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ORIGINAL ARTICLE

The relationship between health literacy and health outcomes among male young adults: exploring confounding effects using decomposition analysis

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Abstract

Objectives Previous studies indicate substantial correlations between low health literacy and poor health outcomes. However, empirical findings remain inconsistent and are theoretically challenging. In this study, we conceptually place health literacy within an established model of health inequality. Studying multiple pathways, we estimate the associations between health literacy and six health outcomes and decompose these associations with health literacy's covariates.

Methods Cross-sectional data from the Young Adult Survey Switzerland was used for the analyses (n = 5959, age = 18–25). Logistic regression and KHB decomposition analyses were applied to estimate health literacy's coefficients and confounding percentages.

Results Eleven covariates were associated with health literacy ($p < 0.001$). Ten covariates reduced the naïve health literacy coefficient when included in the regression models (confounding percentages: 36.7–86.9%). In three out of six models, the confounding effects led to non-significant health literacy coefficients.

Conclusions We found that health literacy's associations with health outcomes are confounded by socioeconomic, material, psychosocial, and health-related factors. More investigations on the causal importance of health literacy, respectively, on its potential to health promotion are required.

Keywords Health literacy · Determinants of health · Health status · Health behavior · Decomposition analysis · Young adults

Introduction

In the last decade, several health literacy surveys were launched to assess general health literacy levels in European countries, to explore differences between countries, stratification within countries and to identify the most vulnerable groups (Sørensen et al. 2015; van der Heide et al. 2013; Abel et al. 2014). Along with remarkable quotes of "problematic" and "insufficient" levels of health literacy and a relatively stable association of low health literacy and poor health outcomes (Howard et al. 2006; Berkman et al. 2011), scholars lifted health literacy to the illustrious circle of "determinants of health" (Trezona et al. 2018) or even to "one of the most important social determinants for health" (Duong et al. 2017). In this study, we question these statements after comparing the explanatory power of health literacy with other intermediary determinants of health using six different health outcomes and health behaviors.

On the factual side, health literacy has been statistically associated with different health outcomes (Howard et al. 2006; Berkman et al. 2011). Moreover, health literacy has also been associated with several facets of social stratification (Sørensen et al. 2015; van der Heide et al. 2013). However, several scholars have called for a better theoretical underpinning that describes health literacy as one factor among others to explain the linkages between common determinants of health and health outcomes

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(Poureslami et al. 2016; Berkman et al. 2011). Without a theoretical model, research findings rather reflect statistical associations, e.g., with individual educational achievement, financial situation, social status, age, and gender (Sørensen et al. 2015; van der Heide et al. 2013; Howard et al. 2006) rather than giving insight into the underlying mechanisms (Poureslami et al. 2016; Berkman et al. 2011). Therefore, the aim of this study is to elaborate a theoretical model on the grounds of social determinants of health literature. We then investigate in a more precise estimation of the effect of health literacy on health outcomes—especially considering psychosocial explanations of health literacy and health.

Toward an elementary health literacy model

We use in this study a definition of health literacy, which is suitable to the context of public health. Selden et al. (2000) defined 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." With respect to the social determinants of health literature (Mackenbach 2006; Marmot et al. 1991) and health literacy literature (Paasche-Orlow and Wolf 2007; Manganello 2008; Clancy 2009; Abel 2008), we understand health literacy not just as a "risk factor" of socioeconomic vulnerable people, but more generally as an intermediary (multidimensional) factor within the rather complex mechanisms effecting health. Hence, "modifying" health literacy (Stormacq et al. 2018) may not be easy, due to the many structural constraints people experience in daily life. Health literacy might rather be an intermediary "operator," which explains the mechanisms and functionings of social determinants of health (WHO 2010).

To isolate the explanatory power of health literacy, other determinants of health and its relations to health literacy should be considered (Berkman et al. 2011; Paasche-Orlow and Wolf 2007; Pignone et al. 2005). To achieve more clarity about these relations, scholars established different path models (Paasche-Orlow and Wolf 2007; Manganello 2008; Nutbeam 2008; Baker 2006; Sørensen et al. 2012). From an empirical point of view, aiming to isolate distinct effects from spuriousness, two kinds of problems arise: (a) Some models lack the integration of socioeconomic determinants of health (Manganello 2008; Baker 2006; Nutbeam 2008), and (b) others do not define clear cause–effect relationships between socioeconomic status, psychosocial factors, health literacy, and health outcomes (Sørensen et al. 2012; Paasche-Orlow and Wolf 2007).

To tackle these problems, we propose to include health literacy into a path model which is widely used in the literature of social determinants of health (Mackenbach 2006; Bartley 2017). It distinguishes between socioeconomic status and intermediary (material and psychosocial) factors of health and health behavior (Fig. 1). Generally, psychosocial factors have often been limited to psychosocial stress and social support (Marmot et al. 1991; Bartley 2017; Mackenbach 2006). Referring to more interdisciplinary approaches, we apply a broader understanding of the term "psychosocial" and include parental social support, emotional support from the social network, self-efficacy, and two personality traits conscientiousness and openness (Marmot and Wilkinson 2001; Janz and Becker 1984).

Even though evidence indicates close links between health literacy and socioeconomic factors (van der Heide et al. 2013; Sørensen et al. 2015), no empirical study investigated systematically health literacy's links to intermediary factors of health—although several scholars expect close relationships (Poureslami et al. 2016). Our elementary model not only makes these relationships explicit, but also implies that health literacy is contingent on these material and psychosocial factors and not vice versa. In contrast to health literacy, it is assumed that these intermediary factors are generic (not health-related) and remain more or less stable over time. Also, several health-related factors of a person or its social environment may have effects on health literacy and health outcomes. Since close relationships with health literacy can be expected, we include these factors in the model (Fig. 2).

The elements of the model are interpreted as following. *Health status* covers general measurements of health such as self-rated health, physical and mental health and functioning, and mortality. *Health behavior* includes all observable actions of an individual with direct consequences on health. They are principally changeable by choice and opportunity, e.g., diet, exercise, substance abuse, physical activity, or effective maneuvering within health care institutions. Health status and health behavior are contingent on intermediary psychosocial and material factors, socioeconomic, and health-related factors.

Up-to-date scientific evidence on health determinants shows a wide definition of *psychosocial factors* (Matthews et al. 2010). Besides psychosocial stress, effort reward imbalance, low control and negative life events (Mackenbach 2006), additional psychic and social factors like self-esteem, mastery, self-efficacy (Matthews et al. 2010), personality traits (Löckenhoff et al. 2012), self-management capacities (Goldman and Smith 2002), social ties, and social support should be considered. *Material factors* include potentially harmful physical environment (e.g., housing and working conditions), financial problems, community resources (e.g., access to health institutions and treatment, access to sport and leisure infrastructure as well as natural landscapes, and healthy food), employment status, and access to drugs (Mackenbach 2006). Material and

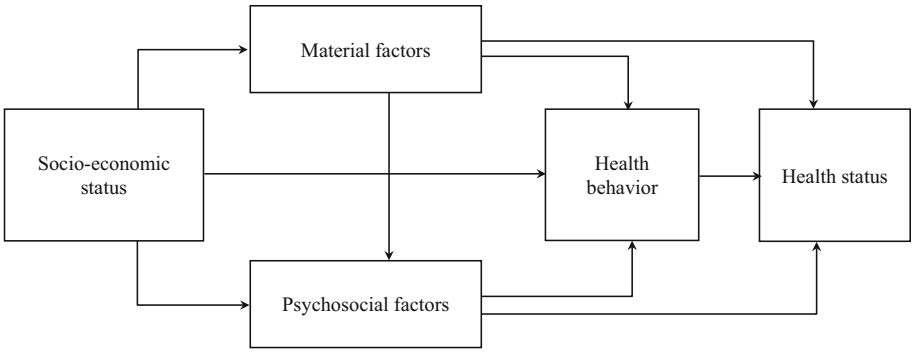

Fig. 1 Intermediary factors between socioeconomic status and health, adopted from Mackenbach (2006)

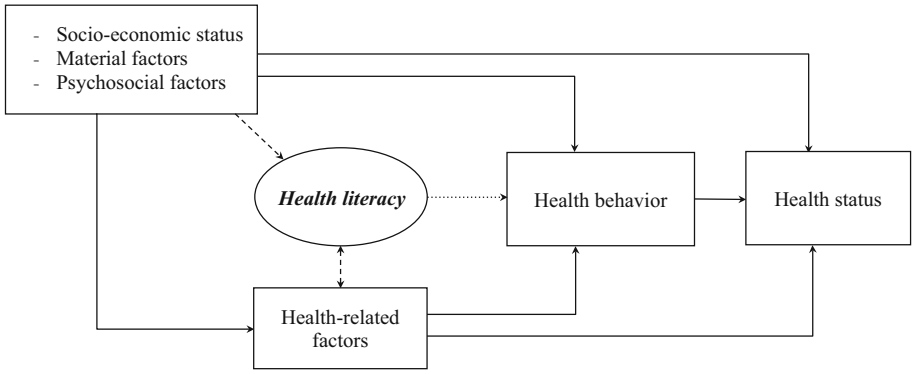

Fig. 2 Elementary health literacy model. Notes: The elementary health literacy model roots in the causation hypothesis (solid arrows). Dashed lines indicate that some intermediary material, psychosocial, and health-related factors are assumed to influence health literacy. Evidence for these connections has yet been poor. To isolate the unique explanatory power of health literacy (dotted arrow), covariates need to be controlled statistically

psychosocial factors are fully or partially dependent on the individual's *socioeconomic status*, which covers income, occupational status, and education of an individual (Freese and Lutfey 2011).

Several *health-related factors* such as attitudes, believes, interests, and social environment have been shown to affect health (Abraham and Sheeran 2005; Conner and Norman 2005). These factors may also have an impact on health literacy or vice versa.

Health literacy, as it is defined above, is determined by socioeconomic factors (Sørensen et al. 2015; van der Heide et al. 2013) and is assumed to be affected—at least partially—by selected intermediary psychosocial and material factors alike.

The elementary health literacy model (Fig. 2) allows us to estimate health literacy's associations with health behavior and health status by statistically controlling for selected competing covariates. Further, we estimate to what extent the uncontrolled associations of health literacy on health can be decomposed into socioeconomic, material, psychosocial, and health-related factors. We hypothesize that the associations between health literacy and health outcomes can partially or fully be decomposed to health literacy's covariates.

Methods

Data

We used data from the Young Adult Survey Switzerland (YASS) conducted in 2010 and 2011 in Switzerland. Data for the male sample were collected during recruitment for compulsory military service with a participation rate of 90%. The complete sample corresponded to 14% of the eligible male population of Switzerland aged between 18 and 25. One-third of each group received an additional health questionnaire with items used in the main analyses. This net sample consisted of 10,740 participants. The survey design is described in more detail elsewhere (Hofmann et al. 2013).

Measures

We used four health status variables and two health behaviors as dependent variables. Due to non-normal distributions, all dependent variables were transformed into dichotomous variables where "1" represents good health or favorable health behavior, respectively.

Health status

Since the general level of health is very high in this age group, *self-rated health* was categorized into 1 = "excellent" and "very good," and 0 = "good," "less good," and "poor." A validated 9-item *depression diagnostic and severity measure* (PHQ-9) has been used to measure mental health (Kroenke and Spitzer 2002). As recommended in the literature, we transformed the index measure into 1 = "none" and 0 = "mild" and "severe" depression tendency (Kroenke and Spitzer 2002). A measure derived from the Swiss Health Survey 2012 captures the frequency of impairments caused by the most prevalent *physical health symptoms* among young adults, namely back pain, abdominal pain, headache, and rheumatic pains. Due to skewness, the sample was split on convenient grounds into 1 = less than 12 day/year with impairments by these physical symptoms and 0 = 12 days and more/year with impairments. Further, the *body mass index (BMI)* was transformed into observations with 1 = normal BMI between 18.5 and 24.9 and 0 = lower or higher BMI.

Health behavior

Smoking behavior was transformed into 1 = non-smokers and 0 = smokers ("every now and then" or "daily"). *Energy drink consumption* was transformed into 0 = frequent consumers "more than once a week" and 1 = low consumers with a consumption of "once a week" or less.

Health literacy

Health literacy has been measured with the "short survey tool for public health and health promotion research" validated in previous research (Abel et al. 2014; Guo et al. 2018). The instrument includes eight Likert-scaled items covering four questions for functional health literacy and two questions each for interactive and critical health literacy. Observations with one or two missing values have been mean imputed and included in the analyses. Observations with more than two missing values have been excluded. Due to normal distribution, health literacy has been included as a continuous variable scoring from 0 to 30.

Health-related factors

The role of a *healthy lifestyle in the family* was dichotomized into 0 = "rather important" or lower and 1 = "very important." We assessed one's *interest in the topic of health* with a 4-point scaled question ranging from "not at all interested" to "very interested." (5) A 7-point scaled question captured one's *life goal of a healthy living* ranging from "not important at all" to "extremely important."

Socioeconomic status

While young adults often experience status inconsistency (Hurrelmann and Quenzel 2015), *socioeconomic status* of the participants has been measured by parent's socioeconomic status and the participant's academic track. Parent's socioeconomic status was assessed by four indicators, household equivalent income, parental financial situation, highest parental educational achievement, and the number of books at home. A factor analysis was performed to reduce data and model complexity. The young adult's *academic track* captures the anticipated educational achievement of the participant and was measured by six levels using the ISCED-scale from 2A to 5A (ISCED 2011 2012).

Material factor

We used one *material factor* as a proxy for community resources regarding healthy living environment: A 5-point Likert-scale "fully agree" to "fully disagree" were used to assess a fair number of offerings from sport clubs and other sport providers in the close environment.

Psychosocial factors

Parental social support was measured by the feeling to be in good hands. Due to skewness it has been transformed into a binary variable 1 = "in very good hands" and 0 = "in good hands and lower." We used a 4-point Likert-scale to assess the perceived *emotional support* from the social network ranging from "many persons providing emotional support" to "far too less persons." The 5-item instrument from Schwarzer and Jerusalem (1995) assessed the level of general *self-efficacy* among the respondents (index from 5 to 20). The 10-item instrument from Rammstedt et al. (2013) assessed two of the big five personality traits *conscientiousness* and *openness* by principal component analysis.

Control variables

Two control variables were included in the analyses, namely the Swiss language regions achieving different levels of health literacy (GFS Bern 2016) and age.

Analyses

STATA 15.1 and the user-written KHB package was used for all statistical analyses. The KHB command allows an

unbiased comparison of regression coefficients between nested models and the decomposition of mediation effects (Karlson et al. 2012; Kohler et al. 2011). To explore the associations of health literacy with its covariates, first we conducted a regression of health literacy on socioeconomic, material, psychosocial, health-related, and control variables (Analysis I). Variables which are not associated with health literacy could possibly be excluded from further analyses (Baron and Kenny 1986). Second, for each health status measure and each health behavior several regression analyses were conducted comparing the coefficients of our key variable, health literacy (Analysis II). The first run included all confounding covariates (full model), and the following runs excluded each of the confounding covariates separately (reduced models). This procedure differs from a classic mediation analysis theoretically, but not statistically. Rather than decomposing a total effect into direct and indirect (mediation) effect, we decompose our effect of interest (health literacy on health) into direct effect and indirect effects due to common causes (covariates). Hence, health literacy functions as the key variable. The KHB method allows a comparison of effect sizes by decomposing effects into a confounding and a rescaling component (Karlson et al. 2012; Kohler et al. 2011). When regressing health outcomes, we did not control for health behaviors because of over-control bias.

Respondents with more than two missing values among the eight health literacy items, with more than three missing values among the nine depression items (median imputation), and with any missing values among the other variables were excluded from the analysis. Missing values among the health literacy items were mean imputed; missing values among the depression items were median imputed.

Results

For our analyses, we used variables from the additional questionnaire which was filled out by one-third of the respondents. Due to different missing values in the outcome variables, different samples with $5959 \geq n \geq 5717$ were used for the analyses. The descriptive results of the largest sample are displayed in Table 1.

Analysis I: covariates of health literacy

First, we conducted a multiple linear regression analysis of health literacy on its covariates. All intermediary and health-related covariates correlate with health literacy on a high level of significance: $p < 0.001$ (Table 2). Among the covariates, interest in health topics, parent's SES, self-efficacy, and openness are the best predictors for a good health literacy level ($\beta > 0.1$). Respondents of the French speaking part of Switzerland have a higher chance of having a good health literacy level than respondents of the German speaking part. Within the age range used, older respondents showed a lower health literacy. These results suggest including all intermediary and control variables in the further analyses.

Analysis II: decomposition analysis

Second, we conducted decomposition analyses based on multiple logistic regression. Therefore, the results of each model per outcome are displayed in Table 3 (full models).

Odds ratios and levels of significance indicate that the associations of health literacy are only significant in models 1–3 (self-rated health, depression tendency, and physical health) Excluding the covariates, health literacy shows significant associations in all six models ($1.16 \geq \text{OR} \geq 1.04$, $p < 0.001$). These naïve odds ratios are moderate to small and can be interpreted as follows: One additional point on the health literacy scale (0–30) increases the chance of having a very good or excellent health by 16% or, e.g., increases the chance for having a normal BMI by 4%.

However, large proportions of these naïve coefficients of health literacy can be attributed to health literacy's covariates. The percentages listed besides the health literacy coefficients (key variable) express to what proportion the naïve, uncontrolled coefficients of health literacy can be accounted for the eleven covariates (Table 3). These total confounding percentages show that 36.7–86.9% of the naïve, uncontrolled coefficients of health literacy can be attributed to its covariates. The confounding analyses were run including covariates with negative coefficients and non-significant covariates as control variables. In models 4–6, the confounders were responsible for a decrease of the health literacy's coefficients to a non-significant level.

The percentages added besides each covariate express the contribution of each variable (or group of variables) to the effect change, respectively, to the total confounding percentage. These latter proportions sum up to 100%. The analyses show that up to 30.0% of the total confounding percentages can be attributed to health-related factors, up to 84.6% to socioeconomic factors, up to 19.2% to the material factor and up to 82.7% to psychosocial factors. Particularly, a young adult's interest in living a healthy life and conscientiousness most often confound the coefficients of health literacy (in four to five models). Further, the analyses show that the coefficients vary significantly across the models.

Overall, the results support our hypothesis that health literacy associations can partially or fully be decomposed into its covariates.

Table 1 Study population (n = 5959)

	Number	%	Mean	SD	Skewness
Dependent variables					
Self-rated health					
Very good	3929	65.9			
Good or poor self-rated health	2030	34.1			
Depression tendency					
No	4104	68.9			
Yes	1855	31.1			
Physical health					
Good	3879	67.3			
Poor	1884	32.7			
Weight					
Normal weight	4318	75.5			
Over- or underweight	1399	24.5			
Smoker					
No	3372	56.9			
Yes	2552	43.1			
Energy drink consumption					
Low consumption	3501	59.4			
High consumption	2396	40.6			
Key variable					
Health literacy			20.231	3.394	− 0.246
Health-related covariates					
Healthy family					
Very important	2703	45.4			
Rather important or lower	3256	54.6			
Interest for health topics (4 cat.)			2.943	0.792	− 0.399
Life goal: healthy living (7 cat.)			5.435	1.344	− 0.890
Socioeconomic covariates					
Parents SES			0.010	0.740	0.142
Own academic track (6 cat.)			3.395	0.873	0.443
Material covariates					
Sport programs nearby (5 cat.)			4.283	0.869	− 1.231
Psychosocial covariates					
Tie to parents					
Strong tie	4034	67.7			
Weak tie	1925	32.3			
Good emotional support (4 cat.)			3.290	0.578	− 0.367
Self-efficacy			15.852	2.302	− 0.260
Conscientiousness			0.033	1.122	− 0.266
Openness			− 0.200	1.068	− 0.006
Control variables					
Region					
German	4487	57.3			
French	1051	17.6			
Latin	421	7.1			
Age			19.62	0.975	1.044

Data from young adult survey Switzerland, Switzerland 2010 and 2011

Table 2 Linear regression of health literacy on covariates

	Health literacy		
	β	*B*	95% CI
Health-related covariates			
Healthy family	0.068	0.46***	0.30, 0.63
Interest for health topics	0.158	0.68***	0.56, 0.79
Life goal: healthy living	0.050	0.13***	0.06, 0.20
Socioeconomic covariates			
Parents SES	0.143	0.66***	0.54, 0.77
Own academic track	0.093	0.36***	0.27, 0.45
Material covariates			
Sport programs nearby	0.094	0.37***	0.28, 0.46
Psychosocial factors			
Strong tie to parents	0.043	0.31***	0.14, 0.48
Good emotional support	0.086	0.50***	0.36, 0.65
Self-efficacy	0.176	0.26***	0.22, 0.30
Conscientiousness	0.061	0.18***	0.11, 0.26
Openness	0.110	0.35***	0.28, 0.42
Control variables			
French region	0.070	0.63***	0.42, 0.83
Latin region	0.026	0.35	0.03, 0.67
Age	− 0.048	− 0.17***	− 0.26, − 0.08
Intercept		11.69***	9.73, 13.65
R^2		0.223	
Observations		5959	

Data from young adult survey Switzerland, Switzerland 2010 and 2011

***$p < 0.001$

Discussion

Along with new scientific knowledge on chronic, non-communicable diseases, their tremendous direct and indirect costs, and their reducibility through healthier living and lifestyles, a strong political motivation for citizen empowerment has emerged: "They need to be empowered to take control of the determinants of their own health." To become "(…) active and informed actors, participating in making decisions on their own treatment (…) increased health literacy and access to good health-related information are prerequisites" (WHO Europe 2013, p. 86). Not only politicians but also scholars acknowledged health literacy as an important health issue and even as an important key determinant of health.

Until today, research findings on health literacy rather reflect statistical associations than giving insight into the underlying mechanisms of health (Poureslami et al. 2016; Berkman et al. 2011). Many studies do not describe cause–effect relationships explicitly or do not include socioeconomic determinants of health in their models (Sørensen et al. 2012; Manganello 2008).

Our elementary health literacy model (Fig. 2) accounts for existing knowledge on social determinants as well as intermediary material, psychosocial, and health-related factors of health. It states that health literacy is contingent on socioeconomic status as well as on intermediary material, psychosocial, and health-related factors of health. Testing our model against survey data, we found that health literacy was associated with socioeconomic status, material, psychosocial, and health-related factors (Table 2).

Further, six binary logistic regression analyses showed confounding effects when covariates were included in the model (Table 3). In three out of six models, these confounding effects reduced health literacy's coefficients to statistically insignificant levels. We observed significant coefficients of health literacy on self-rated health, depression tendency, and physical health. However, we found no empirical support for an effect of health literacy on BMI, smoking, or energy drink consumption.

Among the covariates, ten out of eleven covariates (except openness) contributed to health literacy's effect reductions in at least one model. These ten possible "backdoor" paths confound the naïve coefficients of health literacy on health and may be the reason why intervention studies show scarce and inconsistent evidence for positive effects of health literacy (Nutbeam et al. 2017; Berkman et al. 2011).

Further, a young adult's life goal of a healthy living and conscientiousness appear as the most frequent confounders of the health literacy's coefficients. Since many health literacy measurements do not include the motivation to live a healthy life, health literacy's relations to these and other possible health-related factors need to be clarified and tested in future studies. Until then, our results suggest that a definition of health literacy as "key determinant" of health (Trezona et al. 2018; van der Heide et al. 2013) might be pre-mature. Moreover, health literacy appears to play a secondary role, being highly dependent on socioeconomic, material, psychosocial, and health-related factors of health.

Our findings may serve as starting points for two types of studies. First, studies should investigate the structural constraints (e.g., low education, low social status, and unhealthy material and social environment) that possibly thwart positive and long-lasting effects of health literacy interventions (Razum et al. 2016). Second, more sophisticated intervention studies are needed that put rigorous attention on the interplay between health literacy and personal factors like motivation, conscientiousness, and emotional support regarding different health outcomes. All these studies should strive for better knowledge about how to make those people's live healthier, who are exposed to

Table 3 Odds ratios of health literacy and its covariates for different health outcomes

	Health status								Health behavior			
	1: Very good self-rated health		2: No depression tendency		3: Physical health		4: Normal BMI		5: Non-smoking		6: Low energy drink consumption	
	OR (95% CI)	cp %	OR (95% CI)	cp %	OR (95% CI)	cp %	OR (95% CI)	cp %	OR (95% CI)	cp %	OR (95% CI)	cp %
Health literacy (naïve coeff.)[a]	1.16***		1.10***		1.05***		1.04***		1.04***		1.04***	
	(1.14, 1.18)		(1.08, 1.12)		(1.03, 1.06)		(1.02, 1.05)		(1.02, 1.06)		(1.02, 1.06)	
Health literacy (key variable)[b]	1.06***	63.5	1.03**	74.2	1.03**	36.7	1.01	56.9	1.00	86.9	1.02	49.5
	(1.04, 1.08)		(1.01, 1.05)		(1.01, 1.05)		(0.99, 1.03)		(0.99, 1.02)		(1.00, 1.03)	
Health-related covariates		25.7		5.0		–		15.4		30.0		–
Healthy family	1.31***	7.7	0.83**		0.85**		1.22**	15.4	1.17**	7.6	1.14	
	(1.16, 1.48)		(0.73, 0.94)		(0.76, 0.96)		(1.07, 1.40)		(1.04, 1.31)		(1.01, 1.27)	
Interest for health topics	1.14**	6.9	0.95		0.92		1.11		1.00		0.96	
	(1.05, 1.24)		(0.87, 1.03)		(0.85, 1.00)		(1.01, 1.21)		(0.93, 1.09)		(0.89, 1.04)	
Life goal: healthy living	1.15***	11.1	1.12***	5.0	1.05		1.06		1.27***	22.4	1.11***	15.0
	(1.09, 1.21)		(1.06, 1.17)		(1.00, 1.11)		(1.00, 1.11)		(1.21, 1.33)		(1.06, 1.17)	
Socioeconomic covariates		5.9		–		–		84.6		42.9		–
Parents SES	1.16***	5.9	1.07		1.05		1.25***	53.7	1.00		1.02	
	(1.06, 1.26)		(0.98, 1.16)		(0.97, 1.14)		(1.14, 1.37)		(0.91, 1.07)		(0.94, 1.10)	
Own academic track	1.08		1.00		0.98		1.15***	30.9	1.67***	42.9	1.42***	62.3
	(1.00, 1.15)		(0.93, 1.08)		(0.92, 1.05)		(1.07, 1.24)		(1.55, 1.79)		(1.33, 1.52)	
Material covariates		12.2		12.3		19.2		–		–		–
Sport programs nearby	1.30***	12.2	1.27***	12.3	1.09**	19.2	1.04		1.00		1.00	
	(1.21, 1.39)		(1.19, 1.36)		(1.02, 1.17)		(0.97, 1.12)		(0.94, 1.07)		(0.94, 1.07)	
Psychosocial covariates		56.2		82.7		80.8		–		27.1		22.8
Strong tie to parents	1.49***	7.8	1.56***	7.9	1.13		0.83**		1.26***	6.8	1.09	
	(1.31, 1.69)		(1.37, 1.78)		(1.00, 1.28)		(0.72, 0.96)		(1.11, 1.42)		(0.97, 1.23)	
Good emotional support	1.44***	12.4	1.44***	13.2	1.05		0.88		0.76***		0.86**	
	(1.29, 1.61)		(1.29, 1.61)		(0.94, 1.16)		(0.78, 0.98)		(0.69, 0.84)		(0.77, 0.95)	
Self-efficacy	1.13***	21.9	1.18***	36.4	1.07***	62.6	0.98		1.00		0.98	
	(1.10, 1.16)		(1.15, 1.21)		(1.04, 1.09)		(0.95, 1.00)		(0.96, 1.01)		(0.96, 1.01)	
Conscientiousness	1.28***	14.0	1.52***	25.1	1.08**	18.3	1.03		1.25***	20.3	1.16***	22.8
	(1.21, 1.36)		(1.43, 1.61)		(1.03, 1.14)		(0.97, 1.09)		(1.18, 1.31)		(1.10, 1.22)	
Openness	0.99		0.91**		0.98		0.99		0.88***		1.04	
	(0.94, 1.05)		(0.86, 0.96)		(0.92, 1.03)		(0.93, 1.05)		(0.84, 0.93)		(0.99, 1.09)	

Table 3 (continued)

	Health status				Health behavior	
	1: Very good self-rated health	2: No depression tendency	3: Physical health	4: Normal BMI	5: Non-smoking	6: Low energy drink consumption
	OR (95% CI) cp %	OR (95% CI) cp %	OR (95% CI) cp %	OR (95% CI) cp %	OR (95% CI) cp %	OR (95% CI) cp %
Control variables						
French region	1.34***	0.67***	0.55***	1.04	0.77**	1.77***
	(1.13, 1.59)	(0.57, 0.79)	(0.47, 0.64)	(0.87, 1.24)	(0.66, 0.90)	(1.51, 2.08)
Latin region	1.00	1.21	1.07	0.98	0.80	2.46***
	(0.79, 1.26)	(0.95, 1.54)	(0.85, 1.34)	(0.76, 1.27)	(0.63, 0.98)	(1.92, 3.14)
Age	0.85***	0.87***	0.95	0.82***	0.86***	0.94
	(0.80, 0.90)	(0.82, 0.93)	(0.90, 1.01)	(0.77, 0.87)	(0.81, 0.91)	(0.89, 1.00)
Intercept	0.04***	0.10**	0.83	78.15***	2.7	1.11
	(0.01, 0.15)	(0.02, 0.40)	(0.22, 3.05)	(19.4, 315)	(0.74, 9.74)	(0.31, 4.02)
Pseudo-R^2	0.13	0.13	0.03	0.02	0.10	0.05
Observations	5959	5959	5763	5717	5924	5897

Decomposition of the health literacy effect to health literacy's covariates

Data from young adult survey Switzerland, Switzerland 2010 and 2011; OR = odds ratio; cp % = confounding percentages for *key variable*, respectively, contribution to total confounding percentages of *each covariate* showing positive and significant effect on dependent variable

***$p < 0.001$; **$p < 0.01$

[a]Naïve odds ratios from logistic regressions including control variables and excluding covariates

[b]Odds ratios from logistic regressions including covariates and control variables (coefficients below)

poor structural conditions and who score low on personal health-related attributes.

Limitations and strengths

Due to restrictions in the original questionnaire, our models accounted for only a small number of determinants of health literacy and health. Additional intermediary and health-related factors could possibly influence health literacy and its effects. We analyzed the data from an all-male sample. While male young adults are a particularly interesting subpopulation (e.g., regarding their health risk behaviors), the finding is limited in this respect and calling for similar studies in female populations. The participants in our data set have a small age range from 18 to 25 years. This calls for caution when generalizing the results to young women and other age groups.

Further, there is a risk of bias when explaining self-rated health and depression tendency with a self-rated health literacy instrument: A positive association might occur due to general optimism (or pessimism) that affects self-rated health and self-rated health literacy in the same way. However, an opposite hypothesis might also be true. Respondents with high health literacy could possibly be more critical about their health and tend to underestimate their health status. Similarly, respondents with low health literacy might tend to overestimate their health status. Hence, estimates cannot be interpreted as causal.

There are noticeable strengths of this study. Unlike most health literacy studies to date the present explorations are based on a), an explicit theoretical framework that allows to anchor the concept of health literacy within a social determinant of health approach and b) a data set which had respondents of all social strata sufficiently included. The inclusion of psychosocial and health-related variables mostly missing in previous studies allowed a more comprehensive analysis of the complex mechanisms of health literacy and health.

Conclusions

We found that health literacy's associations with health outcomes are confounded by socioeconomic, material, psychosocial, and health-related factors. In the current sample of Swiss male young adults, in three out of six models confounding effects reduced health literacy's coefficients to statistically insignificant levels. This study identifies a clear need for more investigations on the causal importance of health literacy and respective consequences for health promotion interventions.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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