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The Association Between Health Literacy and Physical Activity in the U.S. Population

By

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Master of Public Health

Epidemiology

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The Association Between Health Literacy and Physical Activity in the U.S. Population

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B.S.
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2016

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An abstract of
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Abstract

The Association Between Health Literacy and Physical Activity
in the U.S. Population

By Caroline Goodroe

Low health literacy is a prevalent issue affecting the health of the U.S population. To understand how literacy truly affects overall health, there is a need to determine how health literacy is associated with specific health behaviors. There is strong evidence that physical activity is a health behavior that significantly impacts overall health status. The objective of this study is to examine the relationship between health literacy and physical activity. This relationship can explain the role of health literacy as one influential factor of an individual's health status. This study analyzed data from 2,593 individuals who completed the Health Information National Trends Survey 5 (Cycle 1). Two multivariate logistic regression models were run, one for aerobic physical activity and one for muscle-strengthening physical activity. Differences in physical activity level were not statistically significant across any of the health literacy groups. For the model of aerobic physical activity, there was a trend of higher health literacy being associated with greater likelihood of adequate physical activity (OR=1.97; 95% CI: 0.97 – 3.61). There was not a clear trend for the association between health literacy and muscle-strengthening activity. The results of this study do not indicate a relationship between health literacy and physical activity. The lack of significant association between health literacy and activity in the general population may suggest that associations are more significant among medically vulnerable subpopulations such as individuals with chronic conditions. This information still supports the importance of health literacy and may further highlight the necessity of targeted public health programs that address particularly vulnerable groups.

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Chapter I: Literature Review

Health Literacy

Health literacy is a concept that gained attention in the public health and healthcare fields in the 1990s (1). Health literacy is standardly defined as the degree to which an individual has the ability to find, process, and understand basic health information and healthcare services (2). Functionally, health literacy is the level to which an individual has the skills needed to access appropriate information and use that information to make decisions related to their health (3). In the United States, it is estimated that 77 million adults have basic or below basic health literacy, indicating that these individuals do not have the skills necessary to complete even simple health tasks, such as following directions on a prescription label (4).

Certain characteristics, like education, race, and age, are consistently associated with health literacy level. Half of adults with less than a high school degree have below basic literacy levels. However, higher education does not always mean higher health literacy, as it has been shown that 12% of adults with a bachelor's degree or higher have basic or below basic health literacy (4). Nearly two-thirds of Hispanic adults have basic or below basic health literacy, which is the highest of any racial or ethnic group (5). African-Americans have the second highest percentage of adults with low health literacy levels, while white Americans have the lowest percentage (5). Individuals over age 65 are more likely to have limited health literacy, indicating that age is negatively associated with literacy (4).

Costs

Low health literacy has been associated with poor healthcare utilization, which can lead to an overall poorer health status and greater healthcare costs (6). Individuals with low health literacy are less likely to use preventative health services, including cancer screenings and influenza vaccinations (7, 8). Individuals with low health literacy are more likely to be hospitalized for health issues and have greater use of emergency departments as their primary access to health care (9, 10). Individuals with limited health literacy are less efficient when using the healthcare system, which leads to higher average per patient costs (11, 12). The patterns of inefficient healthcare utilization and inadequate health management have costly impacts for the entire healthcare system (13). In the United States, low health literacy has been estimated to cost hundreds of billions of dollars every year in direct care costs, and the indirect costs are estimated to be greater than one trillion dollars each year (13). High population levels of low health literacy impact not just patient health, but also the quality and efficiency of the United States healthcare system (14).

National Implications

The growing understanding of the prevalence and impact of low health literacy in the United States has implications for policy and healthcare (13). In 2010, the U.S. Department of Health and Human Services released a "National Action Plan to Improve Health Literacy," which lays out seven goals to improve the health literacy of the U.S. population (15). Health professional organizations, including the National Institutes of Health, the American Medical Association, and other clinical organizations, have also

made health literacy a focal point for their members (15). The 2010 Affordable Care Act (ACA) contained several direct and indirect mentions of health literacy as a part of the changes being made to the U.S. healthcare system (16). The ACA did not specifically call for the creation of health literacy programs or regulations of any kind; however, all of the mentions of health literacy in the ACA called for effective communication and a focus on patient-centered communication strategies.

Measures

The increased awareness among policymakers and health professionals regarding the importance of health literacy has highlighted the need for continued health literacy research (16). As the amount of research has grown, so has the development of health literacy measures. As of 2017, over 150 different health literacy measures exist (17). Despite these measurement options, the majority of historical health literacy research has commonly used two measures, the Rapid Estimate of Adult Literacy in Medicine (REALM) or the Test of Functional Health Literacy in Adults (TOFHLA) (17). Both of these measures focus on an individual's general literacy capabilities, not on their actual skills and abilities to engage with health information or healthcare (18). The REALM is a medical term pronunciation test, and TOFHLA includes both reading comprehension and numeracy components (19). Although these measures are frequently used, they both have significant limitations (17, 20). A major concern with both the REALM and TOFHLA is that the tests overemphasize print literacy ability, which while important, is not the only aspect of health literacy (17-19). Another limitation is that both tests focus on medical terms and settings, which means that the measures are not fully assessing health literacy

outside of the clinical setting (20). In addition, both instruments are administered in-person, which can be cumbersome for researchers and may cause test anxiety or frustration for the patient, which could confound results (20).

Newly developed tools for health literacy measurement have taken into account the weaknesses and limitations of the REALM and TOFHLA. These new tools typically incorporate measures to assess multiple domains of health literacy. Domains are based on conceptual frameworks of health literacy and include skills like listening, numeracy, and information seeking (17). In 2003, the National Assessment of Adult Literacy (NAAL) used a skills-based, multiple domains approach, including written literacy and information seeking, to conduct the first national assessment of health literacy in adults (17, 21). Data from another national survey administered by the National Cancer Institute, the Health Information National Trends Survey (HINTS), has assessed health literacy using a screener item method, where items already included in the HINTS survey are used as single item measures of health literacy. The screener item measures are included in the main study questionnaire, so health literacy can be measured without having to administer a separate assessment (18). Since the primary goal of HINTS is to provide a comprehensive assessment of the American public's access to and use of information about cancer and healthcare, the survey involves items related to health information seeking and comprehension. Multiple HINTS items have been used as screener questions to measure health literacy in the HINTS dataset. One study used HINTS items that measured awareness of clinical research results and interpretation of risk measures to assess various domains of health literacy, including scientific literacy and numeracy (22, 23). This study created a screener tool using the selected items, and

found that the tool produced a health literacy measure that was associated with known demographic factors associated with health literacy (23). More commonly, studies have used HINTS questions about confidence when information seeking and health information comprehension as the screener measures to assess health literacy (24, 25).

The literacy measurement tools previously described highlight some of the potential issues in the area of health literacy measurement. There currently is not any standard tool to comprehensively measure health literacy (18). There is a lack of consistent measurement since the different tools available focus on different aspects of health literacy (17). This lack of consistency affects the generalizability, and possibly even the validity, of health literacy research (17). However, since a standard measurement tool is not available, this research will use the single item screener method to assess literacy.

Health Literacy and Health Behaviors

There remains unknown aspects of the overall spectrum of relationship between literacy and health, such as whether or not improving health literacy can improve the health behaviors of an individual. The associations between health literacy and different types of health behaviors have been studied, but this research is limited to associations in specific subpopulations, like individuals with diabetes or heart transplant patients (26, 27). Some of the behaviors that are associated with health literacy include physical activity, nutrition, smoking, and weight control. These healthy behaviors are directly associated with health literacy, with low literacy being associated with less healthy behaviors, like physical inactivity, daily smoking, unhealthy BMI, and poor diet (26-28).

One study of over 3,000 cardiovascular disease patients found that patients with low health literacy scores were more likely to exhibit unhealthy physical activity and diet behaviors. Patients who had adequate health literacy were half as likely to be physically inactive (OR= .48, CI_{95} .39-.59) and less likely to have an unhealthy diet (OR= .64, CI_{95} .47-.88) when compared to patients with lower health literacy. Results from this study also found that the strength of association varied by the severity of behavior, with low health literacy levels being more strongly associated with extreme unhealthy behaviors like daily smoking and unhealthy diet (28).

The limited research examining the associations between health literacy and health behaviors in the general population have typically focused on health status rather than specific health behaviors. One study of adults in the UK did examine specific behaviors and found associations between higher health literacy and higher fruit and vegetable consumption, as well as higher odds of being a non-smoker. In the general population, several studies found positive associations between health literacy and overall health status (29, 30). Interestingly, a study of the adult population in Hawaii found that both individual and community health literacy are associated with individual health status, indicating a possible need to consider community level interventions when addressing health literacy (29).

To fully assess the association between health literacy and overall health, there is still a need to identify relationships between health literacy and beneficial health behaviors in the general population. Analyzing the relationship between health literacy and physical activity is an important step towards the overall assessment of literacy and behavior. Research supports the possible association between health literacy and physical

activity, with higher health literacy being associated with better levels of physical activity among older adults and heart transplant recipients (27, 31). These results consistently show that health literacy and physical activity are positively associated in certain medically vulnerable subpopulations. In addition, determining if health literacy and physical activity are associated could provide evidence for the role of health literacy on overall health status since physical activity is known to have multiple health benefits, and there is a strong relationship seen between amount of physical activity and an individual's overall health status (32). The physical activity guidelines in the U.S. recommend that adults get 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic activity and at least two days of muscle-strengthening activities per week (33). Only 26% of men and 19% of women in the U.S. are currently achieving the recommended amount of physical activity (34). Adherence to the United States guidelines is associated with reduced all-cause mortality risk among adults, and adults with at least one chronic condition show the greatest reduction in relative mortality risk (35). In conclusion, there is data highlighting the importance of physical activity for overall health, and research showing associations between health literacy and physical activity in subpopulations supports the possibility of an association between heath literacy and physical activity in the general population (27, 31).

Several sociodemographic covariates like age, gender, ethnicity, income, health status, and education are consistently controlled for in studies that have looked at the relationship between health behaviors and health literacy (27, 31). In addition to these covariates, previous literature indicates that self-efficacy is a predictor of various health behaviors, including physical activity, and also may be an important covariate (36). Self-

efficacy is an indication of the individual's belief in their abilities to complete tasks. Individuals with higher perceived self-efficacy chose to do more challenging tasks and pursue higher goals, both related to health behaviors and in other contexts (37). Some of the specific health behaviors that high perceived self-efficacy is associated with include the incorporation and maintenance of physical activity and weight control behaviors (37, 38). In a recent study of a low-income, Hispanic population, the interaction of self-efficacy and health literacy was found to be significantly associated with amount of weekly exercise (39). In addition, self-efficacy was found to modify the effect of an educational intervention aimed at increasing physical activity through increased health knowledge (38). Health literacy and self-efficacy have also been found to be independently associated with each other in several studies (40, 41). This data suggests the need to consider self-efficacy, in addition to the other sociodemographic factors, as a potential covariate of the association between health literacy and physical activity.

Summary

There has been extensive research indicating that low health literacy is associated with poor health behaviors and worse health outcomes. This information alone is helpful in providing evidence to support the need for improving health literacy. Since low health literacy is associated with poor health outcomes and behaviors, there is an assumption that improving literacy could contribute to improving an individual's overall health. If improving health literacy can mitigate the poor health behaviors normally associated with low health literacy, then the health outcomes of individuals could be improved, but truly improving overall health also depends on the incorporation of healthy lifestyle behaviors.

While there has been research looking at associations between health literacy and healthy behaviors like physical activity in higher risk populations, like the elderly and individuals with chronic conditions, there is still a need to determine if higher health literacy is associated with a higher display of physical activity in the general U.S. adult population (28, 42, 43).

Objectives

The overall goal of this research is to determine the association between health literacy and physical activity in the U.S. adult population. For the purpose of this study, health literacy is measured by self-reported health information comprehension (44, 45). This study will consider the association between health literacy and two different measures of physical activity. The measures of physical activity are the number of minutes of aerobic activity and the number of days of muscle-strengthening activity per week. In addition, this study will assess self-efficacy as a possible covariate of the relationship between health literacy and health behaviors.

Significance

Determining if an association exists between health literacy levels and physical activity levels is an important need that must be addressed. By determining if high health literacy and adequate physical activity are associated, we could identify strong evidence for the role of high health literacy on good health outcomes. This evidence will strengthen the argument for a greater emphasis on health literacy as a target for health interventions and will help define the role of health literacy as one influential factor of an

individual's health status. By assessing the relationship between health literacy and physical activity, and the effects of self-efficacy on that relationship, we will have better data to develop future interventions. Specifically, low health literacy and inadequate physical activity are both issues that severely impact the health of the U.S. population (5, 46). This research can assist with explaining the relationship between health literacy, physical activity, and self-efficacy, which will help public health professionals and policymakers implement the best evidenced-based interventions to address low health literacy and physical inactivity in the U.S. population.

Chapter II: Manuscript

Introduction

In the United States, an estimated 77 million adults have basic or below basic health literacy (4). Known associations between an individual's health literacy level and their overall health have led to low literacy being a topic of concern for policymakers and health professionals alike (6, 15, 16). Prior research has identified associations between low literacy and poor health outcomes and health status (6). Research has also found relationships between health literacy and health behaviors in certain populations, for example diet and physical activity among cardiovascular disease patients, and medicine adherence in patients with HIV (28, 47). However, little is known about the associations between health literacy and health behaviors in the general population. In order to understand where health literacy fits in the overall picture of individual health and future health programs, more information is needed about specific associations between health literacy and behaviors. To begin addressing this knowledge gap, this study examines the association between health literacy skills and physical activity level in data from 2,593 adults who completed the nationally representative Health Information National Trends Survey (48).

Physical activity was chosen as the health behavior of interest for two reasons. First, physical activity is a health behavior that has been definitively proven to have multiple health benefits, and there is a linear relationship between amount of physical activity and an individual's overall health status (32). Because the link between physical activity and overall health is well documented, determining if health literacy and physical

activity are associated could provide strong evidence for the importance of health literacy on overall health. Second, research supports the possible association between health literacy and physical activity, with higher health literacy being associated with better participation in moderate to vigorous physical activity in older adults (31). Adequate health literacy is also associated with sufficient levels of physical activity among heart transplant recipients (27). These results consistently show that health literacy and physical activity are positively associated in certain medically vulnerable subpopulations, but there is still the need to identify if this relationship is present in the general population as well.

In addition to examining the association between health literacy and physical activity, this study assesses the role of self-efficacy as a covariate. Self-efficacy is an indication of an individual's belief in their abilities to execute behaviors and meet goals. Individuals with higher perceived self-efficacy chose to do more challenging tasks and pursue higher goals, both related to health behaviors and in other contexts (37). Some of the health behaviors that high perceived self-efficacy is associated with include the incorporation and maintenance of physical activity and weight control behaviors (37, 38). In a recent study of a low-income, Hispanic population, the interaction of self-efficacy and health literacy was found to be significantly associated with amount of weekly exercise (39). Self-efficacy also was found to modify the effect of an educational intervention aimed at increasing physical activity through increased health knowledge (38). Health literacy and self-efficacy have been found to be independently associated with each other in several studies (40, 41). These data suggest that when studying the relationship between physical activity and health literacy, self-efficacy should be

considered as a covariate, in addition to the sociodemographic covariates like age, gender, ethnicity, income, health status and education that have been included in previous studies (27, 31).

The primary purpose of this study is to examine the association between health literacy levels and physical activity levels in the general population. Furthermore, it will assess the role that self-efficacy plays as a covariate of the association between literacy and physical activity.

Methods

Study Design

Data were obtained from the 2017 Health Information National Trends Survey (HINTS 5, Cycle 1), which was administered between January and May 2017. HINTS is a nationally representative cross-sectional survey conducted by the National Cancer Institute (NCI) that aims to provide a comprehensive assessment of the American public's access to and use of information about cancer and healthcare (49). The study's target population is adults aged 18 or older in the non-institutionalized population of the United States (48).

Sampling

The survey used a two-stage sampling design to recruit participants (48). First, a stratified sample of addresses was selected from a database of residential address in the

United States. The second stage consisted of selecting one adult from each sampled household, using the Next Birthday Method to identify which adult would be selected (48). The addresses were stratified by concentration of minority population, and the high-minority strata were oversampled to have adequate sample sizes to represent minority populations (48). The data were weighted to be nationally representative. A nonresponse weighting adjustment was used to adjust for any bias due to nonresponse (48). The nonresponse data was weighted using a quasi-randomization paradigm, where nonresponse adjustment factors were calculated based off variables highly correlated with response likelihood (48).The overall response rate was 32.4% with a final sample of 3,285 participants. The estimated size of the total weighted sample is 247,789,111. For this study, 692 participants who reported never looking for health information were excluded from analysis; resulting in a sample of 2,593 eligible participants (weighted sample of 194,316,561) (48).

Data Collection

The HINTS 5, Cycle 1 survey contained 135 questions focused on the degree to which participants understand health information and how they access and use that information (48). The survey was administered exclusively through mail, with a call-in help line available to answer any questions or concerns from participants. The initial survey sent to all households was in English, but a Spanish version of the survey was available if requested by the participant (48). Thirteen out of the 3,285 submitted surveys were completed in Spanish. The survey was estimated to take between 20 and 30 minutes to complete, and more than 75% of participants reported spending 30 minutes or less on the survey (48).

Measures

Outcomes. This study examined two different physical activity outcome variables, aerobic activity and muscle-strengthening activity. Both outcomes were coded dichotomously to indicate whether the participant met the recommend guidelines. The current U.S. guidelines recommend that adults get at least 150 minutes of moderate aerobic activity every week (33). The HINTS survey included questions about the number of days per week a participant does aerobic physical activity and the average amount of time of activity. Using the number of days of aerobic activity and the average amount of time, a variable was created to capture the weekly minutes of moderate aerobic activity for participants. Using the total weekly minutes of activity, a dichotomous variable was created for aerobic physical activity, with the 150 minute guideline as the cutoff point. The U.S. guidelines also recommend that muscle-strengthening activities be done at least two days each week and the HINTS survey included a question about the number of days per week a participant does muscle-strengthening physical activity (33). A dichotomous variable was created for muscle-strengthening physical activity, using two days per week as the cutoff.

Exposure. Health literacy was measured using the response to the HINTS item, "The (health/medical) information you found was hard to understand" as a single question screener for health literacy with respect to the ability to comprehend health information. This item has been used as a measure of health literacy in previous studies (24, 50). The variable was measured with a four point rating scale (strongly

agree/somewhat agree/somewhat disagree/strongly disagree). These ratings were recoded in terms of health literacy levels, with strongly agree being coded as below basic literacy, somewhat agree as basic literacy, somewhat disagree as intermediate literacy, and strongly disagree coded as proficient literacy (5). The health literacy variable was also examined using a dichotomous coding scheme (below basic/basic versus intermediate/proficient) and a three-level coding where the lower two groups were combined into one group. Models using different coding schemes were similar to the final models, which include health literacy as a four level variable.

Covariates. Measures included age, education, race/ethnicity, gender, household income, self-reported health status, and self-reported confidence in ability to find health information, which was used to measure participant self-efficacy (24, 51).

The age variable was recoded into four categories: 18 to 34 years, 35 to 49 years, 50 to 64 years, 65 to 74 years, and 75 years or older. Education was grouped into four categories: less than high school, high school graduate, some college, and college graduate or higher. A combined race/ethnicity variable was created that had five categories: non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic Asian, and non-Hispanic other. Income was coded into five categories of household income: less than $20,000, $20,000 to less than $35,000, $35,000 to less than $50,000, $50,000 to less than $75,000, and $75,000 or more. Self-reported health status was initially measured on a five point scale (excellent/very good/good, fair/poor), but was recoded to create a four level variable, with the fair and poor categories combined to ensure adequate stratum size. Self-reported confidence was initially measured on a five point scale

(completely/very/somewhat/a little/not at all), and was recoded to a dichotomous variable with "completely/very confident" versus "somewhat/a little/not at all confident." This dichotomizing is consistent with how previous studies have examined this HINTS item (24, 50).

Data Analysis

Data were analyzed using SAS version 9.4 (Cary, NC). The SAS survey procedures were used to account for the complex sampling design and to adjust for the sample weights. First, the distribution of eligible participants was calculated for all the outcome, exposure, and covariate measures. Second, participants were grouped by health literacy level, and descriptive statistics were presented for the characteristics of each health literacy level. All data were reported with weighted percentages and *P* values from unadjusted Wald chi-square tests were used to analyze the differences between the health literacy groups. Significance was set at $\alpha = 0.05$. Third, the crude relationship between physical activity and health literacy was assessed using unadjusted logistic models. Finally, multivariate logistic regression models were run to assess the association between physical activity and health literacy while adjusting for other variables. Two models were run, one for aerobic physical activity and one for muscle-strengthening physical activity. Self-efficacy was assessed as both a potential confounder and as an effect modifier, but all other variables were only assessed as confounders. Modification was assessed in both models using a Wald chi-square test. Self-efficacy was not a statistically significant modifier for either model, and the interaction terms were dropped from the final models. Potential confounders were evaluated by first running the fully-

adjusted model and then dropping potential confounders one-by-one. Any variable that changed the estimated odds ratio by more than 10% was considered a significant confounder and kept in the final model. Both final models were adjusted for age, gender, race/ethnicity, and self-efficacy. The muscle-strengthening model was also adjusted for education and household income. Health status was not included in either final model. In addition to the primary analysis, the data was stratified by age and race to assess potential modification. The stratified results indicate there are differences in association by age and race, but further research is needed.

Results

Table 1 presents the characteristics of the study population using weighted statistics to represent population-level characteristics. Participants were predominately younger than 65 years old and were evenly distributed by gender. Most participants were non-Hispanic whites (69%) and most had at least some college education (74%). Many of the participants reported household incomes of $75,000 or more, good or very good health status, and high self-efficacy for health information seeking. Overall, 44% of participants met the aerobic physical activity guideline and 34% met the muscle-strengthening guideline. Among the participants, 38% had proficient literacy, 38% had intermediate literacy, 19% had basic, and the remaining 5% had below basic literacy.

When stratifying by health literacy level, all demographic covariates, except gender, were statistically significantly associated with health literacy levels (Table 2). Participants with higher health literacy tended to have more education, with 40% of the

proficient group being at least college graduates, compared to only 28% of the below basic group. In addition, 41% of participants with proficient health literacy made at least $75,000, while only 16% of the participants with below basic literacy did. Participants with higher health literacy were more likely to report better overall health status, and 85% of the participants with proficient health literacy reported high self-efficacy compared to only 32% among the participants with below basic literacy. There was no statistical difference across health literacy levels for aerobic physical activity (p=0.0600) or for muscle-strengthening physical activity (p=0.5385).

The associations between health literacy level and physical activity were further examined using logistic models adjusted for the sociodemographic covariates (Table 3). The final models did not include any interaction terms, since self-efficacy was not a significant modifier. The model for the association between health literacy and aerobic physical activity did not produce statistically significant associations at any of the literacy levels. Similarly, there were no statistically significant associations between health literacy and muscle-strengthening physical activity. Of note, when physical activity was modeled as the likelihood of any physical activity versus no physical activity, the crude association between health literacy and physical activity was significant for the group with the highest health literacy (OR=1.88; 95% CI: 1.07, 3.32). However, after adjusting for confounders, the association was no longer statistically significant (OR =1.26; 95% CI: 0.54, 2.93).

Discussion

Results from this study suggest that while individuals with high health literacy may be more likely to meet physical activity guidelines than individuals with low health literacy, the overall relationship between physical activity and health literacy is not significant. Results also indicate that self-efficacy does not have a modifying effect on the association between physical activity and health literacy. These findings, which are some of the first to examine the relationship between physical activity and health literacy among the general population, contribute several new ideas and provide more evidence for some previously identified associations.

These results support previously identified associations between health literacy and various sociodemographic factors. Similar to results from the National Assessment of Adult Literacy, this study found that adults over the age of 65 were more likely to have basic or below basic health literacy than younger adults (4). In addition, our findings indicate an association between health literacy and race/ethnicity. However, while previous studies have found Hispanics to have the greatest percentage of below basic scores, this study found individuals with “other” race/ethnicity to have the greatest percentage of below basic scores (4, 5). For this study, individuals were classified as “other” race/ethnicity if they were non-Hispanic, and multiracial, Native American, or islander origin. Variations between studies in the classification of race and ethnicity may have led to these differing results. In this study, as in previous studies, education and household income varied directly with health literacy, with lower education and lower income being associated with lower health literacy (4, 5). This study also found a

significant difference in overall health status by health literacy levels, with more individual with low literacy reporting fair or poor overall health. Previous studies have identified this association among specific populations, and this study provides further evidence to support the association between health literacy and overall health status among the general American population (29, 52).

Also in support of previous findings, this study found a significant association between health literacy and self-efficacy, with low health literacy being associated with low self-efficacy (40, 47, 53). Prior studies had identified the association between literacy and efficacy among individuals with HIV or diabetes (47, 53). This study provides evidence that the association is also present among the general adult population. However, when we consider self-efficacy as a modifier of the relationship between health literacy and physical activity, we found that self-efficacy was not a significant modifier, which is not consistent with previous research (38, 39). This difference may be a factor of the study populations. Self-efficacy was a significant modifier among a study population of low-income, Spanish-speaking adults in the U.S. This study's population is nationally representative and therefore more diverse across most sociodemographic factors. The data from this study do indicate that there are possible difference in the associations when stratified by race or age, and these differences are not apparent when the data is not stratified (Table S2 and S3). The absence of significant modification by self-efficacy in the general population indicates that the influence of self-efficacy may only be significant in certain populations, like low-income, Spanish-speaking adults (39).

Although our analysis did not identify a significant relationship between health literacy and physical activity, prior studies have found these factors to be significantly

associated in medically vulnerable subpopulations, like the elderly and heart transplant patients (27, 28, 31). There are several possible reasons that could explain this difference. First, it is possible that the effect of health literacy is greater and more significant in the medically vulnerable populations previously studied. Studies have shown that health literacy is more strongly associated with the extreme ends of health behavior spectrums and the effects of physical activity are greater for individuals with chronic conditions (28, 35). It is feasible that the association between health literacy and physical activity is only present in certain medically vulnerable groups, like low literacy individuals with chronic conditions, where the impact of health literacy and physical activity is greater. Another possible reason for the difference is that this study considered adequate physical activity as meeting the U.S. guidelines for activity, while other studies compared doing *any* physical activity to doing *no* physical activity (28, 31). These differing cutoffs change how individuals are grouped, and comparing any physical activity to none could create groups with greater differences than comparing based on guidelines. These differences in grouping could influence the significance of the association between literacy and activity. With this in mind, this study did consider the association between literacy and activity using any physical activity as the cutoff point. While the crude association in that model was significant, after adjusting for confounding there was no significant association between health literacy and any amount of physical activity (Table S1).

By analyzing the relationship between health literacy and physical activity in a nationally representative population, this study provides data that address the gaps in the current knowledge. Previous studies have identified significant associations between

health literacy and physical activity in medically vulnerable subgroups, but the results from this study suggest there is no significant association in the general population.

Strengths and Limitations

There are at least two strengths of this study. First, this study used the existing HINTS survey for analysis. Use of this rich dataset allowed for access to multiple variable for evaluation of the exposure and outcomes of interest, as well as any potential covariates. Second, using the HINTS data allowed this study to have a large sample size and appropriately calculated survey weights to produce nationally representative estimates.

Despite these strengths, there are at least four limitations. First, due to the cross-sectional design of the HINTS survey, we can only assess associations between variables and cannot assess any causality in the data. Second, there is the possibility of self-report bias and this study did not use any validation measures to ensure survey data accuracy. Another study limitation is the low response rate of 32.4%. While the data was weighted to adjust for the nonresponse, there is the possibility of residual nonresponse bias that was not resolved in the weighting process (48). Any unaddressed biases in the data, whether self-report or residual nonresponse bias, could affect the associations estimated using the data. Finally, while using a single survey question to assess health literacy is a simple and efficient way to gauge the status of participants, it is a more limited measure than a tool examining components of health literacy (22).

Future Studies

Though the results of this study do not indicate a significant association between health literacy and physical activity, the overall evidence of an association is still inconclusive. Further studies are needed to examine if the association is only significant among medically vulnerable populations and truly not significant for the general population. Also, stratified results from this data indicate there are differences by age and race, but more research is needed to determine if these difference are significant. One option for future research is to use validated measures of health literacy and physical activity. While there is not one gold-standard measure of health literacy, there are more comprehensive measures than the single screener method used for this study (17). There are also objective measures of physical activity other than self-report, such as wearing an accelerometer. Another option for continued research is to do an updated national assessment, like the National Assessment of Adult Literacy, that also contains health behavior data. The assessment could be designed to ensure adequate sample sizes for a stratified analysis by race and age. Other research options include experimental studies to assess the effect of health literacy interventions such as educational programs on changing physical activity habits. Experimental interventions would provide the strongest evidence if there is any causal relationship between health literacy and physical activity in any population. These future studies could provide valuable information about the relationship between physical activity and health literacy, and this information would inform not only public health interventions, but also policy decisions and funding decisions.

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Tables

Table 1. Characteristics of HINTS 5, Cycle 1 Survey Participants (n=2,593)		
	N	**Weighted %**
Age, years		
18-34	299	22.5
35-49	533	28.7
50-64	864	30.4
65-74	541	11.3
75+	271	7.0
Gender		
Male	1,023	48.0
Female	1,521	52.0
Race/Ethnicity		
White	1,594	68.8
Black	281	8.6
Hispanic	297	14.6
Asian	101	5.3
Other	96	2.7
Education		
Less than high school	112	5.8
High school grad	421	19.8
Some college	740	34.3
College grad or higher	1,256	40.1
Income		
<$20,000	358	13.9
$20,000 to <$35,000	308	12.2
$35,000 to <$50,000	307	15.1
$50,000 to < $75,000	444	19.2
$75,000 or more	947	39.6
Overall Health Status		
Fair/Poor	423	15.9
Good	877	34.2
Very Good	972	38.3
Excellent	293	11.7
Self-efficacy		
Somewhat/Not confident	981	38.6
Completely/Very confident	1,596	61.4
Met Physical Activity Guideline		
No	1,475	56.0
Yes	1,081	44.0
Met Strength Guideline		
No	1,648	65.6
Yes	845	34.4
Health Literacy Level		
Below Basic	141	5.2
Basic	487	18.5
Intermediate	932	38.2
Proficient	967	38.1

Table 2. Characteristics of Survey Participants, by Health Literacy Level

	Below Basic (n=141)		Basic (n=487)		Intermediate (n=932)		Proficient (n=967)		X^2 p-value
	N	Weighted %	N	Weighted %	N	Weighted %	N	Weighted %	
Age, years									
18-34	15	27.4	35	15.0	137	26.8	111	22.3	0.0109
35-49	20	25.5	94	26.7	209	29.3	202	29.9	
50-64	48	28.3	169	34.9	308	28.3	329	30.8	
65-74	36	13.1	108	13.0	177	10.3	200	10.9	
75+	11	5.7	64	10.4	75	5.2	100	6.2	
Gender									
Male	60	58.8	218	49.5	388	49.3	341	45.4	0.3561
Female	73	41.2	258	50.5	534	50.7	613	54.6	
Race/ethnicity									
White	68	67.4	292	68.1	616	71.7	597	66.3	0.0222
Black	14	8.7	49	6.1	74	5.3	136	13.0	
Hispanic	25	15.3	54	15.8	102	14.4	112	14.5	
Asian	5	2.8	23	6.5	45	6.8	26	3.3	
Other	8	5.8	21	3.5	35	1.9	32	2.9	
Education									
< High school	20	15.8	35	8.5	17	2.8	29	4.9	0.0016
High school grad	29	25.7	100	23.1	126	17.1	142	19.0	
Some college	43	30.9	139	34.1	254	33.4	288	36.4	
College grad or higher	43	27.6	196	34.3	516	46.8	490	39.6	
Income									
<$20,000	37	36.8	95	20.5	92	7.3	113	12.9	<.0001
$20,000 to <$35,000	18	12.8	70	16.4	93	10.3	117	12.0	
$35,000 to <$50,000	20	16.5	62	11.7	97	17.7	120	13.6	
$50,000 to <$75,000	23	18.3	74	19.4	168	18.2	171	20.3	
$75,000 or more	28	15.6	140	32.0	403	46.5	371	41.2	
Overall Health Status									
Fair/Poor	43	26.8	93	17.9	139	16.3	124	11.8	<.0001
Good	50	35.4	188	37.2	308	32.0	307	34.4	
Very Good	30	24.9	166	40.0	379	40.8	388	38.5	
Excellent	15	12.9	33	4.8	98	11.0	139	15.4	
Self-Efficacy									
Somewhat/Not confident	99	68.1	333	66.1	376	44.1	143	15.1	<.0001
Complete/Very confident	40	31.9	150	33.9	555	55.9	822	84.9	
Met Physical Activity Guideline									
No	82	64.0	290	60.8	521	55.9	543	52.0	0.0600
Yes	52	36.0	192	39.2	401	44.1	415	48.0	
Met Strength Guideline									
No	87	72.4	317	66.1	593	66.4	616	63.9	0.5385
Yes	41	27.6	152	33.9	314	33.6	315	36.1	

Table 3. Odds Ratios for Meeting Physical Activity Guidelines by Health Literacy Levels		
	Crude OR (95% CI)	**Adjusted OR (95% CI)**
Aerobic Physical Activity Guideline[1] (n=2,268)		
Below Basic	1.00	1.00
Basic	1.15 (0.57 - 2.29)	1.35 (0.63 - 2.87)
Intermediate	1.40 (0.77 - 2.55)	1.54 (0.78 - 3.03)
Proficient	1.64 (0.96 - 2.80)	1.87 (0.96 - 3.63)
Strength Physical Activity Guideline[2] (n=2,050)		
Below Basic	1.00	1.00
Basic	1.34 (0.67 - 2.69)	1.78 (0.74 - 4.24)
Intermediate	1.33 (0.72 - 2.43)	1.46 (0.66 - 3.21)
Proficient	1.48 (0.81 - 2.69)	1.87 (0.81 - 4.31)

[1]Model controls for age, gender, race, and self-efficacy

[2]Model controls for age, gender, race, self-efficacy, education, and household income

Appendix: Supplementary Tables

Table S1. Odds Ratios for Any Physical Activity versus No Physical Activity, by Health Literacy Levels		
	Crude OR (95% CI)	**Adjusted OR (95% CI)**
Any Physical Activity Guideline[1] (n=2,096)		
Below Basic	1.00	1.00
Basic	1.50 (0.78 - 2.88)	1.36 (0.57 - 3.25)
Intermediate	1.73 (0.97 - 3.10)	1.20 (0.53 - 2.74)
Proficient	1.88 (1.07 - 3.32)	1.26 (0.54 - 2.93)

[1]Model controls for age, gender, race, health self-efficacy, education, and household income

Table S2. Crude Odds Ratios for Meeting Physical Activity Guidelines by Dichotomous Health Literacy, Stratified by Age		
	Below Basic/Basic	**Intermediate/Proficient**
Aerobic Physical Activity		
18-34	1.00	0.84 (0.33 - 2.17)
35-49	1.00	1.62 (1.01 - 2.59)
50-64	1.00	1.52 (0.87 - 2.64)
65-74	1.00	1.22 (0.73 - 2.04)
75+	1.00	1.03 (0.46 - 2.30)
Strength Physical Activity		
18-34	1.00	1.05 (0.31 - 3.61)
35-49	1.00	1.18 (0.67 - 2.08)
50-64	1.00	1.28 (0.79 - 2.05)
65-74	1.00	0.72 (0.39 - 1.33)
75+	1.00	0.48 (0.19 - 1.20)
Any Physical Activity		
18-34	1.00	0.65 (0.22 - 1.93)
35-49	1.00	1.47 (0.87 - 2.47)
50-64	1.00	1.53 (0.91 - 2.58)
65-74	1.00	1.27 (0.74 - 2.16)
75+	1.00	0.69 (0.27 - 1.75)

Table S3. Crude Odds Ratios for Meeting Physical Activity Guidelines by Dichotomous Health Literacy, Stratified by Race		
	Below Basic/Basic	**Intermediate/Proficient**
Aerobic Physical Activity		
White	1.00	1.43 (0.96 - 2.11)
Black	1.00	1.47 (0.51 - 4.24)
Hispanic	1.00	1.00 (0.35 - 2.81)
Asian	1.00	1.40 (0.33 - 5.97)
Other	1.00	2.19 (0.57 - 8.45)
Strength Physical Activity		
White	1.00	1.06 (0.64 - 1.75)
Black	1.00	0.78 (0.24 - 2.59)
Hispanic	1.00	1.02 (0.36 - 2.92)
Asian	1.00	2.31 (0.27 - 19.98)
Other	1.00	3.29 (0.69 - 15.73)
Any Physical Activity		
White	1.00	1.27 (0.81 - 1.99)
Black	1.00	1.42 (0.49 - 4.12)
Hispanic	1.00	0.74 (0.30 - 1.82)
Asian	1.00	3.53 (0.72 -17.18)
Other	1.00	3.63 (1.03 - 12.84)