



The Association Between Health Literacy and Diet Adherence Among Primary Care Patients with Hypertension

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Abstract

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Keywords

health Literacy; hypertension; low-salt diet; self-management; black Americans; primary care

Cover Page Footnote

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ABSTRACT

This study examines the association between health literacy and adherence to low-salt diet practices among individuals with hypertension. Health literacy is the ability of individuals to understand and utilize health information. We surveyed 238 patients with hypertension from a primary care clinic in Charlotte, NC. We assessed health literacy and self-reported low-salt diet. Logistic regression was used to model the relationship between health literacy and low-salt diet adherence. Respondents were primarily female (67.3%) and black (80%). Black Americans were less likely to have adequate health literacy as compared to white Americans (21.8% vs. 55.8%). The study found no association between adequate health literacy and adherence to a low-salt diet (OR = 1.06, 95% CI: 0.36-3.10) after adjusting for confounders. This study addresses the conflicting findings for health literacy in two related areas: chronic illness self-care, and nutrition/diet skills. Additional research is warranted among black Americans given their increased risk of hypertension, low rates of diet adherence and previous findings of positive associations between health literacy and nutrition skills.

Keywords: health Literacy, hypertension, low-salt diet, self-management, black Americans, primary care.

INTRODUCTION

Hypertension is the most prevalent chronic condition affecting US adults with one-third of US adults (over age 20) diagnosed with hypertension; however over half of these adults do not have their blood pressure controlled (systolic BP < 140 mm Hg and diastolic BP < 90 mm Hg) (Centers for Disease Control and Prevention, 2011). In particular, black Americans have a significantly higher prevalence of hypertension than white Americans (45.2% vs. 29.1%) (Fryar, Hirsch, Eberhardt, Yoon, & Wright, 2010), and are less likely to have their blood pressure under control (Howard et al., 2006). In order to control blood pressure the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7) recommends six self-care practices: maintenance of a healthy diet with reduced sodium intake; adherence to an antihypertensive medication program; regular engagement in physical activity; maintenance of normal body weight; cessation of tobacco use; and limited alcohol consumption (U.S. Department of Health & Human Services, 2004). A randomized clinical trial of individuals with above optimal blood pressure found that the adoption of a comprehensive lifestyle modification program was effective in lowering blood pressure (Appel et al., 2003).

The diet described in the JNC7 recommendation is commonly referred to as the DASH diet (based on the Dietary Approaches to Stop Hypertension study) (U.S. Department of Health & Human Services, 2004). The DASH diet emphasizes eating a low-salt diet combined with increased consumption of fruits and vegetables, low-fat dairy foods, whole grains, poultry, fish, and nuts, combined with minimal consumption of red meat, sweets, and foods with a high sugar content (Sacks et al., 2001). In a clinical trial examining the benefits of the DASH diet among individuals with untreated blood pressure, the DASH diet was successful in lowering blood pressure (Appel et al., 1997; Conlin et al., 2000; Svetkey, Simons-Morton, Vollmer, & et al., 1999). Conlin et al (2000) found that the relative risk of hypertension for participants on the DASH diet was 60% lower than participants in the control group. Reductions in sodium intake can also have positive effects for hypertensive patients even without altering other nutritional components suggested in the DASH diet (Bray et al., 2004; Sacks et al., 2001). The combined effects on lowering blood pressure by adhering to both a low sodium diet and the DASH diet, although not additive, have been found to be greater than each diet alone (Sacks et al., 2001).

These diets are not the norm in American society. The average American consumes 3300 mg of sodium daily, considerably above the recommended level of 1500 mg (CDC, 2012). Similarly the average American diet contains over 30% of calories from fat (Wright & Wang, 2010) versus the 10% recommended in Dietary Guidelines for Americans (U.S. Department of Agriculture & U.S. Department of Health & Human Services). In later studies examining DASH diet adherence, participants who were not given prepared, prepackaged food servings that were low-sodium, but were self-directed and self-controlled, had low adherence to the DASH requirements (Appel et al., 2003; Folsom, Parker, & Harnack, 2007). Very high concordance with the DASH diet may be required to

realize positive effects on blood pressure levels (Folsom et al., 2007). These studies suggest that primary and secondary prevention of hypertension through diet may be difficult to achieve within the larger population. Black Americans are less likely to maintain a low-sodium, DASH diet than white Americans (Epstein et al., 2012; Mellen, Gao, Vitolins, & Goff, 2008). Differences in food preferences, preparation and traditions, as a result of cultural influences, may require black Americans to make more significant dietary changes to effectively adopt a low sodium, DASH diet (Satia, 2009).

The multitude of lifestyle adjustments required to lower blood pressure such as diet adherence, weight-loss and regular physical activity add to the complexity of managing a chronic condition and increase the risk of non-adherence. One factor that may contribute to self-management of hypertension is an individual's level of health literacy. Health literacy is the ability for individuals to "...obtain, process and understand basic health information and services..." and utilize the information to make health related decisions (Institute of Medicine Committee on Health Literacy, 2004). Thus, health literacy is knowledge applied to the issues of maintaining or achieving good health. Health literacy includes multiple domains such as reading comprehension, oral comprehension, numeracy skills, as well as understanding of civic and cultural concepts (Zarcadoolas, Pleasant, & Greer, 2005). Higher levels of health literacy could increase an individual's understanding of hypertension, what is required to lower blood pressure, as well as assist in interpreting information needed to manage hypertension such as nutritional facts to modify diet.

Health literacy has been positively associated with knowledge of chronic disease (Gazmararian, Williams, Peel, & Baker, 2003; Pandit et al., 2009; Williams, Baker, Parker, & Nurss, 1998). However, there is mixed evidence that health literacy is associated with adherence to the self-care practices necessary for managing chronic disease. The research examining health literacy and self-care for chronic disease focuses largely on diabetes self-care practices. Self-care practices for diabetes are similar to hypertension self-care activities and include diet and medication adherence, regular exercise, smoking cessation, as well as foot care and regular blood glucose testing (Osborn, Bains, & Egede, 2010). Among studies conducted with individuals with diabetes, several reported no association between health literacy and adherence to diabetes self-care activities (Bains & Egede, 2011; Cavanaugh et al., 2008; Osborn et al., 2010; Shigaki et al., 2010). Another study found that patients with low health literacy reported greater adherence to self-care practices (diet, self-glucose monitoring and foot-care) than patients with adequate health literacy (Kim, Love, Quistberg, & Shea, 2004).

In examining health literacy and chronic disease self-care, it has been hypothesized that numeracy skills may be especially pertinent. Numeracy involves a multitude of skills such as basic math functions, measurement, probability, problem solving and knowledge of what operation function to utilize (Rothman, Montori, Cherrington, & Pignone, 2008). Thus, numeracy literacy relates to an individual's ability to interpret, manipulate and comprehend numbers in daily life settings (Rothman et al., 2006). For individuals with chronic illnesses

the ability to work with and understand numbers is of even greater importance. Hypertensive individuals require knowledge of blood pressure levels, while diabetics may need to understand how to titrate insulin based on blood sugar levels. In addition, diet modifications are necessary for many chronic diseases. When making diet changes, individuals may have to substitute foods, be able to calculate calories and total sodium intake based on number of servings consumed, modify recipes, and use information from nutrition labels to alter their diet practices. All these actions require a knowledge and comfort with numbers and their properties, making numeracy literacy essential for individuals managing a chronic illness.

The association between numeracy health literacy and nutrition skills and/or diet adherence has been positive (Huizinga et al., 2009; Rothman et al., 2006; Zoellner et al., 2011). One study found that a one point increase in numeracy health literacy score was associated with a 21% increase in Health Eating Index score, a measure of the conformance of an individual's diet with US Federal dietary guidelines (Zoellner et al., 2011). The same study found a positive association between numeracy health literacy and healthy consumption of fruits and vegetables (Zoellner et al., 2011). Numeracy literacy has also been associated with better comprehension of food nutrition labels (Rothman et al., 2006). Finally participants with higher health literacy had 2.5 times increased odds of being able to estimate a single serving size as compared to those with low literacy (Huizinga et al., 2009). Black Americans have been found to have lower numeracy skills, and lower comprehension of nutrition labels (Gans, Burkholder, Risica, & Lasater, 2003; Papakonstantinou, Hargrove, Huang, Crawley, & Canolty, 2002; Rothman et al., 2006).

The above studies lend support to the idea that health literacy could aid in adhering to a diet designed to lower blood pressure. Currently no studies have examined the relationship between health literacy and adherence to a low-salt and/or DASH diet. The purpose of this study is to examine the association between health literacy, and adherence to diet practices that emphasize low-sodium intake and increased consumption of fruits and vegetables and low-fat foods (consistent with the DASH diet) among individuals with hypertension.

METHODS

Study design

The study was a cross-sectional study conducted at an outpatient primary care clinic from September 2011 to March 2012. The clinic patient population is 65% black, and primarily dependent on public insurance (61% Medicare/Medicaid). The study determined health literacy and self-reported hypertension self-care behaviors including a DASH-consistent diet among patients being treated for high blood pressure.

Study recruitment

Study staff recruited patients from the clinic waiting room. Eligible respondents were informed about the study using a waiver of consent and a waiver of authorization for research staff to extract blood pressure and other

health data from patients' electronic medical records. This consent process was approved by the hospital Institutional Review Board as well as the UNC Charlotte Office of Protection for Research Subjects. Research staff reviewed the information with potential respondents and the waiver content sheet was given to them to keep. Patients who agreed to participate were considered to have given consent. Study staff were available to assist patients if they had questions while completing the survey. A total of 238 patients completed surveys.

Study inclusion and exclusion criteria

Eligible participants were diagnosed with high blood pressure, had been prescribed hypertensive medications, and were at least 21 years old. The diagnosis of hypertension and medication prescription was validated from the patient's medical chart. Individuals who were accompanying patients and not seeing a provider themselves that day were not eligible. Other persons who were ineligible include patients who did not speak English, or were at the clinic for some other reason such that their blood pressure would not be taken (for example, picking up forms).

Measures

Data for this study were collected using an original self-administered survey and medical record abstraction. The six JNC7 prescribed hypertension self-care activities were assessed using the H-SCALE (Hypertension Self-Care Activity Level Effects), which was specifically designed for this purpose. The H-SCALE, its items and properties, have been previously described (Warren-Findlow & Seymour, 2011). Trained research assistants (one undergraduate, four master's and one doctoral student who were majoring in Public Health) recruited participants and collected data. After the surveys were completed, one research assistant accessed patient medical records and abstracted information related to demographics and other health conditions. No personal identifiers were on the surveys once the clinical data had been recorded.

Exposure variable

The exposure of health literacy was assessed using a six item scale, the Newest Vital Sign (NVS). The NVS was designed to measure health literacy with a focus on numeracy literacy. It was intended for use in clinical settings (Weiss et al., 2005). Respondents answer reading and computational questions based on an ice cream food label. Scores range from 0 to 6. Respondents scoring a 4 or above on the NVS were classified as having adequate health literacy. Internal consistency with this sample for the measure was good ($\alpha = .84$).

Outcome variables

Diet adherence was measured using a twelve item scale that assessed nutrition practices based on a low salt, DASH diet (hereafter low-salt plus diet) (Warren-Findlow & Seymour, 2011). Of the twelve items, nine were related to consumption of sodium, such as avoiding salt while cooking and eating, and avoiding foods high in salt content. The remaining three items address following a healthy diet, consuming five fruits and vegetables daily, and avoiding fatty foods. Nine of the items were negatively phrased; these items were reverse coded. A mean score was calculated and participants who followed low-salt plus

diet practices on 6 out of 7 days were considered adherent, consistent with studies suggesting a high congruence with diet recommendations is required to realize a reduction in blood pressure (Folsom et al., 2007). Internal consistency for this scale was adequate ($\alpha = .67$).

Covariates

We assessed the other JNC7 recommended hypertension self-care behaviors as well as patients' self-reported health. To assess medication adherence, three items related to the number of days in the past week that an individual 1) takes blood pressure medication, 2) takes it at the same time every day, and 3) takes the recommended dosage were used. Responses were summed and participants reporting that they followed these 3 recommendations on 7 out of 7 days were considered adherent. Internal consistency for this scale was adequate ($\alpha = .77$).

Physical activity was assessed with two items. "How many of the past 7 days did you do at least 30 minutes total of physical activity?" and "How many of the past 7 days did you do a specific exercise activity (such as swimming, walking or biking) other than what you do around the house or as part of your work?" Responses were summed (range 0-14). Participants who scored an 8 or better were coded as adhering to physical activity recommendations. We established this criterion to ensure that participants had to engage in a combination of frequency and duration of activity and intensity of activity, in order to meet or exceed the minimum requirements of 150 minutes per week of moderate physical activity (Chodzko-Zajko et al., 2009). Internal consistency was adequate ($\alpha = .77$).

Exposure to tobacco smoke was assessed with two items: "How many of the past 7 days did you smoke a cigarette or cigar, even just one puff?" and "How many of the past 7 days did you stay in a room or ride in an enclosed vehicle while someone was smoking?" Responses ranged from 0 to 7 days. Respondents who reported zero days for both items were considered a nonsmoker. Internal consistency was adequate ($\alpha = .78$).

Alcohol intake was assessed using the National Institute on Alcohol Abuse and Alcoholism (NIAAA) Quantity and Frequency Questionnaire (National Institute on Alcohol Abuse and Alcoholism). For these analyses, adherence was deemed to be alcohol abstinent. Participants who reported not drinking any alcohol in the last 7 days or who indicated that they did not drink alcohol were considered abstainers. Internal consistency of the scale was good ($\alpha = .88$).

Adherence to weight management was assessed with ten items to determine dietary practices such as cutting portion size and making food substitutions as well as exercising with the specific intention to lose weight. Items were assessed based on recall of activities over the last 30 days. Using a 5-point Likert scale, participants who reported that they agreed or strongly agreed with all 10 items were considered adherent to weight management practices. Internal consistency of the scale was good ($\alpha = .86$).

Self-rating of health was assessed with responses ranging from excellent (5) to poor (1). Participants who reported good to excellent health were considered to have good self-rated health.

The study also abstracted information on a number of potential confounders from participants' medical charts including: age, gender, race, as well as health-related variables (systolic and diastolic blood pressure, total cholesterol, and the absence or presence of diabetes, high cholesterol and heart disease). We also recorded whether patients had experienced an acute cardiovascular event such as stroke, heart attack or the need for kidney dialysis. These acute events were determined based on the International Classifications of Diseases (ICD-9) codes. Clinical measures were abstracted for the date of the survey or the most recent visit prior to the survey date. Body mass index was calculated from the most recently recorded weight and height (in pounds and inches, respectively). Following conventional guidelines, (National Institutes of Health, 1998) patients were categorized as obese (BMI \geq 30.0) or non-obese (BMI < 30.0).

Statistical analyses

Frequencies and percentages were calculated for demographic, health characteristics, health literacy and participants' adherence to the hypertension self-care activities. Logistic regression was performed to obtain unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) to examine the crude association between health literacy and low-salt diet plus adherence, and to identify other factors associated with the self-care outcome. Multivariate logistic regression was used to further explore the relationship between health literacy and low-salt plus diet adherence. A variable was considered to be a confounder of the association between good health literacy and low-salt diet plus adherence if it changed the OR by at least 10%. For variables that were missing 5% or more of the responses, we created a dummy variable to represent the missing responses and then tested the dummy variable as a confounder; neither of these dummy variables (for obesity and medication adherence) were confounders. For the association between adequate health literacy and low-salt diet plus adherence, race, obesity, heart disease, alcohol abstinence and medication adherence were identified as confounders. All analyses were conducted using SPSS v. 17 and statistical significance was set at $p \leq .05$.

Response rate

Study staff approached 965 individuals. Of these, some indicated that they were not a patient (n=105) or they did not speak English (n=19). Among patients, some were unwilling to take a survey (n=139), or they had already been approached or had previously completed the survey during the data collection period (n=40). Of the remaining 662 individuals approached, 47.9% had hypertension and ultimately 250 patients met the other eligibility criteria and took a survey. Of these, 238 completed surveys were returned for analysis. We excluded responses from respondents who were of race/ethnicities other than white or black (n=4) and respondents who did not complete the NVS or the diet items (n=35). The sample for analysis was 199 participants.

RESULTS

The overall demographics and health characteristics for the sample are presented in Table 1. Over two-thirds of the respondents were female, and nearly

80% were black. The age ranged from 30 to 85, with an average age of 55 years. Based on BMI, almost 60% were obese. In addition to being hypertensive, a majority of the participants had high cholesterol. Only 14% of the participants adhered to the low-salt plus diet. Participants reported high rates of avoiding tobacco and tobacco smoke (70.4%) and alcohol abstention (65.3%) but low adherence rates for weight management practices and physical activity (35.2% and 39.2%, respectively). About half reported being adherent to antihypertensive medications. The majority rated their health as good to excellent. Over 70% of the respondents had inadequate health literacy. The mean score on the NVS for the sample was 2.27 (highest possible score is 6; data not shown).

Differences between black and white individuals were primarily significant within the self-care practices categories. As compared to white Americans, black Americans were less likely to adhere to the low-salt plus diet (8.3% vs. 34.9%), medication regimes (50.0% vs. 82.1%), and not smoking (68.0% vs. 85.7%), but were more likely to adhere to alcohol abstinence (71.4% vs. 46.5%). Blacks were also less likely to have adequate health literacy with only 21.8% of the black Americans scoring 4 or better on the NVS as compared to 55.8% of white Americans.

Table 1 Demographic and health characteristics of primary care patients with hypertension by race (n=199)

Characteristics	Black		White		Total	
	n	%	n	%	n	%
Demographics						
Gender						
Female	117	(75.0)	17	(39.5)	134	(67.3)
Male	39	(25.0)	26	(60.5)	65	(32.7)
Total	156		43		199	
Average age – mean (sd)	53.8	(± 10.7)	61.1	(± 11.7)	55	(± 11.3)
Obese *						
Yes	98	(62.8)	21	(48.8)	119	(59.8)
No	48	(30.8)	19	(44.3)	67	(33.7)
Missing	10	(6.4)	3	(7.0)	13	(6.5)
Blood pressure						
Systolic – mean (sd)	134.1	(± 19.6)	128.2	(± 17.4)	132.8	(± 19.3)
Diastolic – mean (sd)	82.8	(± 12.6)	76.0	(± 14.0)	81.4	(± 13.2)
Co-morbidities/Acute events						
Diabetes*						
Yes	59	(37.8)	9	(20.9)	68	(34.2)
No	97	(62.2)	34	(79.1)	131	(65.8)
High cholesterol						
Yes	92	(59.0)	25	(58.1)	117	(58.8)
No	63	(40.4)	16	(37.2)	79	(39.7)

Missing	1	(0.6)	2	(4.7)	3	(1.5)
Heart disease						
Yes	18	(11.5)	8	(18.6)	26	(13.1)
No	137	(87.8)	33	(76.7)	170	(85.4)
Missing	1	(0.6)	2	(4.7)	3	(1.5)
Kidney dialysis						
Yes	9	(5.8)	1	(2.3)	10	(5.0)
No	146	(93.6)	41	(95.3)	187	(94.0)
Missing	1	(0.6)	1	(2.3)	2	(1.0)
Stroke						
Yes	5	(3.2)	3	(7.0)	8	(4.0)
No	150	(96.2)	40	(93.0)	190	(95.5)
Missing	1	(0.6)	0	(0.0)	1	(0.5)
Self-care practices						
Low-salt plus diet adherence*						
Yes	13	(8.3)	15	(34.9)	28	(14.1)
No	143	(91.7)	28	(65.1)	171	(85.9)
Medication adherence *						
Yes	73	(46.8)	32	(74.4)	105	(52.8)
No	73	(46.8)	7	(16.3)	80	(40.2)
Missing	10	(6.4)	4	(9.3)	14	(7.0)
Physical activity adherence						
Yes	59	(37.8)	19	(44.2)	78	(39.2)
No	92	(59.0)	23	(53.5)	115	(57.8)
Missing	5	(3.2)	1	(2.3)	6	(3.0)
Alcohol abstinence*						
Yes	110	(70.5)	20	(46.5)	130	(65.3)
No	44	(28.2)	23	(53.5)	67	(34.0)
Missing	2	(1.3)	0	(0.0)	2	(1.0)
Weight management						
Yes	50	(32.1)	20	(46.5)	70	(35.2)
No	105	(67.3)	22	(51.2)	127	(63.8)
Missing	1	(0.6)	1	(2.3)	2	(1.0)
Non-smoker*						
Yes	104	(66.7)	36	(83.7)	140	(70.4)
No	49	(31.4)	6	(13.9)	55	(27.6)
Missing	3	(1.9)	1	(2.3)	4	(2.0)
Good self-rated health						
Yes	90	(57.7)	30	(69.8)	120	(60.3)
No	59	(37.8)	13	(30.2)	72	(36.2)
Missing	7	(4.5)	0	(0.0)	7	(3.5)
Adequate health literacy						
*						

Yes	34	(21.8)	24	(55.8)	58	(29.1)
No	122	(78.2)	19	(44.2)	141	(70.9)

* Indicates that differences between black and white individuals were significant based on a $p < 0.05$.

Bivariate results are presented in Table 2. In unadjusted analyses black participants had significantly reduced odds of being adherent to a low-salt plus diet (OR = 0.17, 95% CI: 0.07-0.40) as compared to white participants. No other chronic conditions or acute events were associated with diet adherence. Two of the hypertension self-care behaviors had strong associations with adherence to a low-salt plus diet, and were statistically significant. Participants who were adherent to medication had almost four times the odds of adhering to a low-salt plus diet (OR = 3.75, 95% CI: 1.35-10.44) as compared to patients who did not adhere to medication. Participants who were compliant with weight management activities had 4.5 times the odds of adhering to a low-salt plus diet (OR = 4.54, 95% CI: 1.91-10.77) as compared to those who did not comply with weight management activities.

Table 2 Unadjusted odds ratios (OR) and 95% confidence intervals (CI) for the association between demographic and health characteristics and low-salt plus diet adherence

	Diet adherence OR (95% CI)
Demographics	
Gender	
Female	1.25 (0.52, 3.01)
Male	Referent
Race	
Black	0.17 (0.07, 0.40)
White	Referent
Age	
>65	1.60 (0.44, 5.78)
45 - 64	1.75 (0.40, 7.66)
0 - 44	Referent
Obese	
Yes	0.46 (0.20, 1.06)
No	Referent
Blood pressure	
Systolic	1.00 (0.99, 1.03)
Diastolic	1.00 (0.97, 1.03)
Co-morbidities/Acute events	
Diabetes	
Yes	0.60 (0.24, 1.50)
No	Referent

High cholesterol	
Yes	1.26 (0.55, 2.88)
No	Referent
Heart disease	
Yes	1.52 (0.52, 4.44)
No	Referent
Kidney dialysis	
Yes	2.78 (0.67, 11.45)
No	Referent
Stroke	
Yes	2.10 (0.40, 10.98)
No	Referent
Self-care practices	
Medication adherence	
Yes	3.75 (1.35, 10.44)
No	Referent
Physical activity adherence	
Yes	2.22 (0.98, 4.99)
No	Referent
Alcohol abstinence	
Yes	1.10 (0.47, 2.59)
No	Referent
Weight management	
Yes	4.54 (1.91, 10.77)
No	Referent
Non-smoker	
Yes	1.52 (0.58, 3.99)
No	Referent
Self-rated health	
Good or better	1.97 (0.79, 4.90)
Poor	Referent
Health literacy	
Adequate	1.18 (0.50, 2.79)
Poor	Referent

Table 3 Adjusted odds ratios (OR) and 95% confidence intervals (CI) for the association between adequate health literacy and low-salt plus diet adherence

	Adjusted* OR (95% CI)
Health literacy	
Adequate	1.06 (0.36, 3.10)
Poor	Referent

* Adjusted for race, obesity, heart disease, alcohol abstinence and medication adherence.

In unadjusted analyses, participants with adequate health literacy had 18% increased odds of adhering to the low-salt plus diet as compared to those with inadequate health literacy (OR = 1.18, 95% CI: 0.50-2.79), but results were not statistically significant. After adjusting for confounders (race, obesity, heart disease, alcohol abstinence, and medication adherence; see Table 3) the association between adequate health literacy and low-salt plus diet adherence was attenuated. Participants with adequate health literacy had a 6% increased odds of adherence (OR = 1.06, 95% CI: 0.36-3.10), but the relationship remained non-significant.

DISCUSSION

This study found no association between adequate health literacy and adherence to a low-salt plus, or DASH, diet among primary care patients with hypertension. The findings are consistent with other studies that have examined the association between health literacy and diabetes self-care activities, which included diet (Bains & Egede, 2011; Cavanaugh et al., 2008; Osborn et al., 2010; Shigaki et al., 2010). However, those studies used health literacy measures that focused more on reading comprehension rather than numeracy. Our findings are inconsistent with studies that examined numeracy literacy and its association with more generic nutrition and diet-related skills, (Huizinga et al., 2009; Rothman et al., 2006; Zoellner et al., 2011) including one study which also used NVS to assess numeracy literacy (Zoellner et al., 2011). The NVS survey, while measuring overall health literacy, primarily focuses on numeracy skills. Of the six questions on the NVS, four items require the identification of appropriate numerical information, the ability to problem solve and use of basic math skills (Weiss et al., 2005). The inconsistency in outcomes from the differing types of literacy measures suggests, that within the context of chronic illness, a more specific health literacy measure may be required to assess the skills for adhering to a disease-specific diet; thus additional research related to scale development is required in order to fully understand the effects of numeracy literacy on self-care habits with hypertensive individuals and/or others with chronic diseases.

Less than 30% of our sample had an adequate health literacy rate. The adequate health literacy rate in our study is on the low end compared to other studies utilizing the NVS with samples consisting of majority black Americans (26%- 63.4%) (VanGeest, Welch, & Weiner, 2010; Wood, Price, Dake, Telljohann, & Khunder, 2010; Zoellner et al., 2011). This sample also reported a lower rate of adherence to a low-salt plus diet as compared to a recent study among black Americans (14.1% versus 22% adherence to a low-salt plus diet) (Warren-Findlow & Seymour, 2011). The current study used the H-SCALE as a self-administered questionnaire (SAQ) rather than a face-to-face interview format as in the previous study. Previous participants may have responded with more socially acceptable responses resulting in higher levels of reported adherence. In

addition, our criterion of adhering to the low-salt plus diet for six out of seven days may appear stringent, but earlier studies indicate the necessity of strict adherence to diet to realize the benefits for hypertensive patients (Folsom et al., 2007). The low rates of adherence emphasize the need for a better understanding of the barriers to maintaining a low-salt, DASH diet for hypertensive individuals.

Results from this study confirm existing findings in terms of black Americans having greater difficulty adhering to DASH diets (Epstein et al., 2012; Mellen et al., 2008), and lower health literacy rates than white Americans (Rothman et al., 2006). This study indicated that black Americans were over 80% less likely to adhere to a low-salt plus diet, and were less likely to have adequate health literacy than white Americans. Given the prevalence of hypertension among black Americans, further examination of the association of numeracy literacy and adherence to a low-salt plus diet within black American populations is warranted.

This study emphasizes the need to gain better understanding of how to aid black Americans in diet adherence, not only for blood pressure control but also as they frequently experience other co-morbid conditions that could benefit from improved diet. Thus assessment of health and/or numeracy literacy may be particularly important for primary care clinics who are encouraged to be patient-centered coupled with the current trend to develop Patient Centered Medical Homes (PCMH) (Berenson et al., 2008). Engaging patients in self management skills is an important metric for PCMH accreditation. Physicians' ability to develop health goals with clients, as well as be culturally aware of clients' needs, is an integral requirement for gaining PCMH certification (Wagner, Coleman, Reid, Philips, & Sugarman, 2012).

The study findings should be interpreted with caution. First, our findings are limited by the small sample size and low prevalence rates for numeracy literacy and adherence to the low-salt plus diet, which may leave the study underpowered to detect an association. The lowest detectable odds ratio based on the sample size was 2.83. Women and African Americans were overrepresented even with respect to the clinic population, which is predominantly female (65%) and African American (65%). Selection bias may have occurred and respondents may be different from hypertensive patients who chose not to partake in the study, which would result in an under or over estimate of the true association. We did not assess whether respondents had ever received counseling from a healthcare provider concerning the appropriate diet to control for hypertension. Studies have shown that healthcare providers give limited counseling on diet to hypertensive patients (Bell & Kravitz, 2008; Mellen, Palia, Goff, & Bonds, 2004; Spencer, Jablonski, & Loeb, 2012), but any such counseling may have resulted in an over estimate of the true association. We were unable to control for patients' level of education, which is correlated with health literacy. Inability to control for this variable could result in either an over or underestimate of the true association.

We used the Newest Vital Sign as a SAQ instead of interviewer administered. The NVS has been administered as a SAQ in previous studies (Welch, VanGeest, & Caskey, 2011), but SAQ scores have not been assessed

against other health literacy scales to determine if the criterion for adequate literacy is the same when using this form of administration. If cut points were different, this misclassification could result in an over or underestimate of the true association. Finally, given the small sample size, which was primarily African American women, the results are not generalizable.

The strengths of this study were the use of a pre-existing, reliable measure for health literacy that was specifically designed for the health care setting. The use of a food label as the health scenario in the NVS increases the relevance of this measure to assessing diet skills. We were also able to assess and test for potential confounding of the other JNC7 recommended hypertension self-care activities that may influence diet adherence. In addition, the study sample included a wide age group of hypertensive patients, not solely older adults, who may have other issues affecting the association. The study utilized clinical records to assess chronic diseases and other health events as potential confounders. To the knowledge of the authors, this study is the first to examine the association between numeracy literacy and adherence to a low-sodium diet similar to the DASH diet, in hypertensive patients.

CONCLUSION

Dietary modifications such as reducing sodium intake, fatty foods, and sugary foods, while emphasizing fruits, vegetables and grains, are standard prescriptions for many chronic disease patients. However, nutrition labels, which are meant to be useful in assisting with this self-care behavior, have been found to be confusing for the general population, and specifically for black Americans, who have been found to have lower comprehension of nutrition labels than white Americans (Cowburn & Stockley, 2005; Gans et al., 2003; Kristal, Levy, Patterson, Li, & White, 1998; Papakonstantinou et al., 2002; Rothman et al., 2006). For people with hypertension or other chronic diseases, the challenge of managing their diet is even greater as they are required to translate nutritional guidelines for their disease, such as appropriate foods to eat and proper portion sizes, to conform to information provided in food labels. Health literacy and numeracy literacy can offer skills, in the form of comprehension, interpretation, estimation and measurement that could enhance understanding of food labels and improve diet adherence.

In this study we have expanded the discussion of factors that may be influential on an important self-care behavior, diet maintenance, and emphasized the need to examine other aspects of health literacy such as numeracy. Further, we were able to include other co-morbid conditions that also require self-care activities; these conditions will increase the complexity of an individual's self-care regimen. This study attempts to address the inconsistency between the positive association between health literacy and nutrition skills and the lack of association found for health literacy and chronic illness self-care behaviors, which has previously been limited primarily to individuals with diabetes. While we found no association between health literacy and adherence to a low-salt diet, further research is needed on health literacy and its relationship with chronic

disease self-care activities. In particular for clinicians treating black Americans, who have higher rates of hypertension (Fryar et al., 2010), an improved understanding of health literacy and its affect on adherence to low-sodium, DASH diets is warranted. This improved understanding could assist providers as they seek to support their clients in developing self management behaviors for hypertension, and other chronic illnesses that benefit from dietary changes.

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