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Associations between Health Literacy and Health Behaviors among Urban High Schoolers

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Human Subjects Approval Statement

This study was approved by the Institutional Review Board at Syracuse University (IRB#10-052).

Abstract

BACKGROUND—Health literacy is crucial to develop health-related knowledge, adopt healthy lifestyles, and benefit from health care services. However, research on the association between health literacy and adolescent health outcomes, particularly on their prospective associations, is rare. We assessed health literacy using three validated measures, and examined cross-sectional and prospective associations between health literacy and adolescent health behaviors and outcomes.

METHODS—We conducted a short-term prospective study of 250 adolescents (mean age = 14 years; 57% female; 48% African-American) who were entering or in the 9th grade in an urban school district. Health literacy was assessed by individual interviews at baseline, and health-related behaviors and outcomes were assessed by a paper-and-pencil survey at baseline and at a 6-month follow-up.

RESULTS—Nearly half of the sample was reading at least two grades below expected levels. Lower baseline health literacy was associated with a lower self-rating of general health, unhealthier diet, heavier weight, and greater engagement in problem behaviors and sexual behaviors at baseline. Lower baseline health literacy also was associated with a greater increase in substance use over time.

CONCLUSIONS—Results point to the pressing need to improve health literacy in urban high school students.

Keywords

Child & Adolescent Health; Health Behaviors; Risk Behaviors; Health Communication; Health Literacy; Prospective Studies

Health literacy is defined as “cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health.”¹ Health literacy skills are crucial for individuals to gain knowledge of health issues, make proper health decisions, and benefit from health care services.^{2,3} Despite a number of federal policy initiatives to improve health literacy, 88% of adults in the U.S. were shown to have inadequate health literacy levels (indicated by the Proficient performance level on common health-related prose, documents, quantitative tasks).⁴ These findings indicate that majority of adults do not have the literacy and quantitative skills necessary to understand health care information. Poor health literacy continues to be a serious public health problem.⁵⁻⁷

Numerous studies have documented the impact of poor health literacy on adverse outcomes in adults;⁸ however, much less attention has focused on adolescents.⁹ Adolescents are interested in learning about health issues^{10,11} and increasingly involved in their health decisions.^{12,13} Adolescent health behaviors play a crucial role in the development of a healthy lifestyle, which can affect life-long health outcomes. Thus, better understanding of the association of health literacy with adolescent health behaviors is crucial to inform health literacy interventions for adolescents, which are cost-effective and timely methods to prevent adverse health outcomes later in life.^{2,14}

Although many health literacy measures have been developed for adults, only a few measures have been developed for adolescents (including one developed for Canadian high school students,¹⁵ and another one to assess the use of Electronic health resources¹⁶). Among the health literacy measures developed for adolescents, the Rapid Estimate of Adult Literacy in Medicine-Teen version (REALM-Teen)¹⁴ and the Newest Vital Sign (NVS)¹⁷ are both interviews. The REALM-teen assesses oral word reading (ie, prose literacy),¹⁸ whereas the NVS assesses reading comprehension and the manipulation of quantitative information (ie, numeracy and document literacy).¹⁸ Another measure, the KidsHealth KidsPoll of Health Literacy (KidsPoll),¹⁰ is a questionnaire designed to assess adolescent perceptions about their comprehension of, motivation to obtain, and opinions of health issues. However, benchmarks for identifying limited health literacy among adolescents are not established across measures,¹⁹ making it difficult to compare results from studies using different health literacy measures.

Most research has focused on positive associations of adolescents' broad literacy skills (as opposed to health literacy) with risky health behaviors, such as aggressive behavior,²⁰⁻²² substance use,^{23,24} and sexually transmitted infection acquisition.²⁵ Only a few studies have examined the association of health literacy with adolescents' health outcomes. These studies suggest that adolescents with poor health literacy are at an increased risk for sexually transmitted infection,²⁶ obesity,^{27,28} poor medication adherence,²⁹ and lack of involvement in health-promoting behaviors.³⁰ However, these existing studies are limited by their circumscribed sample characteristics (such as overweight children,²⁸ HIV-infected adolescents,²⁹ women attending a reproductive health clinic,²⁶ and Taiwanese adolescents³⁰) and thus lack generalizability to American adolescents. Further, these studies relied exclusively on cross-sectional research designs. Due to the rapid developmental changes and formal educational learning in adolescence, effects of health literacy on adolescent health outcomes may change in a brief interval; thus, short-term prospective associations of health literacy with adolescent health outcomes need to be examined.³¹ Finally, prior adolescent health literacy studies have used only one measure of health literacy. The use of multiple health literacy measures may inform us about diverse aspects of developing health literacy skills in adolescents.

The present study had two purposes. First, we assessed health literacy in a community-based sample of urban adolescents using three validated adolescent health literacy measures (ie, REALM-Teen, NVS, and KidsPoll). Second, we examined cross-sectional and short-term prospective associations between health literacy levels and a range of health behaviors and outcomes (ie, general health rating, weight status, unhealthy diet, problem behaviors, sexual behaviors, and substance use), before and after accounting for sociodemographic characteristics (ie, age, sex, race, and participation in a free lunch program). We hypothesized that poorer health literacy would be associated with less favorable health behaviors and outcomes cross-sectionally and prospectively.

METHODS

Participants And Procedures

Data were collected as part of a prospective study of 250 adolescents. Eligibility criteria for participation included English speaking, and entering or currently in the 9th grade at public high schools in a moderately sized northeastern city. Adolescents were recruited from community venues (eg, flyers and billboard announcements, outreach at local youth events, mailing and emailing to households of eligible adolescents) and school venues (eg, information tables, open house events, and walk-in registration sessions) as well as a respondent driven sampling method (ie, providing an existing participant an additional payment for referring friends to our study). The baseline participants were between age 13 and 17 at baseline ($M = 14.51$; $SD = 0.73$) and 57% were female. Half of the adolescents reported being African-American (48%), with 18% White, 5% Native American, 2% Asian, 21% biracial or multiracial, and 6% who did not report their race. Hispanic/Latino ethnicity was reported by 16% ($N = 40$). About half of fathers (45%) and mothers (49%) were reported to have a high school education or less; 23% of fathers and 40% of mothers were reported to have completed some college or received a college degree; the remaining adolescents responded that they did not know and/or did not have a father figure (32%) or a mother figure (11%). Among the 250 baseline sample, 100 participants were randomly selected to complete the REALM-Teen and NVS health literacy interviews, due to resource constraints in the staffing costs associated with individual interviews. The third health literacy measure, the KidsPoll self-report, was administered to all participants.

Participants completed two assessment sessions with a six-month lapse (mean lapse = 188 days [$SD = 27$]) between baseline (August 2010 to May 2011) and follow-up (January through September 2011). Out of 250 baseline participants, 202 were invited to the follow-up assessment; 48 were not contacted due to scheduling constraints associated with the conclusion of the project period. Of the invited baseline participants, 90% ($N = 182$, completers) participated at follow-up. Adolescents who did not participate at follow-up (attriters; $N = 20$) did not differ from the completers in any baseline study variables, with one exception that attriters consisted of more boys (65%), as compared to completers (38%), $\chi^2(1) = 5.63$, $p = .03$. Participants received \$30 for completing each of the baseline and follow-up assessments and could receive up to an additional \$15 for referring qualified friends to the study (\$5 per referral, up to 3 referrals permitted).

Instrumentation

Sociodemographics—Participants responded to items assessing demographic characteristics (ie, age, sex, race), and socioeconomic status (ie, participation in the free lunch program) at baseline. These variables were included as covariates in analyses.

REALM-Teen—This individual assessment¹⁴ includes 66 health-related words (eg, eye, ounce, diabetes) arranged in increasing order of difficulty. A research assistant asked participants to pronounce the words one by one and marked correctness of the pronunciation. The total number of correctly pronounced words was used in analysis. Total

scores correspond to reading proficiency at the 3rd or lower grade (0 – 37), 4th/5th grades (38 – 47), 6th/7th grades (48 – 58), 8th/9th grades (59 – 62), and 10th or higher grade (63 – 66).

NVS—The English version of the 6-item measure¹⁷ assesses adolescents' ability to apply health knowledge to understand a nutrition label. Participants were asked to review an ice cream nutrition label and respond to six questions testing their ability to understand and use the numbers in the label. A research assistant recorded participants' responses verbatim. The total number of correct responses was used in analysis, with 4 correct answers indicating average literacy, 2 to 3 indicating marginal literacy, and < 2 indicating inadequate literacy.

KidsPoll—This 8-item self-report measure¹⁰ assesses three of the National Health Education Standards for adolescents:³² (1) understanding health-related concepts, (2) accessing valid health information, and (3) advocating for health issues. Four items assess understanding of and interest in health information (eg, "How interested are you in learning about health?"). Participant responses were summed to obtain a total score (0 to 14), with higher scores indicating higher degrees of health literacy. Participants' responses to the remaining four items assessing opinions about various sources of health information (eg, "Which of these gives the most wrong information about health?") were not included in the total score.

General health—To assess adolescents' overall health ratings, we administered a single item from *Add Health* ("How would you describe your general health?").³³ Adolescents responded using a 1 (*poor*) to 5 (*excellent*) scale at both assessments.

Weight status—Adolescents reported their weight and height at both assessments, and a research assistant measured participants' weight and height at follow-up. Correlations between self-reported and staff-measured values of heights ($r = .72$) and weights ($r = .94$) at follow-up were high. Despite these high correlations and, because objectively measured values are more reliable than self-report, staff-measured weight/height values were used at follow-up to calculate a body mass index (BMI) percentile ranking comparing adolescents of the same sex and age.³⁴ Self-reported weight/height were used to calculate BMI at baseline, because staff-measured values were not available. Then, adolescents were classified into one of three weight status:³⁴ healthy weight (0; 5–84%), overweight (1; 85–94%), and obese (2; 95%). Underweight adolescents were dropped from analyses due to extremely low prevalence (2% at baseline, 1% at follow-up).

Unhealthy diet—Four items assessing frequencies of unhealthy diet of drinking diet soda, regular soda, and energy drinks, and eating fast food (*Monitoring the Future* [MTF])³⁵ were administered. Adolescents responded using a 0 (*never*) to 5 (*every day*) scale. The sum scores at both assessments were used in analyses.

Problem behaviors—Five items assessing problem behaviors (eg, skipping school without permission, being suspended from school)³⁶ were administered. Adolescents responded by choosing 0 (*no*) or 1 (*yes*). Given the small number of items, acceptable levels of internal consistency were found, $\alpha = .65$ at baseline and $\alpha = .61$ at follow-up. Sum scores (0 to 5) at both assessments were used.

Substance use—Three items assessing past-month frequencies of alcohol use (MTF)³⁵ and tobacco and marijuana use (*Youth Risk Behavior Survey*)³⁷ were administered. Because of the low prevalence of using each substance (10–21% at baseline; 14–29% at follow-up), a dichotomous variable was recoded as using alcohol, cigarette, and/or marijuana (1) versus not using any of the substances (0) at both assessments.

Sexual behaviors—Two items adapted from a previous study³⁸ were administered to measure lifetime experience of oral and vaginal sex. A dichotomous variable was created as experienced oral and/or vaginal sex (1) versus no experience (0) at both assessments.

Data Analysis

We conducted multiple regression analyses for continuous health outcomes and logistic regression analyses for dichotomous health outcomes in SPSS, Version 21. For the cross-sectional analyses, two sets of regression analyses were conducted to examine whether baseline health literacy scores were associated with the baseline health outcome, without controlling for covariates, and then after controlling for covariates. Given the small number of extant studies on adolescent health literacy, we conducted cross-sectional analyses first, despite their limited ability to resolve directionality of the associations between health literacy and health behaviors/outcomes. Also, our two sets of cross-sectional analyses without and with controlling for covariates could inform potential confounding roles of these covariates in the observed associations between health literacy and health behaviors/outcomes.

For the prospective analyses, again two sets of regression analyses (ie, one set without controlling for covariates, and another set after controlling for covariates) were conducted to examine whether baseline health literacy scores were associated with the follow-up health outcome, after controlling for the baseline health outcome. Separate analyses were conducted for each of the three health literacy scores. In all regression analyses, the observations missing on any variables included in the specific model were excluded from the analysis. This listwise deletion of missing data resulted in different sample sizes for different models, ranging from N = 62 to 249 (as indicated in the notes of Tables 2 through 4).

RESULTS

Health Literacy Levels

As shown in Table 1, the mean REALM-Teen score indicated that, on average, our 9th grade sample showed health-related reading skills corresponding to 6th/7th grade. Specially, 2% were at the 3rd or lower grade level, 7% at the 4th/5th grade level, 35% at the 6th/7th grade level, 23% at the 8th/9th grade level, and 34% at the 10th or higher grade level. The mean NVS score indicated that participants showed on average marginal health literacy, with 33% inadequate level, 45% marginal level, and 23% adequate level. The mean KidsPoll score indicated that adolescents showed moderate to high levels of interest in health information. The REALM and NVS scores were significantly and positively correlated; however, REALM and NVS scores were not correlated with the KidsPoll score.

Association Of Sociodemographics With Health Literacy And Health Outcomes

As shown in Table 1, the REALM and NVS scores were negatively correlated with age in our 9th grade sample and positively correlated with White race. None of the covariates were significantly correlated with the KidsPoll scores. Older age and participation in the free lunch program tended to be correlated with more adverse health outcomes, whereas White race tended to be correlated with less adverse health outcomes.

Associations Between Health Literacy And Health Outcomes

Cross-sectional analyses—As shown in Table 2, regarding baseline general health, the KidsPoll score was positively associated with general health rating, $\beta = 0.14$, $p < .05$; that is, adolescents with higher KidsPoll scores reported better health at baseline. After accounting for covariates, the association of the KidsPoll score with general health rating remained significant, $\beta = 0.16$, $p < .05$. The REALM and NVS scores were not associated with baseline general health rating without controlling for covariates as well as after controlling for covariates. Regarding baseline unhealthy diet, adolescents with lower NVS scores (but not the REALM and KidsPoll) reported unhealthier diet at baseline without controlling for covariates, as well as after controlling for covariates. Regarding baseline weight status, adolescents with lower REALM scores (but not the NVS and KidsPoll) showed heavier weight status at baseline without controlling for covariates, and after controlling for covariates. Regarding baseline problem behaviors, adolescents with lower REALM scores (but not the NVS and KidsPoll) reported engaging in more problem behaviors at baseline; this association, however, was not significant after controlling for covariates. Health literacy scores explained a small to medium³⁹ amount of the variance in the four baseline health outcomes ($R^2 = .00$ to $.10$, without covariates; $R^2 = .02$ to $.13$, with covariates).

As shown in Table 3, regarding baseline substance use, none of the health literacy scores were significantly associated with baseline substance use, without controlling for covariates. After covariates were controlled for, however, the KidsPoll score was marginally associated with a lower probability of baseline substance use, $OR = 0.87$, $p < .10$; that is, adolescents with higher KidsPoll scores were less likely to use substances at baseline. Regarding baseline sexual behaviors, adolescents with higher REALM scores (but not the NVS and KidsPoll) were less likely to have experienced vaginal/oral sex at baseline without controlling for covariates, and after controlling for covariates. Health literacy scores explained a small to large³⁹ amount of the variance in the three baseline health outcomes (Nagelkerke $R^2 = .00$ to $.08$, without covariates; $R^2 = .04$ to $.15$, with covariates).

Prospective analyses—As shown in Table 4, adolescents with higher NVS scores showed greater substance use at follow-up after controlling for baseline substance use, $OR = 0.62$, $p < .05$, without controlling for covariates. After accounting for covariates, however, the association of the NVS score became non-significant. As was the case in the cross-sectional analyses, when covariates were controlled for, the KidsPoll score was marginally associated with a change in substance use over time, $OR = 0.82$, $p < .10$. Health literacy scores explained a large³⁹ amount of the variance in the subsequent substance use outcome (Nagelkerke $R^2 = .23$ to $.47$ with and without covariates in the model). The analyses testing

for other health outcomes at follow-up as a function of baseline health literacy were non-significant at $p < .05$ (data not shown).

DISCUSSION

This study contributes to the literature by demonstrating the role of health literacy in a range of health behaviors and outcomes in urban adolescents. Lower health literacy was associated with lower general health, unhealthier diet, heavier weight status, and greater engagement in problem behaviors and sexual behaviors cross-sectionally. Lower health literacy also was associated with a greater increase in substance use over 6 months. Most of the associations held after controlling for sociodemographic variables. Besides controlling for these potential confounders, our study has methodological strengths including the use of three validated health literacy measures, the examination of diverse health outcomes, and the use of an urban adolescent sample.

We found that 44% of our sample of 9th graders were reading at least two grades below expected health literacy levels as indicated by the REALM-Teen. Further, 77% showed inadequate or marginal health literacy levels as indicated by the NVS. These findings corroborate previous studies in the U.S.^{14,20,28,40} suggesting a high prevalence of limited health literacy in adolescents. This limited health literacy seems to be compounded for adolescents who were retained in school (“being held back”), as older age was associated with lower health literacy within our sample of 9th graders. Overall, despite the fact that participants indicated high levels of interest in health information (as indicated by the KidsPoll), many adolescents are unable to comprehend health information written at an 8th grade level. Poor health literacy is a serious public concern, because it limits adolescents’ ability to communicate their concerns with health providers, understand and follow providers’ instructions, and benefit from health services.¹³

Health literacy was associated with general health ratings, BMI-based weight status, and unhealthy diet. Our findings of general health rating and unhealthy diet are novel in the literature of adolescent health literacy. The weight status finding is consistent with a study demonstrating that limited health literacy was associated with heavier weight among overweight children.²⁷ Our finding of the association of the REALM-Teen scores with baseline problem behaviors and sexual behaviors are consistent with findings from a cross-sectional study,²⁶ showing that REALM-Adult scores were associated with risky sexual behaviors among women attending a free reproductive health clinic. We also found that adolescents with lower NVS scores were more likely to increase substance use over time. This finding is novel in the literature, although prior studies found that academic achievement is associated with later antisocial²¹ and aggressive behaviors.²² However, this prospective association was no longer significant once sociodemographics were controlled for. These results suggest that poor health literacy may be a marker of risky sociodemographic factors for adolescent substance use at least in the short-term. In particular, White race seems to explain the association of NVS scores with substance use (given its significant effect in the model with covariates, shown in Table 4, the second column of data); this is in line with greater increases in alcohol/substance use among Whites (as opposed to racial minorities) during adolescence.⁴¹

Divergent results were obtained on the three health literacy measures. There was a small association between the REALM-Teen and the NVS, and no association of the KidsPoll with the REALM-Teen and NVS. These divergent results may be due to differences in each measure's assessment of health literacy: that is, the REALM-Teen focused on adolescents' ability to read health-related words, the NVS focused on adolescents' ability to understand and manipulate quantitative health-related information, and the KidsPoll focused on self-reported comprehension of and motivation to obtain health information. Each measure may represent a distinct aspect of health literacy that is differentially associated with diverse health outcomes. This is consistent with the absence in consensus of the operational definition and core dimensions of health literacy.¹⁹ Further, there is little evidence of construct validity, including content, criterion and predictive validity, in most existing health literacy measures. Development and application of a consistent operational definition of adolescent health literacy across measures is critical to better identify adolescents with limited health literacy and guide intervention efforts. Multifaceted assessment that covers core dimensions of health literacy is also crucial to address variation across measures of adolescent health literacy and elucidate the complex associations between health literacy and diverse health behaviors.^{31,42}

Our findings should be interpreted in the context of several limitations. First, some of our health literacy and outcome measurements were not optimal. We administered the two interview-based health literacy measures to only a subset of our sample because of staffing cost. Also, our baseline weight categorization was based on self-reported weight and height (although, at follow-up, our staff measured height and weight). Second, although we used a prospective study design and controlled for potential confounders, this study is correlational in nature and thus causal conclusions should not be made. Further, some of our null findings in prospective analyses may be due to our short-term follow-up. Prospective studies with longer follow-up assessments are needed to examine the long-term predictive power of health literacy. However, these largely null findings in prospective analyses may have been due to lack of statistical power. Due to the absence of prospective studies on adolescent health literacy and health outcomes, no a priori power analysis was conducted. Future studies should identify an optimal sample size based on the effect sizes reported in our findings.

Despite these limitations, this study of urban high schoolers from diverse racial/ethnic and socioeconomic backgrounds found that health literacy levels measured by three validated health literacy measures are astonishingly low, and health literacy is associated with physical health outcomes and high-risk behaviors. Health promotion education needs to be tailored to the health literacy level of adolescents. Literacy enhancement in urban adolescents is a matter of pressing concern and it would yield important benefits for public health.

IMPLICATIONS FOR SCHOOL HEALTH

Given that health literacy has been acknowledged as a major public health issue² and numerous studies demonstrated that adolescent health behaviors are strongly associated with health literacy,^{20-22,24-26,43} the implications for school health are significant. The current study findings provide compelling evidence of urban high school students without functional

health literacy skills as well as robust associations of health literacy with unfavorable health outcomes in a number of diverse areas. These findings reinforce the importance of addressing health literacy in school settings and demonstrate “how education and health can collaborate to achieve both public health outcomes and high levels of skills and knowledge in students.”^{44(p205)}

School settings provide a unique physical and social environment in which educational, mental health, and physical services can be coordinated to improve students’ health literacy and health behaviors. Although often overlooked by public health prevention and intervention models, school systems have the potential to serve as a vital setting for achieving young people’s life-long health. Given that nearly half of the present sample was reading below their grade level and lower health literacy levels were associated with a myriad of health concerns, improving students’ basic literacy as well as health literacy skills through curriculum (eg, remedial reading programs) and school-based practices (eg, health promotion in health education classes) is critical. Although many schools have attempted to address health literacy by incorporating basic health knowledge (eg, healthy diet) into the curriculum, health education at school settings should focus on high risk behaviors (eg, consequences of alcohol and substance abuse, and sexuality and related risks for HIV/AIDS) that are prevalent among adolescents. Further, efforts should be expanded to include facilitating students’ communication and decision-making skills related to health behaviors as well as learning how to obtain health-related knowledge.¹¹ Finally, physical education programs are of importance to provide students a foundation for physical skills to maintain healthy lifestyles.

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Table 1
Means (and Standard Deviations) of Study Variables and Their Bivariate Correlation Coefficients

	M (SD) or %	1	2	3	4	5	6	7	8	9	10	11	12	13
1. REALM-Teen	57.39 (7.47)	1												
2. NVS	2.29 (1.59)	.26*	1											
3. KidsPoll	11.05 (1.84)	-.06	.03	1										
4. Age	14.51 (0.73)	-.23*	-.25*	-.03	1									
5. Male sex	43%	-.01	.06	-.09	.12 [†]	1								
6. White race	32%	.26**	.44***	-.09	-.09	-.05	1							
7. Free lunch program	59%	-.01	-.05	-.03	.17**	-.02	-.05	1						
8. General health rating	3.58 (0.97)	.18 [†]	-.03	.15*	-.08	.10	.03	.00	1					
9. Unhealthy diet	6.38 (2.85)	-.10	-.30**	.00	.11 [†]	.06	-.10	.10	.05	1				
10. Weight status	0.71 (0.87)	-.29*	-.11	-.06	.00	.07	-.11	.02	-.21**	-.05	1			
11. Problem behaviors	1.83 (1.49)	-.23*	-.12	-.06	.19**	.13 [†]	-.17**	.13*	-.19**	.12 [†]	.03	1		
12. Sexual behaviors	40%	-.25*	-.14	-.04	.22**	.14*	-.11 [†]	.11 [†]	-.07	.07	.18*	.41***	1	
13. Substance use	32%	.01	-.06	-.10	.22**	-.08	-.01	.08	-.13*	.18**	-.01	.32***	.37***	1
14. Substance use at follow-up	42%	-.12	-.30**	-.12	.19*	-.03	-.20**	.07	-.06	.20**	.06	.28***	.35***	.43***

[†]
p < .10.

*
p < .05.

**
p < .01.

p < .001.

N = 89 – 250 due to missing data. All study variables presented in this table were assessed at baseline, unless otherwise specified. REALM-teen = Rapid Estimate of Adolescent Literacy in Medicine-Teen version; NVS = Newest Vital Sign; KidsPoll = KidsHealth KidsPoll Health Literacy.

Standardized Coefficients Obtained From Multiple Regression Analyses Predicting Baseline Health Outcomes From Health Literacy Scores Without and With Controlling For Covariates

Table 2

	Baseline general health			Baseline unhealthy diet			Baseline weight status			Baseline problem behaviors		
	REALM	NVS	KidsPoll	REALM	NVS	KidsPoll	REALM	NVS	KidsPoll	REALM	NVS	KidsPoll
models without covariates												
Health literacy [‡]	0.19 [‡]	-0.03	0.14 [*]	-0.11	-0.32 ^{**}	-0.06	-0.29 [*]	-0.11	-0.06	-0.22 [*]	-0.13	-0.05
R ²	.04 [‡]	.00	.02 [*]	.01	.10 ^{**}	.00	.08 [*]	.01	.00	.05 [*]	.02	.00
Models with covariates												
Health literacy [‡]	0.17	-0.11	0.15 [*]	-0.07	-0.27 [*]	-0.05	-0.26 [*]	-0.07	-0.07	-0.16	0.00	-0.05
Age	-0.09	-0.11	-0.09	-0.08	-0.09	0.08	0.08	-0.05	-0.03	0.02	0.06	0.15 [*]
Male sex	0.13	0.16	0.13 [‡]	0.00	-0.02	0.05	-0.06	-0.06	0.06	0.05	0.06	0.09
White race	-0.02	0.09	0.04	-0.25 [*]	-0.17	-0.08	-0.10	-0.15	-0.12	-0.23 [*]	-0.28 [*]	-0.16 [*]
Free lunch program	0.07	0.05	0.02	-0.02	0.01	0.07	-0.09	-0.13	0.01	-0.06	-0.07	0.10
R ²	.07	.05	.04 [‡]	.07	.13 [‡]	.03	.11	.04	.02	.10 [‡]	.09	.09 ^{**}

[‡] p < .10.

^{*} p < .05.

^{**} p < .01.

^{***} p < .001.

N = 73 – 100 in analyses for REALM-Teen; N = 62 – 89 for NVS; N = 162 – 249 for KidsPoll. REALM = Rapid Estimate of Adolescent Literacy in Medicine-Teen version; NVS = Newest Vital Sign; KidsPoll = KidsHealth KidsPoll Health Literacy.

[‡]The health literacy variable refers to one of the three health literacy measure scores (ie, REALM-Teen, NVS, KidsPoll), as indicated on the top row of each column.

Table 3

Odd Ratios (And 95% Confidence Intervals) Obtained From Logistic Regression Analyses Predicting Baseline Health Outcomes From Health Literacy Scores Without and With Controlling For Covariates

	Baseline substance use			Baseline sexual behaviors		
	REALM-Teen	NVS	KidsPoll	REALM-Teen	NVS	KidsPoll
Models without covariates						
Health literacy [‡]	1.00 [0.95,1.06]	0.92 [0.69,1.24]	0.89 [0.77,1.03]	0.93 [*] [0.88,0.99]	0.83[0.62,1.11]	0.96 [0.83,1.10]
Nagelkerke R ²	.00	.01	.01	.08 [*]	.03	.00
Models with covariates						
Health literacy [‡]	1.02 [0.95,1.08]	1.01 [0.72,1.41]	0.87 [‡] [0.74,1.02]	0.94 [*] [0.89,1.00]	0.88 [0.63,1.22]	0.99 [0.85,1.14]
Age	1.37 [0.67,2.82]	1.32 [0.59,2.95]	1.97 ^{**} [1.32,2.93]	1.48 [0.72,3.05]	1.84 [0.81,4.20]	1.71 ^{**} [1.17,2.51]
Male sex	0.58 [0.22,1.52]	0.65 [0.24,1.77]	0.55 [‡] [0.31,1.00]	2.04 [0.82,5.07]	2.22 [0.86,5.75]	1.75 [*] [1.01,3.02]
White race	0.65 [0.22,1.87]	0.64 [0.19,2.16]	1.01 [0.55,1.85]	0.86 [0.31,2.42]	0.87 [0.27,2.88]	0.64 [0.36,1.16]
Free lunch program	1.31 [0.52,3.29]	1.32 [0.50,3.48]	1.22 [0.68,2.19]	1.54 [0.62,3.78]	1.70 [0.66,4.39]	1.54 [0.88,2.70]
Nagelkerke R ²	.05	.04	.10 ^{**}	.15 [‡]	.13	.11 ^{**}

[‡]p < .10.

^{*}p < .05.

^{**}p < .01.

^{***}p < .001.

N = 97 – 100 in analyses for REALM-Teen; N = 86 – 89 for NVS; N = 241 – 249 for KidsPoll. REALM-Teen = Rapid Estimate of Adolescent Literacy in Medicine-Teen version; NVS = Newest Vital Sign; KidsPoll = KidsHealth KidsPoll Health Literacy.

[‡]The health literacy variable refers to one of the three health literacy measure scores (ie, REALM-Teen, NVS, KidsPoll), as indicated on the top row of each column.

Table 4

Results From Logistic Regression Analyses Predicting Follow-Up Substance Use From Health Literacy Scores Without and With Controlling For Covariates

	Substance use at follow-up		
	REALM-Teen	NVS	KidsPoll
Models without covariates			
Health literacy [†]	0.96 [0.90,1.02]	0.62 * [0.43,0.91]	0.89 [0.75,1.07]
Baseline substance use	11.43 *** [3.36,38.88]	13.65 *** [3.59,51.87]	6.96 *** [3.41,14.18]
Nagelkerke R ²	.29 ***	.39 ***	.23 ***
Models with covariates			
Health literacy [†]	0.99 [0.91,1.06]	0.72 [0.47,1.11]	0.82 [†] [0.67,1.00]
Baseline substance use	14.24 *** [3.29,61.67]	17.56 *** [3.72,82.93]	6.73 *** [3.11,14.53]
Age	0.73 [0.28,1.93]	0.59 [0.20,1.77]	1.38 [0.79,2.41]
Male sex	0.64 [0.21,1.95]	0.69 [0.20,2.36]	0.96 [0.47,1.97]
White race	0.08 ** [0.02,0.43]	0.14 * [0.03,0.80]	0.34 * [0.15,0.76]
Free lunch program	0.67 [0.22,2.08]	0.82 [0.24,2.76]	0.98 [0.49,1.95]
Nagelkerke R ²	.44 ***	.47 ***	.29 ***

[†] p < .10.

* p < .05.

** p < .01.

*** p < .001.

N = 82 – 85 in analyses for REALM-Teen; N = 76 – 79 for NVS; N = 176 – 181 for KidsPoll. REALM-Teen = Rapid Estimate of Adolescent Literacy in Medicine-Teen version; NVS = Newest Vital Sign; KidsPoll = KidsHealth KidsPoll Health Literacy.

[†]The health literacy variable refers to one of the three health literacy measure scores (ie, REALM-Teen, NVS, KidsPoll), as indicated on the top row of each column.