UNIVERSITÄT BERN

Graduate School for Health Sciences

University of Bern

Health Literacy: Determinant of Health or Status Indicator?

PhD Thesis submitted by

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for the degree of

PhD in Health Sciences (Public Health)

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source: https://doi.org/10.48549/3992 | downloaded: 23.4.2024

Accepted by the Faculty of Medicine and the Faculty of Human Sciences of the University of Bern

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For the Children.

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Abstract

An increasing burden of preventable diseases, persistent health inequalities, and new infectious diseases call for responsible citizens to take care of their health and health decisions. Therefore, health literacy appears to be a promising concept to foster better health behaviours. However, health literacy is a broad concept and interventions targeting health literacy show mixed results. Against this background, this thesis' aim is twofold. First, it explores health literacy as determinant of health. Secondly, and entwined with the first, it aims to provide a better conceptual understanding of health literacy.

For the empirical analyses, data from Swiss male young adults were used. Three studies were carried out, each with different statistical approaches, to obtain a better understanding of the pathways between health literacy, its contextual factors, and favourable health outcomes. The studies' results do not support the notion that health literacy – as a distinct phenomenon – has a causal importance to health. Rather, the findings suggest that health literacy should be acknowledged as a multifactorial phenomenon with many different dimensions, dependencies, and conversion factors. The latter either amplify or impede health literacy's positive effects on health. Finally, the results indicate that potential health literacy interventions are likely to only address a selection of these aspects and may have limited or no benefit on health depending on personal and contextual factors.

This umbrella text also presents conceptual work that could not be presented in the three journal articles. The health literacy staircase model (HL-SM) introduced here, describes the embeddedness of health literacy in contextual factors and addresses the complex path from knowledge to decision-making and decision-implementation. Further, it discusses several shortcomings of previous health literacy definitions and conceptualizations that are presented in the introduction section. The HL-SM was developed after the second publication and inspired the third study that explores the role of decision-making ability as a mediator from health literacy to health.

This thesis calls for more health literacy research focussing on informed health decision-making in every-day contexts. Further, health literacy research is urged to give more emphasis to the concept's boundaries, dependencies, and conversion factors. Without paying attention to prevailing contextual factors, there is considerable danger towards an individualization of a primarily societal problem.

Acknowledgement

Most of all I thank my thesis advisor, Thomas Abel. His experience in health sciences and health sociology, his support, and patience laid the foundations for this thesis. His appropriate balance between support, demand, encouragement, and self-determination was the key to success for this thesis. Sincere thanks, Thomas!

Next, I thank Thomas Kohlmann for his disposition as co-referee, his invaluable feedback and continued support for this thesis.

Also, I would like to express my thanks to the Graduate School for Health Sciences (GHS), its coordination, supporting staff, and all active and former experts for their engagement in this excellently functioning organisation. I have felt very well taken care of during the complete process of my doctoral studies. For the benefit to other graduate students, I urge the GHS to keep up with their good work in caring for their students.

Special thanks go to the Bern University of Applied Sciences (BFH). The BFH supported this thesis financially and in terms of content. Without this support, which I experienced from all superiors, this thesis would not have been initiated in the first place.

Last, I thank my wife who supported this adventure all the way through and who was patient and sympathetic for the many situations where my mind kept working outside of working hours. Finally, extraordinary thanks go to my parents. They always supported my intellectual career. And then, many thanks go to Janis for his proof-readings.

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1. Introduction

The work of this PhD Thesis is dedicated to the following question: Can health literacy be acknowledged as an independent and modifiable determinant of health? Intuitively, nobody would disagree that better health literacy (in German: *Gesundheitskompetenz*[1]) will be beneficial to a person's health. Better literacy and competence to understand human health – and illness – will most probably lead to better health behaviour or increased adherence to professional advice.

On the other hand, the mere possession of *knowledge* combined with a *willingness* to live a healthy life are not sufficient to change behaviour. Psychologists call this phenomenon the intention-behaviour gap. Thus, many health sciences experts and professionals struggle with the question of how to nudge people into healthier behaviours: in health promotion, in disease prevention, and in health care. These struggles need to be more successful. The burden of non-communicable – but preventable – diseases (NCDs) increases all over the world (Pan et al. 2021; Kluge et al. 2020; WHO 2018). Furthermore, NCDs have a tremendous impact on the severity and dissemination of communicable diseases such as Covid-19 (Kompaniyets et al. 2021; Azarpazhooh et al. 2020). Already before the Covid-19 pandemic, Saha and Alleyne (2018) urged to avoid a reductionist attitude that "limits health security to the control of [pandemic] outbreaks". Instead, they stressed NCDs as an equally important threat to global health security compared to infectious diseases.

Behavioural science extracted three factors that trigger behavioural change and, hence, close the intention-behaviour gap: available opportunities, motivation, and capabilities. The latter is understood as knowledge and skills (Michie et al. 2011). To acquire this knowledge and skills, health literacy appears to be crucial. Therefore, health literacy is usually defined as "knowledge, motivation and competences to access, understand, appraise, and apply health information" (Sørensen et al. 2012).

So far, the concept of health literacy appears to be a compelling starting point to reduce unhealthy behaviour and to tackle NCDs. On the other hand, one must acknowledge the complexity of modern information societies: Which skills are really needed to *access*, to *understand*, to *appraise*, and to *apply* health information, considering the bulk of day-to-day changing

[1] Literacy and competence are obviously not equivalent terms. However, most English definitions of health literacy include more attributes than just reading skills and numeracy. The concept of health literacy will be discussed below.

information? For example, imagine an overweight person who is willing to reduce body weight. Where should she or he search for information? How will she or he appraise the validity of information? According to what criteria will she or he select relevant content for decisions? What skills are necessary to execute her or his decisions in daily life? These few questions reveal that decision-making and complying to one's own health goals are extremely difficult tasks – especially when facing everyday seductions for unhealthy behaviour. Furthermore, these questions give a brief taste of the many abilities and competencies needed to stay health-literate. Moreover, only punctual help may be expected from the health care system (Schaeffer 2015).

Against the backdrop of behavioural science and the insufficiency of bare knowledge and willingness to change behaviour, the requirements to be a health literate person are tremendous. Thus, research is challenged by the risk that health literacy serves as a residual for all individual characteristics promoting good health. In avoid this risk, the health literacy concepts need to be very precise about its boundaries, assumptions, and causal relations. This precision has yet not been achieved in health literacy research and fundamental questions remain largely unanswered. Increasing precision and transparency in health literacy research, this thesis investigates in three of these fundamental questions.

First, *what are a person's preconditions to achieve high health literacy levels?* In societies with many civil liberties and freedom of choice individuals are more or less condemned to make their own (health) decisions. A large burden of responsibility weighs heavily on everyone's shoulders. Although a high demand of self-determined decision-making can be observed, there is yet a lack of effort to investigate this question. For example, most empirical health literacy studies used either measurement tools that focused on functional literacy and numeracy (s. chapter 1.1) or on measurement tools that rated subjective success in executing health-related tasks[2]. Studies on cognitive or non-cognitive capacities determining these success rates are rare. In sum, this thesis investigates in *looking backwards* to the conditional factors of health literacy and then suggests different conceptual models.

Inferring from conditional factors of health literacy, this thesis investigates in a second question: *What is the causal effect of health literacy on one's decision-making ability and, further, on favourable health outcomes considering preconditional factors for health literacy?* Therefore, the thesis' second aim

[2] E.g. the European Health Literacy Survey (HLS-EU) asks participants 47 times the same question: "On a scale from very easy to very difficult, how easy would you say it is to: …" (access, understand, appraise, and apply health information) (Sørensen et al. 2015).

is to provide theoretical and empirical answers to the causal importance of health literacy to explain health outcomes. According to Freese and Kevern (2013) causal importance can only be "articulated and adjudicated in quantitative terms". Hence, those causes with higher attributable fractions for the outcome are more important than those with lower attributable fractions. In the case of health literacy, only empirical tests can answer the question on the causal importance comparing (a) different aspects of health literacy amongst themselves and (b) health literacy aspects with their pre-conditional factors. In sum, this thesis, *looks forward* to exploring conditioned and unconditioned effects of health literacy on different health outcomes.

Third, this thesis aims to give an answer to the question explicated in its title: Is health literacy a health determinant on its own right or rather an indicator for more distal socioeconomic factors? The question can be translated from this more popular to a rather scientific formulation: *Is health literacy a personal characteristic with causal importance or is it rather a function of more stable psychosocial and socioeconomic determinants of health?*

To answer this overriding question, the content of this thesis is structured as following. First, this *introduction* is complemented with a brief history of health literacy followed by a compilation of shortcomings related to the health literacy concept (chapters 1.1 and 1.2). Further, a translation of health literacy's shortcomings into counterfactual thinking is added (chapter 1.3). Chapter 1.4 will provide an introduction in the literature on health literacy in contexts. Based on all considerations and the most relevant literature for this thesis, the scientific research interests are then elaborated in detail (chapter 1.5). In *chapter two*, the statistical methods used for this thesis are described in form of a brief introduction. In *chapters three to five*, two published articles and one accepted article for publication are presented as empirical part of the thesis. *Chapter six* presents the results of the theoretical work that have accompanied this thesis' empirical work. It consists of an adapted model from Edwards et al. (2012), which proved to be of special value. The thesis ends with a general *discussion* of all results and with answers to the three questions raised above.

1.1 A brief history of health literacy

The term health literacy was used as early as in 1974 during an interdisciplinary conference on health education at Saranac Lake, a small village in the State of New York, USA (Okan 2019). Back then the participants discussed the role of school education to prevent illness. During the conference they concluded that the outcome of health education in schools must

be health literacy. Being "health-literate" was associated with an individual being responsible for his/her own health and, secondly, with the public being responsible for creating health-supportive environments. Although almost half a century had passed where an ongoing consensus prevailed to integrate health literacy into primary education, subsequently only few countries have added a health literacy curriculum into schools (Okan 2019).

Concerning the health care sector, the break-through of the health literacy concept occurred at the end of the last century. During the second half of the 20th century the health system became more complex, and health professionals began to deal with more and more active patients investigating in their health issues and decision-making (Okan 2019). In the nineties, worrying results of international literacy surveys increased the attention to the interaction between patient literacy and healthcare outcomes (NALS[3] & IALS[4]). Doctors recognized that poor literacy levels can threaten the effective patient–provider communication, therapeutic adherence, self-management skills, and the appropriate interpretation of health information (ebd.). In consequence, the first screening tools for health literacy were designed for the healthcare context (REALM[5] & TOFHLA[6]). These measurement tools were first and foremost developed to answer the question of how to make a health organisation "health literacy responsive". Health information and services were needed to be equally accessible to all people regardless of their health literacy abilities (Okan 2019).

Since the end of the last century, most published health literacy articles emerged from the field of healthcare. These investigations were not only driven by altruism striving for more patient involvement and patient empowerment. Rather, there "was and still is a desire in order to lower healthcare costs and liability" (Okan 2019). Hence, from a clinical point of view patients need to be compliant and adherent. On the other hand, and outside the narrow clinical context, the educational branch re-entered the scientific discussions – although outside the narrow field of school education. Parker (2009) was probably among the first to conceptualize health literacy as a function (or a result) of the *demands and complexity of the system* on the one hand, and *personal skills and competences* on the other. This conceptualization had a strong impact on the public health debate since it emphasizes a person's competencies that are

[3] National Adult Literacy Survey, USA (1993)

[4] Adult Literacy Survey, Canada (1994)

[5] Rapid Estimate of Adult Literacy in Medicine (1993)

[6] Test of Functional Health Literacy in Adults (1995)

needed to manoeuvre through everyday life and health care systems to maintain a healthy life.

Besides the school-based and the clinical approaches, the third branch of health literacy's history is rooted in the field of public health. Early health literacy ideas in the field of public health and health promotion go back to the Lalonde report published in 1974 and more prominently to the Ottawa Charter of 1986. Although the term health literacy was not mentioned back then, the development of personal skills was one of the five strategies promoting health (WHO Euro 1986). Another decade passed until health literacy was explicitly mentioned in the WHO health promotion glossary in 1998. There it is defined 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 1998). This definition emphasises health literacy not just as a derivate of literacy (e. g. reading pamphlets or medication leaflets) but rather as a wide array of practical abilities needed in everyday life. To bring some order into these abilities, Nutbeam (2000) suggested a three-fold model distinguishing between functional, interactional, and critical health literacy. He derived these three "types" from Freebody and Luke (1990) who proposed three types of literacy approaches to understand and analyse written text. According to these authors, written text can a) be *understood* considering the content, b) be *interpreted* together with peers considering a specific socio-cultural context, and c) be *critically analysed* considering authorship and un-explicated ideological content. Based on these approaches which are all necessary to "use texts effectively, in their own individual and collective interests" (Freebody and Luke 1990, p. 8), Nutbeam (2000) proposed three enabling literacy skills or, rather, live competencies:

> **Basic/functional literacy** – sufficient basic skills in reading and writing to be able to function effectively in everyday situations, broadly compatible with the narrow definition of 'health literacy' (…).
> **Communicative/interactive literacy** – more advanced cognitive and literacy skills which, together with social skills, can be used to actively participate in everyday activities, to extract information and derive meaning from different forms of communication, and to apply new information to changing circumstances.
> **Critical literacy** – more advanced cognitive skills which, together with social skills, can be applied to critically analyse information, and to use this information to exert greater control over live events and situations. (Nutbeam 2000; accentuation by the autor)

Again, Nutbeam (2000) emphasises the failures in scholarly health education to teach functional health literacy skills and knowledge. Furthermore, the three-fold conceptualization of health literacy also emphasizes the need for competences beyond basic reading skills. To promote greater independence and empowerment of individuals and communities, interactive and critical health literacies are equally important. Health information needs to be assessed, interpreted, and translated for one's own context, values, and attitudes. In order to better understand these very personal dimensions of context, recent scientific investigations put more emphasis on the third aspect of health literacy, namely critical health literacy.

In a qualitative review, Chinn (2011) distinguished three domains of critical health literacy: (1) a critical appraisal of information including an assessment of its credibility and personal relevance, (2) an understanding of social determinants of health, and (3) active citizenship through voting or engagement for healthier communities. Furthermore, critical health literacy has been adapted and tested for utility facing pandemic times such as the current Covid-19 pandemic. For example, Abel and McQueen (2020) suggest "critical health literacy in a pandemic" (CHL-P) addressing the decision-making and communication skills of public health and health promotion experts. Therefore, CHL-P is the ability to act and decide not only on the basis of an expert's own living conditions, but rather to account for different social class and other sociocultural factors. Rubinelli et al. (2021), on the other hand, argue for a better training in argument evaluation. In an information society with freedom of speech and freedom of belief, educational programs in critical thinking and scientific thinking may be necessary. In the case of a pandemic, the public must be served with information, argumentation, and reasoning – particularly to counter widespread information with a persuasive nature.

To sum up, two broad historical approaches to health literacy can be identified. First, the *health care approach* which has been mainly driven by medical organisations and health professionals. The aim of this clinical approach is to foster efficient use of medical services, to enhance adherence, to improve patient-provider-interaction, and to adjust health care systems on patients' demands. In contrast, the *public health perspective* is mainly driven by increasing the capacities of individuals and communities to improve health decision-making and health environments. In this perspective, health literacy is understood as a function of individual abilities on the one side and environmental or system complexities on the other (Okan 2019; Parker 2009). Besides improving health, another aspect may be relevant for both perspectives. With a small nuance, both strive for better health decisions: "From a medical and

healthcare perspective, it is about an *appropriate* decision, whereas in public health and education, it is more about an *informed* decision." (Okan 2019, p. 32, accentuation by the author).

1.2 Health literacy's shortcomings

Health literacy appears to be a precondition to wise health decisions and may increase the chances for positive health outcomes. As a starting point, decision-making seems to be an important communality of the two main perspectives in health literacy history. On the other hand, many other aspects to health literacy research remain unclear and are unaddressed. The main problems within the large body of health literacy literature are shortly discussed below.

1.2.1 Blurred boundaries

There is an ongoing struggle which pervades many conceptualization attempts such as the separation between the inner and the outer boundaries of health literacy. While many health literacy definitions refer to skills, competencies, assets, abilities, or capacities to process health information (Sørensen et al. 2012; Nutbeam et al. 2018), the range of potential antecedent factors appears to be endless. The problem of boundaries is similar to the problem of competence acquisition in higher education: Knowledge transmission to students is no longer good enough. Instead, students must acquire competences that enable agency in future working environments (Bachmann 2018). Transferred to the health literacy literature, the range of competencies needed to act in a health literate way is huge. It covers skills in communication, problem-solving, critical thinking, self-management, knowledge about scientific concepts and technology, science literacy, the acceptance of limitations in scientific information, and many more (Bröder et al. 2017; Rademakers and Heijmans 2018; Mårtensson and Hensing 2012).

In order to better grasp health literacy as a well-defined scientific concept, researchers suggested different sets of subcategories. A first attempt to capture the increasing complexity was carried out by Nutbeam (2000) who introduced three different health literacy *types*: Functional, interactive, and critical health literacy (chapter 1.1). After his well-known publication, many other attempts followed. Health literacy was divided into *domains* (health care, disease prevention, and health promotion), *dimensions* (access, understanding, appraisal, and application), or *topics* (internet literacy, mental health literacy, men's health literacy, nutrition literacy, etc.) (Sørensen et al. 2012; Harrison and Alvermann 2018; Slater et al. 2018; Oliffe et al. 2019). Furthermore, Bröder et al. (2017) used three *attributes*: Cognitive attributes

(knowledge, functional health related skills, comprehension and understanding, appraisal and evaluation, critical thinking), behavioural and operational attributes (seeking and accessing information, communication and interaction, application of information, other context specific skills, citizenship), and affective and conative attributes (self-awareness and self-reflection, self-control and self-regulation, self-efficacy, interest and motivation). Lately, Rademakers and Heijmans (2018) contrasted cognitive with non-cognitive *elements*. The former refers to "the capacity to think" and the later to the "capacity to act".

To sum up, cause-effect modelling in health literacy research faces the challenge to distinguish between variables of interest and antecedent variables – whereas the latter potentially confound causal effects. In consequence, a large number of causal path-models have emerged since the break-through of health literacy research at the end of the last century (Paasche-Orlow and Wolf 2007; Manganello 2008; Baker 2006; Nutbeam 2008; Sørensen et al. 2012; Santos et al. 2011; Rowlands et al. 2017; Edwards et al. 2012; Cudjoe et al. 2020). This large number of different models – considering the same variable once as antecedent, once as outcome, or once as genuine health literacy indicator – is scientifically problematic. Finally, it is a strong indicator for the blurred boundaries of the health literacy concept.

1.2.2 Knowledge, competence, or something else

The distinction between health knowledge and health literacy is blurred in many health literacy concepts. Although the widespread definition of Sørensen et al. (2012) emphasizes the acquisition and application of new, previously unknown health information, the conceptual link between health literacy and basic (bio-medical) health knowledge – usually acquired in school – remains fuzzy. The importance of basic knowledge on the human body and its biochemical processes cannot be overestimated to acquire new derived and associated knowledge. Furthermore, it is impossible to be fully informed about every imaginable healthcare situation. Knowledge and standards change over time due to the changing focus regarding health questions over the life course (Batterham et al. 2016).

Many health literacy studies ignore the factor of previous health knowledge acquired in the past. Hence, is health literacy defined only by "ready-to-use" health skills? Example: In a study by Rowlands et al. (2017) an Indian woman in a so called "community health literacy course" learned how "to cut out the salt, … and not be frying". Hence, she acquired information on health problems of high salt intake and, further, on skills to cook with less salt. On the other hand, she did not learn skills of how to find and apply reliable health

information *by herself*. What she acquired is rather health information and cooking skills, but not how to find information and to develop her own knowledge basis which would allow her to decide *on her own*. With other words, with the immense dissemination and use of the term health literacy comes a danger of its un-reflected application. *Factual information* (e.g. "too much salt intake is unhealthy" or "insulin regulates blood sugar level") and *performance-based skills* ("use spices like curcuma or pepper to make dishes tasty" or "how to use an insulin needle") should clearly be distinguished from the ability to develop a knowledge basis for personal decision-making and from the ability to adapt this basis due to changed circumstances (Nutbeam et al. 2017).

1.2.3 Theory meagreness

Probably, the main cause for all shortcomings in many scientific health literacy studies is the lack of a theoretical underpinning. Till today, research on health literacy is data-driven but theory-meagre. For example, health literacy surveys focus on the description of phenomena (e.g. unequal distributions of health literacy among different socioeconomic groups or associations with different health outcomes). Even if large population surveys generate attention for the topic, the interpretation of the results remains fragmentary without theoretical guidance (Abel and Sommerhalder 2015).

The combination of an expanded empirical health literacy research, however, with a lack of theoretical foundation has led to a "theoretical chaos" in the scientific domain (Neter and Brainin 2019). The consequence was an ongoing failure to explain the causal role of health literacy. Empirical studies randomly used a "myriad" of mediators, moderators, and antecedent variables (Neter and Brainin 2019; Bröder et al. 2017; Berkman et al. 2011b; Paakkari and Paakkari 2012). For example, some studies used «self-efficacy» as a core dimension of health literacy, some as an independent individual antecedent variable, and a third group used it as an intermediate outcome of health literacy (Cudjoe et al. 2020; Neter and Brainin 2019; Berkman et al. 2011b; Bröder et al. 2017). The same problem arises with general health knowledge. It can be defined as a core dimension, as an educational precondition, or as an intermediate effect of health literacy (Sørensen et al. 2012; Cudjoe et al. 2020; Santos et al. 2011; Paasche-Orlow and Wolf 2007).

Omitting theory in empirical analyses will lead to different interpretations as two recently published health literacy studies showed exemplarily. Both used similar cross-sectional data, a similar health literacy instrument (HLS-EU-Q), and similar sociodemographic control

variables (sex, age, education level, migration background, and financial status). One study concluded: "HL could negatively affect physical activity and diet, independently from the other sociodemographic conditions, confirming the role of HL as a relevant social determinant of health." (Zanobini et al. 2021) The other study concluded: "Health literacy is not only the responsibility of the individuals, but is also strongly determined by external conditions and the societal context in which individuals live, as the present findings also confirmed." (Guggiari et al. 2021) Even tough both studies used the same health literacy definition, the theoretical meagreness of this definition lead to arbitrary interpretations and conclusions.

1.2.4 Low intervention evidence

Against the backdrop of theory meagerness, difficulties in proving causal effects of health literacy on health may be not surprising. Several literature reviews revealed insufficient or a low degree of evidence in the effectiveness of health literacy interventions (Visscher et al. 2018; Poureslami et al. 2016; Neter and Brainin 2019; Bailey et al. 2014; DeWalt et al. 2004; Pignone et al. 2005; Berkman et al. 2011b). Several causes for low levels of evidence were extracted: weak methodological strength due to short-term follow-ups, substantial attrition, the lack of power to estimate effect stratification across pre-intervention health literacy levels, or outcomes that reflect intermediate results (e.g. knowledge, positive attitudes, self-efficacy) rather than substantive outcomes (e.g. behavioral change or health status) (e.g. Brainard et al. 2016; Visscher et al. 2018). Again, conceptual and theoretical shortcomings were mentioned for low levels of evidence. Inconsistent choices of confounding variables (out of a "myriad of variables") may either over- or underestimate the effect of health literacy that, hence, ended up in mixed results and difficulties when making a research synthesis (Berkman et al. 2011b; Neter and Brainin 2019; Poureslami et al. 2016). One aspect, which caused the weak explanatory power of the reviewed studies, needs to be treated separately: the arbitrary use of outcome variables.

1.2.5 Contingent health outcomes

One problem in health literacy research accentuates the following question: Should health literacy lead to favourable health decisions from a bio-medical or from a personal point of view? For example, a person's decision to smoke may be a totally informed and consciously made decision in the full knowledge of potential harmful consequences. From a medical point of view, this decision may not be appropriate. On the other hand, smoking facilitates

this person's social contacts, it helps to cope with everyday stresses, and consequently provides for a better psychosocial well-being. This example emphasizes the lack of a generalizable definition of health. Health may not only be the absence of disease and health risks, but also a balance between physical, mental and social well-being (WHO 1946). Hence, health literacy may serve different goals depending on the chosen aspects of physical, mental, or social health. Regarding health literacy as engagement for healthier communities (chapter 1.1), pro-social activities (which minimize social inequalities of health by tackling unhealthy behaviours in the community and in consequence promoting a healthier and happier life in one's personal social environment,) may also be stressful or exhausting (Freedman et al. 2009).

Finally, one can even question if bio-medical and economic outcomes should be considered at all as health literacy outcomes. As stated above, the most obvious communality between health literacy definitions and between the clinical and the public health perspective is their shared outcome – namely the ability for health decision-making (chapter 1.1). However, Ilona Kickbusch raised the question if critical health literacy and, hence, autonomous decision-making are still desired in times of crisis (Kickbusch 10/10/2021). At least from a political point of view in the Covid-19 pandemic, critical voices that question the credibility of government information appear to be largely undesired in times of crisis.

To sum up, health literacy research has yet not been sufficiently clear on the desired outcomes of health literacy. In health literacy studies, bio-medical outcomes (e.g. absence of disease, risk adverse health behaviour, or physical functioning) and economic outcomes (e.g. number of emergency visits) predominate others such as well-being, happiness, autonomous decision-making, self-efficacy or civic health engagement (Freedman et al. 2009; Walters et al. 2020).

1.3 Towards counterfactual thinking

In the last chapter I described some of the largest challenges in health literacy research when crossing the line from descriptive analysis to causal thinking. First, not all researchers attest a causal role to health literacy. Rather, authors of early health literacy work defined health literacy mainly as an *outcome* – an outcome of health promotion activities or an outcome of patient-oriented health care systems (Nutbeam 2000; Parker 2009; Okan 2019). On the other hand, more recent authors describe health literacy as a *determinant* of health (Kickbusch 2001; Trezona et al. 2018; Duong et al. 2017). This semantic turn is problematic considering the blurred boundaries of health literacy, its missing theoretical foundation, and all the other

shortcomings described above. More theoretical guidance and empirical arguments would be needed to elevate health literacy to the circle of health determinants. Furthermore, it is important that the causal model is tested against the prevailing data in order to extract the causal effect of health literacy on a desired outcome (Stronks et al. 1996; WHO 2010; Solar and Irwin 2007; Bharmal et al. 2015).

Causal frameworks can help to identify potential pitfalls. This paragraph is dedicated to a scientific debate with important deliverables for modelling health literacy's causal effects. In this example, prospective studies show strong associations between obesity and mortality. Nonetheless, they violate necessary conditions to make a causal inference (Hernán and Taubman 2008). By applying counterfactual thinking and by asking quite naïvely and unsophisticatedly, "*what if* we changed the body mass index (BMI) in a group of", several different interventions could become thinkable. The point of Hernán and Taubman (2008) is that not every sort of intervention on the BMI will have the same effect on mortality: The effect will be different if BMI is lowered by changing diet and physical exercise, or if it is lowered by liposuction, or – in extremis – by removing extremities. Hence, what is the problem with BMI as a causal factor? First and less problematic, the concept of BMI is only a rough proxy of obesity. Second, obesity is the result of "many factors, some are easy to measure and others are not" (Pearl 2018). To sum up, there is no logic "directly estimating the effect of obesity on mortality since there is more than one way that obesity may come about, and these different ways may themselves have an effect on mortality" (Broadbent 2019).

Much can be learned from the above-described obesity debate in health literacy research. Alike obesity, health literacy is determined by a broad set of factors. Hence, many possible interventions may be thinkable to modify health literacy and, second, not all interventions may have the same effect on a desired outcome. Referring to health literacy conceptualizations (chapters 1.1 & 1.2), health literacy is highly dependent on a large number of factors:

- a person's literacy and numeracy
- a person's basic knowledge about the human body
- a person's cognitive capacities
- a person's affective and conative attributes
- a person's self-management skills
- a person's science literacy
- a person's critical thinking skills
- availability of health information

- access to high quality media
- availability of health professionals
- availability of health knowledge in social networks
- communication skills of health professionals
- complexity of available health information
- complexity of the health care system
- a person's resources to investigate in health decisions
- a person's everyday burdens and stress factors

This incomplete list shows – alike obesity – that health literacy is a function (or a vector) of multiple factors. This result has one major consequence: Every estimation of health literacy's causal effect depends on the choice of intervention. In the same way that obesity is typically a symptom of the metabolic syndrome, health literacy is typically a symptom of personal factors and contextual circumstances (chapter 1.1).

Following the Potential Outcomes Approach (POA) or counterfactual modelling, respectively, only interventions or a theoretically consistent technical modelling can generate reasonable causal estimators (Broadbent 2019). Ideally, also health literacy research can apply interventions in a randomized controlled trial (RCT) design. On the other hand, RCTs have several disadvantages. They are expensive, sometimes ethically impossible, and often based on small sample sizes with limited potential for generalization (Cook 2018). The last point is crucial if results need to be interpreted for sample subgroups or population groups not selected into the trial. Far too often, RCTs are not properly planed for subgroup analyses (Keller 2019).

Considering potential limitations of RCT design, consistent theoretical modelling is a reasonable substitute. Therefore, a researcher needs to intervene artificially in her or his variable of interest (e.g. health literacy) while holding those factors constant that potentially could bias the causal estimator. To that end, an appropriate causal model is inevitable to prevent overcontrolling and to include mediation and moderation effects (Hayes 2018). Depending on the research question, this approach using observation data has several major advantages compared to RCTs. Model testing provides important insight to the mechanisms of causal effect structures or observed associations. Furthermore, moderation and subgroup analyses provide insight to effect differences between population subgroups. These results may be of special value for concrete intervention planning in practice. In the case of health literacy

research, interventions can be planned to target the most effective factors among those listed above.

So far, we have acknowledged health literacy as a function of many different factors. Using the analogy of obesity research, it may be too early to give health literacy the attribute of a "health determinant". In favour to gain more clarity about the health literacy concept, the next chapter sheds light onto a person's contextual situation.

1.4 Health literacy in context

Until recent years, health literacy research focused on functional skills, however, neglecting the relevance of contextual factors (Pitt et al. 2019). Before 2010 contextual factors were merely understood as those related to health or the health care system (Institute of Medicine 2004). Abel (2008) and Kickbusch et al. (2013) were probably among the first to consider cultural and social aspects of the society as important factors in health literacy research. Furthermore, Abel and Sommerhalder (2015) were among the first to emphasize the relevance of contextual factors. In their German article they explicitly stress the context-sensitivity of health literacy, which can be understood as variable demands to live a healthy life depending on one's socio-cultural and socio-economic context. For example, in some socio-economic contexts people do not ask for the best type of oil for cooking, but rather ask themselves how to gain more free time to do their own cooking.

At the same time, Rudd (2015) marked the neglect of context as one of three conceptual errors in health literacy research. According to her, most health literacy studies were limited to cognitive and non-cognitive functionality and failed to consider social embeddedness. Similarly, Guzys et al. (2015) note that health literacy measurements were predominantly developed by experts in education, communication, or health care. Only few inputs were given by health care consumers. Therefore, health literacy measurements remain rather abstract and meaningful interpretation into the real world of consumers and their environment remains difficult (Guzys et al. 2015). In consequence, the practical impact of measured health literacy levels in a person's everyday life remains unclear (Abel and Sommerhalder 2015).

One approach to better address the contextual dimensions of health literacy is to change the focus from the individual to the group (Guzys et al. 2015; Freedman et al. 2009). Population health literacy or public health literacy approaches, respectively, intend to escape from the deficiency-orientated perspective on the level of the individual. They address the critique that

research mainly focuses on "health illiteracy" instead of exploring its distal causes within psychosocial or socioeconomic factors. For example, Freedman et al. (2009) claim that health literacy initiatives do not address the "root causes of health illiteracy such as socioeconomic disparities and unequal access to high quality education" (Freedman et al. 2009). Further, they note:

> Moreover, a low level of health literacy may not be the most important barrier for people to overcome when trying to improve their health status. Other barriers, such as lack of access to care and treatment and the requisite time and financial resources related to health-seeking behaviors may present greater challenges to individuals. (Freedman et al. 2009)

Apart from Freedman, few other authors stress this profound conceptual problem in the health literacy discourse (Freedman et al. 2009; Guzys et al. 2015; Rudd 2017; Schaeffer 2015; Abel and Sommerhalder 2015). On the other hand, there is no simple solution to deal with it. Freedman et al. (2009) suggests to focus on "public health literacy" which is defined by the capacity of individuals or groups to make public health decisions beneficial for the community. Hence, public health literacy is not just the sum of individual health literacies (or illiteracies), but rather a community's ability to address social and environmental determinants of health. A (public) health literate community focuses on prevention rather than treatment, critically assesses public health problems and solutions, and fosters in civic engagement in health issues.

Another approach to tackle the contextual complexity of health literacy emphasises the importance of critical health literacy (CHL). Compared to the Freedman approach, CHL puts more emphasis on the individual and starts with the question how to critically follows largely the original meaning by Nutbeam (see chapter 1.1). However, new investigations into CHL observe high demands in critical skills to maintain control over health and well-being –especially when using the health care system (Wit et al. 2020). In this regard, contextual factors play a crucial role in CHL. CHL enables a person to contextualise health information against the backdrop of one's personal and situational context and, hence, considers actual knowledge about psychosocial, environmental, and material factors influencing health and well-being (Sykes and Wills 2019). Ideally, CHL triggers engagement in collective action and – from this point of view – can be argued as a community characteristic (Wit et al. 2020).

To sum up, there is a high demand to integrate contextual factors such as psychosocial, socioeconomic, and environmental factors into the health literacy debate. Hence, it is inevitable

to better understand their status-dependent opportunities and barriers to achieve health literacy and to realize favourable health outcomes (Schaeffer and Pelikan 2017). Furthermore, the semantic proximity of health literacy to "health illiteracy" may individualize the problem and risks to overestimate an individual's opportunities and his or her freedom of choice. Ignoring context-dependency in empirical research risks to individualize the responsibility for health and functioning (Wit et al. 2020; Neter and Brainin 2019; Bittlingmayer and Sahrai 2019; Edwards et al. 2012; Bailey et al. 2014).

1.5 Research process

The general goal of the thesis is to critically assess the notion of health literacy as determinant of health – empirically and theoretically. Empirically, I have investigated the complex relationships between health literacy, contextual factors, and favourable health outcomes using common conceptual frameworks and theories from public health and sociology. Further, the thesis' empirical work aimed to assess existing health literacy frameworks and definitions that have led to the "theoretical chaos" and a "myriad" of mediators, moderators, and antecedent variables observed through the works of many critical health literacy authors (chapter 1.2).

The thesis work followed a stepwise approach exploring different perspectives to the complex relationship between health literacy, contextual factors, and health outcomes. The first investigation of this thesis was to *look back* from health literacy to potentially important factors that affect a person's chances to achieve health literacy. Even though several authors wrote about different factors influencing health literacy, none of them used a general conceptual framework explaining health. Hence, the novelty of this step was to adapt a common model used to explain health inequalities. Hereto, I used the pathway model from Mackenbach (2006) and expanded it for health literacy research. Furthermore, the concept of Directed Acyclic Graphs (DAGs) was consequently applied to estimate causal relationships using survey data (Knight and Winship 2013; Elwert 2013). The study explored socioeconomic, material, psychosocial, and health-related factors that potentially confound the association between health literacy and health (chapter 3).

Secondly, the thesis' work investigated in a *look forward* adapting another well-known theory for empirical purposes. For this study I applied Amartya Sen's Capability Approach (CA) which focuses on the concept of conversion factors. I assumed different conversion factors that influence a person's chances to transform health literacy into favourable health

outcomes. This study explored three different conversion factors and its effects on the association between health literacy and different health outcomes (chapter 4).

The third step of the thesis was a *look into the heart* of the health literacy concept, namely the ability for health decision-making. The study question begins with the observation that most health literacy definitions emphasize on informed decision-making as its ultimate goal. Nevertheless, only few studies were found that investigated into the decision-making process using health literacy in its model. Hence, the aim of this study was to investigate on the question if health literacy determines a person's ability to make favourable health decisions. Again, I used a DAG to estimate mediation effects of decision-making ability between health literacy and health (chapter 5).

The fourth and last goal of the thesis was to *critically assess existing health literacy frameworks and definitions*. Although inherent to all previous steps, the complete result of this work has not yet been published. This theoretical work will initially be published within this doctoral thesis (chapter 6).

2. Methods

2.1 Data

For the empirical analyses, data from the Young Adult Survey Switzerland (YASS) was used. Data from the first wave (2010/2011) was used for the first publication and data from the second wave (2015/2016) for the second and third publication. Only data from male respondents were used due to the data collection procedure. Compared to the postal questionnaire sent to female young adults, the male data was collected during the recruitment for compulsory military service. Among the males, the participation rate was 90%. These samples corresponded to approximately 14% of the eligible male population of Switzerland aged between 18 and 25 and contained over 30'000 cases for each wave. One-third of all participants were randomly selected to fill out an additional health questionnaire containing health literacy items. The survey design and data collection procedure is described in Huber (2019) and Hofmann et al. (2013). Ethical approval for the data collection was obtained from the ch-x supervising board of nine members from the Swiss National Science Foundation and the Swiss Federal Statistical Office. Further approval was not necessary, because the analyses were carried out on an existing dataset.

The datasets used for the analyses are cross-sectional featuring two major advantages. First, the data sampling procedure and the vast sample size ensured a large variety of participants with a sufficient number of cases for each social background. The locally performed paper-pencil survey, hence, faced less selection bias than alternative telephone or online surveys. Secondly, the questionnaires encompassed diverse questions to many topics such as social family background, social network, political attitudes, values, health, and future perspectives. Hence, the empirical analyses were performed with many different variables and validated constructs or indices.

2.2 Methodology

The data analyses were guided by the counter-factual question "what if". What-if-questions address a counterfactual or imaginary outcome without the possibility of going back in time. Thus, counterfactual questioning applies theoretical models that explain an observed outcome – in contrast to an experiment which cannot, by itself, explain the mechanism of a treatment-outcome relationship. A randomized controlled experiment (RCT) is able to show *that* an intervention works or not but cannot answer *why*. For this reason, Pearl and

Mackenzie (2018) defined counterfactual questioning as an intellectual capability which is superior to interventionist questioning (and reserved to human beings). It requires imagination, an underlying theory, and a deep understanding of the investigated phenomenon.

Pearl and Mackenzie (2018) claim that it is absolutely feasible to illuminate a causal claim from observational studies as long as all important confounders are identified: "In short, knowing the set of assumptions that stand behind a given conclusion is not less valuable than attempting to circumvent those assumptions with an RCT, which, as we shall see, has complications of its own." (Pearl and Mackenzie 2018, p. 143)[7] Nonetheless, the essence of counterfactual modelling is to emulate a conditionally randomized experiment or a "surgical intervention", respectively (Pearl and Mackenzie 2018; Hernán and Robins 2019; Morgan and Winship 2007). The conditions for an observational study to be conceptualized as a conditionally randomized experiment are:

1. The treatment values correspond to well-defined interventions that correspond to the values in the data.
2. The conditional probability of receiving every value of treatment, though not decided by the investigators, depends only on measured covariates *L*.
3. The probability of receiving every value of treatment conditional on *L* is greater than zero. (Hernán and Robins 2019)

Translating counterfactual thinking to health literacy research, this thesis asks: *What if* we had changed health literacy levels of male young adults by an isolated, surgical intervention? Hence, condition 1) may ideally be thinkable for the sake of answering the causal role of health literacy. Thus, to isolate a potentially causal effect of health literacy, the variation of health literacy due to other reasons than the ideal treatment (covariates *L*) needs to be controlled. To meet condition 2), this thesis investigated thoroughly in covariates *L* that theoretically confound the estimation of an imaginary treatment. Condition 3) is a technical issue, which is addressed by prerequisite and robustness tests (Backhaus et al. 2016; Ben 2012; Berk 2004).

Methodologically, several choices were made for this thesis. *First*, the thesis studies are aligned with "an almost universal consensus, at least among epidemiologists, philosophers,

[7] Problems of RCTs are e.g. ethical feasibility, selection criteria for participants, high costs, limited generalizability due to limited power for subgroup analysis, and no explanation provided for the underlying mechanism.

and social scientists, that (1) confounding has a causal solution, and (2) causal diagrams provide a complete and systematic way of finding that solution" (Pearl and Mackenzie 2018, p. 141). Therefore, the description of causal diagrams (directed acyclic graphs, DAGs) was central to illuminate causal claims using cross-sectional data. *Secondly*, to shed light onto the attributable fractions of different confounders *L*, the KHB method of Karlson, Holm, and Breen (2012) appeared to be useful and reliable – and was thus applied. Compared to structural equation modelling (SEM) or conventional mediation analysis (Baron and Kenny 1986), KHB has several advantages. Its application with multiple dichotomic and non-normal distributed variables is more straight forward than with SEM. Further, the interpretation of logits is easier than correlation coefficients. Next, SEM cannot handle rescaling effects and, hence, the calculation of confounding percentages (attributable fractions) is not reliable with SEM. Finally, calculations of indirect effects using path analysis (indirect effect = a x b) "never had a meaning for regression analysts outside the bubble of linear models" (Pearl and Mackenzie 2018, pp. 327–328). With other words, neither causal claims nor the estimation of causal importance can be inferred from these calculations.

A slightly different approach was chosen in the second publication. Here, it was assumed that an ideal, surgical health literacy intervention is practically feasible – regardless of the health literacy's constitutional factors. Hence, it was examined what effect could be expected if this isolated treatment were performed. Although this treatment appears to be impossible, some authors claim that health literacy is a somewhat "modifiable" risk factor (Stormacq et al. 2018). Thus, this approach explored possible moderating effects on the association between health literacy and health outcomes using less easily modifiable conversion factors. Methodologically, these moderating effects do not allow causal claims. Rather, they serve as arguments to understand limited evidence from intervention studies and to address critique of limited power for subgroup analyses (chapter 1.2.4).

3. Journal Article #1

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

Published in:
International Journal of Public Health

The article was developed, conducted, and submitted by the thesis author. Thesis supervisor supported the article with feedbacks on theory and methods.

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 to health literacy's covariates.

Methods: Cross-sectional data from the Young Adult Survey Switzerland was used for the analyses (n= 5'959, age=18 to 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% to 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 socio-economic, material, psychosocial, and health-related factors. More investigations on the causal importance of health literacy respectively on its potential to health promotion is required.

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 amongst others to explain the linkages between common determinants of health and health outcomes (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.

Towards an elementary health literacy model

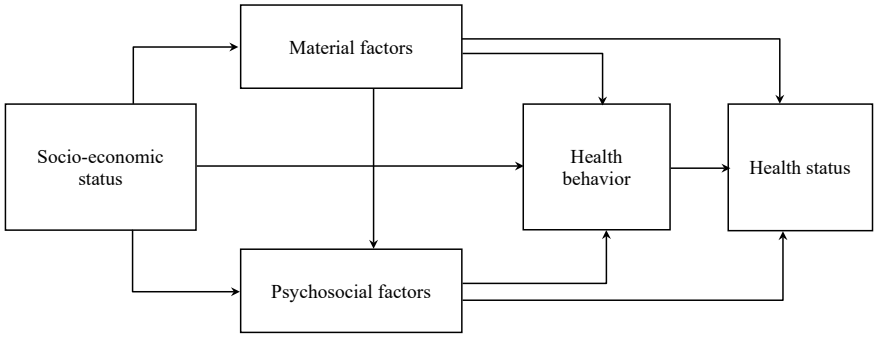
We use in this study a definition of health literacy, which is suitable to the context of public health. Selden et al. (2000) defined health literacy as „the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate 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 socio-economic 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 socio-economic determinants of health (Manganello 2008; Baker 2006; Nutbeam 2008), and (b) others do not define clear cause-effect relationships between socio-economic status, psychosocial factors, health literacy, and health outcomes (Sørensen et al. 2012; Paasche-Orlow and Wolf 2007).

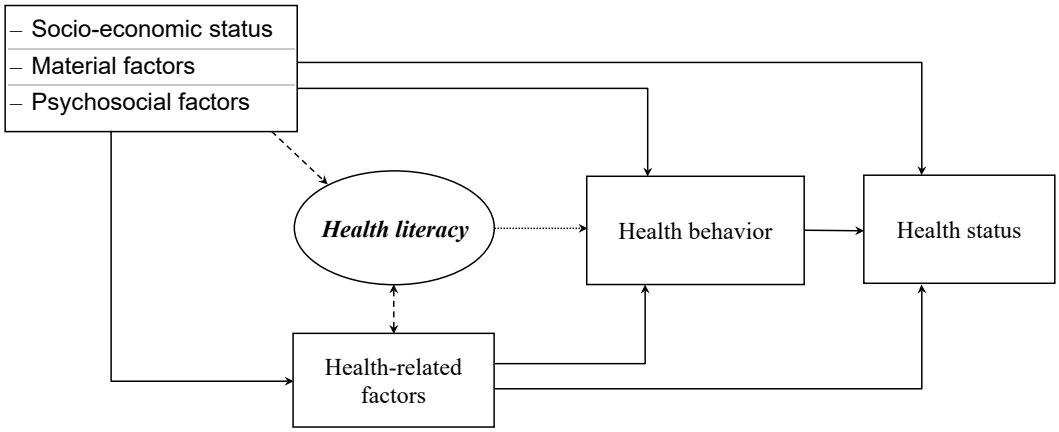
To tackle these problems, we propose to include health literacy into a path model which is widely used in the literature of social determinants of health (Mackenbach 2006; Bartley 2017). It distinguishes between socio-economic status and intermediary (material and psychosocial) factors of health and health behavior (figure 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).

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



Even though evidence indicates close links between health literacy and socio-economic 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 (figure 2).

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 have yet been poor. To isolate the unique explanatory power of health literacy (dotted arrow), covariates need to be controlled statistically.

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, socio-economic, and health-related factors.

Up-to-date scientific evidence on health determinants shows a wide definition of *psychosocial factors* (Matthews et al. 2010). Beside 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 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 socio-economic 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 (figure 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 socio-economic, 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 was 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".

Socio-economic status

While young adults often experience status inconsistency (Hurrelmann and Quenzel 2015), *socio-economic status* of the participants has been measured by parent's socio-economic status and the participant's academic track. Parent's socio-economic 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" was 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 (1995) assessed the level of general *self-efficacy* among the respondents (index from 5 to 20). The 10-item instrument from Rammstedt (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 socio-economic, 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 5'959 ≥ n ≥ 5'717 were used for the analyses. The descriptive results of the largest sample are displayed in table 1.

Table 1: Study population (n=5'959)

	Number	%	mean	SD	skewness
Dependent variables					
Self-rated health					
Very good	3'929	65.9			
Good or poor self-rated health	2'030	34.1			
Depression tendency					
No	4'104	68.9			
Yes	1'855	31.1			
Physical health					
Good	3'879	67.3			
Poor	1'884	32.7			
Weight					
Normal weight	4'318	75.5			
Over- or underweight	1'399	24.5			
Smoker					
No	3'372	56.9			
Yes	2'552	43.1			
Energy drink consumption					
Low consumption	3'501	59.4			
High consumption	2'396	40.6			
Key variable					
Health literacy			20.231	3.394	-0.246
Health-related covariates					
Healthy family					
Very important	2'703	45.4			
Rather important or lower	3'256	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
Socio-economic 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	4'034	67.7			
Weak tie	1'925	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	4'487	57.3			
French	1'051	17.6			
Latin	421	7.1			
Age			19.62	0.975	1.044

Note: Data from Young Adult Survey Switzerland, Switzerland 2010 and 2011

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.

Table 2: Linear regression of health literacy on covariates

	Health Literacy		
	beta	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
Socio-economic 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		5'959	

Notes: Data from Young Adult Survey Switzerland, Switzerland 2010 and 2011; ***p < 0.001

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).

Table 3: Odds ratios of health literacy and its covariates for different health outcomes. Decomposition of the health literacy effect to health literacy's covariates.

	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 consumpt.**	
	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*** (1.14,1.18)		1.10*** (1.08,1.12)		1.05*** (1.03,1.06)		1.04*** (1.02,1.05)		1.04*** (1.02,1.06)		1.04*** (1.02,1.06)	
Health literacy (key variable)[b]	1.06*** (1.04,1.08)	**63.5**	1.03** (1.01,1.05)	**74.2**	1.03** (1.01,1.05)	**36.7**	1.01 (0.99,1.03)	**56.9**	1.00 (0.99,1.02)	**86.9**	1.02 (1.00,1.03)	**49.5**
Health-related covariates		**25.7**		**5.0**		**-**		**15.4**		**30.0**		**-**
Healthy family	1.31*** (1.16,1.48)	7.7	0.83** (0.73,0.94)		0.85** (0.76,0.96)		1.22** (1.07,1.40)	15.4	1.17** (1.04,1.31)	7.6	1.14 (1.01,1.27)	
Interest for health topics	1.14** (1.05,1.24)	6.9	0.95 (0.87,1.03)		0.92 (0.85,1.00)		1.11 (1.01,1.21)		1.00 (0.93,1.09)		0.96 (0.89,1.04)	
Life goal: healthy living	1.15*** (1.09,1.21)	11.1	1.12*** (1.06,1.17)	5.0	1.05 (1.00,1.11)		1.06 (1.00,1.11)		1.27*** (1.21,1.33)	22.4	1.11*** (1.06,1.17)	15.0
Socio-economic covariates		**5.9**		**-**		**-**		**84.6**		**42.9**		**-**
Parents SES	1.16*** (1.06,1.26)	5.9	1.07 (0.98,1.16)		1.05 (0.97,1.14)		1.25*** (1.14,1.37)	53.7	1.00 (0.91,1.07)		1.02 (0.94,1.10)	
Own academic track	1.08 (1.00,1.15)		1.00 (0.93,1.08)		0.98 (0.92,1.05)		1.15*** (1.07,1.24)	30.9	1.67*** (1.55,1.79)	42.9	1.42*** (1.33,1.52)	62.3
Material covariates		**12.2**		**12.3**		**19.2**		**-**		**-**		**-**
Sport programs nearby	1.30*** (1.21,1.39)	12.2	1.27*** (1.19,1.36)	12.3	1.09** (1.02,1.17)	19.2	1.04 (0.97,1.12)		1.00 (0.94,1.07)		1.00 (0.94,1.07)	

Table 3 (continued)

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)	
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	5'959		5'959		5'763		5'717		5'924		5'897	

Notes: 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).

Odds ratios and levels of significance indicate that the associations of health literacy are only significant in model 1 to 3 (self-rated health, depression tendency; and physical health) Excluding the covariates, health literacy shows significant associations in all six models ($1.16 \geq OR \geq 1.04$, $p<0.001$). These naïve odds ratios are moderate to small and can be interpreted as follows: One additional point on the health literacy scale (0 to 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 beside 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% to 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 to 6 the confounders were responsible for a decrease of the health literacy's coefficients to a non-significant level.

The percentages added beside 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.

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 socio-economic determinants of health in their models (Sørensen et al. 2012; Manganello 2008).

Our elementary health literacy model (figure 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 socio-economic 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 socio-economic 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 socio-economic, 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 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 are 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 socio-economic, 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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4. Journal Article #2

Challenging the association between health literacy and health: the role of conversion factors

Published in:

Health Promotion International

The article was developed, conducted, and submitted by the thesis author. Thesis supervisor supported the article with feedbacks on theory and methods.

Abstract

Objectives: Previous studies have found substantial correlations between health literacy and various health outcomes. However, the role of social and personal factors in those links remains understudied. Applying a moderation approach, we assume that these factors function as conversion factors on the associations between health literacy and health outcomes. Consequently, we test if associations between health literacy and health outcomes are stronger among young male adults who score high in conversion factors compared to those who score low.

Methods: Cross-sectional data from the Young Adult Survey Switzerland was used for the analyses (n = 9339, age = 18 to 25). Multiple logistic regression analyses were applied to estimate associations between health literacy and health. Moderator analyses with three conversion factors and five health outcomes were conducted.

Results: For each health outcome at least one conversion factor moderated the association between health literacy and health according to the hypothesis. Although strength and form of the moderation effect differ across analyses, generally stronger associations were found among groups with beneficial social or personal factors.

Conclusions: The present findings support the hypothesis that conversion factors play a crucial role in the associations between health literacy and health. The findings, thus, point towards a potential risk of linear health literacy approaches that assume equal benefits from increased health literacy. Individuals with beneficial social and personal factors (those already privileged) may enjoy greater health benefits from interventions improving health literacy.

Introduction

Health literacy has been associated with different health outcomes including self-rated health (Howard *et al.*, 2006; Bennett *et al.*, 2009; Berkman *et al.*, 2011; van der Heide *et al.*, 2013; HLS-EU Consortium, 2012), physical health (Howard *et al.*, 2006), mental health (Howard *et al.*, 2006), utilization of preventive health care services (Bennett *et al.*, 2009; Berkman *et al.*, 2011), and hospitalization rates (Berkman *et al.*, 2011; HLS-EU Consortium, 2012). These results led scholars to lift health literacy into the illustrious circle of "determinants of health" (Rowlands *et al.*, 2017; van der Heide, 2016). Some studies appraised health literacy as a *key* determinant of health (Ellermann, 2017; WHO Euro, 2013; Kickbusch, 2001).

Against this background, many experts today consider health literacy as a key topic to tackle unequal chances for good health, including to reduce social inequalities in health. Especially vulnerable and migrant populations should be addressed by interventions that increase their health literacy (van der Heide *et al.*, 2013; Ellermann, 2017; WHO Euro, 2013). Further, health literacy has been suggested to empower those with poor health knowledge and poor health behaviours. It may help to manoeuvre more confidently through the health care system, to gain more autonomy in health decision making, and to make healthier choices in daily life (Batterham *et al.*, 2016; Nutbeam, 1998; Sørensen *et al.*, 2012; Lenartz *et al.*, 2016).

However, some scholars questioned the enthusiasm concerning the potentials of health literacy to empower those in need, the vulnerable and disadvantaged individuals or groups (Bittlingmayer and Sahrai, 2019; Abel and Frohlich, 2012). Particularly, evidence for intervention effectiveness among population subgroups is scarce (Pignone *et al.*, 2005; Berkman *et al.*, 2011; Barry *et al.*, 2013; Poureslami *et al.*, 2016). Barry *et al.* (2013) concluded in a meta-analysis, that "none of the studies were sufficiently powered to detect subgroup differences, and this area was highlighted as needing further research". A potentially low effectiveness among groups with low social status may cause an ethical dilemma for health promotion activities. For example, Paakkari and George (2018) raised the question if health literacy skills taught in schools could reduce health inequalities. In other words, it is not yet clear if and under what conditions can health literacy interventions mitigate the effects of cognitive gaps between various groups or the effects of deprived living contexts, where individuals "may have only one option, because of limited spending power or other constraints" (Paakkari and George, 2018).

In the present study, we investigate the question if the associations between health literacy and health varies among groups of different personal and social contexts. We hypothesise that unequal life contexts can explain variations in the associations between health literacy and health. This hypothesis is derived from the capability approach and the concept of conversion factors as described below.

The role of conversion factors

Theoretical support for unequal benefits from health literacy interventions can be derived from the capability approach. Amartya Sen's capability approach is relevant here in particular for its concept of "conversion factors". The notion of conversion factors stresses the idea that it is not sufficient to know a person's resources and commodities in order to assess the well-being or health status he or she can potentially achieve (Robeyns, 2016). Rather, "we need to know much more about the person and the circumstances in which he or she is living" (Robeyns, 2016). An illustrating example is smoking behavior. Knowledge or financial resources may not be sufficient resources for an individual to quit smoking. Working environment factors, availability of cigarettes, motivation, mental stability and more need to be considered to estimate a smoker's chances to quit smoking or – in the words of Robeyns (2011) – to assess his or her "real freedom or opportunities".

Conversion factors play a major role in the process of decision-making and achieving individual goals. In the capability approach, they influence "*the extent to which* a person can transform resources" into an active agency and valuable functioning like bodily health (Hvinden and Halvorsen, 2018). Active agency refers to an active and often interactive process of a person trying to achieve a particular aim or outcome. It involves self-reflection, the evaluation of own experiences and the environment and takes the form of a well-informed planning and decision-making process. This process of evaluation and decision-making may be constrained or facilitated by personal, social, and environmental conversion factors (Hvinden and Halvorsen, 2018). Personal conversion factors are internal to a person and include physical and mental condition as well as reading skills and intelligence. Social conversion factors refer to societal factors such as social norms or public policies, and include also power relations related to class, gender, or race. Environmental conversion factors encompass the physical environment (Robeyns, 2016; Hvinden and Halvorsen, 2018).

Empirical appropriation of the theoretical concept of conversion factors is still under discussion (López Barreda *et al.*, 2019; Hvinden and Halvorsen, 2018). Conversion factors can be

understood as multipliers or "conversion rates" that "capture the efficiency of the link from resources to achievements" (Chiappero-Martinetti *et al.*, 2019). For example, a study by Chiappero-Martinetti *et al.* (2019) revealed groups with different abilities to convert public, private, and nonfinancial resources into health. Hence, conversion factors operate as common moderators that influence the effect of a common explanatory variable X (inputs) on an outcome variable Y (achievements) (Chiappero-Martinetti *et al.*, 2019; Singh-Manoux, 2005). Hence, the decision about which factors are to be employed as conversion factors (or as resources) depends on the theoretical assumptions and particular research question.

To sum up, the theoretical contribution of the capability approach to the current health literacy study is not only to expand the range of relevant factors, but also to draw attention to and explain interactions between them. Discussing health inequalities from a health promotion perspective, Abel and Frohlich (2012) explain interactions of material and non-material factors as "major parts of the dynamic processes in the (re-)production of health advantages and disadvantages" (Abel and Frohlich, 2012). Conversion factors, hence, are likely to multiply or constrain one's opportunities for a healthy life and hold the potential to inhibit his or her "abilities or other internal powers" (Robeyns, 2016). Similarly, they multiply or amplify the effect of health literacy on health outcomes.

Health literacy and conversion factors

We suggest that health literacy should be understood as an individual resource that potentially interacts with conversion factors. We consider health literacy as a principally modifiable and achievable set of personal resources needed to take healthy decisions (Rademakers and Heijmans, 2018). At the same time, there are rather stable and less modifiable structural, contextual conditions, and personal capacities that are essential to act upon these decisions (Rademakers and Heijmans, 2018). These later factors may operate as conversion factors, constrain or enable the process of active agency and the transformation of healthy decisions into good health outcomes. Consequently, we focus here on health literacy as a set of personal knowledge and skills needed to deal with health matters in the private realm (Abel *et al.*, 2014). This focused definition allows distinguishing health knowledge and health skills from more stable and less modifiable structural, contextual, and personal factors. Whereas knowledge and skills can be enhanced by health professionals or health promotion activities, the personal, social, and environmental factors mentioned in the previous section may be more stable and harder to change through educational interventions.

The role of moderating factors has been identified in a health literacy model established by Edwards *et al.* (2012). Elaborated on the grounds of patient interviews, the model describes five consecutive stages from (1) health knowledge, (2) health literacy skills and practices, (3) health literacy actions, (4) production of informed options to (5) the realization of an informed health decision. The model addresses what we introduced above as conversion factors. It describes multiple personal, social, and professional facilitators and barriers, which foster or impede their patients to proceed from one to the next health literacy stage (Edwards *et al.*, 2012). For example, fears and anxieties associated with diabetes deterred a patient from accessing support from a GP (step three). Friends and family have been mentioned as facilitators to build up a better understanding during stressful consultations with lots of complex information (step four).

Recent studies support the consecutive character of the model. For example, high levels of particularly functional and communicative health literacy are preconditions for shared decision making used in stages tree to five (Ousseine *et al.*, 2019). Another study emphasizes the role of disability and impairments like perception disorders, brain damage, traumatic learning disorders or other disorders that impede one's possibility to achieve higher levels of health literacy (Bittlingmayer and Sahrai, 2019). Hence and although developed in a clinical context, the model by Edwards *et al.* (2012) addresses – without explicitly mentioning – the important role of conversion factors. Furthermore, it can help to interpret the mixed findings mentioned above from previous health literacy studies.

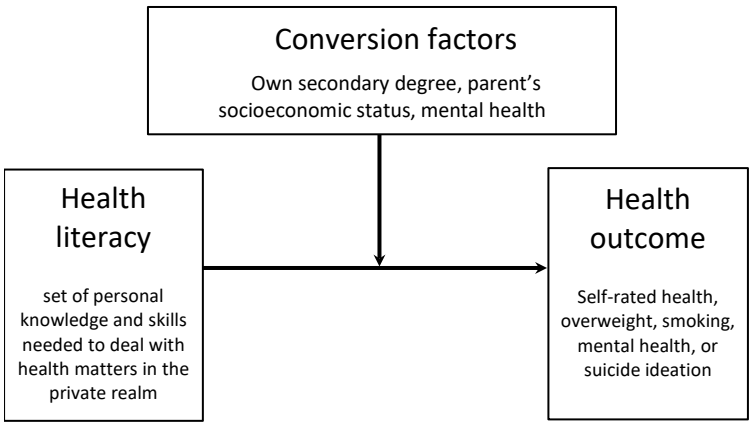
To sum up, addressing moderation effects in health literacy research is an attempt to overcome the restrictions of linear models presented in the literature – e.g. the models of Rüegg and Abel (2019), Sørensen *et al.* (2015), Nutbeam (2008), Manganello (2008), or Paasche-Orlow and Wolf (2007) – and to advance our understanding of differentiated health literacy effects (Pelikan *et al.*, 2018).

Study hypotheses

To our knowledge, no study investigated in the effect of conversion factors or interaction effects regarding the association between heath literacy and health outcomes. Addressing this research gap, this study investigates if and to what degree conversion factors play a role on the pathway from general health literacy to health outcomes. To this end, we simplify the five-stage model from Edwards *et al.* (2012) using health literacy as "knowledge and skills to prevent disease and to promote health in everyday life" (Abel *et al.*, 2014) on one side and

different health outcomes on the other (figure 1). We assume different conversion factors that influence someone's chances to successfully transform health literacy into a good health outcome. This effect is theoretically explained through a higher or lower agency (not included in the empirical model).

Figure 1: Conceptual health literacy model tested in the analyses



Notes: This conceptual graph describes a simplistic model how conversion factors are tested in the analyses. Strong assumptions underly this model if the empirical results want to be interpreted as causal. In this study, we are not interested in causality, but rather in the existence of differences in the association between health literacy and health. Differences are supposed to occur due to the moderating effect of conversion factors. According to the capability approach, conversion factors constrain or facilitate the transformation of a resource like health literacy into active agency and, thus, into an achieved functioning like health.

Two personal and one social conversion factor (lower secondary educational degree, mental health, and parental social status) were applied to test the moderating effects. Using a large and socially divers cross-sectional data set, we hypothesize that young adults who score higher on the conversion factors having stronger associations between health literacy and health outcomes than their colleagues with lower scores. In other words, we expect young adults in better personal or social conditions to have more opportunities to transform health literacy into better health outcomes compared with their colleagues in poorer personal or social conditions. For the first group we expect higher associations between health literacy and health outcomes than in the second group (hypothesis 1). Since we apply three different conversion factors and five distinct health outcomes, we do not expect to find equal results across all analyses. Rather, the moderating effects may vary due to complexity (Keshavarz

Mohammadi, 2019) and depend on the conversion factor and the health outcome (hypotheses 2).

Further, we used mental health in two different ways. On the one hand, we defined mental health as a dimension of health and to that end as a desirable functioning or outcome in the sense of the capability approach (Hvinden and Halvorsen, 2018). On the other hand, we will explore the role of poor mental health as a form of disability and, hence, also as a personal conversion factor (Robeyns, 2016).

Methods

Data

We used data from the second wave of the Young Adult Survey Switzerland (YASS) which was conducted in 2015/2016 in Switzerland. The all-male sample was collected during recruitment for compulsory military service with a participation rate of 90%. This sample corresponds to 14% of the eligible male population of Switzerland aged between 18 and 25. One-third of the participants received an additional health questionnaire with health literacy and health items used in the analyses. The survey design is described in more detail elsewhere (Hofmann *et al.*, 2013). The net sample consisted of 9'339 cases after excluding cases with missing data in health literacy score or in one of the two control variables, age and language region (19%).

Measures

We used self-rated health, overweight, smoking behavior, mental health, and suicide ideation as health indicators. Due to non-normal distributions, all health indicators were transformed into dichotomous variables where "1" represents good health or favorable health behavior, respectively.

Since we observed an overall high health level, *self-rated health* was categorized into 1 = "excellent" and "very good," and 0 = "good," "less good," and "poor". Overweight was dichotomized into 1 = "no overweight, body mass index < 25" and 0 = "overweight, body mass index ≥ 25". *Smoking behavior* was transformed into 1 = non-smokers and 0 = "every now and then" or "daily" smokers. To measure *mental health*, we used the validated 9-item depression diagnostic and severity measure, PHQ-9, from Kroenke and Spitzer (2002). Following the authors recommendations, we transformed the index measure into 1 = "none" and 0 =

"mild" and "severe" depression tendency and used these categories for good or poor mental health. Suicide ideation was measured with the question: "Do you have thoughts of rather being dead or harming yourself?" The answers were categorized into 1 = "not at all" and 0 = "some days/more than half of the days/nearly every day".

To assess health literacy levels, we applied the validated "short survey tool for young adults and public health research" (Abel *et al.*, 2014). This instrument includes eight Likert-scaled items with four questions on functional health literacy and two questions each on interactive and critical health literacy. Observations with one or two missing values have been mean imputed and included in the analyses. Observations with more missing values have been excluded. The health literacy score ranges from 0 to 30. The instrument applies to our focused definition health literacy as introduced above.

We applied three conversion factors in our analyses: a young adult's own lower secondary degree (LSD), the parent's socioeconomic status (PSES), and the own mental health (MH). In Switzerland, compulsory school ends at the age of 16 with one of three different secondary degrees "Realschule", Sekundarschule" and "Gymnasium", which we renamed with low, intermediate, and high level. Hence, we included *LSD* using these categories. *PSES* was assessed by a factor analysis with four indicators: household equivalent income, parental financial situation, highest parental educational achievement, and the number of books at home. We used sextiles to split the participants in six subgroups. Each sextile contained approximately 1'200 cases which appeared to be a good balance between statistical power and discrimination of different effect sizes. Last, we used the same depression tendency score described above as third conversion factor (MH).

Analyses

To identify moderation variables and their effects, two basic procedures can be applied: Moderated regression analysis commonly realized by interaction terms or by multi-group analysis or subgroup analysis respectively. Both procedures provide insights into different functions of a mediator variable (Helm and Mark, 2012). Although both approaches are statistically feasible, they have both several deficits. Moderated regression analysis is typically used for model testing or increasing predictive ability. On the other hand, this approach is susceptible to biases due to multicollinearity, statistical power, artificial dichotomization, and interpretation difficulties (Keller, 2019; Memon *et al.*, 2019; Wang and Ware, 2013). Although

it has been described as an efficient method in intervention studies, it can lead to either false-positive or false-negative results (Keller, 2019; Widaman *et al.*, 2013).

On the other hand, multi-group analysis appears to be a more straight-forward approach that is especially reliable for the analysis of associations (compared to the modelling of causal effects). Particularly, it has been recommended to identify a specific type of moderators named *homologizer* variables. (Sharma Subahsh *et al.*, 1981; Cerin, 2014). By definition, this type of moderator influences the strength of a relationship but not its variables (Allison *et al.*, 1992; Sharma Subahsh *et al.*, 1981). Since this study investigates in the comparison of associations, multi-group approach appears to be more reliable than the moderated regression approach.

We used STATA 15.1 for the analyses. Association analyses were conducted for multiple subgroups, stratifying the sample by different levels of conversion factors (CF). Because differences in standard deviations influence the coefficients and significance levels, standard deviations were analysed for potential variances between subgroups. To avoid the analysis of approximately the same groups using different moderation variables, subgroup stratifications needed to be tested for overlaps. Cross-tabulations were used to detect identically stratified subgroups. The analyses were conducted with multiple logistic regression controlling for age and language region.

Results

Descriptive results

The descriptive results of the net sample are displayed in table 1. All three conversion factors have remarkable associations with health literacy and health outcomes. The higher a young male adult scores on the conversion factors, the higher his health literacy score and his chance of achieving a better health outcome.

Missing rates are also listed in table 1. The missing cases of each conversion factor are displayed in the second column, 395 (1.1%) for LSD, 2159 (23.1%) for PSES, and 198 (2.1%) for MH. Since these three groups with missing data have similar health distributions and missing rates as the total sample, we do not expect bias excluding them from the analyses. Further, relatively high missing rates have been found in the smoking variable. Again, smoking missing rates are roughly equally distributed among each conversion factor's subgroups. Hence, we did not expect bias using only the valid cases for the analyses.

Table 1: Study population (n = 9339)

	n	Health literacy	Very good self-rated health		No overweight		Non-smoking		Good mental health		No suicide ideation	
		mean (SD)	valid %	miss %	valid %	miss %	valid %	miss %	valid %	miss %	valid %	miss %
Total sample	9339	20.5 (3.5)	67.1	1.5	78.0	3.1	61.9	10.3	65.1	2.1	88.2	2.8
Own secondary degree												
Low	2501	19.6 (3.6)	63.9	1.1	72.3	4.3	49.7	9.3	60.3	3.2	81.2	4.0
Intermediate	4032	20.5 (3.3)	66.4	1.1	77.6	2.7	62.3	10.5	66.9	1.5	89.8	2.3
High	2411	21.5 (3.2)	71.5	0.8	84.3	2.0	74.9	10.9	68.0	1.4	93.2	1.8
Missing	395	20.1 (3.8)	68.6	1.5	78.2	7.1	55.3	12.2	59.7	5.8	84.9	6.3
Parents SES												
1. Sextile	1197	19.7 (3.7)	57.2	1.7	71.8	3.6	54.5	9.9	55.7	2.5	83.8	3.0
2. Sextile	1198	20.2 (3.3)	63.4	1.0	75.9	3.3	60.3	10.6	64.6	1.6	87.1	2.1
3. Sextile	1195	20.3 (3.3)	64.7	0.3	76.5	2.3	65.6	8.5	66.7	1.8	88.9	2.1
4. Sextile	1201	20.7 (3.3)	71.9	1.3	78.8	3.3	64.5	10.2	70.7	1.9	91.3	3.2
5. Sextile	1194	21.1 (3.2)	72.2	0.7	81.0	2.4	65.8	9.8	67.4	1.1	90.5	1.6
6. Sextile	1195	21.7 (3.3)	75.9	1.1	83.4	2.1	68.3	14.6	68.7	1.8	91.9	2.4
Missing	2159	20.2 (3.6)	65.7	1.1	78.1	4.2	57.7	9.5	63.4	3.2	85.8	4.0
Mental Health												
Poor mental health	3188	19.6 (3.7)	50.8	1.4	76.9	3.3	54.1	11.0	-	-	68.8	1.0
Good mental health	5953	21.0 (3.2)	75.9	0.8	78.6	2.9	66.4	9.9	-	-	98.6	0.5
Missing	198	20.2 (3.0)	65.5	2.0	77.7	7.1	48.0	12.6	-	-	0.0	99.5

Note: Data from Young Adult Survey Switzerland, Switzerland 2015/16

Table 2: Distributions between conversion factors (n=9339)

	Secondary degree (valid %)			Parents SES (valid %)						Mental health (valid %)	
	Real	Sek	Bez	1.	2.	3.	4.	5.	6.	Poor	Good
Total sample	28.0	45.1	27.0	16.7	16.7	16.6	16.7	16.6	16.6	34.9	65.1
Own secondary degree											
Low				24.8	23.3	18.7	15.4	11.7	6.1	39.7	60.3
Intermediate				16.1	17.2	18.3	18.1	17.1	13.4	33.2	66.9
High				9.6	10.0	12.6	16.5	20.2	31.1	32.0	68.0
Missing Secondary Edu.				21.2	15.4	13.3	10.8	18.7	20.8	40.3	59.7
Parents SES											
1. Sextile	38.8	44.8	16.4							44.3	55.7
2. Sextile	35.9	47.2	16.9							35.4	64.6
3. Sextile	28.8	50.1	21.1							33.3	66.7
4. Sextile	23.5	49.1	27.4							29.3	70.7
5. Sextile	18.3	47.4	34.3							32.6	67.4
6. Sextile	9.5	37.5	53.0							31.4	68.7
Missing Parents SES	35.4	41.8	22.9							36.6	63.4
Mental Health											
Poor	31.6	43.3	25.1	21.3	17.2	16.1	14.2	15.9	15.2		
Good	25.5	46.3	28.2	14.0	16.5	16.9	18.0	17.2	17.4		
Missing mental health	45.1	35.4	19.4	23.4	14.8	17.2	18.0	10.2	16.4		

Note: Data from Young Adult Survey Switzerland, Switzerland 2015/16

In table 2 the distributions of cases between the three conversion factors are displayed. First, we observe strong linear associations between LSD and PSES. Young adults with a higher socioeconomic parenthood are more likely to have a higher level of secondary degree. Secondly, we observe a curvy-linear association between mental health and LSD and PSES respectively. It is more likely to obtain a good MH with a middle-range or a high score than with a low score in LSD and PSES. In this respect, the three conversion factors indeed correlate, but are distinct phenomena that deserve to be treated separately. Furthermore, we observe roughly equally distributed missing rates among all three conversion factors.

Moderation analyses

Table 3 shows the odds ratios of health literacy for five different health outcomes calculated separately for each group and each health outcome. Each coefficient and confidence interval represent the result of one single logistic regression using the whole sample (first row) or the structurally stratified subgroup samples (second to twelfth row) controlling for age and language region. Each different pair of conversion factors and health outcomes represents one of 14 moderation analyses.

Table 3: Associations between health literacy and different health outcomes by male subgroups

	Very good self-rated health		**No overweight**		**Non-smoking**		**Good mental health**		**No suicide ideation**	
Health literacy	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Total male sample	1.121***	(1.11,1.14)	1.027***	(1.01,1.04)	1.045***	(1.03,1.06)	1.129***	(1.11,1.14)	1.206***	(1.18,1.23)
Own secondary degree										
Low	1.096***	(1.07,1.12)	1.014	(0.99,1.04)	1.025*	(1.00,1.05)	1.123***	(1.10,1.15)	1.182***	(1.15,1.22)
Intermediate	1.112***	(1.09,1.14)	1.022	(1.00,1.05)	1.012	(0.99,1.03)	1.121***	(1.10,1.14)	1.198***	(1.16,1.24)
High	**1.165*** **	**(1.13,1.20)**	0.992	(0.96,1.03)	1.023	(0.99,1.05)	**1.145*** **	**(1.11,1.18)**	1.163***	(1.11,1.22)
Parents SES[a]										
1. Sextile	1.113***	(1.07,1.16)	1.007	(0.97,1.04)	1.038	(1.00,1.08)	1.099***	(1.06,1.14)	1.178***	(1.12,1.24)
2. Sextile	1.114***	(1.07,1.16)	1.029	(0.99,1.07)	**1.049***	**(1.01,1.09)**	1.096***	(1.05,1.14)	1.137***	(1.07,1.21)
3. Sextile	1.108***	(1.06,1.15)	1.025	(0.98,1.07)	1.029	(0.99,1.07)	1.124***	(1.08,1.17)	1.126***	(1.06,1.20)
4. Sextile	**1.122*** **	**(1.07,1.17)**	1.003	(0.96,1.05)	0.998	(0.96,1.04)	**1.143*** **	**(1.09,1.20)**	1.204***	(1.12,1.29)
5. Sextile	1.098***	(1.05,1.15)	0.962	(0.92,1.01)	1.028	(0.98,1.07)	**1.131*** **	**(1.08,1.18)**	**1.222*** **	**(1.14,1.31)**
6. Sextile	**1.157*** **	**(1.11,1.21)**	**1.053***	**(1.00,1.10)**	**1.059** **	**(1.01,1.11)**	**1.135*** **	**(1.09,1.18)**	**1.221*** **	**(1.15,1.30)**
Mental health										
Poor	1.084***	(1.06,1.11)	1.027*	(1.00,1.05)	1.025*	(1.00,1.05)	-	-	1.142***	(1.12,1.17)
Good	1.106***	(1.09,1.13)	1.025*	(1.00,1.04)	1.038***	(1.02,1.06)	-	-	1.161***	(1.09,1.24)

Notes: Data from Young Adult Survey Switzerland, Switzerland 2015/16; OR = odds ratio; control variables: age, French speaking, Roman speaking; *** $p < 0.001$; ** $p < 0.01$; bold = coefficients higher than average.
[a] Parental socio-economic status has been measured by four factors: highest parental achievement of mother and father, household equivalent income, subjective financial situation, and number of books at home.

To obtain a quick overview of the coefficients in the moderation analyses, we have highlighted all associations that are higher than the average of the whole sample (bold). Focussing on these coefficients, we see that the highest associations between health literacy and health outcomes are generally among those groups of young male adults that score middle or high on the conversion factors.

Regarding each health outcome separately, we observe at least one conversion factor moderating its association with health literacy. Among *self-rated health*, *mental health*, and *suicide ideation* the moderating effects are predominantly linear or curvy-linear. Young adults from middle-range or high CF groups have generally higher associations between health literacy and health than their colleagues from low CF groups. One exception among these outcomes is LSD on health literacy's association with suicide ideation. Here, no obvious moderating effect can be observed. The association between health literacy and *overweight* is only moderated by PSES. The association between health literacy and *smoking* is linearly moderated by MH, unspecifically moderated by PSES, and is reverse linearly moderated by LSD.

In general, the highest associations between health literacy and health outcomes were observed amongst those young male adults with middle or high scores in conversion factors. Moreover, in each of the five associations analysed we found significant conversion factor effects (at least one) that moderated the association. In only one out of 14 moderation analyses we found the highest association among the group with the least beneficial factors (LSD on health literacy/non-smoking). Here, low levels of statistical significance call for caution and more scientific investigations. In 10 out of 14 moderation analyses we found expected moderation effects. Thus, most of the moderating effects indicate curve-linear relationships, suggesting to re-consider basic assumptions about linearity in the associations between health literary and health outcomes.

Overall, our data provide strong support for our main hypothesis suggesting higher associations between health literacy and different health outcomes among young adults that score higher in conversion factors. At the same time, moderating effects are shown to be complex and depending on the chosen health outcome and conversion factors. Hence, our data supports also our second hypothesis.

Discussion

Health literacy has been found to be associated with many different health outcomes in the area of self-rated health, physical and mental health, hospitalization rates, physical activity, oral health, and even alertness and health complaints (Howard *et al.*, 2006; Berkman *et al.*, 2011; Paakkari *et al.*, 2019). Hence, many scholars have claimed health literacy to be a means to tackle health inequalities. Since it is not easy to change upstream social determinants of health within a reasonable time span, health literacy has been considered as a mediating and modifiable factor that may generate quick effects in public health (Stormacq *et al.*, 2018). It has been argued that especially the most vulnerable and migrant people should be equipped with higher health literacy to achieve better health behavior and better health outcomes (Sørensen *et al.*, 2012; WHO Euro, 2013; Ellermann, 2017).

In this study, we investigated in the question if health literacy may be a toolkit to address poor health of those with less favorable personal and social attributes. Referring to Amartya Sen's capability approach and the concept of conversion factors, we studied the moderating effect of young adults' lower secondary degree (LSD), parental socioeconomic status (PSES), and mental health (ML) on the association between health literacy and health. We hypothesized that the associations between health literacy and health are stronger among young male adults with higher LSD, higher PSES and better ML and weaker among their colleagues with lower LSD, PSES or poor ML.

The results support the first hypothesis in general. Moderating effects were found in the associations between health literacy and for all five health outcomes. At least one conversion factor moderated the associations according to the hypothesis. In only one out of 14 moderation analyses we observed the highest association among the group with the least beneficial factors. Secondly, our analyses support the second hypothesis that strength and form of the moderation effect differ across conversion factors and health outcomes.

Our work should be understood as an exploratory study investigating the complex mechanisms between health literacy and health. Using a large dataset from young adults and insights from the capability approach as theoretical guidance, our analyses show that not all population subgroups may be able to transform health literacy into better health outcomes. Barriers such as low educational degree, parents from low socioeconomic classes, or poor mental health are likely to impede the transformation of health literacy into an active agency and, further, into a positive health outcome. On the other side, young male adults with more

facilitators and less barriers seem to provide better chances to transform health literacy into good health outcomes.

Our findings speak against an uncritical interpretation of health literacy as a basic determinant of health. The data shows, that a narrow focus on personal health knowledge and skills may neglect or downplay the unequal chances *to act* upon this knowledge and skills. A more critical approach can help to explain why health literacy is not associated with a healthy behavior among large groups in our sample. Health literacy was not a determinant for selected health behaviors among these groups and we argue that this is because of the key role of conversion factors. Alike Nutbeam and Lloyd (2021), we thus suggest to understand health literacy as necessary but, not sufficient precondition for individuals (or communities) to achieve favorable health outcomes.

Our findings call for future health literacy studies that give more and specific attention to those people with the least powerful personal and social factors to transform health literacy into real health benefits. Study samples should be designed to go deeper into the effects of personal, social, and environmental conversion factors. Observational studies should question linearity assumptions when analyzing the effect of health literacy on health outcomes and should give attention to complex, nonlinear interaction effects (Pearl and Mackenzie, 2018). Lastly, health literacy intervention studies should provide answers to the question if they are able to reduce existing health inequalities (Stormacq *et al.*, 2020).

Limitations and strengths

The current analyses were restricted to an all-male sample. When it comes to health and health behaviours young male adults are a particularly interesting subpopulation (e.g., regarding their health risk behaviours). Still, the findings are limited with respect to possible gender differences, calling for similar studies in female populations. The participants in this study have a rather narrow age range from 18 to 25 years. Again, this calls for caution when generalizing the results to other age groups.

There are noticeable strengths of this study. The data collection during the military recruitment procedure ensures a sufficient number of respondents of all social strata. Hence, the study sample has sufficient statistical power to detect differences between the study subgroups including those that score low in conversion factors. Moreover, the separated

analyses for each subgroup allowed to identify non-linear moderation effects and, hence, to escape the risks of "linear wonderland" (Pearl and Mackenzie, 2018).

Conclusions

We found stronger associations between health literacy and health among those young male adults who score high in conversion factors compared to those who score low. This study supports the hypothesis that conversion factors play a crucial role in the complex associations between health literacy and health. The present findings await confirmation in future studies using data from a wide range of subpopulations.

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5. Journal Article #3

Decision-making ability: A missing link between health literacy, contextual factors, and health

Accepted for publication in:
Health Literacy Research and Practice

The article was developed, conducted, and submitted by the thesis author. Thesis supervisor supported the article with feedbacks on theory and methods.

Abstract

Background: Health literacy has often been described as an important precondition for good health decisions, healthy behaviors, and health. However, reviews reveal low evidence for intervention effectiveness through health literacy. This result calls for more investigations to be done in the pathway from health literacy to health, considering intermediate outcomes of health literacy. This study explores an important immediate objective of health literacy, namely the decision-making ability regarding health issues. The study's hypothesis claims the decision-making ability (DMA) to be an important mediator between health literacy and health outcomes. Secondly, the study assumes that the effect of the DMA on different health outcomes is not only contingent on health literacy but also on contextual factors. To test the above hypotheses, six different health literacy dimensions and four health outcomes have been analyzed.

Methods: Cross-sectional data from the Young Adult Survey Switzerland was used for mediation analyses (n = 4'569, age = 18 to 25, all-male). Multiple regression and Karlson, Holm, and Breen (KHB) decomposition analyses were applied to estimate mediation effects between health literacy and health outcomes.

Results: Five out of six health literacy dimensions explained the DMA in a linear regression model. The coefficients of the DMA explaining health outcomes were substantially reduced when health literacy items were included into the models (6.1% - 20.3%). Furthermore, the associations between health literacy and the health outcomes were fully explained by contextual factors, except in the mental health model.

Conclusions: The results support the hypothesis that higher health literacy levels do not necessarily lead to better health directly. Rather, health literacy is just one out of multiple factors contributing to a higher decision-making ability and, further, to favourable health outcomes. The results of this study call for more investigations in the health decision-making process and the role of contextual factors.

Plain Language Summary

The study investigated the ability to make good health decisions taking into account health literacy. The results support the intermediate function of the decision-making ability on the path to favorable health outcomes. Furthermore, it is found that the decision-making ability as well as health literacy are highly contingent on contextual factors. The results shed light into the complex decision-making process regarding health issues.

Introduction

Since population surveys had found high prevalences of low health literacy (Kutner et al., 2006; Sørensen et al., 2015), the concept of health literacy has gained increased attention in public health and health promotion. Low health literacy appeared to be a proximate cause of poor health outcomes, poor adherence to medical advice, and increased health system utilization (Bennett et al., 2009; Berkman et al., 2011; HLS-EU Consortium, 2012). In contrast to more distant structural causes of health, such as socioeconomic position and political contexts (WHO, 2010), health literacy appeared to be a modifiable "risk factor" that could be changed through tailored interventions (Geboers et al., 2018; Don Nutbeam et al., 2017; Stormacq et al., 2018). In particular, interventions should strive to increase health literacy levels among persons with low health literacy and empower them to make better health choices (Lenartz et al., 2016; D. Nutbeam, 2000; Sørensen et al., 2012).

However, several literature reviews revealed insufficient or a low degree of evidence for the effectiveness of health literacy interventions (Bailey et al., 2014; Berkman et al., 2011; Neter & Brainin, 2019; Pignone et al., 2005; Iray Poureslami et al., 2016; Visscher et al., 2018). Low levels of evidence have been attributed to various causes: weak methodological strength due to short-term follow-ups, substantial attrition, the lack of power to estimate effect stratification across pre-intervention health literacy levels, or outcomes that reflect intermediate results (e.g. knowledge, positive attitudes, self-efficacy) rather than substantive outcomes (e.g. behavioral change or health status) (Brainard et al., 2016; Visscher et al., 2018). Furthermore, low levels of evidence have been attributed to conceptual and theoretical shortcomings. An inconsistent choice of confounding variables (out of a "myriad of variables") may over- or underestimate the effect of health literacy and, hence, end up in mixed results and difficulties when making a synthesis (Berkman et al., 2011; Neter & Brainin, 2019; Iraj Poureslami et al., 2017).

In this study, I focus on another shortcoming in health literacy research, namely the lack of investigations in the most proximate outcome of health literacy: The ability to make health decision-making. Most health literacy studies are interested in its effects on health outcomes, health-related performance, or the use of health care services (Berkman et al., 2011; Muscat et al., 2021). On the other hand, health literacy definitions focus on other objectives such as "making informed choices", "appropriate health decisions", "informed judgements", or "sound health decisions in the context of everyday life" (Sørensen et al., 2012; van den

Broucke, 2019). Despite the sheer number of health literacy definitions, its primary objective is widely shared. Informed and personally sound decision-making is described as the most proximate outcome of good health literacy – regardless if the decision itself is rational and comprehensible. As a secondary outcome, informed health decisions should presumably lead to less health risks and a better health, respectively (Sørensen et al., 2012).

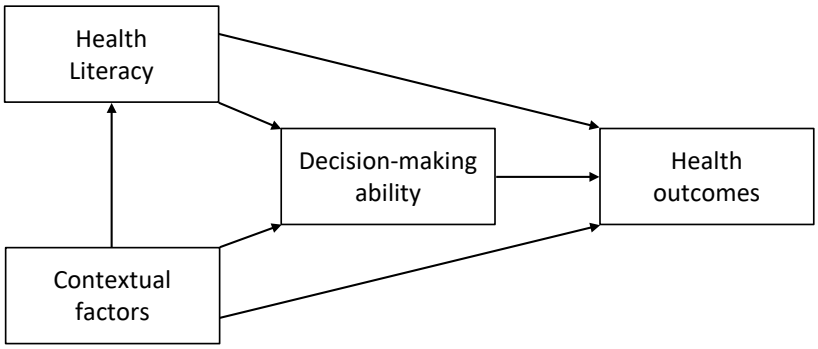
Yet, health literacy research has not investigated the causal pathway from health literacy to decision-making ability and, further, to health behaviors and health outcomes (Berkman et al., 2011; Iraj Poureslami et al., 2017). Hence, in this complex pathway, this study explores one important step in the decision-making process, namely one's ability to make health decisions. The investigation of this intermediate factor is substantially important because it may provide an alternative explanation to the low evidence of intervention research. A person's ability to make health decisions may not only be contingent on health literacy but also on his or her contextual factors e.g. financial barriers, lack of time, social support, personality traits, or system-related barriers (Bröder et al., 2017; Neter & Brainin, 2019; Don Nutbeam et al., 2018; Rüegg & Abel, 2019; Wit et al., 2020). Hence, the chances to transform health literacy into favorable health outcomes may be mediated by one's decision-making ability and – as antecedent factors – by one's contextual factors. Efforts to disentangle these relationships were done in health service and counselling research.

Health service studies investigating in shared decision-making and its prerequisites emphasized the role of contextual factors. Particularly important for active involvement in shared decision-making are higher education and higher order competences such as critical health literacy (Brabers et al., 2017; Smith et al., 2009; Smith et al., 2013). In contrast, patient's general health literacy levels were not associated with their involvement in shared decision-making (Brabers et al., 2017). Other studies emphasize the role of socially available knowledge, which appears to be crucial for a patient's decision involvement (Gunn et al., 2021; Samerski, 2019). Furthermore, Morrow and Chin (2015) emphasize that health decisions are often emotional, value-laden issues in dynamic uncertain conditions. Such conditions require a great deal of knowledge, experience, and understanding of the problem situation. These results show exemplary that health decision-making is not only dependent on health literacy, but also on situational, social, emotional, and educational factors. Hence, studies need to address these contextual factors and its effects on the health decision-making process.

This study investigates in this research gap exploring the mediation role of the decision-making ability (short: decision-making ability, DMA). The first hypothesis tested in the study

claims DMA as a mediator between health literacy and different health outcomes. The second hypothesis claims that the effect of DMA on different health outcomes is not only contingent on health literacy, but also contingent on contextual, antecedent factors. These antecedent factors not only explain DMA, but also the potential in achieving higher health literacy levels. According to literature, five dimensions of contextual factors can be distinguished confounding the effect form health literacy to health: personal, social and cultural, situational, environmental, and socioeconomic factors (Bailey et al., 2014; Berkman et al., 2011; Bröder et al., 2017; Neter & Brainin, 2019; Paasche-Orlow & Wolf, 2007; Rudd, 2017; Rüegg & Abel, 2019; Santos et al., 2011; Wit et al., 2020). The complete and sparce model derived from the theoretical reflections is shown in figure 1.

Figure 1. Empirical model including decision-making ability (DMA) between health literacy and health outcomes.



In line with published definitions, health literacy is understood as a set of personal knowledge and skills needed to make appropriate health decisions in one's own personal context (Abel et al., 2014). In addition, health literacy and its effects on choice and health outcomes depend on contextual personal, social, situational, environmental, and socioeconomic factors.

Methods

Data

Data from the second wave of the Young Adult Survey Switzerland (YASS), conducted in 2015/2016, was used for the analyses (Huber, 2019). The all-male sample was collected during the recruitment for compulsory military service with a participation rate of 90%. This sample corresponds to 14% of the eligible male population of Switzerland aged between 18 and 25. One-third of the participants were randomly selected for an additional health questionnaire containing health literacy items. The survey design is described in more detail elsewhere (Hofmann et al., 2013). Ethical approval for the data collection was obtained from the ch-x supervising board of nine members from the Swiss National Science Foundation and the Swiss Federal Statistical Office. Further approval was unnecessary due to analyses on an existing dataset.

Measures

Each of the two health indicators for general health and for health behavior were used as dependent variables. Six health literacy items were used as explanatory variables and one item for DMA (mediator). Further, eighteen contextual factors (antecedent variables) were integrated in the analyses.

Health outcomes

Due to non-normal distributions, all health outcomes were transformed into dichotomous variables where "1" represents good health or favorable health behavior respectively. Since the general level of health is very high in this age group, self-rated health was categorized into 1 = "excellent" or "very good" and 0 = "good", "less good" or "poor" health. A validated 9-item depression diagnostic and severity measure (PHQ-9) was used to measure mental health (Kroenke & Spitzer, 2002). According to Kroenke and Spitzer (2002) the index measure was transformed into 1 = "none" and 0 = "mild" or "severe" depression tendency. Observations with one to three missing values have been median imputed and included in the depression index. Observations with more than three missing values have been excluded. Smoking behavior was transformed into 0 = daily smokers and 1 = non-smokers (less than daily). Further, overweight was calculated by the body mass index (BMI) which was transformed into 1 = BMI < 25 and 0 = BMI ≥ 25.

Health literacy

Health literacy was measured with the "short survey tool for public health and health promotion research" validated in previous research (Abel et al., 2014). The instrument includes eight Likert-scaled items covering four questions for functional health literacy and two questions each for interactive and critical health literacy. One item (HL9) was added since the last validation: "How well do you understand oral explanations from medical professionals, e.g. in the drugstore or from physicians?" Principle component analysis following Abel et al. (2014) extracted three distinct factors: functional health literacy (HL1,2,9), searching health literacy (HL3,4), and interactive health literacy (HL5,6). All three factors were used for analyses. HL8 was used as singular item representing internet health literacy and HL7 as measure for DMA (see below). Observations with one or two missing values (except for HL7) have been mean imputed and included in the principle component analysis. Observations with more than two missing values have been excluded. Additionally, a measure to assess general health knowledge was applied (Cockerham et al., 1986). 75 percent of correct answers indicate sufficient mental health knowledge (7/9) or sufficient somatic health knowledge (6/8) respectively. Cut-offs have been chosen due to skewness and to maximize statistical variation.

Decision-making ability (DMA)

DMA was measured by the following question: "Today, there are many advices and offers for a healthy life. How well are you doing in choosing the information and offers that fit to you the most?" The respondents could answer on a 5-point Likert-scale from "very bad" to "very good".

Personal (contextual) factors

A 7-point scaled question captured one's motivation for a healthy living ranging from "not important at all" to "extremely important" (source: Shell Youth Study). The item was dichotomized to a high motivation for a healthy living (5-7) and a moderate or low motivation for a healthy living (1-4). One's interest in the topic of health was assessed with a 4-point scaled question. The item was dichotomized into 1 = "rather or very interested" and 0 = "not at all or rather not interested". Two dimensions of self-regulation were assessed with the LAF Locomotion-Assessment-Questionnaire (Sellin et al., 2003). Executive self-regulation captures the degree of activity orientation to reach personal goals in the manner of "just do it".

Evaluative self-regulation captures the degree of information-seeking orientation to reach personal goals in the manner of "do the right thing". Two sum indices of six and three items from the LAF were used to measure executive self-regulation (1-24) and evaluative self-regulation (1-13). Self-esteem was measured by the SISE Single-Item Self-Esteem Scale with five categories (Robins et al., 2001).

Social (contextual) factors

The number of close friends was captured with six distinct categories (0, 1-3, 4-6, 7-9, 10-12, >12). Strong ties to parents were measured by the feeling to be in good hands. Due to skewness this item was transformed into a binary variable 1 = "in very good hands" and 0 = "in good hands and lower".

Situational (contextual) factors

The parental financial situation was dichotomized into 0 = "good" and "very good" and 1 = "humble" and "very humble" according to a self-reported question. Highest parental education was assessed by 1 = primary education to 5 = tertiary education according to the ISCED-scale. The role of a healthy lifestyle in the family was dichotomized into 0 = "not important" and 1= "rather or very important".

Socioeconomic (contextual) factors

Financial constraints were measured by a personal lack of money in two or more of the following areas of life: health costs, education, rent, internet, and clothes. The educational level was assessed by the school level at the end of lower secondary school at the age of 16 (9th year in school). The three different secondary levels of education "Realschule", Sekundarschule" and "Gymnasium" were renamed with a low, intermediate, and high level. Young adults without Swiss nationality were categorized as persons with migration background.

Environmental (contextual) factor

The degree of urbanization was assessed using the ZIP-codes of the residential municipality. Municipalities were assigned to the three categories city, agglomeration, or rural.

Control variable

One control variable was included in the analyses, namely the three language regions of Switzerland speaking German, French or Roman (Italian and Rhaeto-Romanic).

Analyses

STATA 15.1 and the user written KHB package was used for linear and logistic regression analyses and to estimate mediation effects. The KHB analysis allows for an unbiased comparison of regression coefficients between nested models, and hence the decomposition of coefficients into explained and unexplained proportions (Karlson et al., 2012; Kohler et al., 2011). Further, chi-square statistics was applied to compare nested models in their predictive ability (Cleves, 2002).

The mediation analysis was conducted along the three-steps procedure described by Baron and Kenny (Baron & Kenny, 1986). First, the effects of health literacy on DMA were estimated when controlling for contextual factors. The KHB method was applied to estimate the confounding ratios between crude health literacy coefficients and those including contextual factors (analyses I). Secondly, the direct effects of health literacy on health outcomes were estimated when controlling for contextual factors. Again, the KHB method was applied to estimate the confounding ratios between the crude health literacy coefficients and those including contextual factors. Furthermore, chi-square statistics was used to compare model fit (analyses II). Thirdly, the effects of DMA on health outcomes were estimated including health literacy and contextual factors stepwise. Mediation effects were estimated by using confounding ratios. Again, chi-square statistics was applied to estimate additional predictive ability attributable to the DMA (Analyses III).

Results

The additional questionnaire with specific health literacy questions was filled out by one third of the respondents (N = 12'073). After case-wise deletion due to missing values, a net sample of n = 4'569 was used for the analyses. No further imputation strategy was needed due to sufficient statistical power and strong variation among variables. The items variations of the net sample are displayed in table 1.

Table 1: Study sample (n = 4'569)

	Number	%	mean	SD	skewness
Health outcomes					
Self-rated health					
Very good	3'092	68.1			
Good or poor	1'450	31.9			
Mental health					
Good	3'082	67.6			
Poor	1'479	32.4			
Smoking					
No	3'091	75.2			
Yes	1'017	24.8			
Overweight					
No	3'601	80.4			
Yes	878	19.6			
Health literacy					
Somatic health knowledge					
Good	1'835	40.2			
Poor	2'734	59.8			
Mental health knowledge					
Good	2'293	50.2			
Poor	2'276	49.8			
Functional health literacy			0.04	1.382	-0.342
Searching health literacy			0.03	1.236	-1.108
Interactional health literacy			0.07	1.055	-0.275
Internet health literacy			3.19	0.684	-0.770
Decision-making ability (5 cat.)			3.83	0.851	-0.641
Personal (contextual) factors					
Motivation for a healthy life					
high	3'722	81.5			
moderate and low	847	18.5			
Interest in health topics					
Yes	3'732	81.7			
No	837	18.3			
Self-regulation (executive)			16.47	3.493	-0.418
Self-regulation (evaluative)			8.37	2.083	-0.237
Self-esteem (5 cat.)			3.64	0.945	-0.471
Social (contextual) factors					
Number of close friends (6 cat.)			2.38	1.109	0.767
Strong ties to parents					
in very good hands	3'268	71.5			
in good hands and lower	1'301	28.5			
Situational (contextual) factors					
Parental financial situation					
good	895	19.6			
humble	3'674	80.4			
Highest parental education (5 cat.)			3.83	1.125	-0.627
Healthy family					
Yes	4'119	90.2			
No	450	9.9			
Socioeconomic (contextual) factors					
Financial constraints					
in less than two areas of life	3'991	87.4			
in two or more areas of life	578	12.7			
Level at lower secondary school					
high	1'513	33.1			
intermediate	2'106	46.1			
low	950	20.8			

Table 1 (continued)

Migration background		
No	4'049	88.6
Yes	520	11.4
Environmental (contextual) factor		
Urbanization of municipality		
city	871	19.1
agglomeration	2'475	54.2
rural	1'223	26.8
Control variable		
Language region		
German	3'294	72.1
French	925	20.3
Roman	350	7.7

Analysis I: Determinants of the decision-making ability

Initially, the DMA was regressed on health literacy and contextual factors with two nested linear models (table 2). The explained variation R^2=0.210 of model B can be interpreted as acceptable fit. All health literacy items, except for physical health knowledge, were positively associated with DMA (level of significance: $p < 0.01$). Four health literacy coefficients were significantly reduced when including contextual factors (22.3% - 67.0%). The coefficients of mental health knowledge and interactional health literacy were only marginally confounded by the contextual factors. Statistically insignificant coefficients (executive self-regulation, critical attitude, number of friends, migration background, parental financial situation, parental highest education, agglomeration, and rural environment) may also have statistically significant effects on the DMA but may be suppressed by health literacy as mediator.

Table 2: Linear regressions of the decision-making ability (DMA) on health literacy and other determinants in models A and B, without and with contextual factors.

	Decision-making ability (model A)		**Decision-making ability** (model B)		
	OR	95% CI	OR	95% CI	cp %
Health literacy (HL)					
Somatic health knowledge	0.031	(-0.02,0.08)	0.010	(-0.04,0.06)	-
Mental health knowledge	0.072**	(0.03,0.12)	0.074**	(0.03,0.12)	-2.9
Functional HL	0.059***	(0.04,0.08)	0.046***	(0.03,0.07)	22.3
Searching HL	0.124***	(0.10,0.15)	0.084***	(0.06,0.11)	32.3
Interactional HL	0.180***	(0.13,0.22)	0.175***	(0.13,0.22)	2.8
Internet HL	0.091***	(0.07,0.12)	0.056***	(0.03,0.08)	38.3
Contextual factors					
Personal					
Motivation for a healthy life			0.211***	(0.15,0.28)	
Interest in health topics			0.128***	(0.06,0.19)	
Self-regulation (executive)			0.034***	(0.03,0.04)	
Self-regulation (evaluative)			-0.016	(-0.03,-0.00)	
Self-esteem			0.045**	(0.02,0.07)	
Social					
Number of close friends			0.017	(-0.00,0.04)	
Strong ties to parents			0.082**	(0.03,0.13)	
Situational (parenthood)					
Humble financial situation			0.010	(-0.05,0.07)	
Highest parental education			-0.003	(-0.03,0.02)	
Healthy family			0.142***	(0.06,0.22)	
Socioeconomic					
Financial constraints			-0.109**	(-0.18,-0.04)	
Low secondary degree (ref.)					
Middle secondary degree			0.109**	(0.04,0.17)	
High secondary degree			0.118**	(0.05,0.19)	
Migration background			-0.056	(-0.13,0.02)	
Environmental					
Agglomeration			0.028	(-0.03,0.09)	
Rural			0.014	(-0.06,0.08)	
Intercept	3.194***	(3.04,3.34)	1.910***	(1.63,2.19)	
R^2	0.145		0.210		
Observations	4'569		4'569		

Notes: Data from Young Adult Survey Switzerland, Switzerland 2015 and 2016; OR = odds ratio; cp % = confounding percentages for each health literacy item with statistically significant coefficients in model A; ***p < 0.001; **p < 0.01; control variable: Swiss language regions.

Analyses II: Controlled direct effects of health literacy

In a second step, the total direct effects of health literacy were estimated by regressing each of the four health outcomes on the health literacy items and the contextual factors (table 3). The results show that all statistically significant health literacy coefficients in the crude model are confounded by contextual factors (0.5% - 66.9%). Controlling for contextual factors, only few health literacy coefficients remain statistically significant. The chi-square statistics confirm the marginal role of health literacy to explain self-rated health, non-smoking, and non-overweight. Health literacy could not increase the predictive ability in these models. Focusing at the health literacy items separately, psychological health knowledge and searching health literacy were positively associated with two health outcomes each.

Table 3. Comparison of nested logistic models regressing health outcomes on health literacy and contextual factors

	Self-rated health			Mental health			No smoking			Not overweight		
	OR	95% CI	cp %	OR	95% CI	cp %	OR	95% CI	cp %	OR	95% CI	cp %
Health literacy (HL)												
Somatic health knowledge	1.041	(0.90,1.20)	-	1.194	(1.03,1.39)	28.2	1.178	(1.00,1.38)	42.9	1.152	(0.98,1.35)	35.1
Mental health knowledge	1.027	(0.89,1.18)	-	1.234**	(1.07,1.43)	0.5	1.003	(0.86,1.17)	-	1.247**	(1.06,1.46)	32.0
Functional HL	1.032	(0.98,1.09)	-	1.067	(1.01,1.13)	31.1	0.932	(0.88,0.99)	-	1.024	(0.96,1.09)	-
Searching HL	1.125***	(1.06,1.20)	56.7	1.135***	(1.07,1.21)	61.6	0.952	(0.89,1.02)	-	0.940	(0.87,1.01)	-
Interactional HL	1.055	(0.99,1.13)	66.9	0.903**	(0.84,0.97)	-	0.951	(0.88,1.02)	-	1.057	(0.98,1.14)	-
Internet HL	0.977	(0.87,1.09)	-	0.977	(0.87,1.10)	-	1.184**	(1.05,1.34)	25.3	0.968	(0.85,1.10)	-
Pseudo-R^2	0.178			0.169			0.070			0.036		
AUC, null model[a]	0.716	(0.70,0.73)		0.760	(0.75,0.78)		0.672	(0.65,0.69)		0.627	(0.60,0.64)	
AUC, full model[b]	0.721	(0.71,0.74)		0.768	(0.75,0.78)		0.678	(0.66,0.70)		0.621	(0.61,0.65)	
Difference (chi-square)	6.19			13.6***			5.16			2.62		
Observations	4542			4561			4108			4479		

Notes: Data from Young Adult Survey Switzerland, Switzerland 2015 and 2016; OR = odds ratio; cp % = confounding percentage for each health literacy item that showed statistically significant effects when contextual factors were excluded (not displayed); *** $p < 0.001$; ** $p < 0.01$; (a) null model: including contextual factors; (b) full model: including health literacy items and contextual factors.

Analyses III: mediation effects of DMA

Finally, stepwise confounding analyses were applied to explore the mediating role of DMA between health literacy and health outcomes (table 4). The crude associations between DMA and health outcomes are statistically highly significant ($1.188 \leq OR \leq 1.744$; $p < 0.001$). Controlling for all six health literacy items, the coefficients decrease by 6.1% - 20.3%. These results indicate that the DMA is a mediator between health literacy and health outcomes. When controlling for health literacy contextual factors, the crude coefficients decrease by 12.6% - 58.0%. These results support the mediating role of DMA between contextual factors and health outcomes. Furthermore, chi-square statistics indicate that the DMA cannot be completely explained by health literacy and contextual factors in the first two models.

Table 4. Stepwise confounding analyses using logistic models regressing health outcomes on DMA

	Self-rated health			**Mental health**			**No smoking**			**Not overweight**		
	OR	95% CI	cp %	OR	95% CI	cp %	OR	95% CI	cp %	OR	95% CI	cp %
Decision-making ability (crude coeff.)	1.704***	(1.58,1.84)		1.744***	(1.62,1.88)		1.356***	(1.25,1.47)		1.188***	(1.09,1.29)	
Decision-making ability (including HL items)	1.536***	(1.42,1.67)	20.3	1.607***	(1.48,1.74)	16.5	1.332***	(1.22,1.46)	6.7	1.177***	(1.07,1.29)	6.1
Decision-making ability (including HL items and contextual variables)	1.287***	(1.18,1.40)	57.2	1.326***	(1.21,1.45)	58.0	1.211***	(1.10,1.33)	39.0	1.162**	(1.06,1.28)	12.6
AUC, null model[a]	0.728	(0.71,0.74)		0.773	(0.76,0.79)		0.683	(0.66,0.70)		0.633	(0.61,0.65)	
AUC, full model[b]	0.721	(0.71,0.74)		0.768	(0.75,0.78)		0.678	(0.66,0.68)		0.627	(0.61,0.65)	
Chi-square (delta)	11.6***			6.6**			3.9			4.3		
Observations	4542			4561			4108			4479		

Notes: Data from Young Adult Survey Switzerland, Switzerland 2015 and 2016; OR = odds ratio; cp % = confounding percentages; *** $p < 0.001$; ** $p < 0.01$; (a) null model which includes health literacy items and contextual factors; (b) full model which includes DMA to the null model.

Discussion

Strengthening health literacy levels in populations is particularly attractive in modern societies which are strongly built on freedom of choice. Therefore, health literacy appears to be a remedy to achieve equal chances for good health without reducing autonomy and self-determination. On the other hand, the idea of strengthening health literacy in populations in order to enhance general health is contrasted by scarce evidence for health literacy intervention effectiveness (Neter & Brainin, 2019; Iray Poureslami et al., 2016; Visscher et al., 2018).

This study investigated the pathway from health literacy to health assuming that the decision-making ability (DMA) plays a crucial role to explain the low evidence of health literacy intervention effectiveness. Hence, the mediating role of DMA was tested on four different health outcomes using six health literacy indicators and five dimensions of contextual factors. An all-male sample of young adults in Switzerland was used to test the mediation hypotheses according to Baron and Kenny (1986).

The analyses confirmed that the DMA is a mediator on the pathway between health literacy and its contextual factors on the one side and health outcomes on the other. However, our analyses revealed health literacy itself as mediator between contextual factors and health. These results support the hypothesis that higher health literacy levels do not automatically lead to better health. Rather, the widely shared objective of health literacy, the ability to make informed health decisions, is only partially contingent on health literacy and much more contingent on contextual factors such as those applied in the analyses. With other words, the immediate objective of higher health literacy levels cannot exclusively be attributed to health literacy alone. Diverse contextual factors may reduce or impede positive effects on favourable health outcomes.

The study results call for more investigations in the health decision-making process. A range of personal, socio-cultural, situational, socioeconomic, and environmental factors can thwart the pathway from health literacy to decision-making and favourable health outcomes. On the other hand, some health literacy dimensions, such as psychological health knowledge and skills in information seeking, appeared to be the most promising factors supporting favourable health outcomes.

Strengths and limitations

The analyses were restricted to an all-male sample. Even though young male adults are a particularly interesting subpopulation (e.g., regarding their health risk behaviours) the present findings suggest conducting similar studies in gender inclusive contexts and in other age groups. Hence, these limitations call for caution when generalizing the results. Furthermore, the statistical analyses were conducted on the grounds of a simplified empirical model. Further studies are needed to explore additional intermediary steps and more contextual factors that may be relevant in the pathway from health literacy to health outcome. Finally, the theoretical mechanisms were tested with cross-sectional data. It is suggested that more studies with longitudinal data need to be carried out.

There are noticeable strengths of this study. The data collection during the military recruitment procedure ensures many participants of all social strata and personal characteristics. Hence, the statistical power of the net sample is high and ensures robust estimates using many covariates. This is one of only few studies which investigates the health literacy pathway using a broad range of contextual factors.

Conclusions

We found that the decision-making ability (DMA) is an important mediator between health literacy and health outcomes. The results support the hypothesis that higher health literacy levels do not lead to better health directly. Rather, the significant role of contextual factors reveals that health literacy is just one of multiple factors which contribute to a higher decision-making ability and, further, to favourable health outcomes. The study's results call for more investigations to be done in the health decision-making process to gain a better understanding of the transformation of health literacy into favorable health outcomes.

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6. The health literacy staircase model (HL-SM)

Health literacy has been understood as a prerequisite to informed and self-determinant health decision-making and hence to obtaining a greater control over one's own health (chapters 1.1 & 1.2). However, with the freedom of choice comes also a personal responsibility for any decision that may affect health – immediately or in the long-term. Consequently, we are not free but rather forced "to manage our own health (…), because the health care system will help us only punctually" (Schaeffer 2015).

Following many health literacy definitions, health literacy's primary objective is to make "informed choices", "appropriate health decisions", "informed judgements", or to "make sound health decisions in the context of everyday life" (Sørensen et al. 2012; van den Broucke 2019). In line with these health literacy definitions, I argue to mark decision-making as the primary objective of health literacy. By definition, all health literacy interventions must promote informed and personal decision-making – regardles if the final decision is rational or appropriate from a health expert's point of view. Otherwise, health literacy interventions would not support self-determination and enlightened decision-making to their target groups. For example, health professionals are urged to inform their clients neutrally and balanced, independent of their own perception of the most appropriate decision. Their professionality expresses in a client-centred, non-normative and comprehensible information on options, risks, and opportunities. The goal is to support clients to make their own informed judgement in the context of their personal situation.

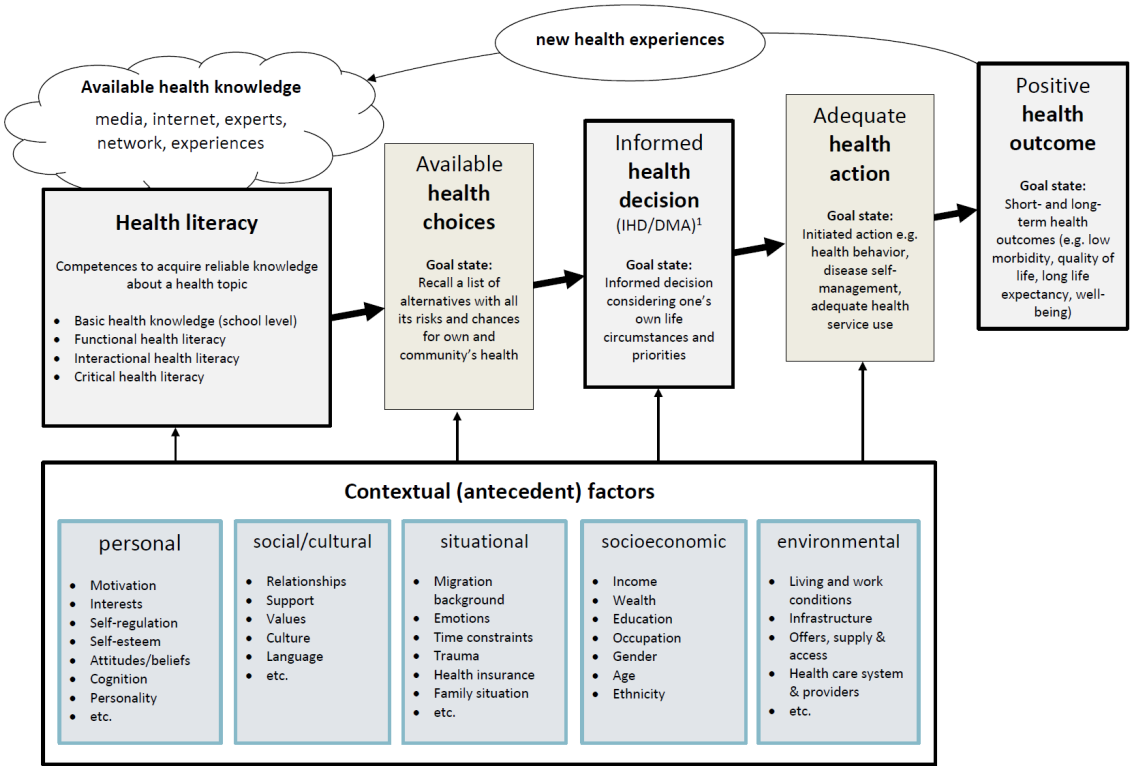
Hence, the starting point of my theoretical analysis is an informed health decision considering one's own personal life context (short: informed health decision, IHD). I suggest considering the IHD as the most important effect of health literacy. Another important intermediate result on the pathway between health literacy and IHD is the recognition of available choices. The initiation of adequate health actions is another intermediate result leading to a positive health outcome (Edwards et al. 2012; Berkman et al. 2011a).

The Health Literacy Staircase Model (HL-SM, figure 1) emphasizes the three intermediate steps from health literacy to positive health outcomes. On the left side, an IHD is contingent on one's knowledge on the *spectrum of available health choices* as well as its risks and opportunities for personal and community's health. This list of available health choices is determined by one's competences to fill and expand this list. Therefore, *health literacy* is needed to tap the body of available health knowledge. A basic understanding about health, basic functional and

interactional competencies to expand present knowledge, and a critical appraisal of information sources is necessary to create the list of health choices. A time variant body of *available health knowledge* serves as source needed to be taped. It consists of information from media, experts, internet, social network, and one's own experiences with health issues.

On the right side, an IHD results in the initiation of an *adequate health action*, e.g. good health behaviour, good health and disease self-management, adherence to professional advice, and adequate health care service use. If the health decision was well grounded, the resulting health actions will lead to short- and long-term *positive health outcomes,* e.g. low morbidity, high quality of life, long life expectancy. Further, achieved (or non-achieved) health outcomes can be evaluated as *new experiences*. These may serve as personal health information that should be considered in future health decisions.

Figure 1. The Health Literacy Staircase Model (HL-SM)



Note: Decision-making ability (DMA) is a subjective measure for one's own ability to achieve informed health decisions considering one's personal life context (short: informed health decision, IHD).

It is obvious that an IHD does not necessarily lead directly to positive health actions, but may be impeded by other factors, e.g. the intention-behaviour gap (Sheeran and Webb 2016). Hence, the whole decision-making process is vulnerable to *contextual antecedent factors* (figure 1). These factors function as background effects that influence all steps of the HL-SM from health literacy to an adequate health action. Based on available literature (Bailey et al. 2014; Neter and Brainin 2019; Bröder et al. 2017; Wit et al. 2020; Nutbeam et al. 2018; Rudd 2017), I have identified five dimensions of contextual factors: personal, social and cultural, situational, environmental, and socioeconomic factors. The choice of categorization is not crucial to the HL-SM. Rather, it is important that the factors are numerous, even though they may be incomplete.

Against the background of the HL-SM it is now more obvious how to define health literacy. I define *health literacy as the competences to acquire reliable knowledge about a health topic that allows him or her to list the available health choices with all risks and opportunities for his or her health and the health of the community. Health literacy and its effects on choice, health actions, and health outcomes depends on the available health knowledge and on contextual personal, social, situational, environmental, and socioeconomic factors.* This definition puts a special emphasis on the immediate outcomes of health literacy that need to gain more attention in health literacy research. Insofar, the definition may serve the scientific community to push forward theoretical models of health literacy.

7. Discussion

Health literacy research gained tremendous attention over the last two decades. Since its early onset, a lively discussion accompanied empirical research questioning its boundaries, conceptualization, and theoretical foundation. In the clinical realm, a trend has led from literacy-orientated assessments to performance-based assessments where patients must learn and demonstrate the correct application of tools and perform correct calculations, or assess the reliability of example websites (Muscat et al. 2021). In the clinical context, health literacy is crucial to ensure a patient's adherence and to keep inequalities in service delivery as low as possible – facing social, economic, or cultural barriers (Bröder et al. 2017).

Even though health care services investigate intensively in health literacy friendliness, chronic diseases will not be contained by hospital care. Therefore, health literacy should be strengthened in disease prevention and health promotion. Along with several health literacy surveys, science and politics were alarmed facing high rates of low health literacy within modern societies. Low health literacy was generally associated with poor health behaviour and many experts identified health literacy as a panacea to tackle health inequalities. Health literacy has been lifted to an important determinant of health without critical assessment or theoretical arguments.

One aim of this thesis is to challenge the notion of health literacy as determinant of health. Therefore, the thesis sheds light onto the empirical and theoretical problems that have emerged when health literacy was lifted to a health determinant. With other words, the thesis is dedicated "to clarify the pathway of effect between health literacy and health outcomes" (Berkman et al. 2011b). To be clear, the thesis' aim is not to question the unequal distribution of health literacy but, rather, to question the causal assumption using the term "determinant" – with all its resulting consequences. The discussion of this thesis is structured into an empirical summary, a conceptual summary, a general summary, a chapter on limitations and strengths, and a conclusion.

7.1 Summary of the empirical findings

Empirically, this work investigates the complex relationship between health literacy, contextual factors, and favourable health outcomes. All three journal articles apply a thorough conceptual or theoretical framework tested against data from male young adults. The results show that the associations between health literacy and health outcomes drop significantly

when including personal, social, situational, environmental, and socioeconomic factors (contextual factors) in the models. Up to 87% of the associations can be attributed to these contextual factors (paper 1). Using more contextual factors, the health literacy items do not increase the predictive ability to explain health (paper 3). Furthermore, contextual factors moderate the associations between health literacy and health (paper 2). These results support the notion that it is not appropriate to claim health literacy as determinant of health. However, more detailed answers are given to the research questions addressed in chapter 1:

Question 1: *What are a person's preconditions to achieve high health literacy levels?*
Male young adults with higher health literacy levels reported healthier families, higher education levels, higher socioeconomic status of their parents, better emotional support from social networks, higher interest in health topics, better psychosocial conditions (self-esteem, conscientiousness, openness, and self-efficacy), and attractive sport programs nearby. However, several other preconditions may be thinkable to strengthen or constrain better health literacy. Theoretically, the HL-SM summarizes potential preconditions for health literacy and its transformation into favourable health outcomes.

Question 2: *What is the causal effect of health literacy on one's decision-making ability (DMA) and, further, on favourable health outcomes considering preconditional factors for health literacy?*
DMA can be explained by health literacy, but only partially (R^2=0.145). The strongest predictor for DMA is interactional health literacy. Basic somatic health knowledge is not associated with DMA. Using a causal diagram and testing it against the data, only a small fraction of DMA's effect on health can be attributed to health literacy (6-20 percent). Moreover, health literacy added no additional predictive power explaining self-rated health, smoking, and overweight. First, these results reveal DMA as a complex and insufficiently explored phenomenon. Secondly, the results show that health literacy plays a marginal role explaining DMA and health.

Question 3: *Is health literacy a personal characteristic with causal importance or is it rather a function of more stable psychosocial and socioeconomic determinants of health?*
The study results do not support the hypothesis that health literacy – as a distinct phenomenon – has a causal importance for health (except marginal causal importance for mental health). According to counterfactual thinking (chapter 1.3), health literacy can be manipulated by many different interventions, each with different impacts. In consequence, it is not health literacy's causal effect, but rather the intervention's target factor (e.g. well-designed health care communication, better self-management, increased interest in health, higher self-

esteem, more social contacts, or knowledge about few reliable information websites). This calls for caution when appraising health literacy as a determinant of health. Rather, researchers should be more explicit on types of interventions and their (sustainable) effects on important health outcomes.

7.2 Summary of the conceptual work

Conceptually, the thesis aims to improve the theoretical understanding of health literacy considering contextual factors on the one hand and the decision-making process on the other. These theoretical considerations address the various shortcomings of previous concepts and definitions (chapter 1.2). All thesis publications, so far with an empirical focus (chapters 3-5), address particular parts of one complete theoretical concept. The first publication addresses the relationship between health literacy and socioeconomic and other health-related factors. The second publication explores conversion factors moderating the association between health literacy and health. Finally, the third publication includes the decision-making ability as a proximate outcome of health literacy and as a mediator between health literacy and health outcomes. In the third publication, contextual factors are categorized for the first time by personal, social, situational, socioeconomic, and environmental attributes.

Hence, the final theoretical framework is deduced logically from observed shortcomings in the health literacy literature. Furthermore, its core pathways are tested against data of male young adults. Due to its basic structure, it is named the Health Literacy Staircase Model (chapter 6). The Health Literacy Staircase Model (HL-SM) stands out due to several important features as follows.

First, the model is explicit about the most proximate effect of health literacy – namely the ability to *list the available health choices with all risks and opportunities for one's health and the health of the community*. Against this background, health literacy is defined as the *competence to acquire reliable knowledge about a health topic that allows him or her to list the available health choices with all risks and opportunities for his or her health and the health of the community*. This definition specifically addresses the third shortcoming described in chapter 1.2.2: Health literacy cannot be a matter of "information possessing" nor can it be an issue of health-related performances or actions. Instead, the term health literacy should be reserved to the *acquisition process*. Acquisition is especially important since new information (including fake information) grows day by day. To recall a list of time- and space-dependent health alternatives is crucial in a health decision-making process. Further, considering one's own life circumstances and preferences, decision-

making and implementing positive health-related actions need to be acknowledged as subsequent steps.

Second, the model addresses the blurred boundaries (chapter 1.2.1) by externalizing contextual factors from the narrow health literacy process. Contextual factors or preconditional factors, respectively, appear as confounding and moderating factors in the model. Contextual factors are defined either as genuine personal attributes (not related to health in the narrow sense) or external features of the situational, social, economic, and environmental world.

Third, available health knowledge depending on time and space is included in the shape of a cloud. This knowledge also incorporates a person's own experiences with health issues. Considering an ever-changing cloud of relevant and reliable health knowledge, including ongoing feedback from one's own health experiences, the whole health literacy staircase must be run up every time when decisions occur.

To sum up, the Health Literacy Staircase Model (HL-SM) provides a sophisticated model that addresses the previous conceptual shortcomings and the general risk that health literacy serves as a residual for all individual characteristics promoting good health.

7.3 Synthesis

The interpretations above may appear to be somewhat contradictory. On the one hand, health literacy appears in a causal diagram and on the other hand it is presented as not being manipulable. Hence, the question about health determinant or not needs to be addressed again in terms of a causal theory. By definition, a strict interpretation of causality requests manipulation (Freese and Kevern 2013). However, health literacy cannot be strengthened by a simple treatment such as giving a pill. Rather, health literacy must be recognised as a complex function of an immense number of preconditional or contextual factors and one's own health experiences. Using a metaphor, health literacy can be compared with the knowledge of how to lead a long-lasting partnership. Successful partnerships cannot be forced by giving a pill or a restricted treatment that fits for all. Rather, a partnership's persistence largely depends on the characteristics of the persons, e. g. their values, desires, attitudes as well as on situational factors, socioeconomic, or timely resources. Skills in relationship building may be a beneficial but are no guarantee for wise decisions nor for sustainable partnerships.

Putting it together, health literacy interventions that foster digital skills may be beneficial for some but not for others. For the latter, it may be more effective to intervene in contextual factors, e. g. to reduce stress or financial constraints. To use the metaphor again, neither a partnership building program nor a couples therapy are determinants for partnership success. In the same way, it is dangerous and scientifically misleading to consider health literacy as a determinant of health. To put it simple, health literacy should not be seen as "a panacea for health inequities created by the maldistribution of opportunity and resources" nor as "a substitute for the need to tackle the root causes of inequity " (Nutbeam and Lloyd 2021).

In consequence, every health literacy manipulation used "as a 'midstream' strategy to reduce the impact of 'upstream' socioeconomic determinants on 'downstream' disparities in health" (Stormacq et al. 2018) needs to be tested with keen attention on its effects on health inequalities. Societal forces which manifest themselves, e. g. in stressful living conditions, limited agency, limited cognitive capacity and non-cognitive functionality, weak social embeddedness, weak access to care, and financial constraints make predictions impossible. Rather than searching for a "magic pill", future health literacy studies should give more emphasis on the complex and stressful living conditions among the poorest – question societal power structures determining inequalities of health (Friel et al. 2021) and question why health inequalities do not decrease although giving them increasing attention (Frank et al. 2020).

The discussion is closed with a few words on the current pandemic. Since the SARS-CoV-2 pandemic increased health inequalities on all levels (Jordan and Adab 2020; Riou et al. 2021; Takian et al. 2020; Mesa Vieira et al. 2020), contextual factors empowering good health will become even more critical in the future than today. Since the beginning of the pandemic, marginalized, socioeconomic disadvantaged and vulnerable people have not been sufficiently protected against the new SARS-CoV-2 virus and have faced more deaths than wealthier groups (Riou et al. 2021; Jordan and Adab 2020; Mesa Vieira et al. 2020). Protective vaccinations came too late and were not available for all people with a special need. Hence, many experts emphasize that the Covid-19 crisis demands multiple interventions including a resolute prevention of non-communicable diseases (Pan et al. 2021; Azarpazhooh et al. 2020; Sheldon and Wright 2020). Considering the challenges to protect the most vulnerable, effective health literacy interventions (as midstream strategy to reduce upstream inequalities) will become increasingly difficult. On the other hand, it is even more important that pandemic information is "health literacy friendly" and ensures the accurate perception by all groups in the population. Population groups with the least advantageous conditions need to be equipped most

urgently with the most effective resources. Furthermore, a fair amount of critical health literacy is demanded from health experts, health service providers, and executive politicians (Abel and McQueen 2020).

7.4 Limitations and strengths

First, the empirical data and findings are limited to male young adults and call for similar studies in female populations and older age groups. Further studies are needed to explore the results generalizability. *Second*, many contextual factors could not be included in the analyses. Regarding the HL-SM, neither all confounding effects nor all moderating effects have been tested against the data. This limitation calls for more investigations exploring the confounding and moderating effects presented in the HL-SM. *Third*, the studies were conducted using cross-sectional data. Thus, the empirical results have to be interpreted against the consistency of the chosen model and it's replicability among other data samples and other health literacy instruments. This last point leads over to the *fourth* limitation. The thesis' data set provides a relatively short health literacy instrument. Other population health literacy instruments such as the HLS-EU-Q47 cover additional health literacy aspects and dimensions. On the other hand, the applied "short survey tool" was specifically developed to use among young adults, was translated and validated in different countries (Abel et al. 2014; Guo et al. 2018). However, the thesis' results need to be replicated using other health literacy instruments.

A major strength of this thesis is its thorough theoretical work that accompanied the empirical studies. These theoretical investigations allow statistical analyses that emulate an experimental research design with causal estimators (Hernán and Robins 2019). Thus, the applied theoretical frameworks facilitate the interpretation of raw statistical analyses. Next, the thesis' empirical analyses used more antecedent variables than many other health literacy study. Using a high number of variables, indices, and validated instruments provide broader insights into the health literacy mechanisms and more robust causal estimators. A large sample size and a large variety of participants among different social strata provide sufficient statistical power for the analyses. Finally, the thesis' third paper is among the first publications that focuses on the decision-making process connecting health literacy and health. This focus provides a new and straight-forward perspective explaining why people with given contextual factors and given health literacy levels have difficulties to make healthy decisions. The definition of health literacy as a precondition to *list the available health choices with all risks and opportunities* is new in the health literacy research and may be important for future research.

7.5 Conclusions

This thesis investigates in the concept of health literacy, empirically and theoretically. Previous literature that ascribes health literacy the status of a health determinant cannot be supported by the data. Rather, health literacy must be considered as a function of various contextual factors and not as a discrete unidimensional phenomenon. The success of health literacy manipulations, hence, will depend on its capacity to address contextual factors that may be as individual as each individual person. Limited respect to contextual factors has characterized previous models describing health literacy's pathways to health. In contrast, this thesis addresses this deficiency and applies a new model, the health literacy staircase model (HL-SM).

This work concludes with a final remark on future health literacy studies. For many experts and politicians, health literacy has been understood as an easy-to-use instrument to stimulate healthier behaviours. But health goals are as individual as each person and span a wide range of social, mental, and physical health issues. Hence, target groups may not agree with the intervention's superior goals – due to their own health visions. Koponen et al. (2016) describe this situation as the paradox between delivering health and enabling autonomous decision-making. The solution to this paradox is simple. Interventions and applied science must be fully transparent regarding the applied normative assumptions. Especially, all proximate and distal goals of interventions must be reflected in their normativity. In the realm of health literacy research, it is actually easier. Investigating in informed and self-determined health decision-making is, from an ethical point of view, unproblematic. Therein, I see a great potential in health literacy research. Alike the transition to shared decision-making in medicine, health literacy research can shift public health from a rather paternalistic paradigm into a new mindset that – first of all – empowers people and communities for self-determined decision-making.

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Rüegg, René; Gehrlach, Christoph (2021, in Erscheinung). «Soziale Qualität» sozialer Dienstleistungen. Eine Scoping Studie. In: C. Gehrlach, M. von Bergen & K. Eiler (Hrsg.) Sozialmanagement und Sozialwirtschaft in einem sich wandelnden Umfeld. Wiesbaden: Springer VS.

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Rüegg, René; Eggli, Andrea (2020). COVID-19-Studierendenbefragung Bericht der Berner Fachhochschule zur «International COVID-19 Student Well-being Study». Berner Fachhochschule BFH, Soziale Arbeit.

Oral contributions to international conferences

2. SAGES-Conference «Förderung der sozialen Teilhabe durch die gesundheitsbezogene Soziale Arbeit – (k)ein leeres Versprechen», Bern, 2021. Workshop «Soziale Arbeit in der Arztpraxis - Vorurteile, Vertrauen und interprofessionelle Kultur» (forthcoming)

FMC Symposium «Wie gelingt eine bessere Vernetzung des medizinischen und sozialen Systems?», 2021. Parallelsession «Soziale Arbeit in der Arztpraxis» (forthcoming)

4. Nationale Tagung Gesundheit & Armut, Bern, 2021. Workshop «Gesundheitskompetenz und Verzicht auf Gesundheitsleistungen»

INAS Fachkongress, Bern, 2020. Workshop «Soziale Qualität sozialer Dienstleistungen. Eine Scoping Studie»

International Conference «Persönlichkeitsentwicklung in Hochschulausbildungen», Bern 2018. Workshop «Kritisches Denken - Die Kunst richtig, statt das Richtige zu denken»

Swiss Public Health Conference, Neuchâtel, 2018. Presentation «Health Literacy and Health: Decomposing a Statistical Association»

10. Declaration of Originality

Last name, first name: Rüegg, René

Matriculation number: 05-186-499

I hereby declare that this thesis represents my original work and that I have used no other sources except as noted by citations.
All data, tables, figures and text citations which have been reproduced from any other source, including the internet, have been explicitly acknowledged as such.
I am aware that in case of non-compliance, the Senate is entitled to withdraw the doctorate degree awarded to me on the basis of the present thesis, in accordance with the "Statut der Universität Bern (Universitätsstatut; UniSt)", Art. 69, of 7 June 2011.

Place, date: Windisch, 04.04.2022

Signature: