy, including the Expanded Numeracy Scale (ENS), Newest Vital Sign (NVS), Rapid Estimate of Adult Literacy in Medicine (REALM), the Test of Functional Health Literacy (TOHFLA)-numeracy, and the TOHFLA-reading.

Results—Hispanic and Black individuals demonstrated less HIV knowledge than non-Hispanic White individuals. Black participants demonstrated fewer health literacy-appraisal skills. Importantly, lower levels of health literacy were linked to poorer CD4 cell count, an index of immune functioning for Hispanic and Black individuals and not for non-Hispanic White individuals.

Discussion—These findings suggest race-group differences for health literacy on current CD4 count such that very specific dimensions of low health literacy (e.g., poorer judgment of health-related information) but not other presumed deficits (e.g., motivation, access) play an important role in clinical health outcomes in HIV.

Compliance with Ethical Standards

CONTRIBUTION TO THE LITERATURE

Findings from this study highlight that very specific dimensions of low health literacy (i.e., poorer health-related knowledge and interpretation and judgment of health-related information) may play an important role in the poorer immune health outcomes among Hispanic and Black HIV+ adults. These relationships were not observed for non-Hispanic White HIV+ adults and were independent of education level and comorbid psychiatric problems. Interventions that target both the appraisal and knowledge aspects of health literacy may improve HIV-related health outcomes for Hispanic and Black adults living with HIV.

Conflict of Interest: The authors state that they have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

Keywords

health literacy; HIV; CD4 cell count; multi-ethnic; Black; Hispanic

BACKGROUND

Hispanic and Black adults commonly experience poorer HIV-related health outcomes and increased mortality relative to non-Hispanic White adults^{1,2}. Some posit that Black adults carry the greatest burden of morbidity and mortality across multiple diseases conditions, including HIV/AIDS^{3,4}. The HIV incidence has been estimated at 7 times higher for Black adults and 3 times higher for Hispanic adults compared to non-Hispanic White adults². Black adults are also more vulnerable to opportunistic infections and overall mortality⁵. Though there has been some attention to HIV-related disparities for Hispanic women⁶, relatively few studies have examined disparities in morbidity/mortality that impact Hispanic adults overall. The purpose of the current study was to (1) examine racial/ethnic group differences in functional and critical competencies in a sample of adults living with HIV infection using Sørensen's integrated model of health literacy and (2) test whether specific domains of health literacy are associated with lower CD4 count, a clinical index of HIV disease severity and immune system functioning⁷.

Though some race group differences in health behavior and health outcomes have been attributed to socioeconomic status (SES),⁸ stigma,⁹ and discrimination,^{10,11} there is evidence that low health literacy may also contribute to these health disparities. Health literacy has been broadly defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions¹².” In a nationally representative sample, low health literacy was uniquely associated with presence of chronic illnesses that can in turn impede work, school, and other activities of daily life¹³. Health literacy has been associated with self-efficacy and health behavior in seronegative Hispanic populations¹⁴. In other studies, health literacy is said to account for race group differences in prevalence of advanced stage prostate cancer¹⁵. Baumann (2015) cited reports of health literacy as the silent epidemic, which may be an important aspect of HIV health outcomes among racial/ethnic minorities¹⁶.

THEORETICAL/CONCEPTUAL FRAMEWORK

In this study, we adopted Sørensen et al.'s (2012) comprehensive, theoretically driven model of health literacy to examine health literacy and CD4 cell count for an ethnically diverse sample of HIV+ adults¹⁷. Sørensen's model addresses determinants and outcomes of health literacy that are poorly understood and thus provides a suitable framework for the present study. In the model, health literacy is characterized by two core dimensions—the functional and critical dimensions of health literacy which satisfy different skillsets for interpreting health-related information. The functional dimension refers to fundamental knowledge, competence, and motivation that renders one capable of interpreting information. The critical dimension includes more advanced appraisal, access, understanding, and application of health information. Although both dimensions are subsumed within the same framework,

they predict disparate health behaviors. Functional health literacy has been shown to influence medication adherence¹⁸, glycemic control¹⁹, HIV viral load detection^{20–21}, sleep disturbance²², and physical function²³. Critical health literacy, on the other hand, has been shown to affect comprehension of diabetes care and self-efficacy²⁴, self-care among persons with heart failure²⁵, and self-management of end-stage health²⁶. Race/ethnicity is a key “personal determinant” that is an antecedent to the core dimensions of health literacy, which then in turn affect downstream health behaviors and eventual health outcomes. Thus, understanding the interplay between race/ethnicity and health literacy in association with HIV clinical biomarkers is important.

Though few studies have examined health literacy and HIV-related health for ethnic minority adults, available studies reveal associations primarily for health behavior and the knowledge and access domains of health literacy. Population-level surveys indicate that both Black and Hispanic populations have significantly lower levels of HIV knowledge than non-Hispanic White adults²⁷. Osborn (2007) found that low Rapid Estimate of Adult Literacy in Medicine (REALM) scores, an index of health knowledge, was a mediating factor that accounted for Black Americans being more than twice as likely to be non-adherent to antiretroviral treatment as White peers²⁸. In other studies, numeracy skills, an index of knowledge, accounted for the association between African American ethnicity and poor management of HIV medication²⁹. There are fewer studies that examine HIV-related health literacy and behavior for Hispanic/Latino populations. Where available, studies have examined knowledge as the primary index of health literacy³⁰, though others also emphasized the importance of access to care and language barriers, particularly for immigrant Hispanic individuals^{31, 32}. Together, these studies suggest basic knowledge and access as problem areas in HIV health literacy for Black and Hispanic adults. The present study aimed to test the hypothesis that (1) functional and critical health literacies, as defined by Sørensen’s (2012) integrated model, vary for Black, Hispanic, and non-Hispanic White adults and that (2) lower functional and critical health literacy competencies are associated with lower CD4 cell count for Black and Hispanic relative to non-Hispanic White adults.

METHODS

Participants

The sample included 81 subjects with HIV infection as determined by an ELISA with Western blot confirmation or a point-of-care test (MedMira Inc., Nova Scotia, Canada). Study exclusion criteria were severe mental illness (e.g., psychosis), active substance use disorders, and non-HIV-related neuromedical disorders that might affect cognitive functions (e.g., seizures, stroke). Participants completed a full neuroAIDS research evaluation³³ that included a comprehensive battery of self-report and performance-based health literacy measures.

Data Collection

This study was reviewed and approved by the University of California, San Diego Human Research Protections Program board and all participants provided written, informed consent. Participants were recruited via flyers, provider referrals, word-of-mouth, and snowball

sampling from the general San Diego area, community-based HIV and LGBT organizations, and local HIV clinics from 2010-2013. The racial/ethnic distribution of the 3 study samples that was 55.6% White is consistent with the epidemiology of HIV disease in San Diego³⁴, but is higher than the (25-30%) current national estimates³⁵.

Measures

We assessed the knowledge domain of health literacy via a composite score for the HIV Knowledge Questionnaire³⁶, Expanded Numeracy Scale³⁷, and Rapid Estimate of Adult Literacy in Medicine (REALM)³⁸. Competence was determined as a composite of the Beliefs Related to Medication Adherence (BERMA)³⁹ and Perceived HIV Self-management Scale⁴⁰ while motivation was appraised using the Health Motivation Questionnaire⁴¹. The access domain of health literacy was measured using the participant's socioeconomic status (SES) by means of insurance/disability status. Understanding was determined by a composite score for the Test of Functional Health Literacy in Adults (TOHFLA)-numeracy⁴², TOHFLA-reading comprehension⁴², Single Item Literacy Screener⁴³, 3-Brief Screening Questions (SQ)⁴⁴, and the Short Assessment of Health Literacy (SAHL)⁴⁵. Appraisal was measured using the Newest Vital Sign (NVS)⁴⁶ and the application competency of health literacy was calculated using scores from the Decisional Conflict Scale and University of California-San Diego Brief Assessment for Capacity to Consent-Treatment version (U-BACCT)⁴⁷. See table 1 for a complete list of measures.

STATISTICAL ANALYSES RESULTS

A two-tailed critical alpha of .05 was used for all analyses, which were conducted in JMP Software (12.1.0). The convenience sample of 81 participants included 18 Hispanic (22%), 18 Black (22%) and 45 non-Hispanic White (56%) adults. A series of one-way ANOVAs (or chi-square tests for categorical data) showed that they were comparable in age ($M^1=45\pm10$ yrs), education ($M=14\pm2$ yrs), estimated verbal IQ, mood and substance use disorders, and hepatitis C co-infection (all $p>.10$). The study samples differed in the representation of women ($p<.05$) with the Hispanic sample being exclusively male. The proportion of participants with current immunosuppression (i.e., CD4 cell counts < 200 cells/ μ L) was significantly higher in the Hispanic (18%) and Black (12%) samples as compared to the non-Hispanic White sample (0%) ($p<.05$). The study groups did not differ in AIDS status⁴⁸, viral load, or antiretroviral therapy ($p>.10$). Detailed description of demographic, psychiatric, and HIV characteristics are presented in Table 2. We first conducted a mixed model ANOVA to examine the association between race/ethnicity (fixed, between-subjects factor) and health literacy composite scores (within-subjects factor), while controlling for sex. Results revealed no significant main effects of race/ethnicity ($F=1.5$, $p=.23$), health literacy ($F=1.3$, $p=.285$), or sex ($F=1.3$, $p=.178$). Moreover, there was no interaction between sex and health literacy ($F=1.1$, $p=.36$). However, there was a significant interaction between race/ethnicity and health literacy ($F=2.2$, $p=.02$). Post-hoc multiple linear regressions also controlling for sex showed significant effects of race/ethnicity on knowledge (adj $R^2 = .09$, $p=.026$) with both Hispanic participants performing lower than non-Hispanic White participants (estimate = -0.41 [-0.80 , -0.02], $p=.04$) and Black participants performing lower than non-Hispanic White participants (estimate = -0.47

[-0.87, -0.08], $p=.02$). Significant effects of race/ethnicity were also observed for appraisal (adj $R^2 = .16$, $p=.01$) with Black participants performing lower than non-Hispanic White participants (estimate = -0.91 [-1.43, -0.38], $p=.01$). Data for these analyses are displayed in Figure 1.

Next we used Spearman's rho to examine the correlations between health literacy and current CD4 count in the different race/ethnicity groups (see Figure 2). Findings revealed moderate and significant positive correlations between CD4 count and both knowledge ($\rho=.48$, $p<.05$) and appraisal ($\rho=.55$, $p=.02$) in the Black participants. A similar pattern of results emerged in the Hispanic group, with moderate and significant positive correlations between CD4 count and both knowledge ($\rho=.50$, $p=.04$) and appraisal ($\rho=.51$, $p=.04$). However, in the non-Hispanic White group, there was virtually no association between CD4 count and either knowledge ($\rho=.00$, $p=.95$) or appraisal ($\rho=.00$, $p<.99$).

DISCUSSION

Health literacy is an important determinant of health outcomes among persons living with HIV disease, yet we know little about the moderating role of race and ethnicity in the expression and clinical impact of lower health literacy in this vulnerable population. The present study used aspects of Sørensen's integrated model of health literacy to demonstrate racial and ethnic group differences in particular health literacy competencies among a well-characterized sample of adults living with HIV infection. As compared to non-Hispanic White persons, both Hispanic and Black HIV+ persons demonstrated less conceptual HIV knowledge and also more errors in interpreting health-related information compared to White HIV+ persons. Importantly, the observed race/ethnicity effects were of a moderate magnitude and independent of education and comorbid conditions. No differences were observed for other aspects of health literacy, including motivation, access, and application. Thus, the lower health literacy knowledge and appraisal health literacy functioning appear to have some degree of both sensitivity (i.e., detectability) and specificity (i.e., they are not simply an artifact of a global health literacy decrement).¹⁴

Our data suggest that these race/ethnic group differences in health literacy also have some clinical relevance. Specifically, lower scores on both knowledge and appraisal were associated with lower current CD4 cell counts in Black and Hispanic HIV+ adults. However, these same associations were non-existent in the non-Hispanic White adults. Thus there appears to be a particular immune vulnerability to low health literacy in Black and Hispanic HIV+ persons that is not apparent among non-Hispanic White persons. Such findings raise questions about the role of potential mediating and moderating factors, including medication management skills, Antiretroviral (ARV) adherence, acculturation, retention in HIV care, and health beliefs (including beliefs that one is resistant to disease-related morbidity/mortality). Specific research efforts are warranted for HIV+ adults who demonstrate limited English proficiency given greater risks for low health literacy⁴⁹.

Of course, the findings from this study should be interpreted with consideration of its methodological limitations. Most notably, our samples of Black and Hispanic adults were relatively small, which may have increased our Type II error risk for detecting problems in

other aspects of health literacy. Despite these small sample sizes, we observed moderate group-level effects of two aspects of health literacy and within-group correlations with current CD4 count. Future studies with larger sample sizes are needed to replicate these findings and to examine the role of modulating factors. Another limitation of this study was that we did not measure all aspects of Sørensen's health literacy model, which is very complex and comprehensive. As an example, healthcare access differs, regionally, with southern states reporting poorer overall health outcomes compared to others⁵⁰. Sørensen's health literacy model may in fact serve as a guide for future work to determine modulating factors. Finally, we used only a single indicator of immune function, CD4 count. Future studies may wish to explore these relationships using more detailed, sensitive, and specific biomarkers.

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Fig. 1. Box and whisker plots displaying the scores of the Black, Hispanic, and non-Hispanic White participants on health literacy measures of knowledge and appraisal.

Fig. 2.

Scatter plots for z-scores on health literacy measures of knowledge and appraisal in association with CD4 cell counts by Race/Ethnicity.

Table 1**Measures of Functional and Critical Competencies**

Functional Competencies	
Specific Competency	Measure
Knowledge	HIV-Knowledge Expanded Numeracy REALM
Competence	BERMA Perceived HIV Self-Management Scale
Motivation	Health Motivation Questionnaire
Critical Competencies	
Understand	TOHFLA-numeracy TOHFLA-reading comprehension Single Item Literacy screener 3-Brief Screening questions Short Assessment of Health Literacy
Appraise	NVS
Apply	Decisional Conflict Scale UCSD BACCT
Access	SES/Insurance or disability status

Note. HIV-Knowledge=18 item HIV knowledge Questionnaire; REALM=Rapid Estimate of Adult Literacy in Medicine; BERMA=Beliefs Related to Medication Adherence; TOHFLA=Test of Functional Health Literacy in Adults; NVS=Newest Vital Sign; UCSD BACCT=University of California-San Diego Brief Assessment for Capacity to Consent-Treatment version.

Table 2

Demographic, Psychiatric and HIV Characteristics

Variable	Black (n = 18)	Hispanic (n = 18)	Non-Hispanic White (n = 45)	p	Group differences
Demographic characteristics					
Age (years)	44.06 (11.33)	41.56 (0.90)	47.09 (8.41)	0.11	
Education (years)	12.61 (1.72)	14.00 (2.28)	13.73 (2.70)	0.17	
% College graduate	11.1	33.3	33.3	0.18	
Gender (% female)	27.78	0.00	8.89	0.02	B>W>H
Income level (% <\$25K)	72.22	72.22	48.89	0.20	
Mean Provider satisfaction (SD)	91.9 (14.2)	88.6 (16.9)	93.3 (13.4)		
Psychiatric and substance abuse variables					
Current MDD (% yes)	5.56	5.56	2.38	0.77	
Lifetime MDD (% yes)	44.44	55.56	70.45	0.14	
Lifetime anxiety disorder (% yes)	5.88	0.00	20.45	0.06	
Lifetime any	70.59	55.56	68.18	0.57	
Substance Use					
Disorder (% yes)					
Medical/HIV disease characteristics					
HAND (% yes)	55.56	55.55	37.78	0.34	
Nadir CD4 count (cells/ μ L)	203.24 (246.37)	210.00 (211.46)	285.48 (223.25)	0.19	
Duration of HIV infection (years)	15.97 (8.03)	8.58 (7.62)	12.80 (9.44)	0.05	
AIDS status (% yes)	58.82	50.00	48.89	0.78	
Plasma viral load (% ≤ 50)	72.22	81.25	91.11	0.15	
Any ARV (% prescribed)	100.00	81.25	88.64	0.56	
ARV naïve	0.00	12.50	6.82	0.56	
HCV (% yes)	0	11.8	13.6	0.28	
CVD (% yes)	50	38.9	48.9	.74	

Note.

^aB = Black; H = Hispanic; W = non-Hispanic White. Provider satisfaction = Beliefs Related to Medication Adherence (BERMA)-Dealing with Health Professionals subscale²⁹. MDD = Major Depressive Disorder, diagnosed with the Composite International Diagnostic Inventory. HAND = HIV-associated Neurocognitive Disorder, diagnosed with a comprehensive clinical battery (see Woods et al., 2016). AIDS = Acquired Immune Deficiency Syndrome. ARV = Antiretroviral. HCV = Hepatitis C Virus. CVD = Cardiovascular disease.

Between-group differences are based on either ANOVA for continuous variables or chi-square test for categorical variables.

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