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The Relationship Between Health, Education, and Health Literacy: Results From the Dutch Adult Literacy and Life Skills Survey

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Health literacy has been put forward as a potential mechanism explaining the well-documented relationship between education and health. However, little empirical research has been undertaken to explore this hypothesis. The present study aims to study whether health literacy could be a pathway by which level of education affects health status. Health literacy was measured by the Health Activities and Literacy

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Scale, using data from a subsample of 5,136 adults between the ages of 25 and 65 years, gathered within the context of the 2007 Dutch Adult Literacy and Life Skills Survey. Linear regression analyses were used in separate models to estimate the extent to which health literacy mediates educational disparities in self-reported general health, physical health status, and mental health status as measured by the Short Form-12. Health literacy was found to partially mediate the association between low education and low self-reported health status. As such, improving health literacy may be a useful strategy for reducing disparities in health related to education, as health literacy appears to play a role in explaining the underlying mechanism driving the relationship between low level of education and poor health.

The scientific literature on health inequalities has repeatedly demonstrated a strong association between lower levels of education and poorer health outcomes (Adler & Newman, 2002; Kunst et al., 2005; Mackenbach et al., 2008; Marmot et al., 2002). However, the mechanisms through which level of education affects health outcomes are not yet well understood (Cutler & Lleras-Muney, 2012; Rademakers, Delnoij, Nijman, & de Boer, 2012). Recently, health literacy has been put forward as a potential pathway between level of education and health (Howard, Sentell, & Gazmararian, 2006; Lee, Tsai, Tsai, & Kuo, 2010; Nielsen-Bohlman, Panzer, & Kinding, 2004; Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, & Rudd, 2005; Schillinger, Barton, Karter, Wang, & Adler, 2006). A definition chosen by the U.S. Institute of Medicine describes *health literacy* 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” (Ratzan & Parker, as cited in Nielsen-Bohlman et al., 2004). In this context, health information can be understood as health-related printed materials, but also as spoken language (Baker, 2006).

Health literacy skills are conceived as an important asset for maintaining or improving one’s health. From this perspective, low health literacy skills may, for example, be a barrier in access to health information and health care, medication use, and the prevention of disease (Nutbeam, 2008). It is, therefore, not surprising that low health literacy has been associated with a range of poor health outcomes (Bennett, Chen, Soroui, & White, 2009; Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Howard et al., 2006). Not only were people with low health literacy found to be less healthy, but also to be less able to deal with chronic diseases, to have less knowledge about health, and to have difficulties reading and understanding information on medicine packages or hospital forms (Davis et al., 2006; Gazmararian et al., 1999; Peterson et al., 2011; Rothman et al., 2009). Low health literacy skills have not only been found to be related to poor health but have also been shown to have a relationship with level of education: People with lower education were found to demonstrate lower health literacy skills in comparison with people with higher education (Howard et al., 2006; Lee et al., 2010; Nutbeam, 2008; Paasche-Orlow et al., 2005; Rudd, 2007). However, most studies to date have been performed among patients with somatic diseases, and less evidence is available for the association between health literacy and mental health (Berkman et al., 2011).

Although studies have found clear relationships between (a) education and health literacy, (b) education and health, and (c) health literacy and health, this study is among the first to actually examine the possible contribution of health literacy in explaining the relationship between education and health (Bennett et al., 2009; Howard et al., 2006; Schillinger et al., 2006). The aim of the present study is to examine whether health literacy constitutes a pathway by which education affects health. Attention was

also given to possible differences in the role of health literacy between levels of education and between three indicators of health—that is, self-rated general health status, physical health status, and mental health status.

Method

Study Design and Data Collection

The data stemmed from the Adult Literacy and Life Skills Survey (ALL). The ALL is an international cross-sectional survey, which used graded everyday tasks to assess literacy (prose and document), numeracy, and problem-solving skills in nationally representative samples of 16- to 65-year-old individuals. The ALL was conducted in several countries, including The Netherlands (Organisation for Economic Co-operation and Development & Statistics Canada, 2011). The Dutch Centre for Expertise in Vocational Education and Training (ecbo) translated and adapted test items and a background questionnaire for the Dutch part of the survey. Between July 2007 and January 2008, data were collected from 5,617 noninstitutionalized and legal citizens of The Netherlands by interviewing and testing respondents face-to-face in their homes. The response rate was 47%. No information was collected on reasons for nonresponse. Persons born in The Netherlands were overrepresented in this sample (92.1% vs. 88.6% in the Dutch general population in 2011; CBS-Statline, 2012b). For the purpose of this study, we limited the analyses to respondents 25 years of age or older, because level of education is more stable thereafter. This led to a subsample of 5,136 respondents. Details regarding the test items, study design, and data collection have been reported elsewhere (Organisation for Economic Co-operation and Development & Statistics Canada, 2011).

Main Variables

Level of Education

Education was measured by the highest self-reported level of education completed. In all, 25 response options were possible, which were grouped into (a) preprimary or primary education, (b) lower secondary education, (c) upper secondary education, and (d) tertiary education, in accordance with the International Standard Classification of Education (see Table 1). Education was used as a categorical variable in the analyses.

Health Literacy

Health literacy was measured by the Health Activities and Literacy Scale (HALS) which was derived from a selection of health-related tasks included in the ALL (Educational Testing Service, 2004; Canadian Council on Learning, 2007). Respondents were asked, for example, to read a medicine dosage chart and indicate the correct dose for a child of a particular weight and age. By directly testing respondents' performance on a variety of graded tasks, the HALS provides an objective measurement of health literacy. Because not every respondent completed the full set of tasks in the assessment ($n = 191$), imputation was applied on the basis of an estimation procedure that was used to represent each respondent's proficiency as a probability distribution over all possible scores. This was a standard procedure performed by the Educational Testing Service. The Educational Testing Service scaled and transformed the HALS scores to

a 0 to 500 metric. Individual sum scores on this scale reflect the progression of health literacy skills from very poor skills (level 1) to very strong skills (level 4; see Appendix A). The Organisation for Economic Co-operation and Development considers level 3 as the minimum level needed to function adequately in a knowledge society (Kirsch et al., 1993). Health literacy was used as a continuous variable in the analyses.

Health Status

Health status was measured by three indicators—self-reported general health, self-reported physical health score and self-reported mental health score, using the Medical Outcomes Study Short Form 12 (Ware et al., 1995). Self-reported general health was assessed by a single item: “In general, how is your health?” Answer options were provided on a 5-point Likert scale ranging from 1 (*poor*) to 5 (*excellent*). The physical health scores and mental health score scores were each derived from six items and standardized to population norms (based on a U.S. norm sample). The Short Form 12 has been found to be valid for the Dutch situation (Mols et al., 2009). Self-reported general health status, physical health scores, and mental health scores were used as continuous variables in the analyses, after a prior check for linearity.

Statistical Analyses

To test the hypothesis that health literacy is a pathway by which education affects health, we examined the mediation effect of health literacy on the relationship between education and health status (i.e., self-reported general health, self-reported physical health, and self-reported mental health). Separate mediation models were applied for all three indicators of health status on the basis of linear regression analyses (see Figure 1). All linear regression analyses were controlled for age and sex as covariates, because both were expected to be associated with health, education, and health literacy (Fleishman & Lawrence, 2003; Lee et al., 2010; Nielsen-Bohlman et al., 2004; Paasche-Orlow et al., 2005; Schillinger et al., 2002). The product-of-coefficients test by MacKinnon was used to estimate the mediating effect on the basis of four steps, as illustrated in Figure 1 (MacKinnon, Fairchild, & Fritz, 2007): (a) regress the mediator health literacy on the independent variable education (a-coefficient); (b) regress the dependent variable health on the mediator health literacy while controlling for the

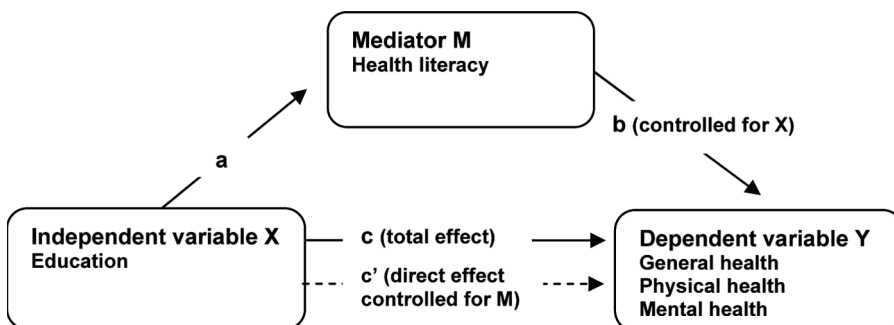


Figure 1. Conceptual model of health literacy as a mediator between education and self-reported general health, self-reported physical health, and self-reported mental health, adjusting for age and sex in all steps of the model.

independent variable education as a potential confounder (b-coefficient); (c) calculate the total effect by regressing the dependent variable health on the independent variable education (c-coefficient); (d) calculate the direct effect by regressing the dependent variable health on the independent variable education while controlling for the mediator health literacy (c'-coefficient).

The ab-coefficient ($a*b$) represents the mediation effect (Preacher & Hayes, 2008; Shrout & Bolger, 2002). Complete mediation is indicated when the ab-coefficient is significant, as estimated by the Sobel test, and the c'-coefficient is equal to 0. Partial mediation is indicated when the ab-coefficient is significant and c' is reduced. The analyses were performed using SAS (version 9.3). The mediation effect size ($ab/(ab+c') \times 100\%$) was used to indicate the extent of the mediating role of health literacy in the relationship between education and health status. The effect size percentages can be interpreted as the proportion of the association between a specific level of education and health that is explained by health literacy. The calculated proportions provide insight into the relative importance of the mediating role of health literacy. Because the data contained few missing values, complete case analysis was applied.

Results

Sample Characteristics and Health Literacy

Table 1 shows the sample characteristics. The mean age is 46.7 years ($SD=11.2$), and most of the respondents completed upper secondary education (30.3%) or tertiary education (39.5%). As for health status, scores ranged from 12.0 to 65.4 for physical health ($M=49.9$, $SD=8.8$) and from 11.3 to 70.5 for mental health ($M=52.9$, $SD=8.5$), whereby the mean scores were above the cutoff for good health (not tabulated).

As for health literacy, a substantial proportion of the respondents demonstrated poor (43.4%) or very poor health literacy (10.6%). Table 2 shows that the higher the level of education, the greater the proportion of respondents who scored in the levels of adequate and strong health literacy. Half the respondents (51.1%) who had completed preprimary/primary education scored in level 1, compared with only 2.1% of those who had completed tertiary education.

Association Between Education and Health Literacy (a-path)

To assess whether health literacy is a mediator in the relationship between education and health, the association between health literacy and education was tested first, controlling for age and gender (a-path). Linear regression analysis indicated that compared with those who had completed tertiary education, respondents who had completed upper secondary education demonstrated lower health literacy proficiency ($B=-17.6$, $SE=1.20$, $p<.001$), followed by respondents who had completed lower secondary education ($B=-31.7$, $SE=1.09$, $p<.001$) and preprimary/primary education ($B=-60.5$, $SE=2.15$, $p<.001$; not tabulated).

Association Between Health Literacy and Health (b-path)

Second, the associations between health literacy and each of the health outcomes (i.e., self-reported general health, physical health, and mental health) were estimated by linear regression analyses, controlling for age, gender, and education (b-path). Those with higher health literacy skills had better self-reported general health ($B=0.002$,

Table 1. Sample characteristics and health literacy (*N* = 5,136)

Characteristics ^a	<i>n</i>	%
Female	2,863	55.7
Age (years)		
25–35	1,070	20.8
36–45	1,473	28.7
46–55	1,230	23.9
56–65	1,363	26.5
Level of education		
Preprimary/primary	284	5.5
Lower secondary	1,256	24.5
Upper secondary	1,553	30.2
Tertiary	2,027	39.5
Missing	16	0.3
Self-reported general health		
Excellent	797	15.5
Very good	1,198	23.3
Good	2,354	45.8
Fair	675	13.1
Poor	103	2.0
Missing	9	0.2
Mental health ^b		
Good mental health	4,537	88.3
Physical health ^c		
Good physical health	3,505	68.9
Health literacy level		
Level 1 (very poor)	542	10.6
Level 2 (poor)	2,227	43.4
Level 3 (adequate)	2,138	41.6
Level 4 (strong)	229	4.5

^aMissing values are reported when applicable.

^bNorm score for good mental health greater than 41 (Ware et al., 1995).

^cNorm score for good physical health greater than 49 (Ware et al., 1995).

Table 2. Health literacy, by level of education (*N* = 5,120)

Level of education	Health literacy level							
	Level 1 (very poor)		Level 2 (poor)		Level 3 (adequate)		Level 4 (strong)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Tertiary	42	2.1	610	30.1	1,198	59.1	177	8.7
Upper secondary	120	7.7	755	48.6	635	40.9	43	2.8
Lower secondary	226	18.0	736	58.6	287	22.9	7	0.6
Preprimary/primary	145	51.1	121	42.6	16	5.6	2	0.7

$SE = 0.0006$, $p < .001$), physical health ($B = 0.017$, $SE = 0.006$, $p = .005$) as well as mental health ($B = 0.012$, $SE = 0.004$, $p = .007$) than those with lower health literacy skills.

Association Between Education and Health (c-path)

Table 3 shows the results for the total effect of education on health (c-coefficient) and the direct effect of education on health, adjusted for health literacy as covariate (c'-coefficient). Lower education was associated with poorer self-reported general health, physical health, and mental health (c-coefficients). As for mental health, only those who had completed preprimary/primary education reported worse mental health. For all three health outcomes, the c'-coefficients are smaller than the c-coefficients, indicating that the effect of education on health is partly mediated by health literacy.

Mediation Effect of Health Literacy (ab-path)

Table 4 presents the mediation effects of health literacy (ab-coefficient). The results indicate that health literacy mediates the associations between education and self-reported general health, self-reported physical health, and self-reported mental health. For both self-reported physical health as well as self-reported general health, health literacy mediates a larger proportion (effect size) of the association between lower secondary education and health compared to preprimary/primary education or upper secondary education. For mental health, no total (c) or direct (c') effects were found for upper and lower secondary education; therefore, the mediation effect was calculated only for preprimary/primary education. Comparing the effect sizes for preprimary/primary education and self-reported general health, self-reported mental health,

Table 3. Results regression analyses for the total effect and direct effect of education on health

	Education ^a (reference: tertiary)	Total effect (c) ^b (without health literacy)		Direct effect (c') ^c (including health literacy)	
		B	SE	B	SE
Self-reported general health	Upper secondary	-0.18**	0.032	-0.14**	0.033
	Lower secondary	-0.20**	0.034	-0.12*	0.039
	Preprimary/primary	-0.53**	0.060	-0.37**	0.071
Self-reported physical health	Upper secondary	-1.79**	0.287	-1.47**	0.304
	Lower secondary	-1.86**	0.311	-1.30*	0.356
	Preprimary/primary	-4.49**	0.551	-3.43**	0.646
Self-reported mental health	Upper secondary	-0.54	0.284	-0.32	0.294
	Lower secondary	-0.40	0.308	-0.01	0.338
	Preprimary/primary	-2.42**	0.545	-1.68*	0.607

^aIncluding covariates age and sex in the linear regression model.

^bc-path: association between education and health.

^cc'-path: association between education and health via health literacy.

*Significant regression coefficient at $p < .05$. **Significant regression coefficient at $p < .0001$.

Table 4. Mediation effect of health literacy in the association between education and health

	Education (reference: tertiary)	Mediated effect (ab)		Effect size (%)
		<i>B</i>	<i>SE</i>	
Self-reported general health	Upper secondary	-0.04*	0.011	22.2
	Lower secondary	-0.06**	0.019	33.3
	Preprimary/primary	-0.12**	0.037	24.5
Self-reported physical health	Upper secondary	-0.30*	0.108	16.9
	Lower secondary	-0.54*	0.191	29.3
	Preprimary/primary	-1.03*	0.365	23.1
Self-reported mental health ^a	Preprimary/primary	-0.73*	0.243	30.3

^aNo total (c) or direct (c') effects were found for upper and lower secondary education; therefore, the mediation effect was calculated only for preprimary/primary education.

*Significant regression coefficient at $p < .01$. **Significant regression coefficient at $p < .0005$.

and self-reported physical health, the mediating role of health literacy seemed smallest between preprimary/primary education and physical health (23.1%), followed by self-reported general health (24.5%) and mental health (30.3%; see Table 4).

Discussion

This study examined whether health literacy is a pathway by which level of education affects health. Consistent with the literature on the association between education and health, our results confirm that low education is a predictor of having low self-reported health (Kunst et al., 2005; Mackenbach et al., 2008; Marmot et al., 2002). Also in accordance with literature (Rudd, 2007), the present study confirms that low education is associated with low health literacy. Furthermore, low health literacy is associated with low self-reported general health, low self-reported physical health and low self-reported mental health, a finding that again is in line with current research (Berkman et al., 2011; Howard et al., 2006; Lee et al., 2010; Paasche-Orlow et al., 2005). Thus, our findings confirm the existence of interrelationships among education, health literacy, and health status. We subsequently studied the nature of this mutual relationship in greater detail by examining whether health literacy serves as a mediator in the relationship between education and health, as has been found in a few other studies (Bennett et al., 2009; Howard et al., 2006). The mediation analysis indicated that this is indeed the case.

As to the relative importance of health literacy as a pathway between education and health status, the results of the mediation analysis indicate that health literacy plays a larger role among those with lower education than among those with higher education, but health literacy seems to be a more important pathway for lower secondary educated than for preprimary/primary educated. This indicates that the mediating role of health literacy exhibits no linear gradient as education increases. To determine to what extent improving health literacy could contribute to reducing

education-related disparities in health, further research is needed on the relative importance of the mediating role of health literacy among different levels of education.

The mediating role of health literacy appeared to vary for each of the three measures of health status included in this study—that is, self-reported general health, self-reported physical health, and self-reported mental health. Health literacy seemed to be a larger mediator between level of education and mental health than the other two indicators of health status.

Regarding the implications for further research, the finding that a substantial proportion of highly educated respondents demonstrated poor health literacy needs further attention. Only a small percentage of respondents scored at the level of strong health literacy, which seems remarkable given the fact that this Dutch sample included many highly educated adults and few adults with low education. However, the distribution of low and high health literacy scores is in accordance with findings from the ALL in Australia and the United States with only 6% of those national samples demonstrating strong health literacy (Australian Bureau of Statistics, 2006; Educational Testing Service, 2004). This indicates that just like literacy and education, health literacy is not equivalent to level of education despite strong correlations. Reading daily for work or leisure seems to have a positive effect on health literacy, suggesting that literacy-related habits in daily life could contribute to health literacy and compensate for low levels of education (Canadian Council on Learning, 2007). Alternatively, infrequent reading might contribute to lower health literacy.

Another implication for further research is to apply the analyses of the present study on data that include objective health measures. Most studies on the association between health literacy and health have used subjective measures for health. To obtain a better understanding of the association between health literacy and health outcomes, objective measures of the latter may provide important evidence.

In the present study we focused on education-related disparities in health, which is a frequently used indicator of socio-economic status. In future research, the mediating role of other indicators of socio-economic status, such as income and occupation, can also be examined in order to explore the associations between socioeconomic status, health literacy and health in greater depth.

The present study is subject to some limitations. First, the number of respondents who completed upper secondary or tertiary education was higher than in the general population aged 25 to 65 (CBS-Statline, 2012a). However, this is not expected to affect our conclusions about the mediating effect of health literacy because the numbers of respondents in all educational levels were sufficient to perform the analyses.

A second limitation is that the linear parameterization of self-reported general health may have led to an underestimation of the effect of education on this particular health measure. The differences in mean scores seemed larger between those with preprimary/primary and higher education than between those with lower secondary, upper secondary and tertiary education.

A third limitation is that the health literacy tasks may not reflect the full range of some respondents' skills or resources in a more natural setting. The test called on respondents to perform activities completely alone, while situations in real life often enable persons to sort through materials with the help of others. Furthermore, in real life people may use health information in stressful situations or may lack the time and/or motivation to read information thoroughly. Stress or lack of concentration and motivation may affect people's ability to understand and use health information.

A final limitation of the present study, as in most other studies addressing the concept of health literacy, is that it does not measure health literacy to its fullest extent. Health literacy also encompasses oral literacy, which seems to be an underexplored domain so far (Baker, 2006; Nielsen-Bohlman et al., 2004) or, even more broadly, it can be considered “a package of competencies for health” (Wang et al., 2012). That said, the HALS is one of the broadest assessments of health literacy, going far beyond functional health-related reading skills in clinical settings, and methodologically among the strongest assessments, as the exercises were developed, graded, and scored by educational testing professionals.

In summary, this study provides strong evidence that health literacy serves as a pathway by which education affects health and it quantified this association. Although the relationship between low education and poor health can be explained in part by health literacy, poor health literacy is also relatively common among those with a high level of education. The findings of this study suggest that strategies for reducing disparities in health related to education may benefit from attention to health literacy. For example, adapting health information in a way that can be more readily accessed, understood, and used by those with difficulties in reading and calculating, may improve their opportunities to maintain or improve their health.

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Appendix A

Interpretation of health literacy levels

Level	Score	Interpretation
1	0–225	Very poor health literacy skills. An individual at this level may, for example, be unable to determine from a package label the correct amount of medicine to give a child. Tasks at this level require the ability to read relatively short text, locate or enter a piece of information, and complete simple, one-step tasks such as counting, sorting dates, or performing simple arithmetic.
2	226–275	Poor health literacy skills. The capacity to deal only with simple, clear material involving uncomplicated tasks. People at this level may develop everyday coping skills, but their poor literacy makes it hard to conquer challenges such as learning new job skills. Tasks at this level require, for example, the ability to sort through distractors (plausible but incorrect pieces of information), integrate two or more pieces of information, compare and contrast information, and interpret simple graphs.
3	276–325	Adequate health literacy skills. An individual at this level has the ability to cope with the demands of everyday life and work in an advanced society. It roughly denotes the skill level required for successful high school completion and college entry. These tasks require the ability to integrate information from dense or lengthy text, integrate multiple pieces of information, and demonstrate understanding of mathematical information represented in a range of different forms. Tasks typically involve a number of steps or processes in order to solve problems.
4	326–375 376–500	Strong health literacy skills. An individual at these levels can process information of a complex and demanding nature. Tasks at this level involve multiple steps to find solutions to abstract problems. Tasks require the ability to integrate and synthesize multiple pieces of information from lengthy or complex passages and make inferences from the information. Very strong health literacy skills. Tasks at this level require the ability to search for information in dense text that has a number of distractors, make high-level inferences or use specialized background knowledge, and understand complex representations of abstract formal and informal mathematical ideas.

Appendix B

Health literacy by level of education weighted for the Dutch population

Level of education	Health literacy score		Equal to health literacy level
	Weighted <i>M</i>	<i>SE</i>	
Total	267.60	0.805	Poor health literacy skills (2)
Tertiary	287.68	1.189	Adequate health literacy skills (3)
Upper secondary	268.71	1.116	Poor health literacy skills (2)
Lower secondary	252.98	1.249	Poor health literacy skills (2)
Preprimary/primary	220.57	2.912	Very poor health literacy skills (1)