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Health Literacy Mediates the Relationship Between Educational Attainment and Health
Behaviour: A Danish Population-based Study

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Abstract

Individuals with lower education generally have more unhealthy behaviours than individuals with higher education, but the pathway is not fully understood. The aim of the study was to investigate if health literacy mediates the association between educational attainment and health behaviour (smoking, physical inactivity, poor diet) and obesity. The study was based on respondents aged 25 years or older from a large population-based survey from 2013 ($N=29,473$). Two scales from the Health Literacy Questionnaire were used: ‘Understanding health information well enough to know what to do’ and ‘Actively engage with healthcare providers’. Multiple mediation analyses were conducted using the Karlson Holm Breen method. The study showed that health literacy – and in particular the ability to understand health information - is a mediator in the relationship between educational attainment and health behaviour especially in relation to being physically inactive (accounting for 20 % of the variance), having a poor diet (accounting for 13 % of the variance), and being obese (accounting for 16 % of the variance). The findings suggest that strategies for improving health behaviour and reducing health inequalities may benefit by having a focus on health literacy within prevention, patient education and other public health interventions.

Key words: health literacy, health behaviour, education, social inequality, smoking, diet, physical activity, obesity

Health Literacy Mediates the Relationship Between Educational Attainment and Health Behaviour: A Danish Population-based Study

The persistence of social inequality in health is one of the major concerns in public health (Mackenbach, 2012). Individuals with low education levels in general experience poorer health status than well-educated individuals, as indicated by lower levels of self-reported health and physical functioning as well as higher levels of morbidity, disability and shorter life expectancy (Diderichsen et al., 2012; Gallo et al., 2012; Mackenbach, 2012; Ullits et al., 2015). One of the main contributing factors to the inequality in health is that individuals with lower educational attainment generally have more unhealthy behaviours such as being smokers, being physical inactive and having a poor diet and more often being obese than individuals with higher levels of education (Buck & Frosini, 2012; Laaksonen et al., 2008; Lantz, Golberstein, House, & Morenoff, 2010; Marmot, 2005; McFadden, Luben, Wareham, Bingham, & Khaw, 2008; Nandi, Glymour, & Subramanian, 2014; Nordahl et al., 2014; Stringhini et al., 2010; Stringhini et al., 2011). In order to target these disparities, it is important to understand how educational attainment is related to health behaviour. There are a number of competing mechanisms that may mediate the relationship between education and health behaviour including work and economic conditions as well as social-psychological resources (Cutler & Lleras-Muney, 2010), but the pathway is still not fully understood. To reduce inequality in health and develop targeted interventions, a clearer conceptualization and investigation of the pathways between education and health behaviour is needed.

Health literacy is defined by the World Health Organisation as the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health (Nutbeam, 1986).

Health literacy brings together many concepts that relate to what people need in order to make effective decisions about health for themselves and their families. It is well established that educational level is associated with health literacy level (Barber et al., 2009; Beauchamp et al., 2015; Bo, Friis, Osborne, & Maindal, 2014; Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, & Rudd, 2005; Van der Heide et al., 2013). Some studies have also indicated that inadequate health literacy is associated with unhealthy behaviours (Adams et al., 2013; Geboers, de Winter, Luten, Jansen, & Reijneveld, 2014; Husson, Mols, Fransen, van de Poll-Franse, & Ezendam, 2015; Speirs, Messina, Munger, & Grutzmacher, 2012; von Wagner, Knight, Steptoe, & Wardle, 2007; Wolf, Gazmararian, & Baker, 2007). However, other studies (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011) have shown little or no associations between health literacy and different health behaviours and therefore evidence remains inconclusive.

Some authors have suggested that health literacy is a mediator between educational level and health outcomes (Howard, Sentell, & Gazmararian, 2006; Lee, Tsai, Tsai, & Kuo, 2010; Nielsen-Bohlman, Panzer, & Kinding, 2004; Paasche-Orlow et al., 2005; Schillinger, Barton, Karter, Wang, & Adler, 2006; van et al., 2013). As poor health behaviours directly affect health outcomes it is therefore reasonable to assume that health literacy also mediates the relationship between education and health behaviour. Yet, to the best of our knowledge this relationship has not been investigated in population-based studies. Health literacy may mediate the effects of education on health behaviour through a number of mechanisms.

Previous studies have shown that inadequate health literacy (measured in terms of health-related reading ability and numeracy) is associated with poor problem-solving ability, low self-efficacy, low motivation, and poor knowledge on how to perform self-care behaviours (Amalraj, Starkweather, Nguyen, & Naeim, 2009; Geboers et al., 2014; Husson et al., 2015; Kaminski & Good, 1998; Osborn, Paasche-Orlow, Bailey, & Wolf, 2011; Paasche-Orlow &

Wolf, 2007; Schillinger et al., 2006; Torres & Marks, 2009; Verhoeven & Snow, 2001; Wolf et al., 2004). It is important to know whether health literacy mediates the relationship between educational level and health behaviour. If this is the case, adults with lower formal education, may benefit from health literacy-informed interventions.

Based on a large population-based survey, the aim of this study was to investigate if health literacy mediates the association between educational level and health behaviour (smoking, physical inactivity, poor diet) and obesity. Figure 1 illustrates the model for the mediation analyses. Two distinct health literacy dimensions were used from the nine-dimension Health Literacy Questionnaire (HLQ): ‘Understand health information well enough to know what to do’ and ‘Actively engage with healthcare providers’ (Osborne, Batterham, Elsworth, Hawkins, & Buchbinder, 2013).

Methods

Study design and data collection

The study is based on respondents aged 25 years or older from the 2013 Danish health and morbidity survey called “How Are You?”. Geographically, Denmark is divided into five administrative regions. The present study comprises data from one of these regions - the Central Denmark Region - where approximately 22% of the Danish population resides. The population of the Central Denmark region is characterized by a demographic composition (gender, age and marital status) that is similar to the total Danish population. Furthermore, a study has confirmed that the population of the Central Denmark Region is comparable to the total Danish population on health-related and social factors (Christensen, Davidsen, Ekholm, Pedersen, & Juel, 2014).

The survey consisted of a county-stratified random sample of 46,354 individuals and was drawn from the Danish Civil Registration System using the unique personal identification number given to each Danish citizen as a key. People were invited to complete

a postal or a web-based questionnaire. Three reminders were issued. Data were collected by the Central Denmark Region between February and April 2013. A total of 29,473 people (63.6 %) completed and returned the questionnaire. The personal identification number was used by Statistics Denmark to link respondents as well as non-respondents to the Danish national registers. Weights were used to account for differences in selection probabilities and response rates. These weights were constructed using a model-based calibration approach based on register information from Statistics Denmark. Data were weighted to represent the population in the Central Denmark Region.

Measures

Health literacy. The Health Literacy Questionnaire (HLQ) is a widely used measure of health literacy that has been translated into many European and Asian languages (Osborne et al., 2013). It was developed using a validity-driven approach including in-depth grounded consultations, psychometric analyses, and cognitive interviews (Osborne et al., 2013). The HLQ consists of nine scales. The translation and cultural adaption of the questions from English into Danish followed a rigorous forward-backward translation procedure, and cognitive testing, to ensure cross-cultural validity.

In the present study two of the nine HLQ dimensions each with five items were included: ‘Understand health information well enough to know what to do’ and ‘Actively engage with healthcare providers’ For each item, participants indicated their response using a Likert scale; 1 = very difficult, 2 = difficult, 3 = easy, and 4 = very easy. Scale scores were calculated for each individual as the mean of item scores for the five items and then standardised to range between 1 (lowest ability) and 4 (highest ability) to be consistent with the response options. If responses to more than two items in a scale were missing, the scale score was regarded as missing. As a result of this 1,962 observations (6.7 %) were excluded for the ‘understanding health information’ scale and 1,925 observations (6.5 %) for the

‘actively engaging with healthcare providers’ scale. Cronbach’s alpha coefficients indicated high internal consistency of both scales: ‘Understanding health information’ $\alpha = 0.87$ and ‘Actively engage with healthcare providers’ $\alpha = 0.91$.

Health behaviour and obesity. Three measures of health behaviour (smoking, physical inactivity, poor diet) and one for obesity were used. Respondents who smoked on a daily basis were classified as smokers. Respondents were classified as physically inactive if during a typical week they were not physically active at least 30 minutes per day as recommended by the Danish Health and Medicines Authority (Kiens et al., 2007). Dietary habits were assessed using the Diet Quality Score (Toft, Kristoffersen, Lau, Borch-Johnsen, & Jorgensen, 2007), which was developed to identify the quality of the diet in relation to cardiovascular risk. The scale consist of 25 items including questions about type of bread spread, fats used for cooking and how often the participants consumed selected food items (including fish, meat, fruits and vegetables). Poor diet was defined by a low amount of fruit, vegetables and fish and a high amount of saturated fat. Finally, self-reported height and weight were used to calculate body mass index (BMI), and obesity was defined as BMI 30 kg/m² or more.

Educational attainment. The participants were asked about their highest level of completed school education and further level education. Participants were classified into two educational categories 1) ‘Low level of education’ and 2) ‘Medium/high level of education’. Low level of education included basic education (primary and lower secondary school). Medium/high level included educational level above low level (vocational education, upper secondary school, and short-, medium- and long-term higher education).

Demographic and socio-economic factors. Age, gender, ethnic background, and marital status were collected from national registers to avoid missing data. Respondents were

defined as Danish if they had Danish citizenship or if at least one of their parents was a Danish citizen. Marital status refers to whether an individual is married or not.

Ethics

The study was approved by the Danish Data Protection Agency (j. no. 2007-58-0010) and was undertaken in accordance with the Helsinki Declaration. Information about the survey was provided to potential participants in writing and via the web. The participants' voluntary completion and return of the survey questionnaires constituted implied consent.

Statistical analysis

Prior to the multiple mediation analyses we tested a) the association between educational level and the two health literacy scales, b) the association between the two health literacy scales and each of the four health behaviour measures, and c) the association between education level and each of the four health behaviour measures (see figure 1) using regression analyses. All the bivariate analyses identified significant associations (data not shown).

To determine the indirect effect of health literacy on the association between education and each of the four dependent variables (smoking, physical inactivity, poor diet, obesity), multiple mediation analyses were conducted using the Karlson Holm Breen (-knb-) STATA-command (Breen, Karlson, & Holm, 2013; Kohler, Karlson, & Holm, 2011). This command decomposes the total effect into direct effect (the effect of the independent variable (educational level) on the dependent variable (health behavior) when controlling for mediating variables (health literacy scales) and indirect effect (the effect of the independent variable on the dependent variable through mediating variables) (Breen et al., 2013). All the mediation analyses were further adjusted for age, gender, ethnic background, and marital status. Significance was set at $p < 0.05$. Statistical analyses were performed using STATA 13.

Results

Table 1 shows that 18.6 % of the respondents have low levels of education. In total, 17.6 % are daily smokers, 18.9 % are physically inactive, 12.3 % have a poor diet, and 15.6 % are obese.

As shown in Table 2, low educational attainment significantly predicted daily smoking (total effect). Also, low educational attainment predicted daily smoking when the two health literacy scales were included as mediating factors (direct effect). Both health literacy scales were significant mediators in the association between educational attainment and daily smoking (Table 3), but the contributing factor was relatively small ('Understanding health information' 6.6 %; 'Actively engage with health care providers' 4.5 %).

Table 2 also shows that low educational attainment is a significant predictor of physical inactivity (total effect), also when the two health literacy scales were included as mediating factors (direct effect). Moreover, both health literacy scales were significant mediators in the association between educational attainment and physical inactivity (Table 3). The scale 'Understanding health information' accounted for 20.1 % of the variance between educational attainment and physical inactivity, whereas 'Actively engaged with health care providers' only accounted for 5.4 % of the variance. Hence, 'Understanding health information' had the strongest indirect effect on physical inactivity (78.8 %).

Low educational attainment was also a significant predictor of having an unhealthy diet (total effect), also when the health literacy scales were included as mediating factors (direct effect) (Table 2). 'Understanding health information' mediated the relationship between education and having an unhealthy diet (accounting for 13.3 % of the variance), whereas the scale 'Actively engage with health care providers' did not contribute significantly to the total effect between educational attainment and healthy diet (Table 3).

Finally, Table 2 shows that low educational attainment was also a significant predictor of obesity (total effect), including with the two health literacy scales as mediating factors

(direct effect). Both health literacy scales were significant mediators in the association between education and obesity (Table 3). The scale ‘Understand health information’ accounted for 16.2 % of the total variance, whereas ‘Actively engaged with health care providers’ only accounted for 4.2 % of the variance. Of the two scales ‘Understanding health information’ had the strongest indirect effect on obesity (79.6 %).

Discussion

To our knowledge this is the first population-based study examining if components of health literacy mediate often observed associations between education and a number of important health behaviours. We found that pertinent elements of health literacy indeed act as mediators in the relationship between education and health behaviour. Especially for those people who report that they are physically inactive, have a poor diet and are obese, the ability to understand health information, accounted for a large percentage of the total relationship with educational attainment. Of the two health literacy scales, ability to understand health information was clearly the strongest mediating factor. A reason for this could be that that this scale reflects a basic set of abilities needed for people to become equipped with knowledge through reading and comprehension of information and instructions about health. The other scale, ‘Actively engage with healthcare providers’, may have a less direct or downstream impact on health behaviours. Individuals with inadequate skills related to understanding health information will have less exposure to universal health information, and, if they are exposed to health promoting literature, they may not have the skills needed to comprehend and act upon it (Nutbeam, 2008; Roberts, 2015).

Our study showed that compared with the other health behaviours, health literacy mediates the relationship between education and smoking only to a small extent. The underlying causes for this may relate to the fact that in Denmark, there have been policy regulations and mass media campaigns for more than a decade in relation to tobacco use.

Therefore most individuals, regardless of health literacy, are aware of the health-related consequences of smoking. Instead, certain cultural factors and normative beliefs in people with low educational attainment may be part of the explanation of the strong social gradient in smoking status (Mackenback). Such a hypothesis requires further exploration.

Our study also shows that even though the association between educational attainment and health behaviour is partly mediated by health literacy, educational attainment remains associated with all four health behaviour factors when two indicators of health literacy are taken into account and when the analyses are adjusted for age, gender, ethnic background and marital status. Hence, this study suggests that the two indicators of health literacy we measured are contributing factors to the link between education and health behaviour, but the measures do not offer a complete explanation of the pathway. The full construct of health literacy, as defined by the HLQ, includes seven other independent scales, which may also be strong determinants. Other variables such as social norms, workplace environments, knowledge, stressors/resources and work status/income that differs between educational groups could also be part of the mechanisms between education and health behaviour as found in other studies (Cutler & Lleras-Muney, 2010; Godin et al., 2010; Layte & Whelan, 2009; Matsuyama et al., 2011; Mulder, de Bruin, Schreurs, van Ameijden, & van Woerkum, 2011).

To date, most health literacy research focused on reading ability and numeracy collected through direct testing procedures (Davis et al., 1993; Parker, Baker, Williams, & Nurss, 1995; Weiss et al., 2005). We used two different measures of health literacy that are self-reported. The health literacy measures used in the present study reflect a dynamic state related to what an individual sees as their current situation. Importantly, the way individuals' respond to the questions about their ability to understand health information and actively engage with healthcare providers varies depending upon the presence or absence of

demands related to their specific health conditions and the complexity of their immediate healthcare system (Edwards, Wood, Davies, & Edwards, 2012) [Batterham et al 2016]. It follows that individuals with unhealthy health behavior have poorer health status and encounter higher demands to manage their health (Paasche-Orlow & Wolf, 2007). As a result of this they may report greater difficulties in understanding health information and engaging with health care providers.

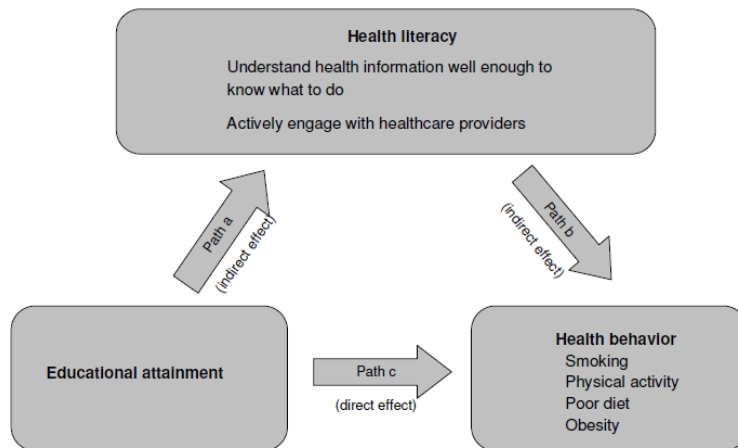
This study has some limitations. First, it is important to note that the findings are based on cross-sectional data, and therefore no conclusions about the temporality or causation can be made. Second, the ability and motivation to fill out a health survey can be viewed as a health literacy competency in itself; thus, the most vulnerable groups may have been excluded from our study. The study is also limited by including only two of the nine defined elements of the HLQ, thus the study suffers from construct underrepresentation [Buchbinder et al] . Consequently we can only draw conclusions about the two elements we measured, and not about health literacy overall. Application of the complete tool was not practical in this large population survey. Future research will be strengthened by measuring the full range of health literacy indicators to generate a more complete understanding of the potential health literacy strengths and limitations individuals may have, independent of educational attainment, which determine health behaviour and health status.

Conclusion

Health literacy, particularly the ability to understand health information, is a mediator in the relationship between educational attainment and health behaviour especially in relation to being physical inactive, having a poor diet, and being obese. The findings of this study suggest that strategies for improving public health and reducing health inequalities may be improved through a focus on health literacy. Health literacy is very closely linked to education and health inequalities, and therefore interventions aimed at improving health

behaviour and health status have the potential to be more targeted and effective when informed by robust data on the health literacy of the target populations.

Figure 1. Model of Mediation Analysis



THE MEDIATING ROLE OF HEALTH LITERACY ON HEALTH BEHAVIOUR

Table 1
Participant characteristics, N=29,473

	n	% ^a	Mean	SD
Demographic and socio-economic factors				
Age			52.1	16.3
Gender				
Men	14,045	49.4		
Women	15,448	50.6		
Ethnicity				
Danish	28,400	93.6		
Not danish	1,073	6.4		
Educational attainment				
Low	5,507	18.6		
Medium/high	23,037	81.4		
Marital status				
Married	19,828	58.9		
Not married	9,645	41.1		
Health literacy scales				
Understand health information well enough to know what to do			3.1	0.6
Actively engage with healthcare providers			3.1	0.6
Health behaviour				
Smoking				
Daily smoking	4,856	17.6		
Not daily smoking	23,971	82.4		
Physical activity				
Physical inactive	5,253	18.9		
Not physical inactive	23,484	81.1		
Diet				
Poor diet	3,268	12.3		
Not poor diet	24,872	87.7		
Obesity				
Obese	4,602	15.6		
Not obese	24,057	84.4		

Notes

^a All percentages are weighted based on register data to represent the population of the Central Denmark Region, 2013.

SD = Standard deviation

Table 2

Direct Effect of Education on Health Behaviors and Indirect Effect of Health Literacy on the Association Between Education and Health Behaviors

Dependent variable	Effect ¹	OR (CI)	Std. error	Z	P
Smoking	Total effect	1.86 (1.68-2.05)	0.09	12.23	0.000
	Direct effect	1.73 (1.57-1.92)	0.09	10.65	0.000
	Indirect effect	1.07 (1.05-1.10)	0.01	5.88	0.000
Physical inactivity	Total effect	1.57 (1.43-1.72)	0.07	9.46	0.000
	Direct effect	1.40 (1.27-1.54)	0.07	6.95	0.000
	Indirect effect	1.12 (1.10-1.15)	0.01	9.40	0.000
Unhealthy diet	Total effect	2.37 (2.12-2.65)	0.13	15.16	0.000
	Direct effect	2.10 (1.88-2.36)	0.12	12.83	0.000
	Indirect effect	1.13 (1.10-1.16)	0.02	8.25	0.000
Obesity	Total effect	1.72 (1.56-1.90)	0.09	10.67	0.000
	Direct effect	1.54 (1.39-1.71)	0.08	8.28	0.000
	Indirect effect	1.12 (1.09-1.15)	0.01	8.67	0.000

Notes. All the estimates are adjusted for age, gender, ethnic background and marital status

¹ *Total effect*: the effect of the independent variable (education) on the dependent variable (specific health behaviours) when not controlling for mediating variables (health literacy). *Direct effect*: the effect of the independent variable (education) on the dependent variable (specific health behaviours) when controlling for mediating variables (health literacy). *Indirect effect*: the effect of the independent variable (education) on the dependent variable (specific health behaviours) through mediating variables (health literacy)
 OR = Odds ratio; CI = confidence interval; SE = Standard error

Table 3

Contribution of Each Health Literacy Mediator on the Association Between Education and Health Behaviors

Dependent variable	Health literacy mediating variable	Coef.	Std. error	P	Contribution to the indirect effect (%)	Contribution to the total effect (%)
Smoking	Understanding health information well enough to know what to do	-0.14	0.06	0.015	59.5	6.6
	Actively engaged with health care providers	-0.14	0.05	0.008	40.5	4.5
Physical inactivity	Understanding health information well enough to know what to do	-0.31	0.06	0.000	78.8	20.1
	Actively engaged with health care providers	-0.12	0.08	0.015	21.3	5.4
Unhealthy diet	Understanding health information well enough to know what to do	-0.41	0.07	0.000	96.3	13.3
	Actively engaged with health care providers	-0.02	0.07	0.739	3.7	0.5
Obesity	Understanding health information well enough to know what to do	-0.30	0.06	0.000	79.6	16.2
	Actively engaged with health care providers	-0.11	0.06	0.042	20.4	4.2

Note. Coef. = Coefficients; SE = Standard error

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