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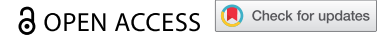
Determinants of vaccination behavior among university students 20 months after the COVID-19 outbreak: Results of the COVID-19 German Student Well-being Study (C19 GSWS)

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ABSTRACT

Evidence indicates a higher COVID-19 vaccine hesitancy among university students due to their age and a lower risk of COVID-19 related complications compared to the general population in Germany. However, little is known about the other determinants of COVID-19 vaccination behavior for the population of German university students. This study aimed to investigate determinants of vaccination behavior in this population. The cross-sectional COVID-19 German Student Well-being Study was conducted at five German universities from October 27th to November 14th, 2021, via an online survey (n=7,267). Multiple logistic regressions were calculated to examine associations of psychological antecedents of vaccination (5Cs: confidence, complacency, constraints, calculation, collective responsibility), Critical Health Literacy in a Pandemic (CHL-P), and additional determinants (previous infection, trust in the health care system, feeling informed about the COVID-19 vaccine) and vaccination status (not vaccinated vs. fully vaccinated). All 5Cs were associated with reporting to be vaccinated, except for complacency. Regarding the CHL-P, students who felt that the current scientific knowledge about COVID-19 in terms of the policy decisions on pandemic measures was very complex had higher odds for reporting being vaccinated (OR=3.02; 95% CI: 2.26-4.04). Students who felt well informed about the COVID-19 vaccines were also more likely to report being fully vaccinated (OR=2.20; 95% CI: 1.51-3.21). Due to our finding that the 5Cs are associated with vaccination status among university students, we recommend that the different components of the 5Cs should be considered in future vaccination campaigns implemented in the university context.

Introduction

Results of mathematical models suggest that a substantial proportion of the population is vulnerable to severe courses of COVID-19, especially in countries with a low proportion of the population vaccinated.[1] In Germany, approximately 22% of the population had not been vaccinated at least once by June 21st, 2022, and 38% had not received the third vaccination (booster vaccination).[2] The vaccine against COVID-19 remains key for reducing mortality, avoiding severe courses of the disease, and decreasing the overall burden on the healthcare system.[3,4] Furthermore, due to the higher transmissibility of the BA.1 and BA.2 variants compared to the delta variant, the number of infections will increase significantly and in order not to over-burden the healthcare system, a high vaccination rate continues to be important.[4] Therefore, a high proportion of population immunity should continue to be the overall aim of the German vaccination strategy for containing the ongoing pandemic.[4]

The reasons why people get vaccinated or, conversely, display vaccine hesitancy differ from individual to individual.[5] Trust in the safety or effectiveness of the COVID-19 vaccine, health literacy, disease risk perception or the willingness to protect others are determinants which may influence the decision to get vaccinated.[5] Also, unavailability of the vaccine or limited access to the healthcare system (e.g. vaccination centers cannot be easily reached) may affect vaccination behavior.[5]

In Germany, the "COVID-19 Vaccination Rate Monitoring in Germany" (COVIMO) and the "COVID-19 Snapshot Monitoring" (COSMO) studies investigated determinants of COVID-19 vaccination behavior.[6,7] The aim of the COVIMO study was to investigate vaccination willingness and acceptance and to identify barriers to vaccination across different age groups.[7] In the COSMO study, on the other hand, vaccination readiness and factors influencing vaccination behavior were quantified for the German population.[6] While there is

increasing evidence regarding determinants of vaccination status and behavior in the general German population based on these studies, little is known about these determinants in the population of university students in Germany.

Higher education students represent a unique population, because they are mostly young, healthy, and highly educated. Also, due to their generally good health status, they are at a lower risk for a severe course of the disease after infection compared to the general population.[8] However, due to their frequently shared living situation or social interactions at the university campus, German students may be at a higher risk of getting infected. This was recently demonstrated by a study among Swiss university students.[9] In addition, new evidence among Swiss university students indicates that vaccine hesitancy is higher among university students compared to the general population.[9] Another study which was conducted from November 15th to December 10th 2021, revealed an incidence of COVID-19 infections of 3,4% among medical students in Poland.[10] Unfortunately, comparable data from Germany do not exist. However, it is likely that the population of German university students also has concerns and expectations which differ from the general population and which may influence vaccination behavior.[9] However, to date, despite the need to be particularly targeted in the German vaccination campaign, this population is under-investigated.[9] To date, there are no comprehensive data available on determinants of vaccination behavior for the entire German population of university students. To increase the general vaccination rate in this population, it is necessary to better understand these determinants and related concerns and expectations of individuals and their peer groups regarding the COVID-19 vaccination.[5] The aim of this study is to investigate determinants of vaccination behavior among German university students.

Materials and methods

Survey and recruitment

The COVID-19 German Student Well-being Study (C19 GSWS) is based on the cross-sectional COVID-19 International Student Well-being Study (C19 ISWS) which was conducted internationally.[11] The aim of the C19 ISWS was to examine how the COVID-19 pandemic affected the health of university students in Europe.[11] The C19 ISWS was initiated and coordinated by researchers of the University of Antwerp and Ghent University and was conducted in 26 countries in 110 higher-education institutions, including five German universities.[11] A standardized questionnaire was developed in cooperation with the other participating universities.[11] For this initial survey, the survey questionnaire that had been developed by the consortium leaders (Antwerp) and refined in the international consortium was subsequently translated independently by two researchers from the German team and implemented in Spring 2020.

In the subsequent C19 GSWS project, the questionnaire of the C19 ISWS was used again and adapted by a team of German researchers. The questionnaire was piloted with German university students and adapted based on their suggestions to improve comprehensibility. It is composed of various validated scales, such as the CES-D 8, the PHQ-2 or the 5-C scale which is used in this investigation. The web-based survey was conducted from October 27th to November 14th, 2021, via Limesurvey. In total, five universities in Germany participated in the survey: Heinrich-Heine-University Duesseldorf, Charité - Universitätsmedizin Berlin, Martin-Luther-University Halle-Wittenberg, University of Bremen and University of Siegen. The students were invited to the study in different ways. At the Martin Luther University-Halle-Wittenberg, University of Siegen, and University of Bremen, students were invited via e-mail, as well as via e-learning platforms. At the Heinrich-Heine-University Duesseldorf, the invitations were distributed via social media (Instagram). Medical students in Duesseldorf were additionally contacted by e-mail and invited to the study. Students had the option to complete the survey in German or English. All participants gave their informed consent before participating in the survey. The ethics committees of the five universities granted ethical approval for the study (University of Bremen 2021-28-EIL, University Halle-Wittenberg 2020–066, Heinrich-Heine-University 2020-958_1).

Study sample and context of the C19 GSWS

Data from 7,267 students were used for the analysis after data cleaning. Of all participants, 29.8% were enrolled at the Martin-Luther-University Halle-Wittenberg, 25.0% at the University of Bremen, 21.5% at the University of Siegen, 15.6% at the Charité – Universitätsmedizin Berlin, and 7.2% at the Heinrich-Heine-University Duesseldorf.

The C19 GSWS was conducted during a time of increasing incidence rates. The 7-day-incidence (new cases/100,000 citizens) of the total population in Germany increased from October 27th to November 15th 2021, by approximately 258%.[12,13] At the time of the study, the COVID-19 vaccines were available free of charge and there was a choice of vaccines from different companies. During the survey period, on November 5th, 2021, new restrictions for the German population were passed by the German Ministry of Health. These restrictions included the introduction of the '3-G-rules' (vaccinated, recovered or tested) for indoor events and a stricter control of the '3-G-rules.'[14,15] Despite the rapid increase in infection, schools, sports facilities or shopping centers in Germany were not closed and could still be visited. During the survey, universities were aiming for face-to-face lectures during the winter semester 2021/2022. However, most universities conducted their lectures online and a normal university routine was not offered.[16]

Measures and determinants

In addition to the sociodemographic characteristics of students (gender, age, migration background, parental level of education), living conditions (financial situation, housing situation) and health risk behavior (substance use, physical activity) were assessed. In the following sections, variables used for this investigation are described in detail.

Vaccination status

The vaccination status was assessed with the following question: "What is your current vaccination status?." Possible response options were "fully vaccinated," "partly vaccinated," "not vaccinated" and "no answer." We considered students as "fully vaccinated," if they were a) partly vaccinated or b) fully vaccinated against the SARS-CoV-2-Virus. This classification of vaccination status is similar to the COVIMO study of the Robert Koch Institute (RKI).[7] Moreover, the COVIMO study pointed out that 99.4% of the participants in the general population who were partly vaccinated also preferred to get fully vaccinated.[7] Therefore, we assumed that students who had been vaccinated for the first time would also opt for the second vaccination.

Students were considered as "not vaccinated," if they had not received a vaccine against the SARS-CoV-2-Virus approved by the European Medicines Agency (EMA). The response option "no answer" was not considered in our analysis, because a logical allocation of this response option was not possible. The booster vaccination was not considered, as the recommendation for the booster vaccination for citizens above the age of 18 years was only given by the Robert-Koch-Institute after the survey had been completed.[17]

Psychological antecedents of vaccination

Psychological antecedents of vaccination were assessed with the 5Cs-scale, including items on confidence (confidence in the effectiveness and safety of vaccination), complacency (risk perception of disease and vaccination), constraints (present barriers to vaccination), calculation (evaluation of the benefits and risks of vaccinations), and the collective responsibility (social motivation to contribute to reducing disease transmission through vaccination) (also see Table 1).[18] The C19 GSWS

questionnaire used a Likert scale with seven response options ("1 - strongly agree" to "7 - strongly disagree").[18] The 5Cs scale is a validated measure for assessing vaccination behavior.[18] In order to increase external validity, we based the coding of the 5Cs items on the COSMO study, which recorded each of the five items into three categories.[6] In Table 1 the psychological antecedents are listed.

Critical health literacy in a pandemic

The construct of critical health literacy in a pandemic (CHL-P) was of interest to our research, because the two main aspects of CHL-P, complexity perception of a pandemic and uncertainty of an individual caused by the not well-understood new disease, may influence vaccination behavior.[19] The items of the CHL-P were developed by Abel and Benkert[20] in the context of the COVID-19 pandemic. The developed items were pre-tested among university students in the languages German, French, and English.[20] For each item, a Likert scale with five response options was used (fully agree to fully disagree). These categories were dichotomized for each item on the basis of the theoretical concept by Abel and Benkert.[20] In Table 2, the items of the critical health literacy in a pandemic scale are described in detail.

Further determinants and covariates

We identified further determinants for vaccination behavior through a literature search in PubMed. We were able to identify four relevant determinants from the current literature which were also assessed in the C19 GSWS-questionnaire. The first determinant is already having had an infection (negative, positive, suspected infection) or not.[21] Determinants two and three are related to trust in the health care system (i.e., concerns that the medical staff and hospitals are not being

Table 1. Description of the 'psychological antecedents of vaccination' (5cs)-Scale.

Description of the items	Categories
Confidence: "I am completely confident that the COVID-19 vaccines are safe."	Complete confidence in the safety (1), medium confidence in the safety (2–4) and no confidence in the safety (5–7)
Complacency: "Vaccination against COVID-19 is unnecessary because vaccine-preventable diseases are not common anymore."	Vaccination is very necessary (1), vaccination is rather necessary (2–4), vaccination is not necessary (5–7).
Constraints: "Everyday stress prevents me from getting vaccinated against COVID-19."	Everyday stress does not prevent vaccination (1), everyday stress rather prevents vaccination (2–4), everyday stress prevents vaccination (5–7).
Calculation: "When I think about getting vaccinated against COVID-19, I weigh benefits and risks to make the best decision possible."	Weighting benefits and risks is not relevant (1), weighting benefits and risks is rather not relevant (2–4), weighting benefits and risks is relevant (5–7).
Collective responsibility: "When everyone is vaccinated against COVID-19, I don't have to get vaccinated, too."	If everyone vaccinated, vaccination for me still necessary (1), if everyone vaccinated, vaccination for me is rather necessary (2–4), if all vaccinated, no vaccination is necessary for me (5–7).

Table 2. Description of the 'critical health literacy in a pandemic'-scale.

Description of the items	Categories
"How would you rate the current scientific knowledge on COVID-19 available to guide political decisions in Germany."	Low complexity perception (1,5), high complexity perception (2–4).
"Overall, the challenges in this COVID-19 crisis are simple and decision-making is fairly straight-forward."	Low complexity perception (1,2), high complexity perception (3–5).
"How important is it for you to understand the different interests and motivations among the key players in this crisis (e.g., the government, political parties, employer organizations, unions, health authorities, etc.)?"	Low importance (1,2), high importance (3–5).
"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 apply only to them."	Low understanding of the need for preventive restrictions (1,2), high understanding of the need for preventive restrictions (3–5).
"Independent of their social class or status, individuals are equally affected by the current pandemic."	Low awareness of social class differences in the pandemic (1–2), high awareness of social class differences in the pandemic (3–5).

adequately equipped with medical supplies to deal with the COVID-19 outbreak [metric], confidence that the necessary medical help can be provided in case of a severe COVID-19 infection by doctors and hospitals [not confident, confident]).[22] The fourth determinant is to feel informed about the COVID-19 vaccine (poorly informed, moderately informed, very well informed).[21,22]

Data analysis

To describe the characteristics of the study population, we performed a descriptive analysis. To analyze which determinants were associated with vaccination status, we cross-tabulated the 5Cs, CHL-P, the four determinants identified in the literature search, and the covariates with vaccination status. The results are presented in absolute (n) and relative (%) frequencies.

Subsequently, two multiple binary logistic regressions were performed. The first model includes vaccination status as the dependent variable and the 5Cs, as well as the four determinants found in the literature, as independent variables. The second model includes vaccination status as dependent variable and the CHL-P and the four determinants found in the literature as the independent variables. For all statistical analyses, we included the following demographic categories in all models: age (18–23, 24–29, 30 years and older), gender (male, female, diverse), migration background (yes, no), parents' level of education (at least one parent with academic degree, no parent with academic degree), and present chronic diseases (yes, no).

Results

Student characteristics stratified by vaccination status

Of the 7,267 survey participants, almost 91% of all students reported their vaccination status. About 94% were vaccinated and about 6% reported that they did not get any vaccine against COVID-19. The sample characteristics are displayed in Table 3. There were only small differences in the distribution of gender between vaccinated and unvaccinated students. Students who were vaccinated were on average younger (24.0 years; SD 4.8) in comparison to unvaccinated students (24.7 years; SD 5.2). About 21% of the vaccinated students and 32% of the students who reported to be vaccinated, had a migration background.

Regarding the 5Cs, about 31% of the vaccinated students and about 2% of the unvaccinated students had complete confidence in the safety of the vaccination. About 81% of the vaccinated students and 55% of the unvaccinated students agreed to the statement that everyday stress did not prevent them from getting vaccinated. Sixty percent of the vaccinated students and almost all of the unvaccinated students (92%) indicated weighting benefits and risks of the vaccination, before getting vaccinated. Seventy-seven percent of the vaccinated and 18% of the unvaccinated students agreed with the statement that they were also going to get vaccinated if everybody had got vaccinated.

The distribution of the first item of the CHL-P suggests that 85% of the vaccinated and 63% of the unvaccinated students displayed a high complexity perception regarding the scientific knowledge for guiding political decisions. Regarding the item, that behavioral restrictions should only apply to risk groups (+65 years), 24% of the students who reported to be vaccinated had a good understanding of the need for preventive restrictions. In contrast, 56% of the students who reported not to be vaccinated had also a good understanding of the need for preventive restrictions.

Seven percent of the students who reported to be vaccinated and 16% of the students who reported not to be vaccinated had been previously infected with COVID-19. Regarding worries about doctors and hospitals not having adequate medical supplies to handle the COVID-19 outbreak, students who reported to be vaccinated felt more worried (5.1 points, SD 3.1) compared to students who reported not to be vaccinated (3.3 points, SD 3.3). Eighty-three percent of the vaccinated students and 46% of the non-vaccinated students felt very well informed about the vaccination.

Association between the 5Cs and other determinants and vaccination status as the dependent variable

The results of the first regression model are shown in Table 4. Students who had complete confidence in the safety of the COVID-19 vaccination had a 50.60-fold odds to report to be fully vaccinated compared to students who had no confidence (95% CI: 15.45–165.68). Compared to students whose everyday stress discouraged them from getting vaccinated, students whose everyday stress did not discourage them from getting vaccinated had a higher odds to be fully vaccinated (OR = 2.95; 95% CI: 1.80–4.81). Students who did not report weighing risks and benefits of a COVID-19 vaccination displayed a higher odds to be fully vaccinated in comparison to students who reported weighing risks and benefits (OR = 4.76; 95% CI: 1.14–19.92). Students who indicated that they needed a vaccination despite everyone around them already being vaccinated, had 4.71-fold odds to report to be fully vaccinated in comparison to students who stated that they did not feel they needed to get vaccinated if everyone else was already vaccinated (95% CI: 2.79–7.95).

In comparison to students who reported no previous infection with COVID-19, students who reported a previous infection, had a lower odds for being vaccinated (OR = 0.52; 95% CI: 0.34–0.80). Regarding the worries (0–10 points) that doctors and hospitals would not have adequate medical supplies to handle the COVID-19 outbreak, students had a 1.12-fold odds of being vaccinated for each increase in score-point (95% CI: 1.06–1.17). Students who felt confident that they would receive adequate medical care had higher odds for being fully vaccinated, compared to their unvaccinated counterparts (OR = 1.82; 95% CI: 1.23–2.69). Students who felt very well informed about the COVID-19 vaccination had a higher odds for reporting a full vaccination status (OR = 2.20; 95% CI: 1.51–3.21).

Students above the age category of 18–23 years had a lower odds to be fully vaccinated (category "24–29 years;" OR = 0.71; 95% CI: 0.52–0.97). Furthermore, female students generally

Table 3. Student characteristics (n = 6,580) stratified by vaccination status.

	Not vaccinated (n = 411)	Fully vaccinated (n = 6,169)
Socio-demographic information		
Age		
18–23 years	204 (50.0%)	3,497 (56.8%)
24–29 years	149 (36.4%)	1,982 (32.2%)
+30 years	56 (13.7%)	674 (11.0%)
Mean (SD)	24.7 (5.2)	24.0 (4.8)
Gender		
Male	131 (32.2%)	1,893 (31.1%)
Female	275 (67.6%)	4,121 (67.7%)
Diverse	1 (0.3%)	72 (1.2%)
Migration background		
No migration background	272 (68.0%)	4,820 (78.6%)
Migration background	128 (32.0%)	1,311 (21.4%)
Academic status of parents		
Both parents without academic degree	103 (28.3%)	1,463 (25.1%)
At least one parent with academic degree	261 (71.7%)	4,370 (74.9%)
Present chronic disease		
No present chronic disease	310 (82.2%)	4,889 (85.5%)
Present chronic disease	67 (17.8%)	828 (14.5%)
5C-Items		
Confidence in the safety of the COVID-19 vaccine		
No confidence in safety	281 (68.5%)	541 (8.8%)
Medium confidence in safety	123 (30.0%)	3,689 (59.9%)
Complete confidence in safety	6 (1.5%)	1,925 (31.3%)
Vaccination not necessary because COVID-19 is not common anymore		
Vaccination is not necessary	37 (9.1%)	66 (1.1%)
Vaccination is rather necessary	263 (64.5%)	1,414 (23.0%)
Vaccination is very necessary	108 (26.5%)	4,667 (75.9%)
Everyday stress prevents me from getting vaccinated		
Everyday stress prevents from vaccination	52 (12.8%)	146 (2.4%)
Everyday stress prevents rather not from vaccination	123 (32.6%)	1,015 (16.6%)
Everyday stress does not prevent from vaccination	223 (54.7%)	4,960 (81.0%)
Weight benefits and risks to make decision to get vaccinated		
Weighting benefits and risks is relevant	379 (92.4%)	3,673 (59.9%)
Weighting benefits and risks is rather not relevant	26 (6.3%)	1,941 (31.7%)
Weighting benefits and risks is not relevant	5 (1.2%)	514 (8.4%)
If all are vaccinated, I do not need vaccination		
If all vaccinated, no vaccination is necessary for myself	86 (21.3%)	131 (2.1%)
If all vaccinated, vaccination is rather necessary for myself	245 (60.6%)	1,269 (20.7%)
If all vaccinated, vaccination is still necessary for myself	73 (18.1%)	4,733 (77.2%)
CHL-P-Items		
Rate the current scientific knowledge on COVID-19 available to guide political decisions		
Low complexity perception	151 (37.1%)	933 (15.3%)
High complexity perception	256 (62.9%)	5,173 (84.7%)
Challenges in this crisis are simple and decision-making is fairly straight-forward		
Low complexity perception	57 (14.0%)	781 (12.8%)
High complexity perception	349 (86.0%)	5,316 (87.2%)
Importance to understand the different interests and motivations among the key players in this crisis		
Low importance	27 (6.7%)	317 (5.2%)
High importance	376 (93.3%)	5,765 (94.8%)
Greatest problems are the high risk groups (+65 years) - behavioral restrictions should only apply to the high risk groups		
Little understanding of the need for preventive restrictions	180 (44.3%)	4,648 (76.3%)
High understanding of the need for preventive restrictions	226 (55.7%)	1,448 (23.8%)
All individuals are equally affected by pandemic, regardless of their social status or class		
Low awareness of social class differences in the pandemic	207 (51.0%)	2,733 (44.7%)
High awareness of social class differences in the pandemic	199 (49.0%)	3,384 (55.3%)
Literature-based determinants		
COVID 19-diagnosis		
Negative	284 (69.8%)	5,420 (88.3%)
Positive (confirmed)	65 (16.0%)	409 (6.7%)
Suspected infection (not confirmed)	58 (14.2%)	312 (5.1%)
Confidence receiving necessary medical care in case of a severe course of infection		
Not confident receiving medical care	91 (23.0%)	539 (8.8%)
Confident receiving medical care	304 (77.0%)	5,603 (91.2%)
Worries that doctors and hospitals will not have adequate medical supplies to handle the COVID-19 outbreak		
Mean (SD)	3.6 (3.3)	5.1 (3.1)
Sufficient information about the COVID-19 vaccine		
Poorly informed	120 (29.3%)	239 (3.9%)
Moderately informed	102 (24.9%)	804 (13.0%)
Very well informed	188 (45.9%)	5,114 (83.1%)

Results: Student characteristics stratified by vaccination status

Table 4. Results of the multiple logistic regression to quantify the association between the 5cs and four additional literature-based determinants and vaccination status as the dependent variable.

	OR	95% CI
Confidence in the safety of the COVID-19 vaccine		
No confidence in the safety (ref.)	-	-
Medium confidence in the safety	5.76*	4.22–7.86
Complete confidence in the safety	50.60*	15.45–165.68
Vaccination not necessary because COVID-19 is not common anymore		
Vaccination is not necessary (ref.)	-	-
Vaccination is rather necessary	0.86	0.43–1.73
Vaccination is very necessary	1.25	0.59–2.63
Everyday stress prevents me from getting vaccinated		
Everyday stress prevents from vaccination (ref.)	-	-
Everyday stress prevents rather not from vaccination	2.82*	1.69–4.71
Everyday stress does not prevent from vaccination	2.95*	1.80–4.81
Weighing the benefits and risks of vaccination		
Weighting benefits and risks is relevant (ref.)	-	-
Weighting benefits and risks is rather not relevant	5.19*	3.10–8.73
Weighting benefits and risks is not relevant	4.76*	1.14–19.92
If all are vaccinated, I do not need vaccination		
If all vaccinated, no vaccination for myself is necessary (ref.)	-	-
If all vaccinated, vaccination is rather necessary for myself	1.56*	1.02–2.37
If all vaccinated, vaccination is still necessary for myself	4.71*	2.79–7.95
Literature-based determinants		
Covid 19-Diagnosis		
Negative (ref.)	-	-
Positive (confirmed)	0.52*	0.34–0.80
Suspected infection (not confirmed)	0.60*	0.39–0.95
Worries that doctors and hospitals will not have adequate medical supplies to handle the COVID-19 outbreak (metric)	1.12*	1.06–1.17
Confidence of receiving necessary medical care in case of a severe course of the infection		
Not confident receiving medical care (ref.)	-	-
Confident receiving medical care	1.82*	1.23–2.69
Sufficient information about the COVID-19 vaccine		
Poorly informed (ref.)	-	-
Moderately informed	1.70*	1.13–2.58
Very well informed	2.20*	1.51–3.21
Socio-demographic information		
Age		
18–23 years (ref.)	-	-
24–29 years	0.71*	0.52–0.97
+30 years	0.99	0.63–1.55
Gender		
Male (ref.)	-	-
Female	1.38*	1.01–1.88
Diverse	2.56	0.32–20.55
Migration background		
No migration background (ref.)	-	-
Migration background	1.67	0.84–1.62
Academic degree of parents		
Both parents without academic degree (ref.)	-	-
At least one parent with academic degree	1.07	0.78–1.46
Chronic disease		
Present chronic diseases (ref.)	-	-
No present chronic diseases	0.76	0.52–1.11

OR: odds ratio; CI: confidence interval; ref.: reference category; * $p < .05$.

were more likely to be fully vaccinated compared to male students (OR = 1.38; 95% CI: 1.01–1.88).

Association between CHL-P, as well as with further determinants, and vaccination status

Students, who had a high complexity perception in rating the scientific knowledge for guiding political decision in the COVID-19 pandemic, had a 3.02-fold odds to be fully vaccinated in comparison to students with a low complexity perception (95% CI: 2.26–4.04) (see Table 5). Students with a good understanding of the need for preventive restrictions for risk groups had a lower odds to be vaccinated compared to students with a low understanding (OR = 0.41; 95% CI: 0.32–0.53).

Students who reported a previous infection, had a lower odds to be vaccinated in comparison to students who never had been infected (OR = 0.40; 95% CI: 0.28–0.59). With regard to worries (0–10 points) that doctors and hospitals would not have adequate medical supplies to handle the COVID-19 outbreak, students had a 1.15-fold odds of being vaccinated for each point in increase on the scale (95% CI: 1.10–1.20). Students who were confident in receiving medical care in case of a severe course of infection, had a 2.69-fold odds to report to be vaccinated in comparison to their less confident

Table 5. Results of the multiple logistic regression to quantify the association between the CHL-P and four additional literature-based determinants and vaccination status as the dependent variable.

	OR	95% CI
Rate the current scientific knowledge on COVID-19 available to guide political decisions		
Low complexity perception (ref.)	-	-
High complexity perception	3.02*	2.26–4.04
Challenges in this crisis are simple and decision-making is fairly straight-forward		
Low complexity perception (ref.)	-	-
High complexity perception	0.69	0.46–1.03
Importance to understand the different interests and motivations among the key players in this crisis		
Low importance (ref.)	-	-
High importance	0.77	0.46–1.31
Greatest problems are the high risk groups (+65 years) - behavioral restrictions should only apply to the high risk groups		
Low understanding of the need for preventive restrictions (ref.)	-	-
High understanding of the need for preventive restrictions	0.41*	0.32–0.53
All individuals are equally affected by pandemic, regardless of their social status or class		
Low awareness of social class differences in the pandemic (ref.)	-	-
High awareness of social class differences in the pandemic	0.99	0.76–1.28
Literature-based determinants		
COVID-19 diagnosis		
Negative (ref.)	-	-
Positive (confirmed)	0,40*	0.28–0.59
Suspected infection (not confirmed)	0.41*	0.27–0.61
Worries that doctors and hospitals will not have adequate medical supplies to handle the COVID-19 outbreak (metric)	1.15*	1.10–1.20
Confidence of receiving necessary medical care in case of a severe course of the infection		
Not confident receiving medical care (ref.)	-	-
Confident receiving medical care	2.69*	1.89–3.81
Sufficient information about the COVID-19 vaccine		
Poorly informed (ref.)	-	-
Moderately informed	2.38*	1.64–3.47
Very well informed	8.47*	6.07–11.81
Socio-demographic information		
Age		
18–23 years (ref.)	-	-
24–29 years	0.82	0.62–1.08
+30 years	0.87	0.58–1.31
Gender		
Male (ref.)	-	-
Female	0.92	0.69–1.21
Diverse	2.46	0.31–19.63
Migration background		
No migration background (ref.)	-	-
Migration background	0.97	0.72–1.30
Academic degree of parents		
Both parents without academic degree (ref.)	-	-
At least one parent with academic degree	1.04	0.78–1.38
Chronic disease		
Present chronic diseases (ref.)	-	-
No present chronic diseases	0.87	0.62–1.23

OR: odds ratio; CI: confidence interval; ref.: reference category; * $p < .05$.

counterparts (96% CI: 1.89–3.81). Compared to students who felt poorly informed about the COVID-19 vaccination, students who felt very well informed had a 8.47-fold odds to report to be fully vaccinated (95% CI: 6.07–11.81).

Discussion

In the current investigation, we analyzed determinants of vaccination behavior among German university students. An important finding of our study is, that all 5Cs were strongly associated with the vaccination status, except for the item asking students whether they felt that vaccination was not necessary because COVID-19 was not common anymore. Interestingly, the item with regard to confidence in vaccine safety showed the strongest association with vaccination status. At the time point of this investigation, there were no studies examining the relationship between the 5Cs and student vaccination status in Germany. Wismans et al.[23] investigated the

associations between the 5Cs and vaccination intention among university students from the Netherlands, Belgium, and Portugal. In this study, the largest effect sizes regarding COVID-19 vaccination intention were reported for students who felt confident in the safety of the vaccine.[23] Similar results were obtained by Dratva et al.[9] who investigated the relationship of the 5Cs and vaccination intention among Swiss university students. In this study, students with a high level of confidence also showed a higher level of vaccination intention.[9] Thus, the confidence in the vaccine safety seems to be a major contributor to developing a vaccination intention.

Further, we found that students who did not weigh risks and benefits before getting vaccinated against COVID-19 had higher odds of being fully vaccinated compared to students who did. In contrast to our findings, Wismans et al.[23] and Dratva et al.[9] reported that students who did not weigh the risks and benefits had a lower vaccination intention. One explanation for these differences could be that our sample

included a high proportion of students enrolled in health-related studies (27%). It is known that medical students have a higher general health literacy (and vaccine literacy) than students from other study fields and, therefore, have a greater willingness to get vaccinated.[23–26] The higher general health literacy among these students could be explained by a higher medical expertise and vaccine literacy.[24] The study of Bai et al.[27] supports our assumption that students enrolled in health-related studies have a more positive attitude toward COVID-19 vaccines and, therefore, generally tend not to weigh risks and benefits. Another study by Tavolacci et al.[28] suggested that students who studied a health-related subject, were the most likely to get vaccinated and the most willing to be vaccinated compared to students who studied other subjects.

Our investigation of the association between CHL-P and vaccination status revealed that student who had a high complexity perception while rating the scientific knowledge for guiding political decision in the COVID-19 pandemic, were more likely to report being fully vaccinated. These students may have also been better informed about COVD-19-related topics in comparison to students with a low complexity perception. Previous research suggests that students with higher levels of COVID-19-related knowledge also had a higher vaccination intention.[27,29] We conclude that obtaining adequate information regarding COVID-19-related topics is a key component of having a better general understanding of the complexity of the pandemic and of political decisions made during the COVID-19 pandemic.

Furthermore, we found that students who had a good understanding of the need of behavioral preventive restrictions only for the high-risk groups (e.g., +65 years or chronic ill people), had lower odds to be vaccinated compared to students with a poor understanding of the need for restrictions. The lower odds for a complete vaccination status among students with no confidence in the vaccine safety compared to students with higher confidence may explain this finding (compare Table 4). Another explanation is the lower odds for being vaccinated among students who were of the opinion that vaccination is not necessary because COVID-19 is not common anymore (compare Table 4). The lack of confidence in safety, as well as the low understanding that vaccines were necessary for preventing a COVID-19 infection, may have contributed to students' belief that preventive and protective behavior, such as restrictions only for vulnerable populations (+65 years or chronic ill people), is more effective than vaccines for containing the pandemic. This explanation is supported by the study of Zhang et al.[30] who investigated factors contributing to little acceptance of COVID-19 vaccination among students in China. Those who considered protective behavioral restrictions as an alternative to protect others compared to getting vaccinated, had 0.16-fold odds (95% CI: 0.06–0.39) of accepting a COVID-19 vaccination compared to students who had the opinion that protective behavior is not an alternative.[30] This may be a reason why our study found an association between a high level of understanding of the need for behavioral preventive restrictions only for high-risk groups and a lower odds of being fully vaccinated, because these students think that restrictions only for risk groups having a better preventive effect than vaccines.

A further finding of our study was that students who had been previously infected consistently showed lower odds for being fully vaccinated compared to students reporting no previous infection. This finding is in accordance with the results of a previous study that investigated drivers of COVID-19 vaccine hesitancy among Czech university students.[31] One result of this study was that students who had a previous COVID-19 infection were also less likely to accept COVID-19 vaccines.[31] The systematic review by Geng et al.[29] investigated the vaccination willingness of students in several countries and confirmed these results. One other possible reason for our result could be that students feel that they built up sufficient immunity against a reinfection. Further, due to their young age and a lower risk of complications, it is conceivable that students who did not get vaccinated, had a lower-risk perception regarding an infection and were therefore at a higher risk for an infection.[32]

One remarkable finding of our study is that the proportion of vaccinated student (96%) is quite high in our sample despite of a lack of a general mandate for vaccination at university campuses. It is possible that indirect social pressure from the universities (access to the university area only with proof of vaccination status, unvaccinated students having to pay for COVID-19 tests themselves in order to be allowed to enter the university area) may have contributed to the fact that a large number of students were fully vaccinated. In addition, at the time of the survey, the first political discussions about vaccination mandates for medical staff, such as physicians or nurses, were initiated. This could have also led to an increase in social pressure on medical students in our sample to get vaccinated.

Limitations and strengths

One limitation of the C19 GSWS was the high proportion of students enrolled in health-related studies. As previously stated, they tend to have a higher health literacy than students from other study fields which could affect the strength of associations. Further, this study was conducted within a time period, where the number of new cases had started to increase rapidly. These circumstances may have also influenced the psychological antecedents of vaccination behavior. Another limitation is that the vaccination status was only reported by the participants and the proportion of students who were fully vaccinated (94%) was quite high. According to the cross-sectional design of the C19 GSWS, causality of the associations cannot be inferred. The strength of this investigation is that this investigation is the first in Germany to examine determinants of vaccination behavior in German university students using validated measurement instruments, such as the 5Cs, to increase external validity.

Conclusion

Our results suggest that psychological antecedents of vaccination (5Cs) influence vaccination behavior among German university students. The relevance of feeling informed, as well as critical health literacy in a pandemic, also becomes clear based on our results. We conclude that students who feel better informed regarding COVID-19-related topics also have

a better understanding of the complexity of the pandemic and are more likely to obtain full vaccination. Thus, future informational campaigns in the context of universities should focus on evidence-based information related to vaccine safety and benefits. In order to do so, in-person components (e.g., on-site information at vaccination centers) could be combined with online components of the campaign (e.g., university social media, online newsletter, via e-mail).

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