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The Impact of Health Literacy on Exercise Knowledge

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2009

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An abstract of

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University

in partial fulfillment of the requirements for the degree of
Master of Public Health in

Epidemiology

2011

Abstract

The Impact of Health Literacy on Exercise Knowledge

By Vivek Sethumadhavan

Study Objective

To examine the association between health literacy and exercise knowledge.

Study Design

Data for this secondary data analysis came from the Physical Activity and Life Styles (PALS) randomized control trial from 2004-2007 of Emory University (Atlanta, GA) employees. Using data collected at baseline, the association between exercise knowledge and health literacy was examined by constructing multivariate linear predictive models and through multivariate logistic regression models with adjustment for age, race, income, and education.

Results

Compared to those with limited health literacy, those with adequate health literacy were younger, white, better educated, earned more annually on average, but did not vary meaningfully in exercise knowledge. Multivariate linear modeling revealed a very weak linear relationship between health literacy and exercise knowledge ($R^2 = 0.05$, $p = 0.07$). Multivariate logistic modeling, similarly, demonstrated no statistically significant association. Those with limited health literacy only demonstrated a 2% increased odds of low exercise knowledge, compared to those with adequate health literacy (Odds Ratio = 1.02; 95% confidence interval: 0.60, 1.7). However, demographic associations with exercise knowledge, most notably education level, demonstrated a statistically significant direct trend.

Conclusions

The results of this study are inconclusive. While health literacy was not observed to be meaningfully associated with exercise knowledge, demographic associations with exercise knowledge adds to the understanding of those individuals who lack adequate exercise knowledge. Nevertheless, the importance of increasing the physical activity and health literacy of Americans are both critical endeavors for American public health.

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Table of Contents

Introduction

Health literacy has been defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (1)".Unfortunately, the process of making these appropriate health decisions has been identified as a challenge for millions of Americans. Limited health literacy affects people's ability to successfully use and search for important health information, take on healthy behaviors, and respond to important public health alerts, making health literacy a national issue imperative to ameliorating overall health. Worse health outcomes including low health knowledge, poor self-management of chronic diseases, and less than optimal use of preventative health services have been well documented associates with limited health literacy (2, 3). Furthermore, age, race/ethnicity, education level, income, and geographic location have been identified as the most common demographic features associated with low health literacy (4). Due to the severe consequences and demographic features associated with low health literacy, increased research in the field has become a priority in American public health (1).

Several studies have focused on the impact of limited health literacy on chronic diseases and preventative health services, and others have offered insightful and potentially successful initiatives to either mitigate the effect of limited health literacy on health outcomes or decrease the low health literacy rate in America. However, to date, little literature is available on how health literacy impacts exercise knowledge. Exercise knowledge is an understanding of the importance of appropriately utilizing physical activity as a tool to decrease the risk of diseases associated with a sedentary lifestyle and how often one must be physically active to achieve a health benefit (5).

Researching the association between health literacy and exercise knowledge is a critical endeavor to pursue. This study fills a gap in health literacy literature and has the opportunity to further the research on the association between health literacy and a preventative health service – physical activity. Specifically, this study will aim to evaluate the strength and magnitude of the association between health literacy and exercise knowledge.

Background and Literature Review

Health literacy has become a focus of public health endeavors over the last 20 years (1). Research on health literacy, from the nation's first survey of adult literacy skills published in 1992 (6) to today, has provided an enhanced comprehension on associations with adverse health outcomes. Moreover, with this enhanced comprehension, recommendations to promote a health-literate society in America have been initiated. To date, research has suggested that those having limited health literacy may lack the necessary skills to utilize the U.S. health system appropriately (3). As a result of the accumulating research in the field, and the approximately 90 million Americans with limited health literacy (7), the U.S. Department of Health and Human Services has developed a national plan of action to improve health literacy for the future (1). By outlining a national plan of action, increased research in the field of health literacy is expected to improve the quality of health care and improve the health of millions of Americans (1).

Descriptive Epidemiology

An estimated 90 million (36%) adult Americans have been identified as having low health literacy by the U.S. Department of Education (7) with the most common demographic features associated with low health literacy being age, education level, income,

race/ethnicity, and geographic location (4). More than one-third of the United States is below an acceptable level of health literacy. This statistic has been used throughout health literacy research to promote the topic as an urgent matter and has become a motivational factor to understand the associations between health literacy and health outcomes (8, 9).

Additionally, in a meta-analysis of 85 studies offering health literacy prevalence data between 1963 and 2004, a weighted pooled prevalence of low health literacy was reported to be 26% (95% Confidence interval [CI]; 22% - 29%). This result cannot be extrapolated to represent the estimated prevalence of low health literacy in Americans because it does not provide a nationally representative sample, but it does reinforce the necessity for continuing research in the field of health literacy (4).

Established Associations & Barriers

While it has been well documented that low health literacy is associated with several demographic characteristics and poor health outcomes, health literacy has disproportionately impacted the elderly, lower socioeconomic, minority, those without a high school degree, and those living in less resourced area populations in the United States (1, 7, 10). However, the notion that low health literacy is the sole result of an individual's ability to comprehend health information has been challenged by numerous researchers. Rather, it has been postulated that a combination of an individual's ability, their education, environment, and health care encounters is the likely culprit (11). Furthermore, the impact of the individual's environment and health care encounters is a direct result of the contextual demands placed upon the individual within the health care system to which they belong (9).

Accounting for the environment in which an individual interacts along with obtaining a valuable measurement of health literacy is a difficult task, but has been suggested as a necessary development in health literacy research (9). Immersed in an increasingly complex health system, those with low health literacy may feel confused about their health care and feel ashamed to admit their lack of comprehension, further exacerbating their health (12). Paache-Orlow et al elaborated on this concept by identifying the causal pathways between health literacy and health outcomes, buttressing the importance of including the health environment in which an individual operates within when assessing health literacy. The study reported those with low health literacy may delay seeking medical care, tend to be more passive in patient-physician interactions, and have poor self-management of day-to-day activities to control their illnesses (13). Poor health outcomes have been the result of these behavioral associations with low health literacy.

Studies measuring literacy levels and the knowledge and use of health care services such as cancer screenings (14, 15) and heart health knowledge (10, 16) demonstrated statistically significant positive associations between higher health literacy and knowledge pertaining to the use of these health care services (2). Additionally, studies assessing the knowledge or comprehension of pertinent health issues such as smoking (17), hypertension (16, 18), diabetes (16, 18), and asthma (16, 19) generally found statistically significant positive associations between literacy level and individuals' knowledge of these issues (2). However, research demonstrating the association between exercise knowledge and health literacy has yet to be conducted.

Exercise Knowledge & Health Literacy

In summary, improving an individuals' health literacy will advance their ability to process health information into a health benefit. Thus, one may hypothesize that exercise knowledge, an understanding of the benefits of physical activity on overall health, may be associated with health literacy. Those with adequate health literacy would likely possess a higher level of exercise knowledge (i.e. an awareness of the health benefits of participating in an appropriate[1] amount of physical activity per week(20)) than those with a limited health literacy. Physical activity, like health literacy, is a focus of American public health initiatives (21).

Studies evaluating the general population's exercise knowledge have been performed in the past and have suggested the need for continuing education about physical activity and exercise recommendations (5, 22). These studies report inconsistent results about a national percentage of those with adequate exercise knowledge, but have reported improvement in this area over the last 20 years (5). While these studies did confirm there are statistically significant patterns associated with demographic characteristics such as age, race, and education, these studies did not account for the relationship between health literacy and exercise knowledge.

If a statistically significant association exists between these two, intervention initiatives focused on health literacy may meaningfully improve an individual's exercise knowledge. This association, the impact of health literacy on exercise knowledge, is the objective of this study.

[1] The Centers for Disease Control and Prevention (CDC) recommend that adults "engage in moderate-intensity physical activity for at least 30 minutes on five or more days of the week," or "engage in vigorous-intensity physical activity for at least 20 minutes on three or more days of the week" (21).

Methods

Data Source

The data source for this study was the Physical Activity and Life Styles (PALS) study. PALS was a randomized control trial that was intended to evaluate the effect of physical activity programming for the Emory University employee population between 2004 – 2007. The Emory University employee population was used in order to generalize findings to other collegiate workplace environments.

Study Subjects

The main study population intended to represent Emory University's on-campus, non-exempt employees working at least 20 hours per week. Invitations were sent to 1,107 Emory University employees in 60 departments. Of the 1,107 employees considered for the main study, 27 (24%) were not able to be contacted, 497 (44.9%) were non-eligible[2], and 173 (15.6%) refused to participate in the main study for a final total of 410 participants. However, for this study, only those of white (Caucasian) or black (African American) race/ethnicity were included. Other races including Asian, Indian, American Indian, and Hispanics had too few participants in the main study population. Grouping these highly variant races together would be difficult to interpret.

[2] Non-eligibility was primarily due to meeting CDC exercise recommendations, not being non-exempt staff, working off campus, no longer employed by the University, currently on long-term leave or planned long-term leave during the study, working a nightshift or as clinic staff, not comfortable speaking English, or a physical impairment.

Finally, those with missing data were excluded from analyses (n = 24). Of these participants with missing data, 8 had missing data on self-reported annual income alone and 16 had missing data on self-reported annual household income and self-reported highest education level. Those excluded due to missing information did not vary significantly from those included in the study in terms of exercise knowledge score or health literacy. There was no missing data on the main exposure, health literacy, or the main outcome, exercise knowledge. The final study population for analyses included 359 participants.

Data Collection

Covariates

Demographic data for the PALS study were collected from the Emory University Human Resources Department (age and sex) and from the first of two baseline information gathering sessions (race, education, income) through an online survey or in person. Exercise knowledge was acquired during the first baseline information session as well. Health literacy was acquired during the second baseline information gathering session in person only. IRB approval was obtained from the Emory University IRB.

Education level was grouped into 5 categories: Some high school (without a high school diploma), high school graduate (or GED), some college (technical degree or less than a 4 year university degree), college graduate (4 year university degree), or post-graduate (Master's, PhD, etc.). Annual household income was grouped into 6 categories: less than

$20,000, $20,000 - $34,999, $35,000 - $49,999, $50,000 - $74,999, $75,000 - $99,999, and $100,000 and over.

Outcome

Exercise knowledge was determined using five interview type questions based from the exercise knowledge tool created by Morrow et al (5). The questions intended to measure the participant's knowledge of physical activity based on CDC guidelines for physical activity (21). Participants were asked what the minimum number of days and hours per day of physical activity are needed to obtain a health benefit. These questions were asked about both moderate and vigorous physical activity. Finally, the participants were asked if it is necessary to engage in vigorous physical activity in order to obtain a health benefit. Based on the accuracy of the participant's answers, an exercise knowledge score was calculated. One point was awarded for each correct response and zero points were awarded for each incorrect or "unsure" response. A total score (out of a possible 5) was summed to determine the exercise knowledge score. Low exercise knowledge was defined as those with exercise knowledge scores below 4.

Exposure

Health literacy was measured using the Newest Vital Sign (NVS) instrument. NVS is a six question assessment on the interpretation of the nutrition label from a pint of ice cream (23). NVS measures health literacy well, is quick to administer, and has been correlated with other tools used to measure health literacy (11). NVS score ranges from 0-6 and corresponds to the number of questions answered correctly (23). Commonly, scores of 0 to 1 indicate limited literacy likely, scores of 2 to 3 indicate limited literacy possible, and scores greater

than or equal to 4 indicate adequate literacy (24). This study defined limited health literacy as those with a NVS score below 5 and adequate health literacy greater than or equal to 5.

Data Analysis

All statistical analyses were performed using SAS version 9.2 (Cary, NC). All variables (exercise knowledge score, NVS score, sex, age, race, annual household income, and highest education level) were initially assessed for adhering to normality assumptions. Only the main exposure of interest in this study, health literacy, did not meet normality assumptions. However, once dichotomizing the health literacy variable into adequate and limited health literacy, equal distribution of adequate and limited health literacy was restored.

Participants who possessed adequate health literacy were compared with those with limited health literacy. Continuous data was compared using t-tests and all categorical variables were compared using χ^2 tests. Significance was set at $\alpha = 0.05$.

The coefficient of determination, R^2, was examined to analyze the simple linear relationship between exercise knowledge and health literacy in an attempt to predict future exercise knowledge scores. Additionally, multivariate linear regression was performed to better predict exercise knowledge scores. Multivariate models included all potential confounders including age, race, education, and income. Comparison models using health literacy as a continuous NVS score and as a dichotomous (adequate health literacy versus limited health literacy) variable were provided to assess which model best predicted exercise knowledge scores. Following this, logistic regression modeling was utilized to demonstrate this relationship.

The odds ratio (OR) with 95 percent confidence interval (95 % CI) was calculated as a measure of association between exercise knowledge and health literacy with demographic covariates using standard logistic regression methods. Criteria for the inclusion of variables, including interaction, in the final model included their fit at the α level and/or evidence of confounding based on the variables effect on the association between health literacy and exercise knowledge. Variables considered as potential confounders included age, race, annual household income, and education level and were the variables that were included in the final logistic model based on significance.

Results

Table 1 presents the demographic characteristics of the study population. Overall, participants tended to be female (63%) and black (60%) with a mean age of 42. Nearly thirty-four percent of the participants earned between $20,000 and $34,999 annually and nearly half reported their highest education was some college (technical school degree or less than a 4-year university degree). Upon stratifying by health literacy, all demographic covariates, with the exception of sex, demonstrated statistically significantly different values between those with limited health literacy and adequate health literacy. Those with adequate health literacy tended to be younger (mean age of 38 compared to 45), female (66% compared to 59%), and white (60% compared to 18%). Additionally, on average, those with adequate health literacy were observed to have higher annual household income and were generally more educated than those with limited literacy. No statistical difference between exercise knowledge scores among limited and adequate health literate participants was observed ($p=0.0961$).

Models using NVS score for health literacy were examined in comparison to models dichotomizing health literacy into limited and adequate health literacy (table 2). Univariate models examined the linear relationship between health literacy and exercise knowledge. Multivariate models examined the linear relationship between health literacy, age, race, education, and income with exercise knowledge. Very weak linear relationships between health literacy and exercise knowledge were observed for both univariate and multivariate models. This remained true whether using health literacy as NVS score (continuous variable) or dichotomizing health literacy into limited and adequate. Using health literacy as a dichotomized predictor of exercise knowledge score in a multivariate analysis observed only a non-statistically significant R^2 of 0.05 ($p = 0.0782$).

Health literacy was treated as a dichotomous variable to assess the odds of possessing low exercise knowledge in the final logistic model. None of the multiplicative interaction terms were statistically significant in the logistic model. Table 3 presents the multivariate-adjusted associations of the primary exposure and covariates with low exercise knowledge. Only a non-statistically significant 2% increased odds of a low exercise knowledge for those who have a limited health literacy was observed (OR = 1.02; 95% CI [0.605, 1.726]).

Age, treated as a continuous variable, demonstrated an increased odds of low exercise knowledge with older ages (p for trend = 0.0859). Additionally, education level observed an increased odds of low exercise knowledge with lower levels of educational achievement (p for trend = 0.0298). Although the 95% confidence intervals for these odds ratios included the null, a statistically significant trend was observed for education level. This suggests that those with lower academic achievement are more likely to possess low exercise

knowledge compared to those of higher education levels. However, the associations between low exercise knowledge and annual household income did not follow the expected pattern observed with age and education.

Those earning less than $20,000 annually were nearly half as likely to have low exercise knowledge, compared to those earning over $100,000 annually (OR = .505; 95% CI [.101, 2.53]). These results suggest those with the highest income are more likely to have low exercise knowledge. However, the lack of statistical significance and wide 95% confidence intervals for all associations may make these observed associations due to chance.

Furthermore, blacks demonstrated a 6% decreased odds of low exercise knowledge compared to whites (OR = 0.94; 95%CI [.563, 1.57]). However, as with all associations observed, the 95% confidence interval included the null; suggesting the observed associations are likely due to chance.

Discussion

The original hypothesis of this study was that those with limited health literacy would be more likely to possess low exercise knowledge. Individuals with limited health literacy are limited in their ability to utilize health communication towards a health benefit and those with low exercise knowledge are not aware of the quality and quantity of physical activity needed to achieve a health benefit. The data presented in this study do not support this hypothesis. In this secondary data analysis of a randomized control trial, health literacy was not observed to be a significant predictor of exercise knowledge. Moreover, those with limited health literacy do not appear to have any substantial increased odds of also possessing low exercise knowledge.

The relationship between health literacy and exercise knowledge observed in this study is not consistent with the literature. Studies examining the relationship between health literacy and knowledge of health care services (e.g. cancer screening) or knowledge of chronic diseases (e.g. diabetes) demonstrated statistically significant associations between higher health literacy and comprehension of issues associated with the use of the services or the chronic disease (2). However, several of these studies used hospital-based convenience sampling or sampled elderly populations (15-17, 19). Results from hospital-based convenience sampling on the knowledge of the use of health care services or of chronic diseases may be biased because these participants are more likely to engage in less than healthy behaviors. Similarly, sampling the elderly, a population illustrated in the literature to have lower health literacy on average (7, 14), may influence the observed relationship between health literacy and knowledge of the use of health care services or of chronic diseases.

Moreover, methods to alleviate certain chronic diseases, such as cancer screening, may be perceived as an active method of addressing a specific chronic disease whereas physical activity can be perceived as a passive method of addressing several chronic conditions. Physical activity has been proven effective in reducing the risk of cardiovascular disease (25), diabetes (26), and some cancers (27, 28), but over a substantial period of time. Therefore, physical activity may not be perceived as an immediate medium for reducing risk factors related to chronic diseases when compared to healthcare services such as cancer screening. Thus, exercise knowledge may not be a major focus of comprehension amongst the general population to reduce the risk of chronic diseases compared to more active methods.

Although health literacy was not identified as a significant predictor of an individual's exercise knowledge, this study also explored the relationships between demographic characteristics and exercise knowledge. This study observed a statistically significant trend between increased education level and exercise knowledge. Those with higher academic achievement would be expected to have a stronger grasp of the necessary quality and quantity of physical activity to achieve a health benefit. The statistically significant trend amplifies our understanding of the types of academic backgrounds whom we would expect to have low exercise knowledge. This pattern, along with age where increased age is associated with lower exercise knowledge, followed exercise knowledge trends observed in other studies assessing the prevalence of adequate exercise knowledge in Americans and buttressed the existing evidence found in literature (5, 22).

Unlike education level and age, the association between annual household income and exercise knowledge was puzzling. Based on the results from this study, those earning over $100,000 annually are more likely to possess low exercise knowledge than those earning less. It is important to note that these data account for entire household's income. It is possible that those self-reporting their annual household income as over $100,000 may not be the individual earning the majority of the income. However, it is also important to note this study did not find a strong correlation between education level and annual household income ($R = 0.13$, $p = 0.01$), which is contrary to the literature (29). Nevertheless, the association observed in this study between income level and exercise knowledge is inconclusive, similar to the results of another study which assessed the knowledge of physical activity recommendations among American men and women (22).

Strengths and Limitations

There were three limitations of this study. First, misclassification of self-reported information, particularly education level and/or annual household income, is a potential threat to the internal validity of this study. Notably, recall and/or social desirability biases may be present and could potentially influence the observed relationships. Second, the decision to not include observations with missing data (n=24) contributes to the selection bias. Fortunately, those with missing data did not vary statistically significantly from those without missing data. Comparing those with missing data to those without missing data, neither health literacy nor exercise knowledge values varied significantly. Finally, the small study population, employees of Emory University, makes the results of this study difficult to generalize and threats the external study validity of this study.

There were two strengths of this study. First, the use of established tools to quantify our main exposure (health literacy via NVS) and our outcome of interest (exercise knowledge via Morrow et al.) is the most considerable strength of this study (5, 24). The second strength of this study was the careful review of normality assumptions for each variable and validated use of the final logistic model. The use of appropriate statistical measures adds to the integrity of this study's main conclusions.

Conclusion

Although the results of this study do not suggest an association between health literacy and exercise knowledge, the results of this association are inconclusive. Before a general association can confidently be identified between health literacy and exercise

knowledge, confirming the findings from this study would be desirable in a larger university population and/or in the general population. The knowledge of the quality, quantity, and benefits of appropriate physical activity is essential to meeting U.S. public health initiatives (21). Nevertheless, scientific progress towards the improvement of health outcomes will be weakened without improvements in health literacy (3). Intervention initiatives addressing physical activity and health literacy separately remain imperative to achieve improved health outcomes in the United States.

Table 1. Characteristics of Study Population for those with Limited and Adequate Health Literacy (HL)†

		Total	Limited HL n = 175	Adequate HL n = 184	p-value
Exercise Knowledge Score	Mean (SD)	3.49 (1.1)	3.38 (1.1)	3.58 (1.1)	0.0961
Age	Mean (SD)	41.87 (11.1)	45.1 (11.1)	38.8 (10.3)	<0.0001
Sex	(% Female)	62.7%	59.40%	65.80%	0.2150
Race	(% White)	39.8%	18.30%	60.30%	<0.0001
Annual Income					0.0003
	≥ $100,000	2.8%	2.3%	3.3%	
	$75,000 - $99,999	8.1%	7.4%	8.7%	
	$50,000 - $74,999	18.4%	9.7%	26.6%	
	$35,000 - $49,999	30.9%	32.0%	29.9%	
	$20,000 - $34,999	33.7%	39.4%	28.3%	
	< $20,000	6.1%	9.1%	3.3%	
Highest Education					<0.0001
	Post Graduate	6.1%	4.0%	8.2%	
	College Grad	28.1%	12.6%	42.9%	
	Some College	48.2%	52.0%	44.6%	
	High School Grad	15.9%	28.0%	4.4%	
	Some High School	1.7%	3.4%	0.0%	

†Adequate Health Literacy = NVS score ≥ 5; Limited Health Literacy = NVS score < 5

Table 2. Comparison of Exercise Knowledge Linear Predictive Models: Health Literacy as a Continuous Variable versus Health Literacy as a Dichotomous Variable

Predictors Included in Model	R^2	p-value
Health Literacy as NVS score†		
Health Literacy	0.0060	0.1441
Health Literacy, Income, Age, Ethnicity, Education	0.0548	0.0713
Health Literacy Dichotomized into Limited and Adequate‡		
Health Literacy	0.0077	0.0961
Health Literacy, Income, Age, Ethnicity, Education	0.0539	0.0782

†NVS Score ranges from 0-6.
‡ Limited Health Literacy = NVS score < 5

Table 3. Results of Multivariate Analyses Describing the Relationship between Low Exercise Knowledge and Health Literacy with Trend Analysis on the Association Between Low Exercise Knowledge and Demographic Characteristics

		OR	95% CI	P-value for Trend†
Health Literacy				0.0974
	Adequate	Reference		
	Limited	1.02	(0.61, 1.73)	
Age‡				0.0859
	40	1.33	(0.57, 3.14)	
	50	1.43	(0.49, 4.18)	
	60	1.54	(0.43, 5.56)	
Race				0.2788
	White	Reference		
	Black	0.94	(0.56, 1.57)	
Annual Household Income				0.3308
	≥ $100,000	Reference		
	$75,000 - $99,999	0.83	(0.19, 3.63)	
	$50,000 - $74,999	0.56	(0.14, 2.20)	
	$35,000 - $49,999	0.51	(0.14, 1.95)	
	$20,000 - $34,999	0.93	(0.24, 3.57)	
	< $20,000	0.51	(0.10, 2.53)	
Highest Education				0.0298
	Post-Graduate	Reference		
	College Grad	0.66	(0.25, 1.75)	
	Some College	0.96	(0.38, 2.44)	
	High School Grad	1.16	(0.41, 3.31)	
	Some High School	4.97	(0.44, 56.21)	

†All p-values are one-sided

‡Age values are arbitrary and used to portray the point estimate trend.

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