PLOS ONE

Psychological characteristics associated with students' COVID-19 vaccination intention

--Manuscript Draft--

Manuscript Number:	PONE-D-21-15022
Article Type:	Research Article
Full Title:	Psychological characteristics associated with students' COVID-19 vaccination intention
Short Title:	Psychological characteristics associated with students' COVID-19 vaccination intention
Corresponding Author:	Annelot Wismans Erasmus University Rotterdam: Erasmus Universiteit Rotterdam Rotterdam, NETHERLANDS
Keywords:	vaccination intention; COVID-19; students; 5C model; public health
Abstract:	To achieve herd immunity against COVID-19, it is crucial to know the drivers of vaccination intention and, thereby, vaccination. As the determinants of vaccination differ across vaccines, target groups and contexts, we investigate COVID-19 vaccination intention using data from university students from three countries, the Netherlands, Belgium and Portugal, and the 5C model. This model includes five antecedents of vaccination: Confidence, Complacency, Constraints, Calculation and Collective Responsibility. First, we show that the majority of students have a positive propensity toward getting vaccinated against COVID-19, though only 41% of students are completely acceptant. Second, using the 5C model, we show that 'Confidence' and 'Collective Responsibility' are most influential in terms of students' COVID-19 vaccination intention. Using mediation analyses, we show that the perceived risk and effectiveness of the vaccine as well as trust in the government and health authorities indirectly affect vaccination intention through 'Confidence'. The perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly affect vaccination intention through 'Collective Responsibility'. Hence, targeting the psychological characteristics associated with 'Confidence' and 'Collective Responsibility' can improve the effectiveness of vaccination campaigns among students.
Order of Authors:	Annelot Wismans
	Roy Thurik
	Rui Baptista
	Marcus Dejardin
	Frank Janssen
	Ingmar Franken
Additional Information:	
Question	**Response**
Financial Disclosure Enter a financial disclosure statement that describes the sources of funding for the work included in this submission. Review the submission guidelines for detailed requirements. View published research articles from *PLOS ONE* for specific examples. This statement is required for submission and **will appear in the published article** if	The author(s) received no specific funding for this work.

the submission is accepted. Please make sure it is accurate. **Unfunded studies** Enter: *The author(s) received no specific funding for this work.* **Funded studies** Enter a statement with the following details: • Initials of the authors who received each award • Grant numbers awarded to each author • The full name of each funder • URL of each funder website • Did the sponsors or funders play any role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript? • **NO** - Include this sentence at the end of your statement: *The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.* • **YES** - Specify the role(s) played. * typeset	
Competing Interests Use the instructions below to enter a competing interest statement for this submission. On behalf of all authors, disclose any competing interests that could be perceived to bias this work—acknowledging all financial support and any other relevant financial or non-financial competing interests. This statement is required for submission and **will appear in the published article** if the submission is accepted. Please make sure it is accurate and that any funding sources listed in your Funding Information later in the submission form are also declared in your Financial Disclosure statement. View published research articles from *PLOS ONE* for specific examples.	The authors have declared that no competing interests exist.

NO authors have competing interests Enter: *The authors have declared that no competing interests exist.* **Authors with competing interests** Enter competing interest details beginning with this statement: *I have read the journal's policy and the authors of this manuscript have the following competing interests: [insert competing interests here]* * typeset	
Ethics Statement Enter an ethics statement for this submission. This statement is required if the study involved: • Human participants • Human specimens or tissue • Vertebrate animals or cephalopods • Vertebrate embryos or tissues • Field research Write "N/A" if the submission does not require an ethics statement. General guidance is provided below. Consult the submission guidelines for detailed instructions. **Make sure that all information entered here is included in the Methods section of the manuscript.**	The study was approved by the Internal Review Board non-experimental research of the Erasmus School of Economics, Erasmus University Rotterdam (reference: ESE IRB-NE Application 2020-10 and 2020-05). Participants gave consent to the anonymous collection, processing, archiving and possible publication of their answers before starting the surveys.

Format for specific study types **Human Subject Research (involving human participants and/or tissue)** • Give the name of the institutional review board or ethics committee that approved the study • Include the approval number and/or a statement indicating approval of this research • Indicate the form of consent obtained (written/oral) or the reason that consent was not obtained (e.g. the data were analyzed anonymously) **Animal Research (involving vertebrate animals, embryos or tissues)** • Provide the name of the Institutional Animal Care and Use Committee (IACUC) or other relevant ethics board that reviewed the study protocol, and indicate whether they approved this research or granted a formal waiver of ethical approval • Include an approval number if one was obtained • If the study involved *non-human primates*, add *additional details* about animal welfare and steps taken to ameliorate suffering • If anesthesia, euthanasia, or any kind of animal sacrifice is part of the study, include briefly which substances and/or methods were applied **Field Research** Include the following details if this study involves the collection of plant, animal, or other materials from a natural setting: • Field permit number • Name of the institution or relevant body that granted permission	
Data Availability Authors are required to make all data underlying the findings described fully available, without restriction, and from the time of publication. PLOS allows rare exceptions to address legal and ethical concerns. See the PLOS Data Policy and FAQ for detailed information.	Yes - all data are fully available without restriction

A Data Availability Statement describing where the data can be found is required at submission. Your answers to this question constitute the Data Availability Statement and **will be published in the article**, if accepted. **Important:** Stating 'data available on request from the author' is not sufficient. If your data are only available upon request, select 'No' for the first question and explain your exceptional situation in the text box. Do the authors confirm that all data underlying the findings described in their manuscript are fully available without restriction?	
Describe where the data may be found in full sentences. If you are copying our sample text, replace any instances of XXX with the appropriate details. • If the data are **held or will be held in a public repository**, include URLs, accession numbers or DOIs. If this information will only be available after acceptance, indicate this by ticking the box below. For example: *All XXX files are available from the XXX database (accession number(s) XXX, XXX.*). • If the data are all contained **within the manuscript and/or Supporting Information files**, enter the following: *All relevant data are within the manuscript and its Supporting Information files.* • If neither of these applies but you are able to provide **details of access elsewhere**, with or without limitations, please do so. For example: *Data cannot be shared publicly because of [XXX]. Data are available from the XXX Institutional Data Access / Ethics Committee (contact via XXX) for researchers who meet the criteria for access to confidential data.* *The data underlying the results presented in the study are available from (include the name of the third party*	The survey data that support the findings of this study are available from the EUR Data Repository (doi: 10.25397/eur.14356229).

and contact information or URL). • This text is appropriate if the data are owned by a third party and authors do not have permission to share the data. * typeset	
Additional data availability information:	Tick here if the URLs/accession numbers/DOIs will be available only after acceptance of the manuscript for publication so that we can ensure their inclusion before publication.

Psychological characteristics associated with students' COVID-19 vaccination intention

Annelot Wismans[a, b, *], Roy Thurik[a, b, c], Rui Baptista[d], Marcus Dejardin[e, f], Frank Janssen[e], Ingmar Franken[b, g]

Affiliations:

[a] Erasmus School of Economics, Erasmus University Rotterdam, Rotterdam, The Netherlands;

[b] The Erasmus University Rotterdam Institute for Behavior and Biology (EURIBEB), Rotterdam, The Netherlands;

[c] Montpellier Business School, Montpellier, France;

[d] CEG-IST, Instituto Superior Técnico, University of Lisbon, Lisboa, Portugal;

[e] Université catholique de Louvain, Louvain-la-Neuve, Belgium;

[f] Université de Namur, Namur, Belgium;

[g] Erasmus School of Social and Behavioural Sciences, Erasmus University Rotterdam, Rotterdam, The Netherlands.

* Corresponding author: wismans@ese.eur.nl (AW)

Abstract

To achieve herd immunity against COVID-19, it is crucial to know the drivers of vaccination intention and, thereby, vaccination. As the determinants of vaccination differ across vaccines, target groups and contexts, we investigate COVID-19 vaccination intention using data from university students from three countries, the Netherlands, Belgium and Portugal, and the 5C model. This model includes five antecedents of vaccination: Confidence, Complacency, Constraints, Calculation and Collective Responsibility. First, we show that the majority of students have a positive propensity toward getting vaccinated against COVID-19, though only 41% of students are completely acceptant. Second, using the 5C model, we show that 'Confidence' and 'Collective Responsibility' are most influential in terms of students' COVID-19 vaccination intention. Using mediation analyses, we show that the perceived risk and effectiveness of the vaccine as well as trust in the government and health authorities indirectly affect vaccination intention through 'Confidence'. The perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly affect vaccination intention through 'Collective Responsibility'. Hence, targeting the psychological characteristics associated with 'Confidence' and 'Collective Responsibility' can improve the effectiveness of vaccination campaigns among students.

Introduction

The development of a vaccine has been recognized as a crucial means to halt the spread of COVID-19. Since effective vaccines against COVID-19 have been developed [1][2], the greatest challenge is to ensure sufficiently high vaccination rates to establish herd immunity. The estimates of the needed vaccination rates to achieve herd immunity range from 67% to 95% [3–5].

In 2019, the World Health Organization declared 'vaccine hesitancy' one of the top ten threats to global health [6]. Vaccine hesitancy is defined as the refusal or reluctance to get vaccinated despite the availability of a vaccine [7]. Vaccine hesitancy has become more

problematic in recent decades [8], with the highest levels of skepticism being found in Europe [9]. In a sample of over 7,000 Europeans, 18.9% of respondents reported being unsure about getting vaccinated against COVID-19, while 7.2% indicated that they will certainly not get vaccinated [10]. Even more pessimistic numbers have been shown in a UK and Irish sample, with only 65% and 69% of respondents fully willing to get vaccinated, respectively [11].

Governments and public health agencies must be prepared to address COVID-19 vaccine hesitancy [12]. Given its novelty, much is still unknown about the acceptance and motivation behind COVID-19 vaccination. This vaccine differs from previous vaccines in many respects: development speed, innovativeness of the techniques used, uncertainty regarding the magnitude and extent of its effectiveness, and potential side effects. As vaccination willingness is context-, time-, place-, and vaccine-dependent [13], research on COVID-19 vaccination intention and its antecedents is needed, preferably across a variety of target groups and countries.

Previous literature reports potential barriers to vaccine acceptance at different levels [14], ranging from the political and sociocultural levels to the individual level. At the aggregate level, in addition to factors such as the availability and cost of vaccines [7], trust in health officials, the media and governments play an important role in vaccination intention [8]. At the individual level, studies have, among others, shown the relevance of psychological theories of behavior for vaccine acceptance, like the theory of planned behavior [15–17]. Several models have been developed to integrate previous literature on vaccination behavior, such as the 3C [7], 4C [15] and 5C models [18]. The most recent model, the 5C model, includes five psychological antecedents of vaccination: Confidence (i.e., trust in the effectiveness and safety of vaccines and in the system that delivers them), Complacency (i.e., perceived risk of diseases and perceived level of threat), Constraints (i.e., structural psychological and physical barriers), Calculation (i.e., individuals' engagement in extensive information searching) and Collective responsibility (i.e., willingness to protect others) [18]. A scale assessing these five drivers explains more variance in

vaccination behavior compared to previous measures that have focused almost solely on Confidence. However, the literature shows that the pattern of the most important Cs within the 5C model varies across vaccines, target groups and countries [18].

Regarding COVID-19 vaccination, studies have shown that women, younger adults, unemployed individuals and those with a lower socioeconomic status are less likely to get vaccinated [11,19,20]. Moreover, psychological profiles play a role: vaccine-hesitant and vaccine-resistant individuals are less altruistic, conscientious, more disagreeable, emotionally unstable, and self-interested than are vaccine-acceptant individuals [11]. Finally, higher COVID-19 vaccination intention is associated with more positive general and COVID-19 vaccination beliefs, as well as higher perceived vaccine efficacy and safety [20–22].

The importance of studying psychological variables to understand vaccination intention and inform effective interventions has been advocated [14]. A deeper understanding of the underlying psychology of vaccine-resistant and vaccine-hesitant groups can enhance the potential effectiveness of the public health messages targeting these groups. In this study, we aim to increase the understanding of COVID-19 vaccination by studying the 5C model and its psychological drivers. Since younger people are less likely to suffer from the negative health consequences of COVID-19 infection [23], it is important to know what the main drivers of getting vaccinated are for these individuals. Based on a sample of university students from the Netherlands, Belgium, and Portugal, we pursue the following four objectives.

First, we assess the intention to get vaccinated in our international student sample by using a seven-point scale, ranging from completely resistant to completely acceptant.

Second, as shown in previous research, the antecedents of vaccine hesitancy differ across vaccines, target groups and countries [18]. We are the first to study which Cs—Confidence, Complacency, Calculation, Constraints, Collective Responsibility (5C's) – are most important for COVID-19 vaccination intention in a sample of young adults.

Third, as stressed by the authors of the 5C model, knowing the relative importance of the Cs is just a first step, which should be followed by further exploration of the potential levers of these drivers [18]. Using mediation analyses, we investigate which psychological variables, including COVID-19 vaccine-related and COVID-19-related attitudes and personality traits, affect vaccination intention through the 5Cs. This will improve our understanding of vaccination antecedents and, consequently, for which groups reaching desirable levels of these 5Cs and, thereby, vaccination intention may be problematic. The mediation analyses we performed are summarized in Fig 1. Previous studies have shed light on several bivariate relationships between the 5Cs and psychological constructs [18] (presented by the orange arrows in Fig 1). We study whether these constructs indeed affect vaccination intention through the suggested C. Additionally, we study the new indirect relationships represented by the blue arrows in Fig 1. Direct and total relationships are excluded from Fig 1 for clarity reasons.

Finally, integrating all results, we formulate advice for governments and public health officials on which Cs should be targeted while taking their drivers into account. Knowing for which students' psychological profiles the Cs are less likely to be present should facilitate the design of targeted public health vaccination campaigns.

We find that Confidence and Collective Responsibility are most important in explaining COVID-19 vaccination among students. The perceived risk and effectiveness of the vaccine and trust in the government and health authorities indirectly affect vaccination intention through Confidence. The perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly affect vaccination intention through Collective Responsibility. Thus, vaccination campaigns targeted at students should aim to increase both Confidence and Collective Responsibility, while considering their underlying psychological characteristics.

Fig 1. Overview of expected mediation relationships. Direct effects are excluded for clarity reasons. (C-19=COVID-19)

Materials and methods

Data

The data used in this study are part of the Erasmus University Rotterdam International COVID-19 Student Survey (EURICSS). This is a longitudinal study on COVID-19-related behaviors and attitudes among university students from multiple countries [24]. Thus far, data have been collected at two points in time. For both studies, approval was obtained by the Internal Review Board of the Erasmus University Rotterdam. All students signed an informed consent form before starting the survey.

During the early days of the pandemic (weeks 17-19, 2020, T1), data were collected for the first time. Students were approached through university student systems and invitations sent to university e-mail addresses. In total, data from 7,400 university students in ten countries worldwide were collected.

Data collection for T2 took place between weeks 51 and 52, 2020. Only students who participated at T1 and studied in the Netherlands, Belgium and Portugal were approached. Other country samples were not reapproached since the number of students who agreed to be contacted for follow-up was insufficient to assure large enough samples at T2. Students were contacted through invitations that were sent to the e-mail addresses they provided at T1. Two reminders were sent to those students who did not yet finish or start the survey three and seven days after the first invitation. In total, data were collected from 1,137 students, for a response rate of 39.2%.

At both T1 and T2, surveys were shared using the online survey software Qualtrics. At T1, the survey contained questions on COVID-19-related attitudes, compliance with COVID-19 regulations, and several personality traits. For this study, only the T1 data on personality traits are used. As personality traits are relatively stable over time [25], we suppose that this is not a problem for the validity of our outcomes. If anything, using multiple measurement times decreases the probability of common method bias [26]. At T2, the survey contained similar

questions on COVID-19-related attitudes and compliance with regulations. In addition, questions on COVID-19 vaccination intention and vaccination attitudes were posed. Finally, several personality traits were assessed. The surveys could be completed in English, Dutch or French.

Since we mainly use data collected during T2, the dataset for this study contains the 1,137 students who participated both at T1 and T2 and were studying in one of the three countries mentioned (the Netherlands N=195; Belgium=745; Portugal N=294). On average, students were 22.92 years old, and 59.3% of the sample was female.

Measures

The operationalization of all variables is explained in this section. The means, standard deviations of all variables and correlations of all variables with vaccination intention and the 5C scale are presented in Supporting Information S1 Table.

Vaccination intention (T2)

Participants were asked the following question: 'If a coronavirus vaccine that was approved safe and effective was available to you free at cost, would you get vaccinated?' Answers could be given on a seven-point scale: 'definitely not' (1), 'very probably not' (2), 'probably not' (3), 'unsure – neutral' (4), 'probably yes' (5), 'very probably yes' (6) and 'definitely yes' (7). A higher score thus indicates a higher intention to get vaccinated against COVID-19. The continuous scale is used instead of grouping students as being acceptant, hesitant, or resistant. This approach offers a more accurate understanding of vaccination intention, as grouping all students who indicate somewhere between 'probably will not' and 'probably will' under hesitant conditions will lower the unique variation that can be exploited.

5C scale (T2)

The 5Cs were assessed using the previously validated 5C scale [18]. The scale consists of 15 items. Each of the Cs—Confidence, Constraints, Calculation, Complacency and Collective responsibility—is captured by three items. Answers are given on a seven-point Likert scale,

ranging from ‘strongly disagree’ to ‘strongly agree’. The scale was adapted to specifically focus on COVID-19 vaccinations. A French translation was available [27], while a Dutch translation was performed by two native Dutch speakers individually, after which a consensus meeting took place to discuss and decide on inconsistencies. All items are scored in a way such that a higher score indicates a higher degree of the C assessed. The scores of one of the items of the Collective Responsibility subscale was reversed to be in line with this scoring (‘*When everyone is vaccinated, I don’t have to get vaccinated too’*). Internal consistency, as reflected by Cronbach’s alpha, is acceptable in our sample: Confidence α =.87, Complacency α=70, Constraints α=.69, Calculation α=.76, Collective responsibility α=.71.

Perceived risk of the COVID-19 vaccine

Bipolar questions were used to assess the perceived risk of the COVID-19 vaccine. Students were asked the following: ‘To what extent do you think the following characteristics apply to COVID-19 vaccines?’ Answers could be given on a seven-point scale using bipolar adjectives, which is common practice when assessing attitude [28]. An average score was taken for the following three characteristics: safety (‘very unsafe’ (1) to ‘very safe’ (7)), likeliness of side effects (‘side effects are very likely’ (1) to ‘side effects are very unlikely’ (7)) and riskiness (‘very risky’ (1) to ‘not risky at all’ (7)). The score on safety was reversed before analysis, such that a higher score indicates a higher perceived risk of the vaccine. Internal consistency is very good (α=.85).

Perceived effectiveness of the COVID-19 vaccine

A similar question was used to assess the perceived effectiveness of the COVID-19 vaccine. Students were asked the following: ‘To what extent do you think the following characteristics apply to COVID-19 vaccines?’ Answers could be given on a seven-point scale, ranging from ‘very ineffective’ (1) to ‘very effective’ (7).

Normative beliefs about the COVID-19 vaccine (T2)

The descriptive social norms in students' social environment regarding getting vaccinated against COVID-19 was assessed using two questions, distinguishing between the norm among family and that among friends. The following questions were used: '*In general, if a coronavirus vaccine that was approved safe and effective was available to your friends for free, what would most of your friends do?*' and '*In general, if a coronavirus vaccine that was approved safe and effective was available to your family for free, what would most of your family do*?'. Answers were given on a scale from 1 (definitely not get vaccinated) to 7 (definitely get vaccinated). An average of the two answers was taken (r=.62, p<.01).

Perceived benefits of the COVID-19 vaccine (T2)

A question was asked on the perceived personal versus social benefits of COVID-19 vaccination using a bipolar seven-point scale. We asked students to complete a statement—'*Getting vaccinated against the coronavirus will mainly benefit*:', with answer options ranging from 'myself' (1) to '(vulnerable) others around me' (7).

Perceived risk of COVID-19 for oneself and for others (T2)

Three questions were asked about the risk of COVID-19 for the students themselves. These questions asked about the perceived likelihood of getting infected with COVID-19, getting severely ill if infected and being hospitalized if infected. The same three questions were asked about the risk of COVID-19 for the friends and family of the student. Average values of the three items were taken to create a general COVID-19 risk score for oneself and for others. Internal consistency is acceptable (COVID-19 risk: self α=.67; others α=.71).

COVID-19 infection (T2)

Students were asked whether they had been infected with the coronavirus before (1=yes, either confirmed by a test or only expected; 0: no or have not been aware of it).

General risk attitude (T2)

General risk attitudes were assessed by using the risk propensity scale (RPS) [29], which consists of seven items. All statements were rated in terms of agreement on a nine-point Likert scale, ranging from 'totally disagree' (1) to 'totally agree' (9), except for the final item, which was rated on a scale ranging from 'risk avoider' (1) to 'risk seeker' (9). Higher scores indicate a higher risk-seeking tendency. Internal consistency was good, at α=.77. A French translation was previously presented based on a back translation approach [30]. The scale was translated to Dutch by two native speakers who first translated the scale individually, after which a consensus meeting took place to discuss and decide on inconsistencies.

Delay discounting (T1)

Delay discounting is a behavioral measure related to impulsivity and reflects the degree to which people are able to delay rewards, i.e., a measure of impatience. Delay discounting was assessed by the discount rate, with a higher rate reflecting a faster devaluation of delayed rewards and thus greater impulsivity. To capture the discount rate in a fast and accurate manner, the 5-trail Adjusting Delay Discounting Task was used, in which students had to make five consecutive hypothetical choices between receiving €1,000 after a specific delay and receiving €500 directly[31]. The task starts with a delay of 3 weeks, which is increased or decreased based on previous choices. The discount rate is calculated using the hyperbolic discounting model [32] and is log-transformed before analysis, as is commonly done in previous research [31,33].

Impulsivity (T1)

The Barratt Impulsiveness Scale-Brief (BIS-Brief), which is a short unidimensional version of the BIS-11, was used to assess the personality construct of impulsivity [34,35]. It consists of 8 items scored on a four-point scale, ranging from 'rarely/never' (1) to 'almost always/always' (4). Half of the items were reverse scored. Validated French and Dutch translations were used [36,37]. The reliability was good, at α=.75.

Optimism (T1)

Using the Life-Orientation Test-Revised (LOT-R), dispositional optimism was measured [38]. Both Dutch and French translations were already available [39,40]. The LOT-R consists of 10 items, of which four are filler items. Answers are given on a five-point scale, ranging from 'strongly disagree' (1) to 'strongly agree' (5). Higher scores indicate a higher level of dispositional optimism. Internal consistency was good, as reflected by Cronbach's alpha (α=.81).

Self-efficacy (T1)

General self-efficacy was measured using the General Self-Efficacy Scale (GSES), which was designed to predict individuals' coping with daily hassles and adaptation after stressful events [41]. The scale consists of ten items scored on a four-point scale (1: not at all true; 4: exactly true). French and Dutch translations were available [42,43]. Internal consistency was very good, at α=.85.

Psychopathy (T1)

To assess subclinical psychopathy, the psychopathy subscale of the Short-Dark Triad (SD-3) was used [44]. The scale generally consists of 9 items. One item ('*I enjoy having sex with people I hardly know'*) was not included due to cultural controversy. Answers were given on a five-point scale, ranging from 'strongly disagree' (1) to 'strongly agree' (5). Previously made Dutch and French translations were used [45]. Internal consistency was relatively low but acceptable (α=.64).

Altruism (T1)

The altruism (versus antagonism) subscale of the 100-item version of the HEXACO Personality Inventory-Revised was used, which consists of four questions scored on a five-point scale (1: 'strongly disagree'; 5: 'strongly agree') [46]. Two questions were reverse coded and then transformed; higher scores indicate higher levels of altruism (i.e., being sympathetic and kind). Dutch and French translations were available [47,48]. Internal consistency was low, at α=.58. Previous studies have found similar low alphas of the altruism subscale while also

showing high test-retest reliability and validity [46,49]. There has been a debate on the relevance of alpha values in evaluating brief personality constructs in such cases [50,51].

Need to belong (T2)

The need to belong was assessed using the single-item Need to Belong scale (SIN-B)[52]. It is shown that the SIN-B explains most of the reliable variance of the longer Need to Belong scale [52]. The psychometric properties of the scale are good. Participants indicated to what extent they agreed with the statement '*I have the strong need to belong'* on a five-point scale (1: strongly disagree; 5: strongly agree). A French translation was taken from a French version of the full Need to Belong scale [53], and a Dutch translation was made by two native speakers and decided upon after a consensus meeting.

Trust in government and health authorities (T2)

Trust in government was measured using the following item: '*In general, how much trust do you personally have in the [name country] government on a scale from 1 (no trust at all) to 10 (full trust)?*' Trust in health authorities was assessed using a similar question and scale: 'In general, how much trust do you personally have in health authorities on a scale from 1 (no trust at all) to 10 (full trust)?' Since the two scores were highly correlated (r=.68), we used an average of the two scores for analyses.

International student (T1)

We inferred that students who answered 'no' to the question '*Have you lived in [name country] for more than 5 years?'* were international students, which was coded with a value of 1.

Gender (T1)

Gender was included as a dummy variable, with female (1) and male (0) as answer options.

Methodology

The analyses used are linked to the first three objectives of the study. For the first objective, the percentage of students who indicated a certain degree of willingness to get vaccinated against

COVID-19 were calculated. For the second objective, one-sided ordinary least squares (OLS) regression analyses were conducted with the 5C subscales as independent variables, vaccination intention as a dependent variable, and country and gender as control variables. We controlled for country differences by including country dummies, and Dutch students were used as a reference group. The standardized coefficients of the regression analysis were used to assess the effect sizes of all Cs to conclude which of these components is most important in explaining COVID-19 vaccination intention among students. Finally, for the third objective, mediation analyses were conducted using the PROCESS macro in SPSS [54]. The models were estimated for all predictors of a particular C at the same time; consequently, the direct and indirect effects were estimated while controlling for the other predictors of the C. All resulting paths were therefore as if they have been estimated simultaneously using simultaneous equation modeling [54]. Three regression models were estimated. Model 1 includes the independent variables and controls, with vaccination intention as the dependent variable. This model presents the total effect for the independent variables (c, see Fig 2). Model 2 includes all independent variables and controls, with the mediator as the dependent variable. This model includes path 'a' (Fig 2). Finally, Model 3 includes—next to the independent variables and controls—the mediator as a predictor, with vaccination intention as the dependent variable. This model contains the direct effect (c', Fig 2) and path b (Fig 2). To estimate the indirect effect, bias-corrected bootstrapping was used to generate a 95% confidence interval (CI). Bias-corrected bootstrapping is now considered the standard for testing mediation [55,56]. A common seed was used so that at each run, the bootstrap confidence intervals were based on the same set of 10,000 resamples from the data [54]. As the unstandardized indirect effect cannot be interpreted as a measure of effect size [57], we present standardized indirect effects for all continuous independent variables and partially standardized indirect effects for all binary independent variables [54,57]. All data analyses were conducted using IBM SPSS for Windows Version 25.0 [58].

Fig 2. All paths involved in the mediation analyses, excluding covariates

Results

COVID-19 vaccination intention among students

Vaccination intention was measured on an ordinal scale, ranging from definitely not to definitely yes. We asked about intention under the condition that the COVID-19 vaccine was approved as being safe and effective and could be received free of cost. Fig 3 shows the percentage per vaccination intention category and cumulative percentages indicated with a dashed orange line (from positive to negative propensity). While the majority of students (85.49%) indicated that they intended to get vaccinated within a range between 'probably' and 'definitely', only 40.9% of the students were totally convinced to get vaccinated ('definitely yes'). Only a very small group was totally resistant to COVID-19 vaccination (1.58%) and indicated that they will 'definitely not' get vaccinated. Almost 1 out of 10 students (9.41%) indicated a negative propensity toward COVID-19 vaccination, as they answered within a range between 'probably not' and 'definitely not'. A total of 5.10% of students indicated being unsure about getting the COVID-19 vaccination and had neither positive nor negative vaccination intention.

Fig 3. Vaccination intention in percentages per category and cumulative percentages

5C model and COVID-19 vaccination intention

Table 1 presents the results of an OLS regression analysis containing the 5Cs as independent variables and vaccination intention as the dependent variable while controlling for gender and country. The table shows that all Cs are significantly related to vaccination intention in the

expected direction based on the previous literature. Higher Confidence in the vaccine and higher feelings of Collective Responsibility both lead to higher intentions to get vaccinated against COVID-19, while higher Complacency, Calculation and Constraints lead to lower COVID-19 vaccination intentions. Relative to the other Cs, the effect sizes of Confidence (B=.32, β=.33, SE=.03, p<.001) and Collective Responsibility (B=.46, β=.35, SE=.04, p<.001) are largest. We therefore infer that the levels of Confidence and Collective Responsibility play the most important role in explaining the intention to get vaccinated against COVID-19 among students.

Table 1. OLS regression analysis with vaccination intention (1-7) as the dependent variable

	B	95%-CI	β	SE	*p*
Intercept	2.25	[1.62, 2.88]		.32	<.001
Confidence	.32	[.27, .37]	.33	.03	<.001
Complacency	-.16	[-.23, -.09]	-.12	.04	<.001
Constraints	-.08	[-.15, -.003]	-.05	.04	.042
Calculation	-.06	[-.10, -.01]	-.06	.02	.009
Collective Responsibility	.46	[.39, .53]	.35	.04	<.001
Female	-.11	[-.23, .01]	-.04	.06	.078
Belgium	-.003	[-.17, .16]	-.001	.09	.968
Portugal	-.03	[-.21, .16]	-.01	.10	.788
R^2	0.54				
N	1127				

Note: B is the unstandardized beta, and β is the standardized beta. Dutch students serve as the reference group.

The 5C model as a mediator in explaining vaccination intention

For the third objective, mediation analyses were conducted [54]. Models were estimated for all predictors of a particular C at the same time. In this way, we could ascertain the direct and indirect effects of the variables of interest while accounting for the effects of the other predictors of the studied C. In Tables 2 to 6, the results of mediation analyses are presented, while each table presents the analyses of a particular C. Fig 4 shows an example of all relationships presented in the tables, using the example of the perceived safety of the vaccine as an independent variable and Confidence as a mediator. In Fig 4, we do not show the covariates.

As presented above, Confidence is an important positive driver of COVID-19 vaccination intention among students. The results of the mediation analyses in Table 2 show that the perceived risk of the COVID-19 vaccine is most strongly associated with vaccination intention through Confidence (*ab*=-.17; 95% bias-corrected confidence interval (95% BC-CI) = [-.22, -.13]), of which all corresponding relationships are visually presented in Fig 4. Additionally, the perceived effectiveness of the vaccine (*ab*=.09; 95% BC-CI = [.07, .12]) and trust in the government and health authorities (*ab*=.11; 95% BC-CI = [.08, .14]) are positively and significantly related to vaccination intention through Confidence. Moreover, a higher descriptive norm (normative beliefs) surrounding COVID-19 vaccination among students' family and friends (*ab*=.03., 95% BC-CI = [.02, .05]) is also significantly related to higher COVID-19 vaccination intention through Confidence, although the indirect effect is small. Finally, the descriptive norm has a very strong direct effect on vaccination intention, even after controlling for Confidence (β=.38, p<.01).

Table 2. Mediation analyses with Confidence as the mediator and vaccination intention as the dependent variable (N=1124)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Confidence		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Trust in government & health authorities	.11	<.001	.29	<.001	-.004	.88	**.11 [.08 , .14]**
Normative beliefs	.41	<.001	.08	<.001	.38	<.001	**.03 [.02 , .05]**
Perceived risk of vaccine	-.29	<.001	-.44	<.001	-.12	<.001	**-.17 [-.22 , -.13]**
Perceived effectiveness of vaccine	.07	.01	.23	<.001	-.02	.51	**.09 [.07 , .12]**
Optimism	-.04	.08	.03	.08	-.05	.02	.01 [-.001 , .02]
Control variables							
Female	.03	.26	-.04	.02	.04	.07	
Belgium Dummy	.08	.01	-.05	.01	.10	<.001	
Portugal Dummy	.01	.63	-.02	.28	.02	.43	
Mediator							
Confidence					.39	<.001	
R^2	.48		.76		.51		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Fig 4. Example of all paths involved in mediation analyses using the independent variable 'perceived risk of vaccine' and mediator 'Confidence' (Table 2), excluding covariates

Table 3 presents the analyses involving Calculation as a mediator. The perceived risk of the COVID-19 vaccine is significantly and negatively related to vaccination intention through Calculation (ab=-.04, 95% BC-CI = [-.06, -.02]). A higher perceived risk of the vaccine is related to more Calculation, which is subsequently related to a lower intention to get vaccinated against COVID-19. Moreover, a small indirect effect is present for the level of impulsivity, and more impulsive students show lower levels of Calculation, which is related to lower vaccination intention (ab=.01, 95% BC-CI = [.01, .02]). Other indirect effects, which were expected, are insignificant.

Table 3. Mediation analyses with Calculation as the mediator and vaccination intention as the dependent variable (N=1129)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Calculation		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Perceived risk of C-19: self	.06	.02	-.06	.08	.06	.04	.01 [-.001 , .01]
Perceived risk of C-19: others	.01	.76	.03	.37	.01	.68	-.003 [-.01 , .004]
Perceived risk of vaccine	-.57	<.001	.35	<.001	-.53	<.001	**-.04 [-.06 , -.02]**
Risk attitude	-.07	.01	-.02	.53	-.07	.01	.002 [-.01 , .01]
Optimism	-.03	.18	.04	.20	-.03	.23	-.004 [-.01 , .002]
Impulsivity	-.06	.03	-.11	<.001	-.07	.01	**.01 [.01 , .02]**
Psychopathy	.002	.94	.02	.50	.004	.87	-.002 [-.01 , .004]
Control variables							
Female	-.02	.38	.02	.47	-.02	.42	
Belgium Dummy	-.01	.77	.03	.51	-.01	.83	
Portugal Dummy	.001	.98	-.03	.41	-.003	.94	
Mediator							
Calculation					-.11	<.001	
R^2	.34		.14		.35		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Analyses with Complacency as a mediator are presented in Table 4. All expected indirect effects are significant. Stronger indirect effects are present for the descriptive norm surrounding COVID-19 vaccination among students' social circles (*ab*=.12, 95% BC-CI = [.09, .15]). A higher descriptive norm surrounding COVID-19 vaccination is related to lower Complacency and therefore to higher vaccination intention. Moreover, the perceived risk of COVID-19 for both students themselves (*ab*=.05, 95% BC-CI = [.03, .08]) and for their social environment (*ab*=.05, 95% BC-CI = [.02, .07]) is associated with higher vaccination intention through lower Complacency. Having been infected with COVID-19 is related to higher Complacency and, therefore, lower vaccination intention (partially standardized *ab*=-.05, 95% BC-CI = [-11, -.003]). Students' general risk attitude (*ab*=-.05, 95% BC-CI = [-.08, -.03]) and discount rate (*ab*=-.03,

95% BC-CI = [-.05, -.01]) are also indirectly negatively associated with COVID-19 vaccination intention through higher Complacency.

Table 4. Mediation analyses with Complacency as the mediator and vaccination intention as the dependent variable (N=1128)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Complacency		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Perceived risk of C-19: self	.03	.33	-.15	<.001	-.03	.33	**.05 [.03 , .08]**
Perceived risk of C-19: others	.04	.13	-.12	<.001	.0003	.99	**.05 [.02 , .07)**
Normative beliefs	.60	<.001	-.33	<.001	.49	<.001	**.12 [.09 , .15]**
C-19 Infection	-.03	.24	.06	.02	-.01	.76	**-.05 [-.11 , -.003]**
Risk attitude	-.07	.003	.15	<.001	-.02	.40	**-.05 [-.08 , -.03]**
Delay discounting	-.02	.47	.09	<.001	.01	.51	**-.03 [-.05 , -.01]**
Control variables							
Female	-.05	.08	-.04	.18	-.06	.01	
Belgium Dummy	.02	.60	-.11	.003	-.02	.49	
Portugal Dummy	-.01	.75	-.15	<.001	-.06	.05	
Mediator							
Complacency					-.35	<.001	
R^2	.38		.23		.48		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Table 5 shows the mediation analyses with Constraints as a mediator. We only find a small significant indirect effect of self-efficacy (*ab*=.03, 95% BC-CI = [.003, .07]). Students with a higher level of self-reported self-efficacy perceive fewer constraints, which is related to higher vaccination intention. However, a significant direct effect of self-efficacy on vaccination intention remains after controlling for Constraints (β=-.09, *p*<.01). Optimism, impulsivity and being an international student do not indirectly relate to vaccination intention through Calculation as the confidence intervals corresponding to these variables contain zero.

Table 5. Mediation analyses with Constraints as the mediator and vaccination intention as the dependent variable (n=1129)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Constraints		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Optimism	.02	.62	-.05	.11	-.01	.78	.02 [-.003 , .05]
Impulsivity	-.11	<.001	.03	.42	-.10	<.001	-.01 [-.04 , .02]
Self-efficacy	-.06	.10	-.07	.03	-.09	.003	**.03 [.003 , .07]**
International Student	.01	.64	.06	.05	.04	.11	-.09 [-.18 , .01]
Control variables							
Female	-.10	<.001	.01	.63	-.10	<.001	
Belgium Dummy	-.08	.07	.05	.22	-.05	.16	
Portugal Dummy	.06	.14	-.09	.03	.02	.60	
Mediator							
Constraints					-.47	<.001	
R^2	.05		.03		.26		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Analyses with Collective Responsibility as a mediator are presented in Table 6. We show that the risk of COVID-19 for family and friends, as perceived by students, is positively related to vaccination intention through Collective Responsibility (*ab*=.08, 95% BC-CI = [.04, .13]). Moreover, several personality traits are indirectly associated with vaccination intention through Collective Responsibility. Higher levels of psychopathy traits are negatively related to vaccination intention through lower levels of Collective Responsibility (*ab*=-.08, 95% BC-CI = -.13, -.04]). Conversely, higher levels of altruism (*ab*=.06, 95% BC-CI = [.01, .10]) and the need to belong (*ab*=.07, 95% BC-CI = [.03, .11]) positively indirectly relate to vaccination intention through Collective Responsibility.

Table 6. Mediation analyses with Collective Responsibility as the mediator and vaccination intention as the dependent variable (n=1127)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Collective Responsibility		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Perceived risk of C-19: others	.03	.27	.13	<.001	-.05	.04	**.08 [.04 , .13]**
Benefits vaccine: self vs others	-.04	.13	.05	.09	-.08	<.001	.03 [-.01 , .07]
Pyschopathy	-.10	<.001	-.13	<.001	-.02	.35	**-.08 [-.13 , -.04]**
Altruism	.01	.66	.09	.01	-.04	.09	**.06 [.01 , .10]**
Need to Belong	.14	<.001	.11	<.001	.06	.01	**.07 [.03 , .11]**
Control variables							
Female	-.14	<.001	-.08	.01	-.08	<.001	
Belgium Dummy	-.14	<.001	-.09	.04	-.09	.01	
Portugal Dummy	.03	.41	.06	.12	-.01	.82	
Mediator							
Collective Responsibility					.65	<.001	
R^2	.07		.08		.45		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Discussion

According to the results, the majority of the 1,137 Dutch, Belgian and Portuguese students do not have a full and definite intention to get vaccinated against COVID-19. More than half of them (57.7%) fall on a continuum between leaning toward acceptance and leaning toward resistance. Although a large majority of our sample has a positive propensity toward getting vaccinated against COVID-19 (85% of students indicate intentions between 'probably' and 'definitely'), the group of students who are completely acceptant of the vaccine (41%) is quite small. At the same time, only a very small group indicates to refuse a vaccination (1.6%). To achieve herd immunity through vaccination, it is crucial that more students shift their intention toward a more positive definite answer. Most gains can be achieved by targeting students who

already have a positive propensity toward vaccination but are not completely certain. As previous studies mostly use yes/no scales to assess vaccination intention, it is not possible to directly compare our results to those of previous studies. For example, using a yes/no format, 95% of respondents indicate a willingness to be vaccinated against COVID-19 in a sample of students in Italy [59].

5C drivers of students' COVID-19 vaccination intention

We show that all five components of the 5C model—Confidence, Calculation, Complacency, Constraints and Collective Responsibility—are related to COVID-19 vaccination among students. Confidence, i.e., the degree of trust in the vaccine and the system that delivers it, and Collective Responsibility, i.e., the willingness to protect others by getting vaccinated, are the strongest predictors of COVID-19 vaccination intention. This suggests that campaigns targeted at increasing vaccination intention among young adults will likely be most successful when focused on enhancing the levels of both Confidence and Collective Responsibility. Smaller negative links are present between vaccination intention and Complacency, Constraints, and Calculation.

Psychological profiles underlying COVID-19 vaccination intention

We show that psychological profiles indeed play an important role in explaining vaccination intention. As vaccination campaigns will most likely be most successful when targeted at Confidence and Collective Responsibility, we discuss which psychological variables underlie these drivers and should therefore be considered when designing interventions.

First, we show that the perceived risk and effectiveness of the vaccine both affect vaccination intention through changes in Confidence levels. The level of Confidence will likely be lower for students who perceive the vaccine as being riskier (e.g., less safe and with a higher risk of side effects) and less effective. Moreover, trust in the government and health authorities plays an important role in explaining vaccination intention through Confidence. Students with lower trust in these institutions report lower levels of Confidence, which translates into lower vaccination

intention. Finally, the descriptive norm in students' environment—the degree to which family and friends intend to get vaccinated—has a small effect on intention through Confidence. However, we show that the descriptive norm has a strong direct relationship with vaccination intention.

With respect to Collective Responsibility, it is evident that the perceived risk of COVID-19 for people in a student's social circle indirectly affects his/her vaccination intention through Collective Responsibility. Students who perceive the risk of COVID-19 for their environment as being low indicate a lower intention to get vaccinated against COVID-19, motivated by a lower willingness to protect others. Moreover, we show that personality plays an important role in explaining the perception of vaccination as a Collective Responsibility. Traits of psychopathy, which are related to antisocial behavior caused by deficits in empathy, emotion, and self-control [44], negatively relate to Collective Responsibility and, therefore, to a lower intention to get vaccinated. Similarly, students with more altruistic personalities, e.g., those who feel more sympathy toward others and want to help those in need, have a higher intention to get vaccinated against COVID-19, caused by higher levels of Collective Responsibility. Additionally, the degree to which students feel the 'need to belong' indirectly relates to higher vaccination intention through Collective Responsibility. The need to belong relates both to the human needs of wanting to affiliate with others and wanting to be accepted by others [60]. We expect that both a need to be in contact with others at risk for COVID-19 without worrying and signaling prosocial behavior to be accepted by others underlie the indirect positive relationship between the need to belong and vaccination intention through Collective Responsibility.

Implications for vaccination campaigns and interventions

What implications can these results have for public health policy? First, the data suggest that seeking to increase both Confidence and Collective Responsibility simultaneously will be

512 worthwhile since vaccination interventions that address multiple underlying drivers have been
513 shown to be more successful [61]. We provide several suggestions for both drivers separately.

514 In influencing Confidence, it is important to influence the perceived safety and effectiveness
515 of the COVID-19 vaccine. In our survey, the most prevalent reasons for not getting vaccinated
516 were related to worries about safety, side effects, development speed and the wish for the vaccine
517 to be proven effective and safe over a longer period. By challenging the misinformation
518 surrounding the vaccine and providing factual information on, for example, the reasons that the
519 vaccine was able to be developed so fast, Confidence in the vaccine can be increased. However, it
520 is important to think about how and who communicates this information because, for people with
521 a strong prior opinion, a correction of information could backfire and lead to even more divided
522 attitudes [62]. Since we showed that low Confidence is related to lower trust in the government
523 and health authorities, information about safety and efficacy should preferably be communicated
524 by people not within traditional positions of authority. A good strategy would be to use
525 'surprising validators', i.e., people seen as credible to the target audience but who are not
526 expected to share this information [62]. To reach young adults, one could, for example, think of
527 campaigns including peers or celebrities.

528 We find Collective Responsibility to be the strongest predictor of COVID-19 vaccination
529 among students. It is logical that this is an important driver for this group since students are less
530 at risk of developing severe health consequences if infected by COVID-19. Willingness to protect
531 others is thus a strong motivator. We show that the perceived risk of COVID-19 for others in a
532 student's social circle indirectly affects his or her vaccination intention through Collective
533 Responsibility. Students with at-risk family members will be more likely to get vaccinated to
534 protect those around them. Vaccination campaigns aimed at young adults may thus be more
535 successful by showing the risks for those in the close environment of students. Explaining the
536 concept of herd immunity through vaccination is an important approach, as was also

experimentally shown [63]. Students can and should be made aware that they are not just making an individual decision but also a collective decision when deciding whether to get vaccinated. To increase identification, campaigns should seek to explain why certain groups are unable to get vaccinated (e.g., people with allergic reaction to vaccines, pregnant or breastfeeding women, and those aged under 18 years). Nevertheless, our results also indicate that students with less altruistic, emphatic, and social personalities will be less likely to feel Collective Responsibility. Influencing these traits is likely to be very difficult, maybe even impossible. As these students feel less empathy toward others, campaigns focused on stressing the prosocial consequences of vaccination may not be sufficient to influence these groups as strongly and could even promote the idea of free riding [64]. Therefore, it remains important to communicate the personal risks of COVID-19 for young adults, for example, by communicating the possibilities of long-lasting adverse consequences of COVID-19, also known as 'long COVID' [65].

In addition to positively affecting vaccination intention through Confidence and Complacency, we show that the descriptive norm has a strong direct effect on vaccination intention. Descriptive norms have been proven to be strong drivers of behavior, especially in times of uncertainty [66]. Vaccination campaigns could be more successful if they make the norm among students more salient by stressing that the majority of students intend to get vaccinated.

In most countries, young adults will be the last in line for vaccination. Although this makes sense from a health perspective, governments should realize that by the time students must actively decide whether to get vaccinated, the vaccination strategy may have already led to decreased infection rates and, therefore, also to a lower perceived risk of COVID-19. Importantly, when family members are already vaccinated, the level of Collective Responsibility may decrease through a lower perceived risk of COVID-19 for others. It is therefore vital that campaigns focused on young adults start early on since the necessity of vaccination is now most salient, and therefore, positive intentions can be formulated. Studies show that once a strong

enough intention to get vaccinated is formed, this likely translates into action [67]. In terms of policy, to enhance the transition from intention to behavior, the process of getting vaccinated should be easy, fast and without unforeseen barriers [68].

Limitations and future research

The study has several limitations. *First*, we measure vaccination intention and not actual vaccination behavior. As the intention-behavior gap shows us that not all intentions translate into behavior [69], it would be interesting to research whether our results also hold with actual vaccination behavior as the dependent variable. *Second*, we study a highly educated sample of university students. Although this provides a fairer picture of the drivers of vaccination intention among young adults than studies employing a sample of the general population, the results may not be completely generalizable to all young adults. Although we expect the drivers of vaccination intention to be generalizable across this group, it may be higher in our study, as previous studies have shown higher education to be positively related to COVID-19 vaccination intention [70]. *Third*, as discussed, vaccination intention is context- and time-dependent. Since we use a snapshot of vaccination intention assessed in December 2020, attitudes and intention toward vaccination may have shifted over time. *Finally*, for future research, an important next step will be to design and test which interventions have the best outcomes in both experimental and real-life settings.

Despite its limitations, our study provides governments and public health officials with much needed levers of the important drivers of COVID-19 vaccination intention among students. Given the suggested rate of COVID-19 vaccination acceptance in our sample, we hope that our findings will contribute to the designing and improving of effective public health messaging to increase the acceptance above the percentages needed to achieve herd immunity.

Acknowledgements

We thank Karl Wennberg, Srebrenka Letina, Enrico Santarelli, Andrew Burke, Jinia Mukerjee, José María Millán, Jorge Barrientos Marín, Joern Block and Olivier Torrès for their involvement in the T1 data collection in countries not used in the present study.

References

1. Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. New England Journal of Medicine. 2020;383: 2603–2615.
2. Voysey M, Clemens SAC, Madhi SA, Weckx LY, Folegatti PM, Aley PK, et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. The Lancet. 2021;397: 99–111.
3. Mills Melinda, Rahal Charles, Brazel David, Yan Jiani, Gieysztor Sofia. COVID-19 vaccine deployment: Behaviour, ethics, misinformation and policy strategies. 2020.
4. Randolph HE, Barreiro LB. Herd immunity: understanding COVID-19. Immunity. 2020;52: 737–741.
5. Anderson RM, Vegvari C, Truscott J, Collyer BS. Challenges in creating herd immunity to SARS-CoV-2 infection by mass vaccination. The Lancet. 2020;396: 1614–1616.
6. World Health Organization. Ten threats to global health in 2019. 2019. Available: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019
7. MacDonald NE. Vaccine hesitancy: Definition, scope and determinants. Vaccine. 2015;33: 4161–4164. doi:10.1016/j.vaccine.2015.04.036
8. Dubé E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger JA. Vaccine hesitancy. Human Vaccines & Immunotherapeutics. 2013;9: 1763–1773. doi:10.4161/hv.24657
9. Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, et al. The State of Vaccine Confidence 2016: Global Insights Through a 67-Country Survey. EBioMedicine. 2016;12: 295–301. doi:https://doi.org/10.1016/j.ebiom.2016.08.042
10. Neumann-Böhme S, Varghese NE, Sabat I, Barros PP, Brouwer W, van Exel J, et al. Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. The European Journal of Health Economics. 2020;21: 977–982.
11. Murphy J, Vallières F, Bentall RP, Shevlin M, McBride O, Hartman TK, et al. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. Nature Communications. 2021;12. doi:10.1038/s41467-020-20226-9
12. Lazarus J v, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, et al. A global survey of potential acceptance of a COVID-19 vaccine. Nature Medicine. 2020. doi:10.1038/s41591-020-1124-9
13. Dubé E, Gagnon D, Nickels E, Jeram S, Schuster M. Mapping vaccine hesitancy—Country-specific characteristics of a global phenomenon. Vaccine. 2014;32: 6649–6654. doi:https://doi.org/10.1016/j.vaccine.2014.09.039
14. Schmid P, Rauber D, Betsch C, Lidolt G, Denker M-L. Barriers of Influenza Vaccination Intention and Behavior – A Systematic Review of Influenza Vaccine Hesitancy, 2005 – 2016. PLOS ONE. 2017;12. doi:10.1371/journal.pone.0170550

15. Betsch C, Böhm R, Chapman GB. Using Behavioral Insights to Increase Vaccination Policy Effectiveness. Policy Insights from the Behavioral and Brain Sciences. 2015;2: 61–73. doi:10.1177/2372732215600716
16. Gerend MA, Shepherd JE. Predicting human papillomavirus vaccine uptake in young adult women: comparing the health belief model and theory of planned behavior. Annals of Behavioral Medicine. 2012;44: 171–180.
17. Xiao X, Wong RM. Vaccine hesitancy and perceived behavioral control: A meta-analysis. Vaccine. 2020;38. doi:10.1016/j.vaccine.2020.04.076
18. Betsch C, Schmid P, Heinemeier D, Korn L, Holtmann C, Böhm R. Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. PloS one. 2018;13. doi:10.1371/journal.pone.0208601
19. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. EClinicalMedicine. 2020;26: 100495. doi:https://doi.org/10.1016/j.eclinm.2020.100495
20. Rhodes A, Hoq M, Measey M-A, Danchin M. Intention to vaccinate against COVID-19 in Australia. The Lancet Infectious Diseases. 2020.
21. Karlsson LC, Soveri A, Lewandowsky S, Karlsson L, Karlsson H, Nolvi S, et al. Fearing the disease or the vaccine: The case of COVID-19. Personality and Individual Differences. 2021;172: 110590. doi:https://doi.org/10.1016/j.paid.2020.110590
22. Sherman SM, Smith LE, Sim J, Amlôt R, Cutts M, Dasch H, et al. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey. Human Vaccines & Immunotherapeutics. 2020; 1–10. doi:10.1080/21645515.2020.1846397
23. Verity R, Okell LC, Dorigatti I, Winskill P, Whittaker C, Imai N, et al. Estimates of the severity of coronavirus disease 2019: a model-based analysis. The Lancet Infectious Diseases. 2020;20. doi:10.1016/S1473-3099(20)30243-7
24. Wismans A, Letina S, Thurik R, Wennberg K, Franken I, Baptista R, et al. Hygiene and social distancing as distinct public health related behaviours among university students during the COVID-19 Pandemic. Social Psychological Bulletin. 2020;15: 1–26.
25. Costa Jr PT, McCrae RR. Set like plaster? Evidence for the stability of adult personality. 1994.
26. Podsakoff PM, MacKenzie SB, Podsakoff NP. Sources of method bias in social science research and recommendations on how to control it. Annual review of psychology. 2012;63: 539–569.
27. Guillot C, Phirmis L, Servy H, Duputel B, Bauduceau B, Sultan A. Représentations et pratiques de vaccinations : enquête auprès de 3721 personnes diabétiques. Revue d'Épidémiologie et de Santé Publique. 2020;68: S81–S82. doi:https://doi.org/10.1016/j.respe.2020.04.036
28. Ajzen I. Constructing a theory of planned behavior questionnaire. 2006 [cited 16 Feb 2021]. Available: http://people.umass.edu/aizen/pdf/tpb.measurement.pdf.
29. Meertens RM, Lion R. Measuring an Individual's Tendency to Take Risks: The Risk Propensity Scale1. Journal of Applied Social Psychology. 2008;38: 1506–1520. doi:https://doi.org/10.1111/j.1559-1816.2008.00357.x
30. Ferrero MCA, Bessière V. The Implementation of Creative ideas: an Experimental Investiation of the Role of Entrepreneurs' Confidence and Risk-Taking Behaviour. Frontiers of Entrepreneurship Research. 2017;37: 11.
31. Koffarnus MN, Bickel WK. A 5-trial adjusting delay discounting task: accurate discount rates in less than one minute. Experimental and clinical psychopharmacology. 2014;22: 222.
32. Mazur JE. An adjusting procedure for studying delayed reinforcement. Commons, ML; Mazur, JE; Nevin, JA. 1987; 55–73.

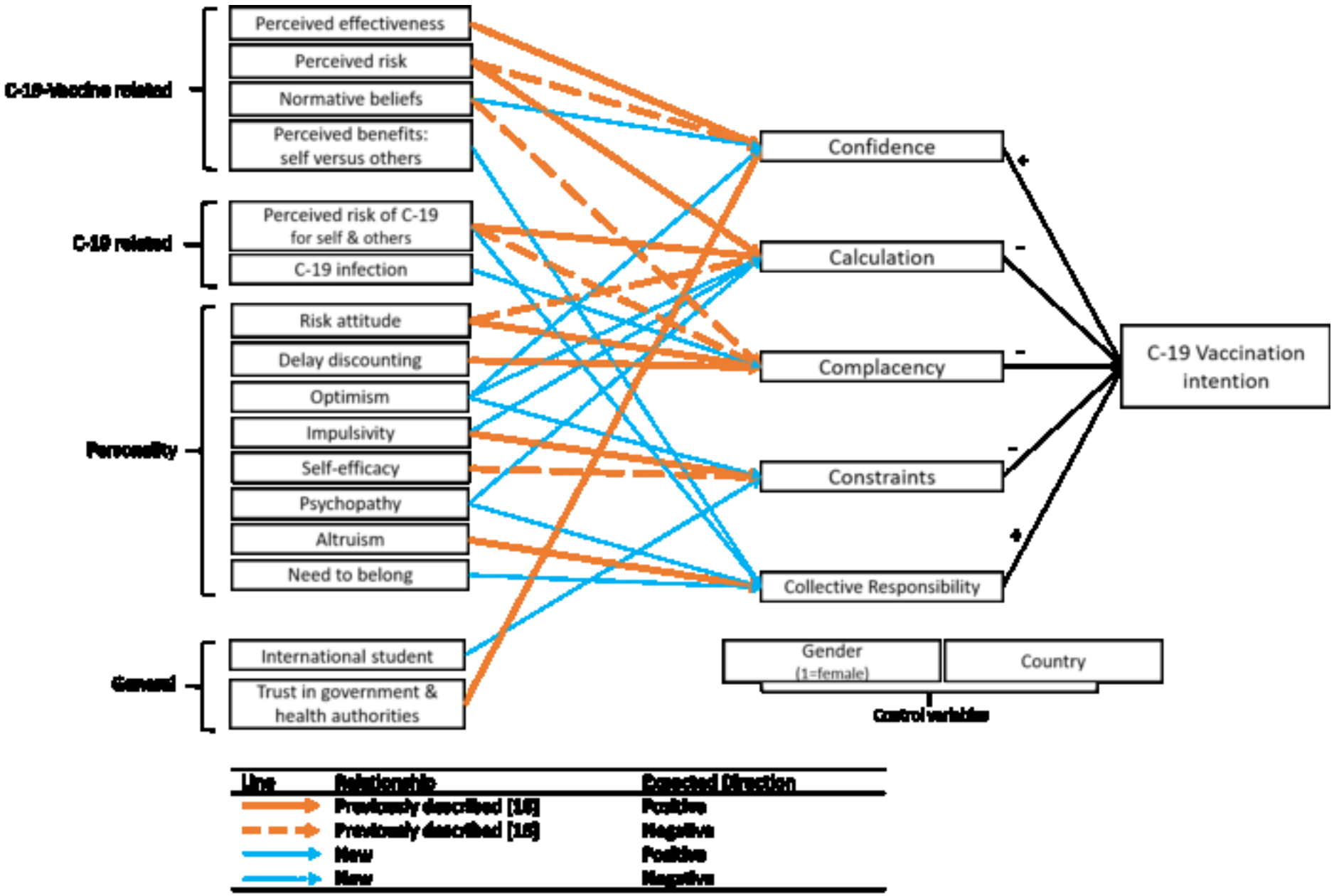
33. Yoon JH, Higgins ST. Turning k on its head: Comments on use of an ED50 in delay discounting research. Drug and Alcohol Dependence. 2008;95: 169–172.
34. Steinberg L, Sharp C, Stanford MS, Tharp AT. New tricks for an old measure: The development of the Barratt Impulsiveness Scale–Brief (BIS-Brief). Psychological assessment. 2013;25: 216.
35. Patton JH, Stanford MS, Barratt ES. Factor structure of the Barratt impulsiveness scale. Journal of clinical psychology. 1995;51: 768–774.
36. Bayle FJ, Bourdel MC, Caci H, Gorwood P, Chignon JM, Ades J, et al. Factor analysis of french translation of the Barratt impulsivity scale (BIS-10). Canadian journal of psychiatry Revue canadienne de psychiatrie. 2000;45: 156–165.
37. Lijffijt M, Barratt ES. Unpublished Translation of the Barratt Impulsiveness Scale. 2005.
38. Scheier MF, Carver CS, Bridges MW. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. Journal of personality and social psychology. 1994;67: 1063.
39. ten Klooster PM, Weekers AM, Eggelmeijer F, van Woerkom JM, Drossaert C, Taal E, et al. Optimisme en/of pessimisme: factorstructuur van de Nederlandse Life Orientation Test-Revised. Psychologie en Gezondheid. 2010;38: 89–100.
40. Trottier C, Trudel P, Halliwell WR. Présentation des deux principales théories nord-américaines sur l'optimisme. Staps. 2007; 9–28.
41. Schwarzer R, Jerusalem M. Generalized self-efficacy scale. Measures in health psychology: A user's portfolio Causal and control beliefs. 1995;1: 35–37.
42. Teeuw B, Schwarzer R, Jerusalem M. Dutch general self-efficacy scale. 1994. Available: http://userpage.fu-berlin.de/~health/dutch.htm
43. Dumont M, Schwarzer R, Jerusalem M. French Adaptation of the General Self-Efficacy Scale-Auto-efficacité Généralisée. 2000. Available: userpage. fuberlin. de/~ health/french. htm
44. Jones DN, Paulhus DL. Introducing the short dark triad (SD3) a brief measure of dark personality traits. Assessment. 2014;21: 28–41.
45. Atitsogbe KA, Hansenne M, Pari P, Rossier J. Normal Personality, the Dark Triad, Proactive Attitude and Perceived Employability: A Cross-Cultural Study in Belgium, Switzerland and Togo. Psychologica Belgica. 2020;60: 217.
46. Lee K, Ashton MC. Psychometric properties of the HEXACO-100. Assessment. 2018;25: 543–556.
47. Boies K, Yoo T-Y, Ebacher A, Lee K, Ashton MC. Validity studies psychometric properties of scores on the French and Korean versions of the Hexaco personality inventory. educational and Psychological Measurement. 2004;64: 992–1006.
48. de Vries RE, Lee K, Ashton MC. The Dutch HEXACO Personality Inventory: Psychometric properties, self–other agreement, and relations with psychopathy among low and high acquaintanceship dyads. Journal of personality assessment. 2008;90: 142–151.
49. Romero E, Villar P, López-Romero L. Assessing six factors in Spain: Validation of the HEXACO-100 in relation to the Five Factor Model and other conceptually relevant criteria. Personality and Individual Differences. 2015;76: 75–81. doi:https://doi.org/10.1016/j.paid.2014.11.056
50. de Vries RE. The 24-item Brief HEXACO Inventory (BHI). Journal of Research in Personality. 2013;47: 871–880. doi:https://doi.org/10.1016/j.jrp.2013.09.003
51. McCrae RR, Kurtz JE, Yamagata S, Terracciano A. Internal consistency, retest reliability, and their implications for personality scale validity. Personality and social psychology review. 2011;15: 28–50.
52. Nichols AL, Webster GD. The single-item need to belong scale. Personality and Individual Differences. 2013;55: 189–192. doi:https://doi.org/10.1016/j.paid.2013.02.018

53. Sanquirgo N, Oberle D, Chekroun P. The Need to Belong scale: French validation and impact on reactions to deviance. Annee Psychologique. 2012;112: 85–113.
54. Hayes AF. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. Guilford publications; 2017.
55. Shrout PE, Bolger N. Mediation in experimental and nonexperimental studies: new procedures and recommendations. Psychological methods. 2002;7: 422.
56. Hayes AF, Scharkow M. The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis: Does method really matter? Psychological science. 2013;24: 1918–1927.
57. Cheung MWL. Comparison of methods for constructing confidence intervals of standardized indirect effects. Behavior Research Methods. 2009;41: 425–438.
58. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.; 2017.
59. Pastorino R, Villani L, Mariani M, Ricciardi W, Graffigna G, Boccia S. Impact of COVID-19 Pandemic on Flu and COVID-19 Vaccination Intentions among University Students. Vaccines. 2021;9: 70.
60. Baumeister RF, Leary MR. The need to belong: desire for interpersonal attachments as a fundamental human motivation. Psychological bulletin. 1995;117: 497.
61. Frew PM, Lutz CS. Interventions to increase pediatric vaccine uptake: An overview of recent findings. Human vaccines & immunotherapeutics. 2017;13: 2503–2511.
62. Glaeser E, Sunstein CR. Does more speech correct falsehoods? The Journal of Legal Studies. 2014;43: 65–93.
63. Betsch C, Böhm R, Korn L, Holtmann C. On the benefits of explaining herd immunity in vaccine advocacy. Nature human behaviour. 2017;1: 1–6.
64. Ibuka Y, Li M, Vietri J, Chapman GB, Galvani AP. Free-riding behavior in vaccination decisions: an experimental study. PloS one. 2014;9: e87164.
65. Mahase E. Covid-19: What do we know about "long covid"? bmj. 2020;370.
66. Cialdini RB. Influence: Science and practice. Pearson education Boston, MA; 2009.
67. Auslander BA, Meers JM, Short MB, Zimet GD, Rosenthal SL. A qualitative analysis of the vaccine intention–behaviour relationship: parents' descriptions of their intentions, decision-making behaviour and planning processes towards HPV vaccination. Psychology & Health. 2019;34: 271–288. doi:10.1080/08870446.2018.1523408
68. daCosta DiBonaventura M, Chapman GB. Moderators of the intention–behavior relationship in influenza vaccinations: Intention stability and unforeseen barriers. Psychology & Health. 2005;20: 761–774. doi:10.1080/14768320500183368
69. Sheeran P. Intention—behavior relations: a conceptual and empirical review. European review of social psychology. 2002;12: 1–36.
70. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. EClinicalMedicine. 2020;26: 100495. doi:https://doi.org/10.1016/j.eclinm.2020.100495

Supporting information

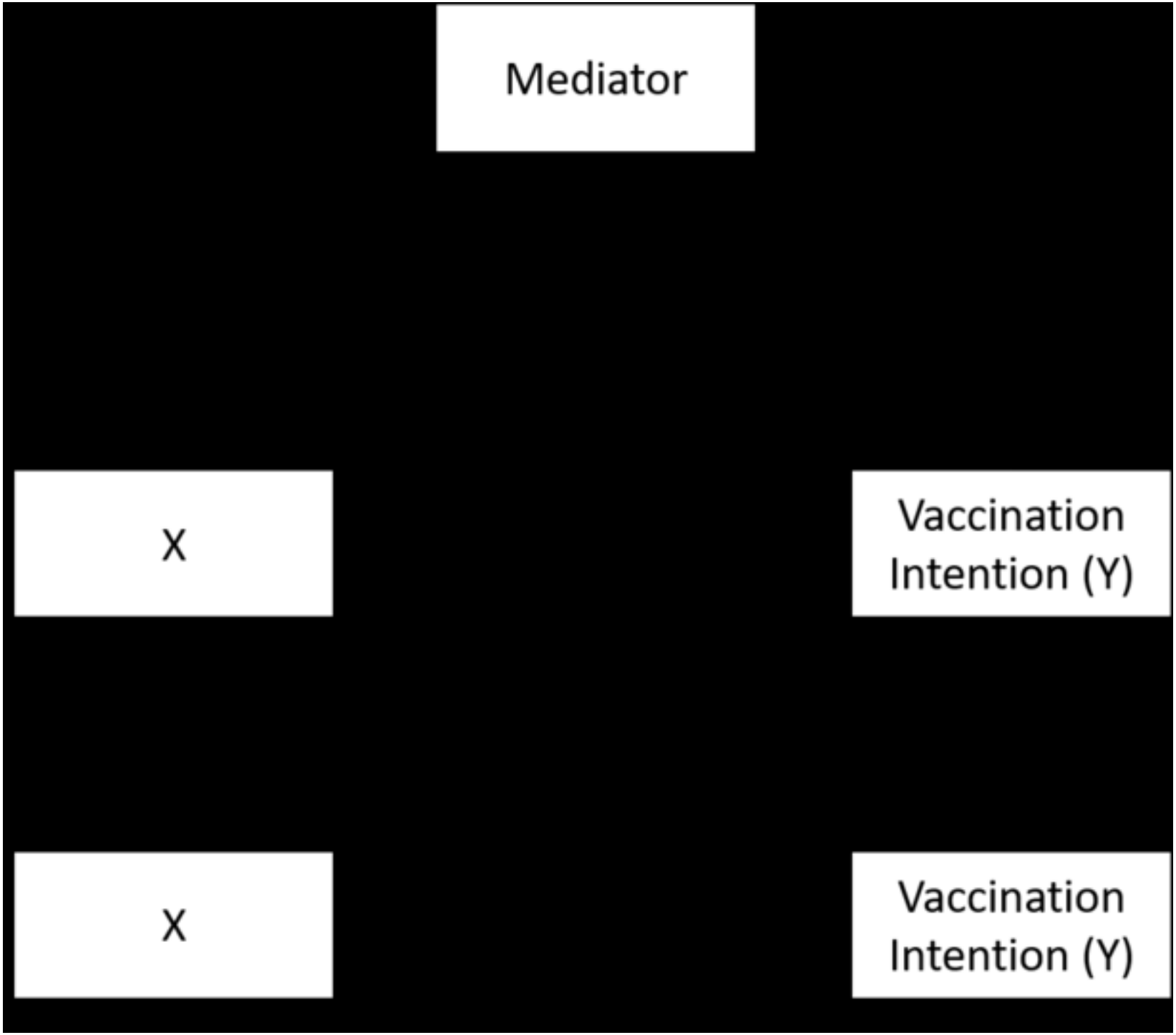
S1 Table. Mean, Standard Deviations (SD) and Correlations of all Variables.

Figure



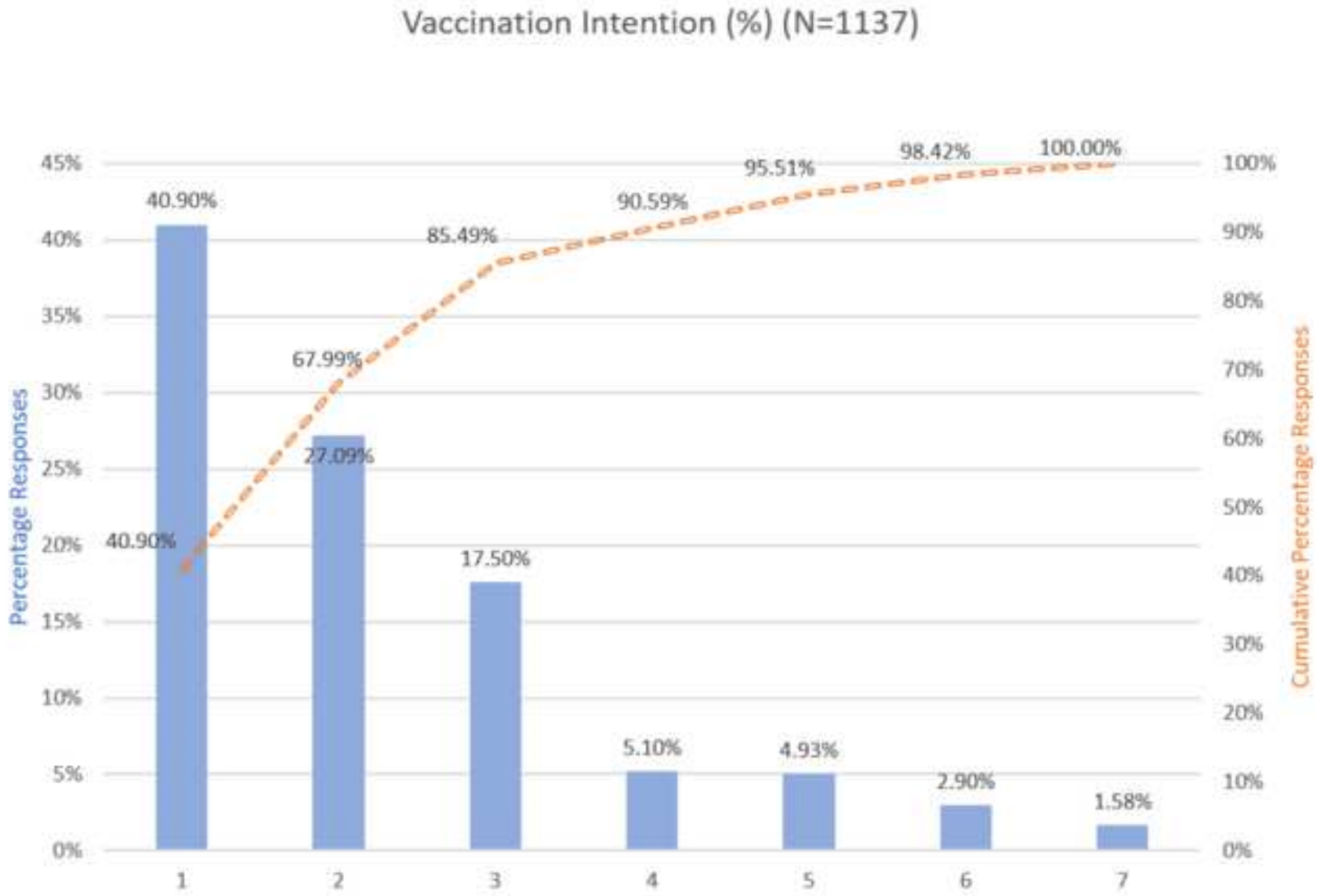
Figure

Click here to access/download;Figure;Fig2.tif

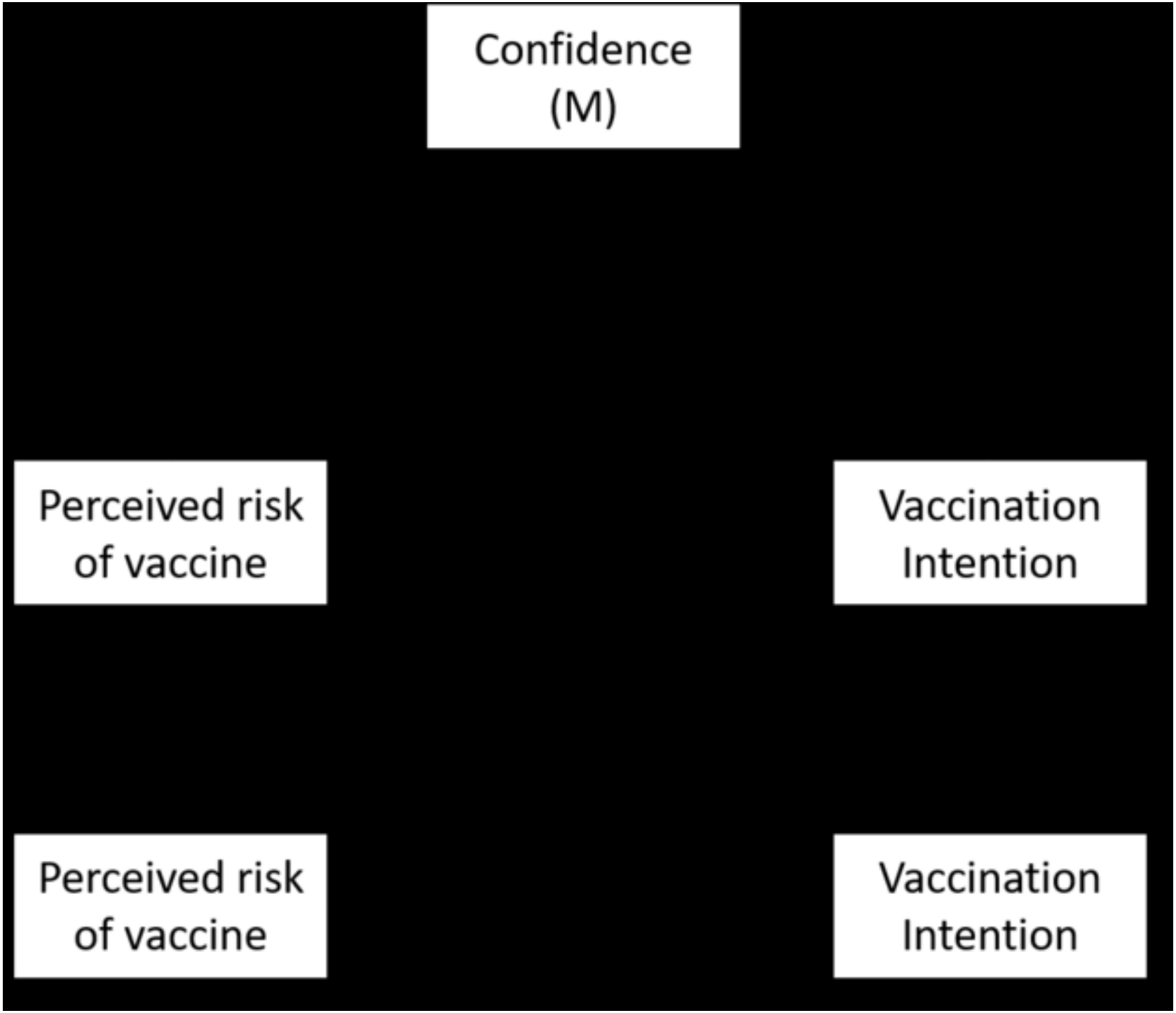


Figure

Click here to access/download;Figure;Fig3.tif



Figure



Click here to access/download

Supporting Information

S1_file.docx

Data Review URL