

# Complexity awareness among university students in Switzerland during the Covid-19 pandemic

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## Summary

Public health challenges relating to Covid-19 are highly complex and reasons behind preventive measures can be difficult to understand. Complexity awareness, an important part of healthy literacy, may help young people to understand the situation and act accordingly. However, we could not find any tools to assess complexity awareness during a pandemic in the literature. The purpose of this study was to develop pandemic-specific items to assess complexity awareness and explore relationships with sociodemographic characteristics in university students. Based on critical health literacy concepts and expert knowledge from public health, we developed four survey items, which were answered by 3616 Swiss university students online as part of the COVID-19 International Student Well-Being Study. Relationships between awareness and sociodemographic characteristics were explored using logistic regression and odds ratio (OR). Results showed that 49.6% of the students demonstrated limited and 50.4% demonstrated high complexity awareness. Being female (OR = 1.26; 95% CI 1.07–1.47), having highly educated parents (OR = 1.29; 95% CI 1.06–1.57), and being at a practically oriented university (OR = 0.79; 95% CI 0.64–0.97) was associated with high awareness. Covid-19-related complexity awareness varied significantly among university students, indicating that they have difficulties in dealing with complex information and processes in this pandemic. The results call for action to support students in understanding the complexity of this pandemic and to investigate complexity awareness in the general population.

## Lay summary

There is a large amount of complex information and misinformation around Covid-19 available. Complexity awareness refers to awareness about these complex issues which may help young people to identify and process appropriate information. We were interested how sociodemographic characteristics relate to complexity awareness in young people. Thus, in May 2020, we conducted a survey at four universities in Switzerland, with more than 3500 students participating and asked, for example, how strong students rate the at that time available scientific evidence to guide political decision-making regarding Covid-19. We also asked them about some personal characteristics, such as gender and parental education. Despite the highly educated sample, we found that only about half of the students demonstrated high-complexity awareness. We found that students who were women or who had at least one parent with a university degree were more likely to demonstrate high complexity awareness. In contrast, students at a practically compared to a research-oriented university were less likely to demonstrate high-complexity awareness. Our results indicate that even highly educated university students have difficulties in dealing with complex information and processes regarding the Covid-19 pandemic. Thus, university students should be specifically targeted to empower them to deal with complex information and processes around Covid-19.

**Keywords:** health disparities, sociodemographic characteristics, social inequality, awareness, pandemic, health literacy

## INTRODUCTION

In March 2019, the World Health Organization declared Covid-19 a global pandemic. Over the course of the virus' spread, Covid-19 has resulted in far-reaching social and economic ramifications (Nicola *et al.*, 2020). To mitigate the virus' spread, several countries introduced policies at the institutional and individual level (e.g. limiting mobility and closing borders, physical distancing). These policies and measures are characterized by a high complexity regarding the conditions and consequences of their implementation. Behavioral measures and restrictions have legal mandates, but the effectiveness of these measures depends upon individuals' willingness to cooperate and adopt behavioral restrictions (Abel and McQueen, 2020), which is decisive to mitigate the virus' spread (López and Rodó, 2020). Thus, individuals must be aware, understand, and critically assess the information obtained. This poses major challenges, many of them related to the large amount of information available, and the presence of conflicting information or misinformation—a challenge public health experts have termed an 'infodemic' (WHO, 2020; Zarocostas, 2020). Likewise, uncertainty of scientific knowledge and various stakeholder interests make it difficult for individuals to come to reasonable conclusions and decisions.

A key resource to process health-related information is health literacy, comprising competencies at different levels, ranging from basic reading and writing skills to navigate everyday life to advanced cognitive and social skills to act as agents in matters of health (Nutbeam, 2000). Healthy literacy has also been applied to this pandemic, showing, for example, that it is positively associated with handwashing knowledge behavior and negatively associated with socializing (Riiser *et al.*, 2020). Another study showed that the number google searches for the term 'wash hands' was strongly correlated with a slower Covid-19 spread in 21 countries (Lin *et al.*, 2020).

However, in this pandemic, basic healthy literacy is not enough—instead, critical health literacy (CHL) is crucial in reflecting, assessing and applying pandemic-related information. Yet, the importance of CHL has been underestimated in this pandemic (Paakkari and Okan, 2020; Sentell *et al.*, 2020). CHL refers to the advanced cognitive and social skills used to critically analyze and apply relevant health information to gain greater control in life and to take over collective responsibility (Sykes and Wills, 2018; Nutbeam, 2000). It focuses on the *interactions* between individuals and health information, consisting of various facets such as advanced cognitive skills, social skills and political action (Nutbeam, 2000; Chinn, 2011; Sykes and Wills, 2018), showing that promoting CHL requires the consideration of multiple interconnected and

complex aspects. The importance of acknowledging complexity in health promotion has also been recently acknowledged in complexity science for health promotion, emphasizing the need to consider the interconnection of different aspects within a socio-ecological framework with regards to general health promotion (Mohammadi, 2021; von Heimburg and Cluley, 2021) and health promotion in the Covid-19 pandemic (Gubrium and Gubrium, 2021).

### Awareness to achieve CHL

A crucial factor to accomplish CHL is awareness (Frisch *et al.*, 2012; Sykes and Wills, 2018; Abel and McQueen, 2020). Awareness is a multi-facet construct that requires being cognizant about the best information available (Doyle, 1992), having a basic understanding of the different mechanisms involved in complex political decisions (Zaller, 1992), and recognizing how ones' decisions influence public health (Zarcadoolas *et al.*, 2006). Also, people should be aware that there is a social gradient in health outcomes (Sykes and Wills, 2018).

Based on theoretical foundations from Freire's critical pedagogy (Freire, 2005), we consider awareness being an important factor of reflection, a process in which individuals understand and analyze relationships between the individual and society and how structural aspects shape opportunities and human agency (Jemal, 2017). To be able to analyze and understand these complex relationships, individuals must be aware how the personal context, societal issues and structural aspects are interrelated. In that sense, being aware of these interrelations is a prerequisite to be able to critically analyze relevant health information, the core skill of CHL (Nutbeam, 2000; Sykes and Wills, 2018). Also, previous research on CHL points out that awareness is an important construct as part of CHL: For example, Sykes *et al.* [(Sykes *et al.*, 2013), p. 2] define CHL as 'a process in which citizens become aware of issues, participate in critical dialogue and become involved in decision making for health'. In addition, the key characteristics of CHL resulting from Nutbeam's work [i.e. critical appraisal of information; understanding of the social determinants of health; engagement in collective action, (Chinn, 2011)] are closely related to awareness. This includes awareness about uncertainties in scientific knowledge and political decision-making as well as about health inequalities. The importance of these awareness types in the pandemic context have been recently discussed (Abel and McQueen, 2020).

As mentioned above, awareness means to be cognizant about the best information available (Doyle, 1992). In the Covid-19 context, this translates to being aware about *uncertainties in scientific knowledge* which can be facilitated by basic knowledge

about scientific methods. Chinn links (Chinn, 2011) this type of knowledge to critically appraising information, one CHL domain. This domain also includes being aware about the science process (Chinn, 2011), an important element of so-called science literacy (Zarcadoolas *et al.*, 2005; Zarcadoolas *et al.*, 2006). The latter is characterized by understanding of fundamental scientific concepts, scientific uncertainty and rapid changes in accepted science (Zarcadoolas *et al.*, 2005). Uncertainty in scientific knowledge poses major problems for political decisions in this pandemic due to the urgency of measures (Abel and McQueen, 2020).

Moreover, awareness means to have a basic understanding of the different mechanisms involved in complex political decisions (Zaller, 1992). In the Covid-19 context, this translates to individuals having a basic understanding for political structures as well as civic and governmental processes in order to be aware that public health decision-making needs to consider multi-factorial and multi-level processes with the resulting complexity being difficult for individuals to understand. Such basic knowledge is also seen as an important component of health literacy enabling citizens to become involved in decision-making processes for health (Zarcadoolas *et al.*, 2005). In a pandemic situation, individuals' *awareness about uncertainty in science and in political decision-making* may be considered key factors for behavioral changes required at the individual and population level (Abel and McQueen, 2020).

Chinn (Chinn, 2011) considers understanding *health inequalities* another CHL key characteristic, referring to the understanding about social determinants of health. Being cognizant about how one's decisions influence public health and being cognizant about the social gradient in health outcomes are also important parts of awareness (Zarcadoolas *et al.*, 2006; Sykes and Wills, 2018). In the Covid-19 context, this translates to being aware that risks and resources are unequally distributed at a social level and the ability to assess who experiences benefits or detriments from public health measures (Freedman *et al.*, 2009). In the current pandemic, the issues around social inequalities are striking. For example, social vulnerability (i.e. poverty, lower education, unemployment and belonging to a racial minority) has been associated with an increased risk for Covid-19 morbidity and mortality (Baqui *et al.*, 2020; Kim and Bostwick, 2020; Patel *et al.*, 2020) and an increased risk to develop psychiatric disorders during the pandemic (Xiong *et al.*, 2020). Awareness about those pandemic-related inequalities can be considered a CHL component.

To conclude, uncertainty in scientific knowledge, complexity of political decision-making, and social inequalities regarding Covid-19 create a high degree

of complexity for each citizen (Abel and McQueen, 2020). Building awareness is crucial in building CHL that enables individuals to process the complex information available and make informed decisions (Abel and McQueen, 2020).

Applying the outlined awareness concept concretely to individuals during Covid-19, this means that people are not only aware of the pandemic's direct health threat, but also its impact on socio-economic areas such as agriculture, education, tourism, sports or mental health (Asfaw *et al.*, 2020; Nicola *et al.*, 2020; Schmidt *et al.*, 2020; Wunsch *et al.*, 2021). Likewise, it means individuals are aware that their behavioral decisions, such as socializing, pose a risk to others as they may become transmitters of the virus. Additionally, they should be aware that the pandemic poses a stronger direct health risk to older people (Figliozzi *et al.*, 2020), while it also reinforces social inequalities, unfolding a disproportional impact on minority and marginalized groups (Gauthier *et al.*, 2020; Tavares and Betti, 2021).

Low complexity awareness might be a major reason driving the current problems we see in compliance with behavioral restrictions and measures [e.g. (Nivette *et al.*, 2021)]. Regarding compliance with behavioral restrictions, a population that is becoming increasingly important is young adults. Although young and healthy adults are less likely to die from Covid-19 (Figliozzi *et al.*, 2020), they play a critical role in spreading the virus as they are more likely to become infected, are stronger drivers of super-spreader events than older people, and are less likely to comply with behavioral restrictions (Alsan *et al.*, 2020; Goldstein and Lipsitch, 2020; Lau *et al.*, 2020; Li *et al.*, 2020; Nivette *et al.*, 2021). At the same time, the pandemic affects younger people more than older people in other domains, including an increased risk for psychiatric disorders (Huang and Zhao, 2020; Xiong *et al.*, 2020), unemployment (OECD, 2020) and drastic changes in academic and personal structure (Sahu, 2020; Lederer *et al.*, 2021). Thus, young adults are crucial for mitigating the virus' spread while at the same time being highly vulnerable to its negative impacts.

Awareness may be one aspect that enables young adults to better deal with Covid-19's complexity and may enhance compliance with behavioral measures and collective responsibility in this target group. Yet, we know very little about how complexity awareness in this pandemic is distributed among young adults, making empirical investigation warranted. To our best knowledge, no measurement tools exist that assess pandemic-specific complexity awareness. Thus, the purpose of the current study was to: (i) develop survey items to specifically explore Covid-19 related complexity awareness and (ii) explore complexity awareness in university students. Due to our sample's

high-educational background, we expected a high degree of complexity awareness in Covid-19 challenges related to available information, political decisions, and social determinants.

## METHODS

### Development of the items to assess complexity awareness during a pandemic

We are studying awareness of complex public health issues typically occurring in a pandemic like Covid-19 (Abel and McQueen, 2020). We focus on two of these issues, namely: awareness about (i) uncertainties related to emerging scientific knowledge in political decision-making, and (ii) inequalities in the burden of disease and distribution of risk. We address both with two items, respectively: awareness about uncertainty and complexity in decision-making with items 1 and 2, and awareness about the unequal distribution of disease burden and risk with items 3 and 4 (see Table 1).

The items were developed by public health experts during the early stages of the Covid-19 pandemic (around March 2020). In the first step, a small group of researchers discussed and developed a first draft of the items. Public health experts in health literacy provided input regarding content and wording of the items. After the items had been revised, they were pre-tested with a convenience sample of university students ( $N = 8$ ). Students across different study disciplines (e.g. sports science and health science) were emailed the questions and asked to provide written feedback about how well they understand the content of the items, phrasing and wording. If students indicated that content, phrasing

or wording was not well understood, they were asked to provide an alternative phrasing or wording which they could understand better. The feedback of the pre-tests was incorporated in the final version of the items. The wording and phrasing of all four items of all items was slightly altered after the feedback process, however, the content remained unchanged.

### Participants and procedures

This study is part of the Covid-19 International Student Well-Being Study (C19 ISWS). C19 ISWS is the result of a study design, study protocol and questionnaire developed by a team of the University of Antwerp, Belgium (van de Velde *et al.*, 2021). Data were collected in 27 countries via an online questionnaire to assess the impact of Covid-19 on the university student population (van de Velde *et al.*, 2021).

The original questionnaire was developed in English. Researchers in the respective countries discussed and translated the questionnaire into the language(s) of their country. For Switzerland, the questionnaire was provided in German, French and the English. In addition to the standardized questionnaire, every country had the opportunity to add questions to the online survey that were then only provided to students in this specific country. For Switzerland, the items about awareness were added at the end of the questionnaire. As none of the other countries added the items about awareness, for this study, we only used data collected at Swiss universities.

The questionnaire was distributed using the online survey-tool Qualtrics. For Switzerland, the survey was open from 28 April 2020 to 27 May 2020. This was approximately when Switzerland started to re-open

**Table 1:** Item definitions of complexity awareness

Item	Response options
1	How would you rate the current scientific knowledge available on Covid-19 to guide political decisions in Switzerland? 1: very strong; 2: rather strong; 3: neutral; 4: rather weak; 5: very weak
2	Please, indicate how much you agree or disagree with the following statement: Overall, the challenges in this Covid-19 crisis are simple and decision-making is fairly straightforward 1: fully agree; 2: rather agree; 3: neutral; 4: rather disagree; 5: fully disagree
3	Please indicate how much you agree or disagree with the following statement: The biggest problem in this pandemic is with the high-risk groups (e.g. 65+; people with chronic health problems)—consequently the behavioral restrictions should only apply to them 1: fully agree; 2: rather agree; 3: neutral; 4: rather disagree; 5: fully disagree
4	Please, indicate how much you agree or disagree with the following statement: Independent of their social class or status, individuals are equally affected by the current pandemic 1: fully agree; 2: rather agree; 3: neutral; 4: rather disagree; 5: fully disagree

after the first Covid-19 lockdown: at the end of April, certain businesses (e.g. gardening shops, hairdresser) were allowed to re-open, and in mid-May, schools and restaurants were re-opened. However, universities were not allowed to re-open until the beginning of June and thus were closed for the entire survey duration.

Participants were recruited at four universities in Switzerland. Recruitment was conducted via email sent out by the university administration to all students enrolled at the respective universities. Participation in the study was voluntary. All data were collected anonymously. Before starting the survey, participants were informed about the study purpose and that they could withdraw from the survey at any point. As the survey contained some sensitive topics (e.g. depression or substance use), participants were also offered the websites and phone numbers of Swiss institutions and organizations offering support on these issues. The Ethics Commission decided that no formal ethics approval was needed for this study.

## Measures

Awareness was assessed using four items that were established based on theoretical foundations as outlined in the participants and procedures.

Several sociodemographic characteristics were assessed in the questionnaire, including gender (male, female and other), level of study (Bachelor, Master and PhD) and affiliation. Due to the low number of cases for the ‘other’ response option in the gender question (~1%) our analysis only included participants who self-identified as male or female. Universities were categorized into the German language region and into the French language region. We distinguished between universities of applied sciences that teach more practically relevant content, and research-oriented universities, teaching more research-oriented content. Parental education was assessed asking for the highest educational degree that was obtained by participants’ parent(s), which was then categorized into low education (both have less than secondary education), middle education (at least one parent with secondary education) and high education (at least one parent with a university degree).

## Statistical analysis

Statistical analysis was conducted in SPSS version 26 (IBM). Significance was set to  $p < 0.05$ . We compared sociodemographic characteristics between study completers and non-completers using chi-squared tests to assess dropout bias. In our analysis, we first explored the distribution of the responses of the single items using frequency analysis. Based on theoretical considerations, we dichotomized the response

options for each item. For item 1, we decided that the extreme response options indicate limited awareness as, although there were some things known about the virus, experts did acknowledge there were significant limitations in the knowledge base. Thus, the middle categories (2–4) indicate that students were aware that some knowledge is available (high awareness; coded 1), whereas the extremes indicate that students either over- or underestimated the evidence at that time (limited awareness; coded 0). For items 2–4, response options 1 and 2 (fully agree/agree) were coded as limited awareness (coded 0, respectively) and the options 3–5 as high awareness (coded 1, respectively). Based on the dichotomized items, a score was created through summing up the single items, resulting in values from 0 to 4. Based on the strongly right-skewed distribution and on theoretical reflections, we categorized scores from 0 to 3 as limited awareness and a score of 4 as high awareness. Lastly, we investigated the relationship between awareness and sociodemographic characteristics (gender and language region), social inequality characteristics (parental education) and academic characteristics (study program and university type) using multivariable logistic regression.

**Table 2:** Sociodemographic characteristics of the study completers ( $N = 3616$ )

	%	N
<i>Gender</i>		
Female	73.7	2634
Male	26.3	941
<i>Parental education</i>		
Low	15.8	543
Middle	17.5	598
High	66.7	2285
<i>Language area</i>		
German	45.2	1614
French	54.8	1954
<i>University type</i>		
Practically oriented	22.8	815
Research-oriented	77.2	2753
<i>Study level</i>		
Bachelor	70.9	2520
Master	26.5	944
PhD	2.6	92

## RESULTS

Overall, 4377 students in Switzerland participated in the survey. Of those, 3616 finished the survey (mean age = 24.20 years, SD = 5.27). Study completers were more likely to be female ( $p = 0.036$ ,  $V=0.03$ ), being from a university in a German-speaking region ( $p < 0.001$ ,  $V = 0.09$ ), and being from a university of applied sciences ( $p < 0.001$ ,  $V = 0.06$ ). No differences regarding the study level or parental education were observed between completers and non-completers ( $p > 0.05$ ). Sociodemographic characteristics of the study completers are presented in [Table 2](#).

### Distribution of awareness in university students: single items

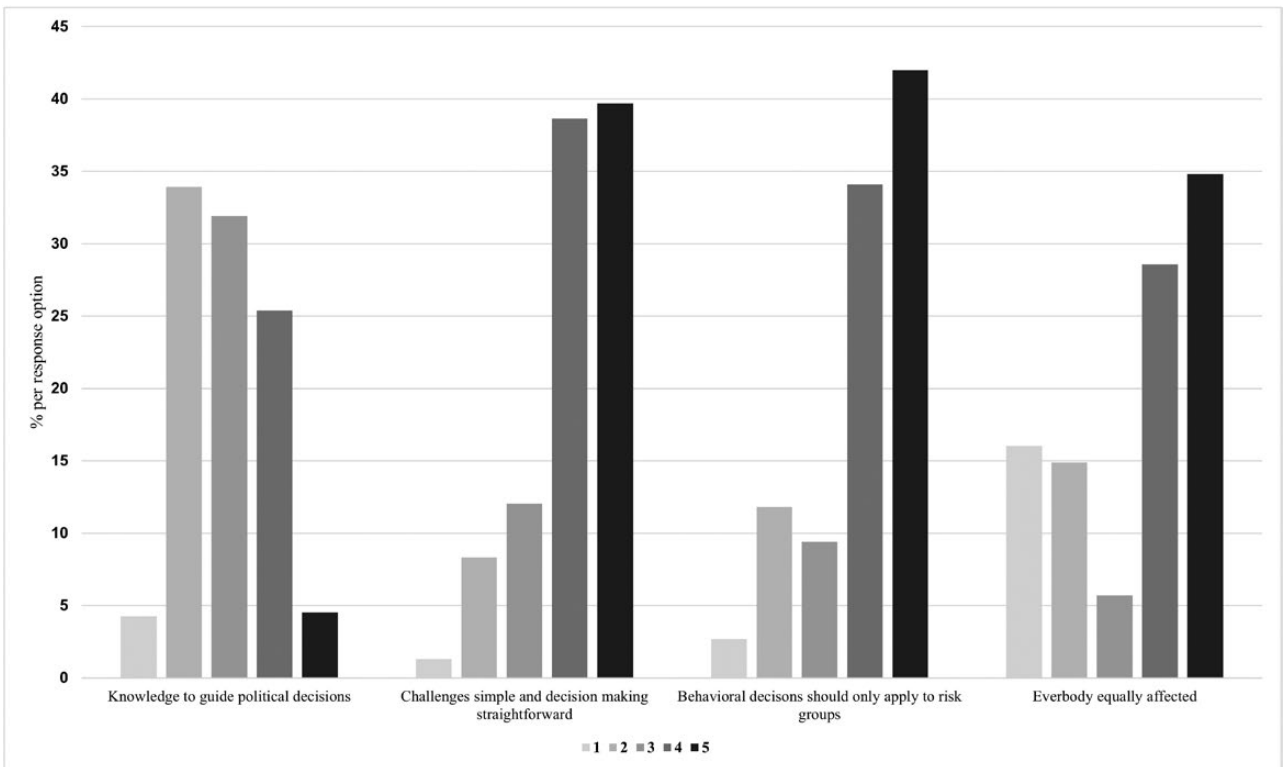
In [Figure 1](#), the distribution of the raw data for the single items is presented. For item 1 (knowledge to guide political decisions), most participants chose options 2 (33.93%, ‘rather strong’) and 3 (31.91%, ‘neutral’). For item 2 (challenges are simple and decision-making is straightforward), most participants chose

options 5 (39.68%, ‘fully disagree’) and 4 (38.66%, ‘rather disagree’). We saw similar patterns with item 3 (behavioral decisions should only apply to the risk groups), with most participants choosing options 5 (41.95%, ‘fully disagree’) and 4 (‘disagree’, 34.13%) and item 4 (everybody is equally affected; option 5: 34.82% (‘fully disagree’); option 4: 28.57%, (‘rather disagree’).

### Awareness score and stratified analysis

As described in the statistics section, the dichotomized items were used to create a score through summing up the single items, with the overall score being again dichotomized: a score from 0 to 3 represented limited awareness, and a score of 4 represented high awareness. Thus, 49.6% of the students were characterized as students with limited awareness and 50.4% as students with high awareness.

In the next step, multivariable logistic regression was conducted to investigate relationships between socio-demographic characteristics and awareness (see [Table 3](#)).



**Fig. 1:** Distribution of the response options of the single awareness items. [Below the figure] Response options item one: Very strong (1) to very weak (5). Response options items two to four: fully agree (1) to fully disagree (5). A more detailed description of the response options is presented in [Table 1](#).

**Table 3:** The association between sociodemographic, social inequality and academic characteristics and awareness estimated by multivariable logistic regression

Predictor	OR	95% CI
<i>Gender</i>		
Male	Ref	
Female	1.26**	[1.07; 1.47]
<i>Parental education</i>		
Low	Ref	
Middle	1.17	[0.92; 1.49]
High	1.29*	[1.06; 1.57]
<i>Study level</i>		
Bachelor	Ref	
Master	1.09	[0.93; 1.27]
PhD	1.38	[0.88; 2.17]
<i>Language region</i>		
German	Ref	
French	1.14	[0.96; 1.36]
<i>University type</i>		
Research-oriented	Ref	
Practically oriented	0.79*	[0.64; 0.97]

\*  $p < 0.05$ ; \*\*  $p < 0.01$ .

The model showed that compared to males, females had 1.26 higher odds of high awareness (95% CI = 1.07–1.47). Having parents with high education was positively associated with the likelihood of high awareness (OR = 1.29; 95% CI = 1.06–1.57). Also, compared to students at a research-oriented university, students at a university of applied sciences had 0.79 lower odds of high awareness (95% CI = 0.64–0.97). No statistically significant relationships were observed with study level or language region.

## DISCUSSION

Uncertainty regarding pandemic-related decisions as well as social inequalities are key challenges during the Covid-19 pandemic. To our best knowledge, we are the first ones to focus on awareness of these issues among university students and its relationship with sociodemographic characteristics.

Overall, our results show that only about half of the students demonstrated high awareness. We consider this as very problematic as our sample consisted of highly educated young people in a rich European country who are regularly confronted with assessing information in the context of their studies. Our results may partially explain why compliance with behavioral measures is rather low (Alsan *et al.*, 2020; Goldstein and Lipsitch, 2020; Lau *et*

*al.*, 2020; Li *et al.*, 2020). If only about half of the highly educated population is aware of key issues of complexity and uncertainty in the Covid-19 context, we might assume that awareness is even lower in populations that do not have a high educational background. This implicates that improving awareness in the general population of young people will empower them to deal with the complex information available, enhancing complexity awareness and thus CHL (Sykes and Wills, 2018).

We also investigated the distribution of awareness based on selected population characteristics. Our findings showed that females were more likely than males to demonstrate high awareness, which is in line with previous results in health literacy research (Lauber *et al.*, 2005; Wagner *et al.*, 2007; Lee *et al.*, 2015). A reason may be that males are more likely to take risks than females in various domains, including health risks and health behaviors (Byrnes *et al.*, 1999; Bayar and Sayil, 2005; Sherman and Lane, 2015). There is also evidence that suggests that this relationship is present when observing decision-making during the Covid-19 pandemic (Leung *et al.*, 2020).

Regarding social inequalities, we observed a considerable social gradient regarding parental education. Students of parents with high education were more likely to demonstrate high awareness than students with parents with low education. This is in line with previous findings showing that social inequality contributes to low-health literacy (Stormacq *et al.*, 2019). A reason for this could be that parents with higher education are more capable of processing complex information than parents with lower education. As parents are usually still involved in their children's lives, even after they enter university (Lewis *et al.*, 2015), discussions and conversations may create higher awareness in university students with highly educated parents. Interestingly, a sub-analysis showed that this gradient was strongly driven by one item which asked students to indicate how much they agree that everybody is equally affected through Covid-19: 37.0% of students with parents with low education either agreed or agreed strongly that everybody is equally affected, compared to 28.8% of students of parents with high education ( $p = 0.001$ ,  $V = 0.06$ ). This might be considered a paradox, given that people with lower education and lower socioeconomic status are more vulnerable to Covid-19 and related consequences due to structural reasons (Baqui *et al.*, 2020; Kim and Bostwick, 2020; Patel *et al.*, 2020). For example, people with lower socioeconomic status are more likely to live in overcrowded housing, limiting personal space and increasing respiratory infection risk, while they are less likely to work in jobs that allow them to work from home (Patel *et al.*, 2020). This paradox may be explained by cognitive dissonance (Festinger, 1957) as,

on the one hand, people with lower socioeconomic status are aware of the dangers of Covid-19, but on the other hand, they have little to no choice but to expose themselves Covid-19 (e.g. because they have to work in a supermarket). One way for them to dissolve the dissonance may be to ignore and suppress the idea that they are more exposed and susceptible to the virus than other people. Another reason could be that people avoid Covid-19 related information to reduce the perceived threat from Covid-19 (Song *et al.*, 2021), which may also result in lower awareness. However, this is mere hypothesizing and should be thoroughly empirically investigated.

Regarding academic characteristics, students at the University of Applied Sciences demonstrated a lower likelihood of high awareness compared to students at research-oriented universities. A reason for this could be that research-oriented universities have a stronger focus on science compared to practically oriented universities. Being exposed and engaging in science may result in skills that promote dealing with complexity and uncertainty, resulting in higher awareness. Additionally, when looking at the study areas of the students, 25% of the students at the University of Applied Sciences reported to study a health discipline, while this was only reported from 18% at the research-oriented universities. This may result in students at the university of applied sciences being more exposed to direct contact due to their study area (e.g. when doing an internship in a hospital), which may be encountered again with cognitive dissonance (Festinger, 1957).

### Strengths and limitations

An innovative strength of this study is, to our best knowledge, the first to develop developed and empirically investigate a measurement tool to assess Covid-19-related awareness of complex issues in university students. This provides first empirical assessment of uncertainty and complexity awareness in a highly relevant group regarding the spread of Covid-19.

The study has its weaknesses. Although the items were well-founded on a theoretical basis, a more comprehensive approach to measure awareness of complex issues might be needed, including more items and the development of psychometrically tested scales. Comparison of study completers and non-completers indicated that there were statistically significant differences, however, effect sizes indicate that those differences are rather small and thus we do not think that they have affected our results in a meaningful way. Finally, we used a selected non-representative sample of young people in higher education. While we assume a good generalizability to a Global North or Western European population of university students, the

generalizability of our results may be limited regarding the general population, that is, people with a less well-educated background and in a different age group in those countries, as well as population in middle- and low-income countries.

### Implications for future research and practice

In this study, we created items that are specific to measuring complexity awareness during a pandemic based on theoretical foundations and expert opinions. A next step could be to investigate those items among the general population of young people to obtain a better picture in this age group. Also, we only had the opportunity to investigate the general distribution of awareness among our sample, however, future research might also investigate if Covid-19 complexity awareness correlates with trust in political or public health institutions and ultimately with adopting behavioral recommendations such as physical distancing or wearing face masks. Our findings indicated considerable differences in awareness between the sub-populations and the underlying mechanisms should be investigated in the future.

From a practice perspective, we suggest that awareness should be targeted and enhanced among university students. Universities might serve as key institutions in enhancing awareness among their students, for example, through discussions. Discussing this topic in a class with a group of peers and a lecturer may result in a process enhancing complexity and uncertainty awareness with regards to pandemic-related decisions and social inequality, which may improve university students' understanding and dealing with complexity. Beyond class discussions, universities may develop communication strategies that target building awareness and understanding the pandemic's complexity. Another way could be to enhance public health's social media presence and applying communication strategies to convey appropriate information through qualified public health experts (Chesser *et al.*, 2020). Considering the high importance of this group for spreading the virus (Alsan *et al.*, 2020; Goldstein and Lipsitch, 2020; Lau *et al.*, 2020; Li *et al.*, 2020; Nivette *et al.*, 2021), research aiming to understand and improve awareness in university students is especially pertinent. Ultimately, this may result in higher compliance with behavioral measures and less infections among and through young people.

### Acknowledgement

This study is part of the COVID-19 International Student Well-Being Study (C19 ISWS). C19 ISWS is the result of a study design, study protocol and questionnaire developed by a team of the University of Antwerp, Belgium (van de Velde *et al.*, 2021).



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## Ethics approval

The Ethics Commission of the Canton of Bern decided that no formal ethics approval was needed for this study (Basec-No.: Req-2020-0455).

## Data deposition

The data that support the findings are available on zenodo (<https://zenodo.org/communities/c19-isws/>).

## REFERENCES

- Abel, T. and McQueen, D. (2020) Critical health literacy in pandemics: the special case of COVID-19. *Health Promotion International*, **36**, 1473–1481.
- Alsan, M., Stantcheva, S., Yang, D. and Cutler, D. (2020) Disparities in coronavirus 2019 reported incidence, knowledge, and behavior among US adults. *JAMA Network Open*, **3**, e2012403.
- Asfaw, E. K., Guo, E. S., Jang, S. S., Komarivelli, S. R., Lewis, K. A., Sandler, C. B. *et al.* (2020) Students' perspectives: how will COVID-19 shape the social determinants of health and our future as public health practitioners? *Health Education and Behavior*, **47**, 850–854.
- Baqui, P., Bica, I., Marra, V., Ercole, A. and van der Schaar, M. (2020) Ethnic and regional variations in hospital mortality from COVID-19 in Brazil: a cross-sectional observational study. *The Lancet Global Health*, **8**, e1018–e1026.
- Bayar, N. and Sayil, M. (2005) Brief report: risk-taking behaviors in a non-western urban adolescent sample. *Journal of Adolescence*, **28**, 671–676.
- Byrnes, J. P., Miller, D. C. and Schafer, W. D. (1999) Gender differences in risk taking: a meta-analysis. *Psychological Bulletin*, **125**, 367.
- Chesser, A., Drassen Ham, A. and Keene Woods, N. (2020) Assessment of COVID-19 knowledge among university students: implications for future risk communication strategies. *Health Education and Behavior*, **47**, 540–543.
- Chinn, D. (2011) Critical health literacy: a review and critical analysis. *Social Science and Medicine*, **73**, 60–67.
- Doyle, C. S. (1992) *Outcome Measures for Information Literacy within the National Education Goals of 1990*. Final Report to National Forum on Information Literacy. Summary of Findings, Washington D. C., USA.
- Festinger, L. (1957) *A Theory of Cognitive Dissonance*. Stanford University Press, Stanford, CA.
- Figliozzi, S., Masci, P. G., Ahmadi, N., Tondi, L., Koutli, E., Aimo, A. *et al.* (2020) Predictors of adverse prognosis in COVID-19: a systematic review and meta-analysis. *European Journal of Clinical Investigation*, **50**, e13362.
- Freedman, D. A., Bess, K. D., Tucker, H. A., Boyd, D. L., Tuchman, A. M. and Wallston, K. A. (2009) Public health literacy defined. *American Journal of Preventive Medicine*, **36**, 446–451.
- Freire, P. (2005) *Pedagogy of the Oppressed*. Continuum, New York, NY.
- Frisch, A. L., Camerini, L., Diviani, N. and Schulz, P. J. (2012) Defining and measuring health literacy: how can we profit from other literacy domains? *Health Promotion International*, **27**, 117–126.
- Gauthier, G. R., Smith, J. A., García, C., Garcia, M. A. and Thomas, P. A. (2020) Exacerbating inequalities: social networks, racial/ethnic disparities, and the COVID-19 pandemic in the United States. *The Journals of Gerontology: Series B*, **76**, e88–e92.
- Goldstein, E. and Lipsitch, M. (2020) Temporal rise in the proportion of younger adults and older adolescents among coronavirus disease (COVID-19) cases following the introduction of physical distancing measures, Germany. *Eurosurveillance*, **25**. <https://doi.org/10.2807/1560-7917.es.2020.25.17.2000596>
- Gubrium, A. and Gubrium, E. (2021) Narrative complexity in the time of COVID-19. *The Lancet*, **397**, 2244–2245.
- Huang, Y. and Zhao, N. (2020) Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: a web-based cross-sectional survey. *Psychiatry Research*, **280**, 112954.
- Jemal, A. (2017) Critical consciousness: a critique and critical analysis of the literature. *The Urban Review*, **49**, 602–626.
- Kim, S. J. and Bostwick, W. (2020) Social vulnerability and racial inequality in COVID-19 deaths in Chicago. *Health Education and Behavior*, **47**, 509–513.
- Lau, M. S., Grenfell, B., Nelson, K. and Lopman, B. (2020) Characterizing super-spreading events and age-specific infectivity of COVID-19 transmission in Georgia, USA. *Proceedings of the National Academy of Sciences of the United States of America*, **117**, 22430–22435.
- Lauber, C., Ajdacic-Gross, V., Fritschi, N., Stulz, N. and Rössler, W. (2005) Mental health literacy in an educational elite – an online survey among university students. *BMC Public Health*, **5**.
- Lederer, A. M., Hoban, M. T., Lipson, S. K., Zhou, S. and Eisenberg, D. (2021) More than inconvenienced: the unique needs of U.S. college students during the COVID-19 pandemic. *Health Education and Behavior*, **48**, 14–19.
- Lee, H. Y., Lee, J. and Kim, N. K. (2015) Gender differences in health literacy among Korean adults. *American Journal of Men's Health*, **9**, 370–379.
- Leung, T. Y., Sharma, P., Adithipyangkul, P. and Hosie, P. (2020) Gender equity and public health outcomes: the COVID-19 experience. *Journal of Business Research*, **116**, 193–198.
- Lewis, J., West, A., Roberts, J. and Noden, P. (2015) Parents' involvement and university students' independence. *Families, Relationships and Societies*, **4**, 417–432.
- Li, S., Feng, B., Liao, W. and Pan, W. (2020) Internet use, risk awareness, and demographic characteristics associated with engagement in preventive behaviors and testing: cross-sectional survey on COVID-19 in the United States. *Journal of Medical Internet Research*, **22**, e19782.
- Lin, Y. -H., Liu, C. -H. and Chiu, Y. -C. (2020) Google searches for the keywords of “wash hands” predict the speed of national spread of COVID-19 outbreak among 21 countries. *Brain, Behavior, and Immunity*, **87**, 30–32.
- López, L. and Rodó, X. (2020) The end of social confinement and COVID-19 re-emergence risk. *Nature Human Behaviour*, **4**, 746–755.

- Mohammadi, N. K. (2021) Diffusion of complexity science into health promotion research and practice: foundations for a complex future. *Health Promotion International*, **36**, 1213–1218.
- Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C. *et al.* (2020) The socio-economic implications of the coronavirus pandemic (COVID-19): a review. *International Journal of Surgery*, **78**, 185–193.
- Nivette, A., Ribeaud, D., Murray, A., Steinhoff, A., Bechtiger, L., Hepp, U. *et al.* (2021) Non-compliance with COVID-19-related public health measures among young adults in Switzerland: insights from a longitudinal cohort study. *Social Science and Medicine*, **268**, 113370.
- Nutbeam, D. (2000) Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International*, **15**, 259–267.
- OECD (2020) *OECD Employment Outlook 2020: Worker Security and the COVID-19 Crisis*. OECD Publishing, Paris.
- Paakkari, L. and Okan, O. (2020) COVID-19: health literacy is an underestimated problem. *The Lancet Public Health*, **5**, e249–e250.
- Patel, J. A., Nielsen, F. B. H., Badiani, A. A., Assi, S., Unadkat, V. A., Patel, B. *et al.* (2020) Poverty, inequality and COVID-19: the forgotten vulnerable. *Public Health*, **183**, 110–111.
- Riiser, K., Helseth, S., Haraldstad, K., Torbjørnsen, A. and Richardsen, K. R. (2020) Adolescents' health literacy, health protective measures, and health-related quality of life during the Covid-19 pandemic. *PLoS One*, **15**, e0238161.
- Sahu, P. (2020) Closure of universities due to coronavirus disease 2019 (COVID-19): impact on education and mental health of students and academic staff. *Cureus*, **12**, e7541.
- Schmidt, S. C. E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C. *et al.* (2020) Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. *Scientific Reports*, **10**, 21780.
- Sentell, T., Vamos, S. and Okan, O. (2020) Interdisciplinary perspectives on health literacy research around the world: more important than ever in a time of COVID-19. *International Journal of Environmental Research and Public Health*, **17**, 3010.
- Sherman, S. M. and Lane, E. L. (2015) Awareness of risk factors for breast, lung and cervical cancer in a UK student population. *Journal of Cancer Education*, **30**, 660–663.
- Song, S., Yao, X. and Wen, N. (2021) What motivates Chinese consumers to avoid information about the COVID-19 pandemic?: the perspective of the stimulus-organism-response model. *Information Processing & Management*, **58**, 102407.
- Stormacq, C., Van Den Broucke, S. and Wosinski, J. (2019) Does health literacy mediate the relationship between socioeconomic status and health disparities? Integrative review. *Health Promotion International*, **34**, e1–e17.
- Sykes, S. and Wills, J. (2018) Challenges and opportunities in building critical health literacy. *Global Health Promotion*, **25**, 48–56.
- Sykes, S., Wills, J., Rowlands, G. and Popple, K. (2013) Understanding critical health literacy: a concept analysis. *BMC Public Health*, **13**, 150.
- Tavares, F. F. and Betti, G. (2021) The pandemic of poverty, vulnerability, and COVID-19: evidence from a fuzzy multidimensional analysis of deprivations in Brazil. *World Development*, **139**, 105307.
- van de Velde, S., Buffel, V., Bracke, P., van Hal, G., Somogyi, N. M., Willems, B. *et al.* (2021) The COVID-19 international student well-being study. *Scandinavian Journal of Public Health*, **49**, 114–122.
- von Heimburg, D. and Cluley, V. (2021) Advancing complexity-informed health promotion: a scoping review to link health promotion and co-creation. *Health Promotion International*, **36**, 581–600.
- Wagner, C. V., Knight, K., Steptoe, A. and Wardle, J. (2007) Functional health literacy and health-promoting behaviour in a national sample of British adults. *Journal of Epidemiology and Community Health*, **61**, 1086–1090.
- WHO (2020) Managing the COVID-19 infodemic: promoting healthy behaviours and mitigating the harm from misinformation and disinformation. <https://bit.ly/36ouowk> (last accessed 30 September 2020).
- Wunsch, K., Nigg, C., Niessner, C., Schmid, S. C. E., Oriwol, D., Hanssen-Doose, A. *et al.* (2021) The impact of COVID-19 on the interrelation of physical activity, screen time and health-related quality of life in children and adolescents in Germany: results of the Motorik-Modul Study. *Children*, **8**, 98.
- Xiong, J., Lipsitz, O., Nasri, F., Lui, L. M. W., Gill, H., Phan, L. *et al.* (2020) Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *Journal of Affective Disorders*, **277**, 55–64.
- Zaller, J. R. (1992) *The Nature and Origins of Mass Opinion*. Cambridge University Press, Cambridge.
- Zarcadoolas, C., Pleasant, A. and Greer, D. S. (2005) Understanding health literacy: an expanded model. *Health Promotion International*, **20**, 195–203.
- Zarcadoolas, C., Pleasant, A. and Greer, D. S. (2006) *Advancing Health Literacy: A Framework for Understanding and Action*. John Wiley & Sons, San Francisco.
- Zarocostas, J. (2020) How to fight an infodemic. *The Lancet*, **395**, 676.