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Health Literacy is associated with Healthy Eating Index Scores and Sugar-Sweetened Beverage Intake: Findings from the Rural Lower Mississippi Delta

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Abstract

Background—Although health literacy has been a public health priority area for over a decade, the relationship between health literacy and dietary quality has not been thoroughly explored.

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Objective—To evaluate health literacy skills in relation to Healthy Eating Index scores (HEI) and Sugar-Sweetened Beverage (SSB) consumption, while accounting for demographic variables.

Design—Cross-sectional survey.

Participants/setting—A community-based proportional sample of adults residing in the rural Lower Mississippi Delta.

Methods—Instruments included a validated 158-item regional food frequency questionnaire and the Newest Vital Sign (scores range 0–6) to assess health literacy.

Statistical analyses performed—Descriptive statistics, ANOVA, and multivariate linear regression.

Results—Of 376 participants, the majority were African American (67.6%), without a college degree (71.5%), and household income level <\$20,000/year (55.0%). Most participants (73.9%) scored in the two lowest health literacy categories. The multivariate linear regression model to predict total HEI scores was significant ($R^2=0.24$; $F=18.8$; $p<0.01$), such that every 1 point increase in health literacy was associated with a 1.21 point increase in healthy eating index scores, while controlling for all other variables. Other significant predictors of HEI scores included age, gender, and SNAP participation. Health literacy also significantly predicted sugar-sweetened beverages consumption ($R^2=0.15$; $F=6.3$; $p<0.01$), while accounting for demographic variables. Every 1 point in health literacy scores was associated with 34 fewer SSB kilocalories/day. Age was the only significant covariate in the SSB model.

Conclusion—While health literacy has been linked to numerous poor health outcomes, to our knowledge this is the first investigation to establish a relationship between health literacy and HEI scores and SSB consumption. Our study suggests that understanding the causes and consequences of limited health literacy is an important factor in promoting compliance to the *Dietary Guidelines for Americans*.

Keywords

Health literacy; diet quality; beverages; health disparities

Introduction

The American Dietetic Association recognizes health literacy as one of their seven public health priority areas and recently identified health literacy as a mega issue for the profession of dietetics¹. Health literacy has also been on the United States' health care agenda for well over a decade^{2–4}. Although defined in numerous ways, the mostly widely accepted definition of health literacy is “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions².” Components of health literacy include oral literacy, print literacy, media literacy, numeracy, and cultural and conceptual knowledge^{3, 5}. Compared to targeting nutrition knowledge through education on specific dietary components or health conditions, addressing health literacy is a more complex concept.

Despite the rapid growth of health literacy in the scientific literature, several gaps have been identified. First, while health literacy has been associated with use of health care services, health care costs, and a wide variety of health outcomes^{6–10}, the relationships between health literacy skills and dietary quality have not been thoroughly explored. Previous research has examined the relationship health literacy and/or numeracy has with body mass index¹¹, interpreting food labels^{12, 13}, acquiring of and trust in nutrition information sources¹⁴, and clinical indicators of dietary self-management such as glycemic control^{15–17}. Importantly, we know of no studies that have investigated the relationship between health

literacy and diet or beverage quality. Since the *Dietary Guidelines for Americans* are the foundation of nutrition policy and education¹⁸, it is imperative to understand the relationship between health literacy skills and adoption of these guidelines. Understanding this association can help guide development and execution of appropriate dietary communication and intervention efforts. Second, in a recent systematic review of 27 health literacy and behavioral interventions targeting disease self-management and health promotion published between 2000–2010, the majority (n=26; 96%) targeted the primary health care setting (May 2010, Unpublished data), with fewer efforts aimed at understanding and promoting the health literacy needs of community-based populations. Given that low health literate individuals typically have less access to primary care and lack the necessary skills to navigate the complex health care system, the need to reach community populations and to explore the relationship between health literacy and health promotion and disease prevention in non-primary care settings warrants attention. Of the 27 reviewed health literacy interventions, none reported on indicators of diet quality and only one study by Kim and colleagues reported on dietary self-management behaviors¹⁹. Further, a consistent finding in clinical settings that has specific relevance for practicing dietitians is that low health literacy is associated with patient difficulty in following basic self-management recommendations²⁰. Finally, and from a practical perspective, understanding the relationship between health literacy and positive dietary change could allow dietitians to be involved in the development and delivery of evidence-based strategies that meet the needs of those with low health literacy.

The connection between health literacy and health disparities is an emerging area of interest²¹, and a key focus of this research. The Lower Mississippi Delta region of Arkansas, Louisiana, and Mississippi is one of the most health disparate regions in the US²². There is a high concentration of African Americans and a high prevalence of chronic disease in the Delta^{23, 24}. The education disparities experienced by Delta residents are well documented and it is estimated that 64% of Mississippi residents, 61% of Louisiana residents, and 56% of Arkansas residents function at the two lowest levels of literacy proficiency, as compared to the national average of 46%^{25, 26}. In the counties that comprise the Delta, the percent of residents functioning at the two lowest levels of proficiency increases dramatically to 80%, 78%, and 78%, respectively for Mississippi, Louisiana, and Arkansas²⁵. Furthermore, numerous studies detail many nutrition challenges facing the Delta population^{27–32}. Despite the documented nutrition, education, and literacy disparities in this region, no known studies have explored the connection between health literacy and health or nutrition behaviors.

One of the most common indicators of dietary quality is the Health Eating Index (HEI). This method is designed to measure adherence to the 2005 Dietary Guidelines for Americans, and examines total diet quality and 12 component scores, one of which is calories from solid fats, alcoholic beverages, and added sugars (SoFAAS)^{33, 34}. Although sugar-sweetened beverages (SSB) are included in the calculation of the SoFAAS component score, the emerging public health concern of SSB^{35, 36} signifies the importance of understanding the contribution of SSB in isolation of other solid fats, alcoholic beverages, and other added sugars. Given the doubling of SSB consumption over the past three decades in the US^{35, 37}, the positive relationship between SSB and obesity^{38–40}, and evidence that SSB consumption is inversely related with education attainment⁴¹, understanding specific associations between health literacy and SSB could lead to important targeted intervention strategies for reversing SSB consumption trends.

Research gaps in health literacy literature and the disparities experienced by Delta residents substantiate the need to explore nutrition literacy in this vulnerable population. The primary aim of this cross-sectional study targeting adult Delta residents was to evaluate the scope of limited health literacy and determine the relationship between health literacy and diet

quality. A second purpose was to determine the relationship between health literacy and SSB consumption. We hypothesized health literacy would be positively associated with total HEI-2005 scores as well as with each of the 12 component HEI scores, and hypothesized a negative association between health literacy and kilocalories/day from SSB.

Methods

This cross-sectional research study was approved by The University of Southern Mississippi's Institutional Review Board (IRB) and informed consent was obtained from each participant prior to administering the survey. Inclusion criteria required participants be 18 years of age (or older), English speaking, and a resident of the Lower Mississippi Delta region. The target population was adults residing in 10 Arkansas counties and 12 Louisiana parishes in the Delta. A proportional quota sampling plan based on educational achievement levels was developed and executed to assure that participants were representative of the greater Delta region. Based on the 2000 US Census Data²³, the proportional quota sampling plan aimed to include: 1) 37% of participants with less than a 12th-grade education, 2) 49% of participants with a high school diploma or equivalent and no college degree, and 3) 14% of participants with a college degree. Seven indigenous Delta residents, including community health workers and/or Extension Program Assistants were hired and trained to recruit residents from their communities to participate in the study. Primary recruitment strategies included community flyers and word of mouth, including face-to-face and telephone contacts. In addition to the proportional quota sampling plan based on educational achievement and its attempts to match the targeted demographics of the region, community health workers were also trained to recruit across all age ranges (>18 years of age), recruit an equal number of men and women, and recruit approximately 70% African American and 30% white participants.

Seven dietetic undergraduate and graduate research assistants, including six African American and one white assistant, were trained to interview-administer the survey. These research assistants attended four training sessions that included numerous practice opportunities to interview-administer the survey and concluded with a certification session supervised by the principle investigator. The investigators continuously monitored data quality throughout the study, including on-site monitoring of adherence to data collection protocol and timely review of surveys for completeness. Data collection locations were arranged by the community health worker and included Extension offices, churches, and community centers. All survey instruments were read aloud and answers were recorded by the data collectors. The survey took an average of 50 (SD=11) minutes to complete. Participants were given a \$25 gift card to compensate their time and transportation.

Measures

Health literacy—Health literacy was assessed using the previously developed and validated Newest Vital Sign (NVS)⁴². With this tool, patients view information on a nutrition information label and answer six questions about how they would interpret and act on the information contained on the label. The number of correct responses is summed to produce a nutrition literacy score ranging from 0 to 6. The NVS can be treated as an equal interval scale with scores ranging from 0 (high likelihood of limited literacy) to 6 (adequate literacy), or a categorical variable whereby 0–1, 2–3, or 4–6 correct answers indicate, respectively, a high likelihood of limited literacy, the possibility of limited literacy, and adequate literacy skills. The NVS has been validated against the Test of Functional Health Literacy in Adults (TOFHLA) in 500 English-speaking and Spanish-speaking primary care patients residing in Arizona. The instrument produces reliable scores (Cronbach $\alpha = 0.76$). It has high sensitivity (72% using a cut score <2, and 100% using a cut score of <4) and

accuracy (area under receiver operator characteristics curve = .88) for detecting limited literacy⁴².

Dietary quality and sugar-sweetened beverage consumption—Dietary intake was assessed using a validated 158-item Food Frequency Questionnaire (FFQ)^{43, 44}. This regional FFQ represents foods typically consumed in the Delta, queries frequency and usual serving size of foods and beverages, and produces a comprehensive nutrient profile including energy, grams of macronutrient, grams/milligrams of micronutrients, and number of servings from each food group. The FFQ was originally developed and field-tested in a representative sample of 100 residents in the Delta, and then revised to improve interpretability⁴³. Subsequently, the FFQ was validated in a sub-sample of participants, purposefully sampled to include half with low and half with high socioeconomic status, from the Jackson Heart Study⁴⁴. In addition, this questionnaire was validated against blood levels of vitamin E and carotenoids⁴⁵. Given the epidemiological approach, targeted sample size, and available resources, the interview-administered FFQ was determined the most appropriate dietary assessment method for this study⁴⁶.

Data were used to construct HEI-2005 scores. Total (overall) HEI-2005 scores range from 0 to 100 and are the sum of 12 component scores including total fruit (including 100% fruit juice) (5 points), whole fruit (5 points), total vegetables (5 points), dark green and orange vegetables and legumes (5 points), total grains (5 points), whole grains (5 points), milk (10 points), meat and beans (10 points), oils (10 points), saturated fat (10 points), sodium (10 points), and calories from solid fat, alcoholic beverages, and added sugars (SoFAAS) (20 points)^{33, 34}. Component scores are calculated using a density approach as a percent of calories or per 1000 calories, and higher scores indicate better adherence to DGA recommendations. For the present study, coding methods developed by National Institutes of Health were replicated to calculate HEI-2005 scores from a FFQ^{47, 48}.

In addition to the HEI scores, SSB consumption was also examined. A SSB variable was created by summing kilocalories from five items on the FFQ, including carbonated soft drinks, fruit drinks, powdered drink mixes, coffee with sugar, and tea with sugar. The amount of sugar added to coffee and tea was queried in a separate question. Artificial sweetener use was also assessed, but not used in our analyses.

Demographics—Gender was recorded, race was reported across four categories, and age was reported on a continuous scale. Income level was reported from 12 categories with \$5000 increments ranging from <\$5,000 to >\$55,000. Education level was reported across seven categories and participants with an associate's or bachelor's degree were collapsed into one category for analyses. Participants also self-reported height and weight, as well as participation in the Expanded Food and Nutrition Education Program (EFNEP), the Supplemental Nutrition Assistance Program (SNAP), and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

Analyses—Descriptive statistics, including frequencies, percents, means, and standard errors, were used to summarize survey responses. One-way ANOVA tests were used to examine associations among demographic characteristics with health literacy scores, HEI scores, and SSB. As a follow-up to the ANOVA models, pairwise comparisons using univariate F tests were used to evaluate statistically significant differences. Significance is reported at the 0.05 and 0.01 levels.

Two multiple linear regression models were used to regress health literacy scores, education level, age, race, gender, income level and SNAP participation on HEI scores and SSB intake. In addition, the moderating effects of health literacy were explored by including two-

way interaction terms (NVS score $\times$ education level; NVS score $\times$ age; NVS score $\times$ race; NVS score $\times$ gender; and NVS score $\times$ income level) in the regression models; however, these interactions were not significant and were, therefore, not included in the final models. Identical procedures were used to regress main and interaction terms on each of the 12 HEI sub-component scores⁴⁹.

This study was powered to detect effects between 13 predictors (7 main effects and 6 interactions) and HEI scores. Based on our power analysis for R^2 , 400 subjects provided sufficient power (80% at $\alpha = .05$) to detect small effects ($f^2 = .05$) (G*Power 3.0.8).

Results

A total of 400 respondents were surveyed. Listwise exclusion of participants who chose not to respond to questions on one or more of the items related to control variables across models resulted in a total of 376 observations used in the analyses. Gender, race, education levels, income levels, and participation in the Supplemental Nutrition Assistance Program (SNAP) are illustrated in Table 1. As indicated by the education and race distribution, the proportional quota sampling plan was sufficiently achieved, yet men are somewhat underrepresented in the sample. Body Mass Index (BMI), calculated using self-reported height and weight, revealed that 22% were categorized as overweight and 52% as obese. Participants ranged in age from 18–84 years with a mean of 45 (SD=16) years.

As compared to females, males had significantly lower health literacy scores ($F=5.08$; $p=0.02$), lower HEI scores ($F=22.37$; $p<0.01$), and higher intakes of SSB ($F=11.47$; $p<0.01$) (Table 1). African Americans had significantly lower health literacy skills ($F=55.25$; $p<0.01$) and higher SSB intake ($F=5.52$; $p=0.02$) when compared to their white counterparts. Finally, respondents participating in SNAP had significantly lower health literacy skills ($F=10.53$; $p<0.01$) when compared to non-participants.

Applying standardized NVS scoring procedures, 195 (51.8%) participants were classified with a high likelihood of limited literacy skills, 83 (22.1%) with a possibility of limited literacy skills, and 98 (26.0%) with adequate literacy skills (Table 2). Among all participants, the average HEI score was 52.2 ± 10.5 and less than half of possible sub-component points were achieved for whole fruit, dark-green and orange vegetables and legumes, whole grains, milk, sodium, and SoFAAS. Total HEI scores varied by nutrition literacy category, such that respondents with adequate health literacy skills scored approximately four points higher than those with high likelihood of or possibility of limited health literacy (Table 2). In general, as compared to respondents with lower health literacy skills, respondents with high health literacy scores scored higher on five sub-component HEI scores including whole fruit, total vegetables, meat and beans, oils, and SoFAAS. Contrary to our hypothesis, participants in the lowest health literacy category scored higher for saturated fat than the higher health literate respondents. For SSB, participants in the lowest health literacy category consumed about 119 kilocalories/day more than those with adequate health literacy.

As indicated in Table 3, the multivariate linear regression model adjusting the heteroskedasticity in the error term to predict total HEI scores was significant ($R^2=0.24$; $F=18.8$; $p<0.01$). Every additional 1 point on the health literacy scores was associated with 1.21 points in healthy eating index scores ($p<0.01$), while controlling for all other variables. Other significant predictors of HEI scores included age, gender, and SNAP participation. While less variability was explained by the model to predict sugar-sweetened SSB consumption, this regression model was also significant ($R^2=0.15$; $F=6.3$; $p<0.01$). Each additional point in health literacy scores was associated with 34 kilocalories/d lower SSB

intakes ($p=0.01$). Age was the only significant covariate in the SSB model. Income and education level were not significant predictors of HEI scores or SSB intake.

The health literacy prediction coefficients for the HEI sub-component scores are illustrated in table 4. Although the data are not shown, coefficients and p-values are adjusted for the main effects of all other covariates including education level, age, race, gender, income level, and SNAP participation. Health literacy was positively associated with five sub-component scores, including whole fruit, total vegetables, dark-green and orange vegetables and legumes, oils, and SoFAAS. Similar to post-hoc findings in table 2, health literacy was negatively associated with intake of saturated fat.

Discussion

While health literacy has been linked to numerous poor health outcomes, to our knowledge this is the first investigation to establish a relationship between health literacy and HEI scores and SSB consumption. Furthermore, this study shows high prevalence of limited health literacy in the Delta. Major strengths of this study include: proportional quota sampling plan based on educational achievement, which supports generalizability of findings to the greater Delta region; the interview/administered survey approach, which diminishes confounding effects of participants not able to read and/or adequately complete survey forms; use of a valid health literacy instrument based on interpreting the nutrition facts panel⁴²; and use of a culturally appropriate and validated diet assessment measure^{43–45}.

In our two main models, health literacy provided the strongest association with total HEI scores and SSB, as compared to non-significant income and education level variables. Although income and education status are sometimes used as proxy indicators of health literacy, our findings signify the importance of accounting for health literacy in predicting diet quality scores and SSB consumption. Our finding that as health literacy decreases so too do HEI scores has important clinical implications. Specifically, HEI scores have been related to numerous health outcomes, including, but not limited to cancer risk⁴⁷, lipid profiles⁵⁰, obesity, and depression⁵¹. Although a variety of demographic and socioeconomic variables (e.g. gender, age, ethnicity, education status, income level, marital status) have been associated with HEI scores, patterns are not consistent across studies and different study populations^{47, 50–52}. Our study findings suggest that inconsistent findings may be due to variations in health literacy, which has not been accounted for in previous studies of diet quality.

The nutrition, health, and socio-economic problems faced by impoverished communities make prioritization and execution of health interventions extremely challenging. In the Delta, issues related to food insecurity and availability have largely been the focus of nutrition-related research efforts^{28, 31, 32}, and are undoubtedly critical factors. This dietary quality study establishes health literacy as another important threat to improving diet. Crude comparisons of the National Assessment of Adult Literacy (NAAL) data to our findings, suggest that the prevalence of limited health literacy in the Delta may be substantially higher than the general US population^{42, 53}. In our previous health literacy study targeting the Delta, individuals with poor health literacy skills were significantly less likely to seek nutrition information regardless of the source, and health literacy was significantly related to the level of trust of nutrition sources¹⁴. Collectively these findings indicate the need for intervention efforts that comprehensively address health literacy issues to reduce the burden of nutrition-related chronic diseases among health disparate populations.

Together with the available literature examining health literacy and health behaviors, the findings from our study suggests several avenues for future research. First, it is thus

imperative to utilize validated measures of health literacy in nutrition research. The most commonly used measures include the Rapid Estimate of Adult Literacy in Medicine (REALM)⁵⁴, the Test of Functional Health Literacy for Adults (TOFHLA)⁵⁵, and the Short-TOFHLA. Given that the Newest Vital Sign (NVS)⁴² is based on the nutrition facts panel and has good reliability with other measures, it is particularly relevant to nutrition research. Using validated measures allows a more direct comparison among health literacy interventions, and allows examination of the moderating effects of health literacy on nutrition outcomes. Second, cross-sectional studies such as this one are useful to establish relationships between dietary outcomes and health literacy, but there is also a need for intervention studies to investigate possible causal relationships and the effectiveness of health literacy intervention strategies on long-term nutrition outcomes. There is an apparent need to distinguish among studies that simply focus on low-literate populations or utilize clear communication strategies versus those that are designed to intervene on health literacy-specific domains. While the nutrition literature is replete with nutrition-related intervention efforts aimed at limited resource audiences, clearly absent from the literature are intervention approaches that comprehensively integrate concepts in health literacy with theory-based approaches to behavior change among low-health literate adults²⁰. Finally, the setting and recruitment protocol of health literacy studies are important methodological issues. Despite the fact that low health literate individuals are less likely to access primary care and have poor navigation skills in health care settings, the majority of health literacy interventions target primary care settings. Without concerted efforts to target low-literate and medically underserved populations in community-based settings, the likelihood of effectively reaching individuals who need the most help is greatly diminished.

While our study was a cross-sectional investigation and cannot be used to suggest causation, it does provide information that can inform practical strategies for dietitians working with high need populations, such as those that reside in the Delta. First, completion of the NVS health literacy measure can be done quickly and could inform the practicing dietitian of their client's possible health literacy limitations. Second, when health literacy limitations are identified clear communication techniques including, hands-on demonstrations, verbal presentation, pictorial information, materials with simplified language, and utilization of the teach back methods have demonstrated effectiveness in other behavioral domains^{7,9}. Third, SSB consumption may be a behavioral target that could be highlighted with nutrition education. The most recent 2005–06 NHANES data indicate that adults in the US consume about 175 kcal daily from SSB³⁷, and it has further been estimated that SSB account for about 10% of total energy intake for US adults⁵⁶. Relationships among SSB and numerous health outcomes are well established and several systematic reviews and meta-analyses illustrate a positive association between SSB and obesity^{38–40}. Coupled with this information our findings suggest that practicing dietitians should be aware of health literacy issues and integrate possible strategies to ensure that low literate clients benefit from strategies developed to reduce SSB consumption. Fourth, of the HEI components, the SoFAAS component has the most clinically meaningful relationship and consequently made the greatest contribution to the overall relationship found between health literacy and total HEI scores. This suggests that when low health literate clients are identified, specific strategies supporting SoFAAS reductions may be necessary.

Limitations

This study is not without limitations. Causality cannot be inferred by the cross-sectional nature of this study, and longitudinal and experimental approaches are needed to further explore the relationship between health literacy and diet quality. Although established coding methods developed by the National Institutes of Health were replicated to calculate HEI-2005 scores from a FFQ^{47, 48}, HEI scores are most commonly computed based on 24-

hour recall data^{33, 34} and caution must be applied when comparing our HEI scores to other studies. Even though FFQ are a standard dietary measure for epidemiologic research, issues surrounding consistency and accuracy have been debated for years^{46, 57, 58}, and these limitations should be considered. Despite attempts to minimize response burden in this study by utilization of well-trained interviewers and food models, it is still feasible that the FFQ was cognitively complex and resulted in higher occurrence of misreporting in the lowest educated segment of this population. Finally, this study did not attempt to account for other factors impacting food choice and dietary behaviors such as availability of grocery stores, availability of high nutrient dense foods, and transportation. To best understand the role of health literacy in dietary quality, future studies are needed to comprehensively account for individual, social, and environmental determinants of diet quality.

Conclusions

Our study highlights an important relationship between health literacy and diet quality and SSB consumption, and illustrates how understanding the causes and consequences of limited health literacy is an important factor in promoting compliance to the *Dietary Guidelines for Americans*. To advance the American Dietetic Association's health literacy agenda and to promote health literacy as a public priority area for the profession, dietetic practitioners and researchers need to better understand how health literacy impacts access to, comprehension of, and adoption of nutrition recommendations. Similarly, the immediate and long-term implications health literacy has on nutrition-related outcomes, both in the context of health promotion and disease self-management, warrants further investigation.

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Table 1

Characteristics of Delta respondents aged 18–84 years in relation to health literacy scores, total Healthy Eating Index (HEI) scores, and sugar-sweetened beverage intake (n = 376)

Demographic variables		Health literacy score ^a	Total HEI total score ^b	Sugar-sweetened beverage intake (kilocalories/day)
	n(%)	Mean(±SE)	Mean(±SE)	Mean(±SE)
Gender				
Male	89 (23.7)	1.7±1.8*	48.0±10.1*	302±462*
Female	287 (76.3)	2.2±1.9*	53.9±10.3*	158±311*
Race				
African American	254 (67.6)	1.6±1.5*	52.0±11.0	224±396*
Non-Hispanic White	116 (30.9)	3.1±2.2*	53.5±9.6	129±253*
Other	6 (1.6)	2.0±1.8	52.0±7.9	54±61
Education level				
Less than 9 th grade	22 (5.9)	0.9±1.0	54.1±9.6	125±181
9–12 grades, some high school	65 (17.3)	1.2±1.5	50.9±10.0	277±533
High school or GED	145 (38.6)	1.8±1.6	51.6±11.1	208±338
some college, no degree	75 (20.0)	2.5±1.9	53.4±10.1	171±340
associate's or bachelor's degree	33 (8.8)	3.1±2.1	50.7±8.7	160±248
grad school	36 (9.6)	3.8±1.9	57.4±11.0	87±164
Household income level^c				
< \$9,999	111 (29.5)	1.1±1.1	51.2±9.5	198±333
\$10,999 – \$19,999	96 (25.5)	1.9±1.7	53.6±11.5	173±290
\$20,999 – \$29,999	59 (15.7)	2.2±1.8	52.4±10.3	139±210
> \$30,000	110 (29.3)	3.2±2.1	52.8±10.8	230±477
Participation in SNAP				
Participation	103 (27.4)	1.6±1.5*	53.1±9.8	190±333
No participation	273 (72.6)	2.3±2.0*	52.2±10.8	192±367

* p<0.01 indicates statistically significant difference for the demographic variable within each column. Statistical comparisons are only illustrated for categorical variables that are dummy coded as indicator variables in the regression models. Since education level and income level are treated as continuous variables in the regression models in Table 3 and 4, statistical comparisons are not tested here.

^a Assessed using the Newest Vital Sign with scores ranging 0–6.

^b Healthy Eating Index scores ranging from 0–100.

^c A 12-range categorical variable was used to assess income level and used in the regression models; data is collapsed here for illustrative purposes.

Table 2
Healthy Eating Index (HEI) scores and sugar-sweetened beverage intake in relation to health literacy categories (n = 376)

	Maximum Score	Overall	Category 1 ^a : High likelihood of limited health literacy	Category 2 ^a : Possibility of limited health literacy	Category 3 ^d : Adequate health literacy	P-value
		n=376	n=195	n=83	n=98	
		Mean(±SE)	Mean(±SE)	Mean(±SE)	Mean(±SE)	
Total HEI Score	100	52.5±10.5	51.4±10.4	51.5±10.6	55.5±10.3	1<3 ^{**} ; 2<3 [*]
Total fruit (includes 100% juice)	5	2.9±1.6	2.9±1.6	2.7±1.6	2.9±1.6	NS
Whole fruit (not juice)	5	2.3±1.7	2.2±1.6	2.0±1.5	2.6±1.8	2<3 [*]
Total vegetables	5	2.8±1.2	2.6±1.2	2.7±1.1	3.1±1.1	1<3 ^{**}
Dark-green and orange vegetables and legumes	5	1.4±1.2	1.4±1.2	1.4±1.2	1.6±1.1	NS
Total grains	5	4.1±1.0	4.1±1.0	4.0±1.0	4.2±0.9	NS
Whole grains	5	1.5±1.4	1.4±1.4	1.4±1.4	1.7±1.3	NS
Milk	10	4.7±2.8	4.5±2.8	4.6±2.7	5.3±2.8	NS
Meat and beans	10	9.3±1.5	9.3±1.5	8.9±1.8	9.5±1.2	2<3 [*]
Oils	10	5.9±2.5	5.4±2.4	6.3±2.8	6.5±2.3	1<3 ^{**} ; 1<2 [*]
Saturated fat	10	5.3±3.2	6.0±3.0	5.1±3.5	4.3±3.2	1>3
Sodium	10	3.2±2.7	3.2±2.8	3.7±2.8	2.7±2.3	NS
SoFAAS ^b	20	9.2±5.4	8.4±5.4	8.8±5.5	11.1±4.9	1,2<3 ^{**}
Sugar-sweetened beverages (kilocalories/day)	N/A	192±357	230±426	197±315	111±195	1>3 ^{**}

^a Assessed using the Newest Vital Sign: 0–1 correct answers=high likelihood of limited literacy, 2–3 correct answers=possibility of limited literacy, and 4–6 correct answers=adequate literacy skills.

^b SoFAAS=Solid fat, alcohol, and added sugar.

* p<0.05;

** p<0.01

Using health literacy and demographic variables to predict Healthy Eating Index (HEI) scores and sugar-sweetened beverage intake (n = 376)

Table 3

Variables	HEI Total Score			Sugar-sweetened beverages (kcal/day)		
	Units	b	p-value	b	p-value	
Health literacy scores	Score	1.21	0.00	-33.69	0.01	
Education levels	Category	0.35	0.43	-23.62	0.09	
Age	Year	0.27	<0.01	-6.70	<0.01	
White	Dummy	-0.03	0.98	-67.66	0.07	
Male	Dummy	-4.02	0.00	94.49	0.06	
Household income levels	Category	0.06	0.71	8.95	0.20	
SNAP participation	Dummy	2.49	0.03	-31.57	0.46	
R-squared (p-value)		0.24	(p<0.01)		0.15	(p<0.01)

Table 4

Associations among health literacy and Health Eating Index (HEI) sub-component scores, accounting for demographic variables (n = 376)

HEI Sub-Component Scores	Health Literacy Coefficient ^a	
	b	p-value
Total fruit (includes 100% juice)	0.03	0.58
Whole fruit (not juice)	0.12	0.03
Total vegetables	0.12	<0.01
Dark-green and orange vegetables and legumes	0.11	<0.01
Total grains	0.04	0.20
Whole grains	0.08	0.08
Milk	0.16	0.10
Meat and beans	0.06	0.25
Oils	0.25	<0.01
Saturated fat	−0.32	<0.01
Sodium	−0.15	0.10
SoFAAS ^b	0.70	<0.01

^a Health literacy coefficients and p-value are adjusted for the main effects of all other covariates including education level, age, race, gender, income level and SNAP participation.

^b SoFAAS=Solid fat, alcohol, and added sugar.