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ORIGINAL ARTICLE

Why some people do not get vaccinated against COVID-19: Social-cognitive determinants of vaccination behavior

Qing Han[1] | **Bang Zheng**[2,3] | **Georgios Abakoumkin**[4] | **N. Pontus Leander**[5,6] | **Wolfgang Stroebe**[5]

[1]Department of Social Policy and Intervention, University of Oxford, Oxford, UK

[2]Department of Non-communicable Disease Epidemiology, London School of Hygiene & Tropical Medicine, London, UK

[3]Ageing Epidemiology Research Unit, School of Public Health, Imperial College London, London, UK

[4]Laboratory of Psychology, Department of Early Childhood Education, University of Thessaly, Volos, Greece

[5]Department of Social and Organizational Psychology, University of Groningen, Groningen, The Netherlands

[6]Department of Psychology, Wayne State University, Detroit, Michigan, USA

Correspondence
Wolfgang Stroebe, Department of Social and Organizational Psychology, University of Groningen, 9712 TS Groningen, The Netherlands.
Email: wolfgang.stroebe@gmail.com

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Abstract

It is puzzling that a sizeable percentage of people refuse to get vaccinated against COVID-19. This study aimed to examine social psychological factors influencing their vaccine hesitancy. This longitudinal study traced a cohort of 2663 individuals in 25 countries from the time before COVID-19 vaccines became available (March 2020) to July 2021, when vaccination was widely available. Multilevel logistic regressions were used to examine determinants of actual COVID-19 vaccination behavior by July 2021, with country-level intercept as random effect. Of the 2663 participants, 2186 (82.1%) had been vaccinated by July 2021. Participants' attitude toward COVID-19 vaccines was the strongest predictor of both vaccination intention

Qing Han and Bang Zheng are co-first authors.

and subsequent vaccination behavior ($p < .001$). Perceived risk of getting infected and perceived personal disturbance of infection were also associated with higher likelihood of getting vaccinated ($p < .001$). However, religiosity, right-wing political orientation, conspiracy beliefs, and low trust in government regarding COVID-19 were negative predictors of vaccination intention and behavior ($p < .05$). Our findings highlight the importance of attitude toward COVID-19 vaccines and also suggest that certain life-long held convictions that predate the pandemic make people distrustful of their government and likely to accept conspiracy beliefs and therefore less likely to adopt the vaccination behavior.

KEYWORDS

COVID-19, longitudinal study, social psychological predictors, vaccination behavior, vaccine hesitancy

INTRODUCTION

In December 2020, the first vaccines against COVID-19 (Pfizer BioNTech & Moderna) were given emergency approval in the USA as well as in Europe, and the AstraZeneca vaccine was approved shortly afterwards. When it became known that these vaccines were highly effective in protecting people against infection and disease, there was hope that the vaccination campaign that had started in 2021 in the USA and in Europe would soon put an end to the pandemic (CDC, 2021). As we now know, this hope was unrealistic, partly because new variants of the virus emerged against which the present vaccines were less effective (Andrews et al., 2022), but also because in many countries, sizeable sections of the population did not intend to get vaccinated (Aw et al., 2021; Solís Arce et al., 2021). This raises the question of why people do not develop vaccination intentions, to get protection against a disease that can be life threatening, and whether there are early predictors of such vaccination hesitancy.

There is a sizeable literature on psychological factors associated with COVID-19 vaccination hesitancy (i.e., the intention *not* to get vaccinated; Aw et al., 2021; Wang et al., 2021). However, there are (as yet) few published longitudinal studies on the determinants of actual vaccination behavior (Eberhardt & Ling, 2021; Hilverda & Vollmann, 2022; Maciuszek et al., 2022; Okubo et al., 2021; Wang et al., 2022). Although the intention to perform a behavior is one of the best predictors of actual behavior (Ajzen, 2005; Fishbein & Ajzen, 1975), there is a well-known "intention-behavior gap", reflecting the fact that people do not always act according to their intentions (Sheeran, 2002). According to a meta-analysis of 10 previous meta-analyses (422 studies in total), the average correlation between intentions measured at one time point and behavior measured at a subsequent time point is $r = .53$ (Sheeran, 2002). This means that behavioral intentions explained only 28% of the variance in subsequent behavior in these

studies. Using data from a longitudinal survey that started in March 2020, the present study will therefore assess the prediction of both vaccination intention and actual behavior.

Social-cognitive determinants of vaccination intention and behavior

According to models of health behavior, such as the health belief model (Abraham & Sheeran, 2005; Janz & Becker, 1984), at least three conditions must be met to motivate people to engage in COVID-19 infection prevention behavior: They have to believe that (1) they are at risk of contracting the virus, (2) the consequences of getting infected would be serious, and (3) engaging in the recommended protection behaviors (i.e., vaccination) would be effective in reducing that risk. These three sets of beliefs should be the main factors influencing people's attitudes toward getting vaccinated, which in turn should be a major determinant of their vaccination intention (Ajzen, 2005; Fishbein & Ajzen, 1975).

Perceived risk and seriousness of infection

There are inconsistent findings of early studies that assessed whether the perceived risk of an infection—and severity of consequences of such an infection—influenced people's willingness to get vaccinated (Chu & Liu, 2021; Eberhardt & Ling, 2021; Hilverda & Vollmann, 2022; Huynh et al., 2021; Karlsson et al., 2021, Study 2; Shmueli, 2021). Given that several of these studies were conducted before COVID-19 vaccines were developed and made available (Chu & Liu, 2021; Huynh et al., 2021; Karlsson et al., 2021), one might suspect that any failure to find a strong and consistent association between perceived risk and vaccination intention could be due to the time period in which a study had been done. And indeed, a later British study carried out after vaccines had become widely available, reported that both susceptibility to the disease and perceived severity of a COVID-19 infection were significantly associated with respondents' intention to get vaccinated (Eberhardt & Ling, 2021). However, a longitudinal study with a Dutch student sample, that assessed risk perception as well as perceived severity in November 2020 (a few months before COVID-19 vaccination started in the Netherlands), found neither perceived risk nor perceived severity directly associated with vaccination intention assessed in March 2021 (Hilverda & Vollmann, 2022). One reason for this inconsistent finding could be the age of their sample. Younger people are typically less worried about getting infected. Meta-analytic reviews consistently report that older people, who run a higher risk than younger individuals to end up in intensive care and to die, are more fearful of the infection and more willing to get vaccinated (Aw et al., 2021; Wang et al., 2021).

Attitudes toward COVID-19 vaccines as determinants of perceived efficacy

After vaccines had become available, vaccination became the major health-protective behavior. If people perceive themselves at risk of an infection and fear the consequences of such an infection, their willingness to be vaccinated should be determined by their attitude toward COVID-19 vaccines—that is, their positive or negative evaluation of these vaccines (Ajzen, 2005; Fishbein & Ajzen, 1975). According to the health belief model, these attitudes should, in turn, be based on their beliefs about both the efficacy of the vaccine in protecting

them against an infection and the safety of these vaccines (Abraham & Sheeran, 2005; Janz & Becker, 1984).

Evidence supports the hypothesis that people's attitude toward the COVID-19 vaccine is a major determinant of their willingness to be vaccinated. For example, Chu and Liu (2021) reported that stronger safety concerns were related to lower vaccination intention in a US sample. Similarly, a systematic review of 47 studies conducted in Asia, Europe, the USA, and Africa found safety, side effects, and effectiveness as the most common predictors of vaccine acceptance (Roy et al., 2022). In a study conducted in China, concerns about vaccine safety affected actual vaccination behavior (Wang et al., 2022).

Sources of COVID-19 information and determinants of trust

How do people know about the risk of getting infected, the seriousness of such infections, and the efficacy and safety of vaccines? Although they may personally know somebody who has contracted the infection, they cannot independently—that is, based on their own experience—arrive at an objective or valid evaluation. They are instead likely to make subjective evaluations by relying on indirect information (e.g., from mass media, social media, the Internet, and politicians). Hence, people's perceptions depend on the informational content and delivery techniques of such sources, as well as people's trust in the source credibility (Allington et al., 2021). With regard to vaccines, the two main sources are governments and anti-/pro-vaccination advocates.

Trust in government

Because governments evaluate the information about the safety and effectiveness of these vaccines and provide the legal and regulatory framework for vaccination programs, people's trust in their government is a likely determinant of their attitude toward vaccines and of their willingness to get vaccinated (Han et al., 2021). Prior to COVID-19, a systematic review of studies of trust in government as a predictor of general willingness to get vaccinated (Larson et al., 2018), reported that three out of four studies found a significant positive association. More recently, trust in government emerged also as strong negative predictor of COVID-19 vaccine hesitancy in studies conducted in South Korea (Park et al., 2021), Ireland, and the UK (Murphy et al., 2021). The strongest support comes from a survey of 13,426 people in 19 countries, who were interviewed about their potential acceptance of a COVID-19 vaccine (Lazarus et al., 2021). Respondents who said they trusted their government were considerably more likely to indicate willingness to be vaccinated than people who did not trust their government (odds ratio, OR = 1.67).

Trust in anti-vaccination advocacy

Anti-vaccination advocates spread conspiracy theories about the development, safety, and effectiveness of vaccines (e.g., vaccines can alter your genes), which are inconsistent with scientific evidence (Enea et al., 2022; Jolley & Douglas, 2014). There is a great deal of evidence that people's beliefs in conspiracy theories are associated with vaccine hesitancy. A large cross-national study of 5323 respondents in 24 countries found that conspiracy beliefs were a strong predictor of anti-vaccine attitudes (Hornsey et al., 2018). Further support for this association comes from studies conducted in Chile (Baeza-Rivera et al., 2021), The Netherlands (Dijkstra, 2021), France (Bertin et al., 2020), Ireland (Murphy et al., 2021), and Romania (Maftei & Holman, 2021). Eberhardt and Ling (2021) even found conspiracy beliefs negatively associated with vaccination behavior.

It is important to note, however, that not all the negative information about vaccines comes from conspiracy theories. There have been medical problems associated with some of the vaccines, which led governments to temporarily stop using them. For example, in March 2021, more than 20 European countries temporarily stopped using the AstraZeneca COVID-19 vaccine because there had been a few cases of serious blood clotting and bleeding (Vogel & Kupferschmidt, 2021). These government decisions were taken against the advice of the European Medicine Agency and the World Health Organization, who had recommended that governments should continue immunizations while they investigated these reports. Also for blood clotting, the US government temporarily stopped the use of the Johnson & Johnson vaccine in May 2021 (Remmel, 2021). These actions are likely to have seriously undermined people's trust in the safety of COVID-19 vaccines.

Contextual factors influencing willingness to be vaccinated

People's religiosity and their political orientation are belief systems, which were formed long before the COVID-19 pandemic but influence their trust in government or their tendency to accept conspiracy beliefs. The fact that these downstream beliefs are rooted in such life-defining belief systems will make them highly resistant to change.

Religiosity

There is evidence that religiosity is negatively related to willingness to be vaccinated (Murphy et al., 2021; Upenieks et al., 2022). This relationship could be mediated by a tendency to accept conspiracy beliefs (Lowicki et al., 2022; Tonković et al., 2021), which in turn could be due to the fact that more religious populations tend to have lower trust in science (Evans, 2013). Religious fundamentalism especially, which is related to right-wing extremism, is associated with the tendency to accept conspiracy beliefs (Altemeyer & Hunsberger, 2004; Lowicki et al., 2022).

Political orientation

Because conservative politicians in the USA consistently downplayed the seriousness of COVID-19 infections (Hornsey et al., 2020), political orientation in the USA is inversely associated with perceived health risk and adoption of health-protective behaviors from mask-wearing (Stroebe et al., 2021) to vaccination (El-Mohandes et al., 2021; Huynh et al., 2021). One reason for this distrust in COVID-19 vaccines of US Republicans could be their distrust of science or willingness to believe in conspiracy theories (Jones, 2021). However, internationally opposition to COVID-19 control measures appears not exclusively to be associated with a conservative political orientation. Although in Germany, the UK, and The Netherlands, it is the right-wing/conservative parties that belittle the pandemic, vaccine hesitancy appears sometimes also to be associated with a left-wing political orientation (e.g., in South Korea; Park et al., 2021). In a European study using data of the Eurobarometer survey, ideological extremism on both sides of the political spectrum explained skepticism of vaccination (Debus & Tosun, 2021). Conservatives are probably skeptical of the need to control the pandemic, because control strategies—such as lockdowns—have serious consequences for the economy. In the USA, as well as in

Germany and the UK, conservatives also object to government interference with individual health behavior. Extremists on the left tend to believe that vaccines have not been tested sufficiently and might have serious side effects (Debus & Tosun, 2021).

Stability of belief systems and willingness to be vaccinated

In the early phase of the COVID-19 pandemic, before vaccines were developed, the health protective behaviors recommended by the government and scientific organizations were washing hands, keeping social distance, and quarantining in case of an infection (Han et al., 2021). It is plausible that most of the belief systems that determined people's earlier willingness to comply with these pre-vaccine health behavior recommendations also influence their intention to get vaccinated. A machine learning analysis based on a cross-sectional survey was conducted to identify the best predictors of compliance with the health-protective behaviors recommended earlier (van Lissa et al., 2022). The two best predictors were injunctive norms ("Right now people in my area should self-isolate and engage in social distancing") and support for strict collective virus containment measures (mandatory quarantines, reporting suspected cases, and mandatory vaccination once vaccines became available). The present study is rooted in the same project that was used for this machine learning analysis, except rather than examine the cross-sectional data, the present study focuses on subsequent longitudinal data based on a subset of participants that enrolled in the longitudinal follow-up study. The present study could thus include the same two predictors identified in the machine learning analysis as early predictors of later vaccination behavior.

The present study

We used data from a longitudinal study that assessed a wide range of candidate predictors of vaccination behavior (Agostini et al., 2022). Participants were primarily recruited for a cross-sectional survey, available in 30 languages, conducted from March to May 2020. The cross-sectional survey then served as a platform for subsequent recruitment for a longitudinal follow-up study that included the relevant measures of vaccination beliefs and behavior. Enrollment in the longitudinal study was thus largely independent.

Because little information about potential vaccines was available at the early stage of the pandemic, information about respondents' beliefs and attitudes toward COVID-19 vaccines was only collected in follow-up surveys after December 2020, when the availability of such vaccines had become a reality. At that point in time, participants' intention to get vaccinated was also measured. Given our focus on participants' actual vaccination behavior, this study included participants who completed both the initial survey wave and the final follow-up survey in July 2021—when COVID-19 vaccines were widely available.

METHODS

Data source

This study was based on longitudinal data from the PsyCorona survey on COVID-19 (Agostini et al., 2022). Details of this international web-based survey have been described in previous

papers (Han et al., 2021; van Lissa et al., 2022). After the initial international survey launched in March 2020, participants were invited to complete multiple waves of weekly, monthly, or trimonthly follow-up surveys on a voluntary basis, with the last wave launched in July 2021 (Figure 1). All participants gave informed consent before taking the survey.

Eligible participants

A total of 2841 participants of the baseline survey also completed the last wave of survey. After excluding participants who did not answer the vaccination behavior question in the last wave ($n = 22$), with missing data in country ($n = 4$), age ($n = 2$), gender ($n = 1$), or education level ($n = 3$), and excluding countries with less than 20 participants, we included 2663 participants in the analyses. These 2663 eligible participants were from 25 countries (sample size of each country varying from 27 to 446; Table S1).

Measures

We analyzed participants' vaccination behavior (i.e., having received any COVID-19 vaccine or not) reported in the last survey wave (Wave 22, July 2021). Participants' vaccination intention (i.e., "How likely are you to get vaccinated against coronavirus once a vaccine becomes available?") was repeatedly measured in the prior follow-up surveys, rated on a 5-point Likert scale from −2 (extremely unlikely) to 2 (extremely likely). In this study, we used the vaccination intention data collected right after the vaccine became available (Wave 17, December 2020); for those with missing values in intention during that wave ($n = 625$), we used the earliest intention data that they provided between Wave 18 (January 2021) and Wave 21 (April 2021).

The following candidate predictors were collected in the baseline survey (Wave 0): age (census category groupings), gender, education level, religious or not, political orientation (in a scale of −200 to 200 from left to right),[1] trust in government regarding COVID-19 (i.e., whether the government takes the right measures to deal with the coronavirus pandemic), perceived risk of getting infected with coronavirus (how likely that you will get infected), perceived severity of the negative consequences (how personally disturbing is contracting the virus), injunctive norms ("people should self-isolate and engage in social distancing"), and support for strict collective virus containment measures (Three items: mandatory quarantine, reporting people suspected to have coronavirus, and mandatory vaccination; Cronbach's $\alpha = .66$).

We assessed general conspiracy beliefs (Bruder et al., 2013) in Wave 0 (Three items: many important things are hidden from the public; politicians usually hide the true motives for their decisions; government agencies closely monitor all citizens; Cronbach's $\alpha = .75$) and COVID-19 vaccine-specific conspiracy beliefs starting in Wave 17 (Three items: the vaccine's harmful effects are being covered up; microchips are implanted for tracking people; it will change people's DNA and this fact is covered up; Cronbach's $\alpha = .84$). Item details are in Table S2.

Finally, starting in Wave 17 (December 2020), positive and negative beliefs about the COVID-19 vaccines were assessed: "The coronavirus vaccine would protect me from getting a severe case of the coronavirus", "The rapid development, testing, and approval process for the new COVID-19 vaccines makes me think that the new vaccines may not be safe", "... the new vaccines may not be effective", and "The act of receiving the coronavirus vaccine would be an unpleasant experience (i.e., it would be unpleasant to go to the medical center, talk with

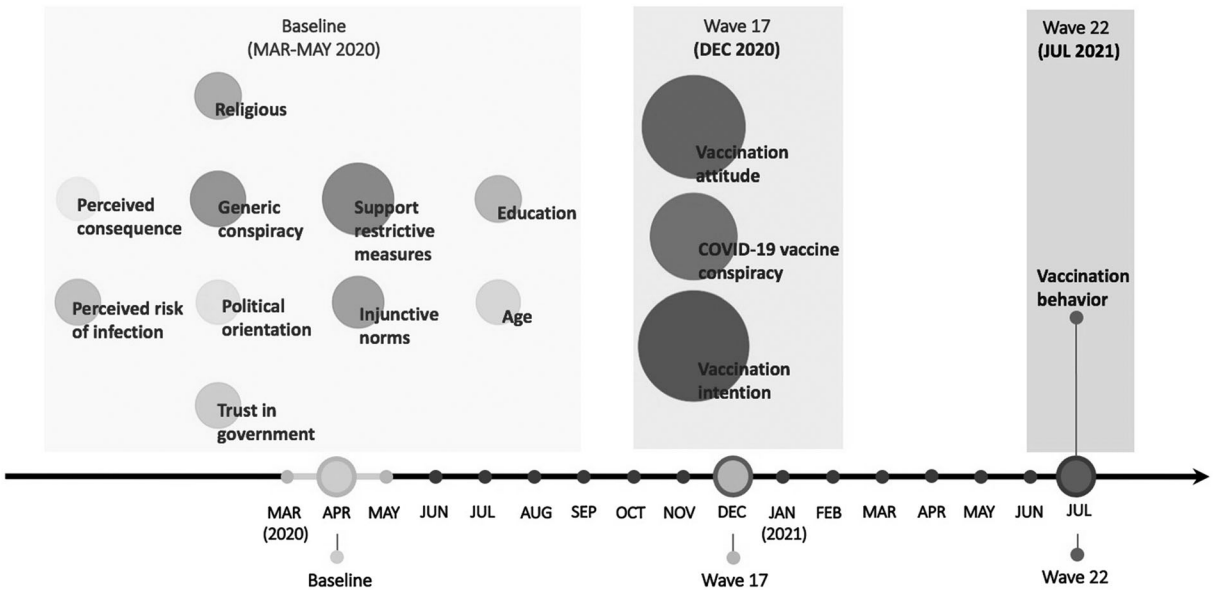

FIGURE 1 Measures of PsyCorona longitudinal survey and their associations with vaccination behavior. *Note*: The size of the bubble for a specific predictor is proportional to the odds ratio of that predictor for vaccination behavior; larger bubbles refer to stronger associations.

medical staff, and/or receive an injection with a needle)". These four items were rated in a 7-point Likert scale from −3 (strongly disagree) to 3 (strongly agree) and formed a belief-based scale for attitudes toward COVID-19 vaccines (Cronbach's $\alpha = .82$). Similar to the intention item, we imputed missing values in these four items using the earliest data available in subsequence waves until Wave 21.

Statistical analyses

Descriptive statistics of the hypothesized predictors are presented by COVID-19 vaccination behavior (yes/no). Pairwise Spearman correlation coefficients between the hypothesized predictors were calculated and tested.

We used multilevel logistic regression to examine the associations between candidate predictors and the latest COVID-19 vaccination behavior (yes/no), with country-level intercept as random effect. Odds ratio (OR) and its 95% confidence interval (CI) were estimated, which quantify the relative odds of the occurrence of the outcome per unit increase in the predictor. These predictors were tested in separate models, all adjusting for age group, gender, and education level. All continuous predictors were scaled in this analysis to reflect their relative contributions to vaccination behavior (i.e., OR of getting vaccinated per 1 SD increase of the predictor). To be noted, we conducted factor analysis with principal-component factor method to derive a COVID-19 vaccination attitude score (a scaled latent variable) from the four belief items described earlier, which showed a single-factor structure for this scale (i.e., only one eigenvalue >1). This vaccination attitude score was then assessed as a predictor in the logistic regression for subsequent COVID-19 vaccination behavior. Similarly, we derived composite scores using factor analysis for three other constructs with multiple items (all single-factor structure): support for restrictive measures, general conspiracy beliefs, and COVID-19 vaccine-specific conspiracy beliefs. Details of the factor analyses are presented in Table S3.

As an exploratory analysis, we repeated the main analysis in Europe and North America separately (where most participants resided). We also explored the associations between the four individual vaccination belief items (instead of the derived COVID-19 vaccination attitude score) and subsequent vaccination behavior.

All statistical analyses were conducted using Stata (version 15). All statistical tests are two-sided; $p < .05$ indicates statistical significance.

RESULTS

Participant characteristics

Of the 2663 participants included in this study, 67% were women; 21% were aged between 18 and 34, 56% between 35 and 64, and 23% over 65 years; 44% had education level below, 25% equivalent, and 31% above Bachelor's degree. Correlations between the hypothesized predictors are presented in Table 1.

The 2186 participants (82.1%) had been vaccinated by the last wave of survey. Those vaccinated were older, with higher education level and had a more positive vaccination attitude and stronger vaccination intention at earlier waves of survey than those unvaccinated (Table 2).

TABLE 1 Correlation table of candidate predictors

Spearman correlation coefficients	Vaccination intention	Vaccination attitude	Injunctive norms	Support for restrictive measures	Perceived risk of infection	Personally disturbing of infected	Trust in government
Vaccination intention	1						
Vaccination attitude	.70*	1					
Injunctive norms	.22*	.18*	1				
Support for restrictive measures	.26*	.18*	.30*	1			
Perceived risk of infection	.07*	.05*	.15*	.01	1		
Personally disturbing of infected	.16*	.07*	.18*	.25*	.03	1	
Trust in government	.10*	0.20*	.04	.09*	−.06*	−.03	1
Political orientation (left to right)	−.20*	−.18*	−.11*	.08*	−.10*	.00	.12*
Generic conspiracy beliefs	−.22*	−.31*	.03	.09*	.02	.11*	−.25*
Conspiracy of COVID-19 vaccine	−.57*	−.68*	−.25*	−.07*	−.08*	−.06*	−.10*
Religious (1 yes, 0 no)	−.08*	−.10*	−.03	.07*	−.06*	.07*	.11*
Age group	.10*	.09*	−.08*	.12*	−.21*	.17*	.06*
Education level	.14*	.13*	.13*	−.12*	.12*	−.06*	−.05*

*refers to $p < .05$.

TABLE 1 (Continued)

Spearman correlation coefficients	Political orientation (left to right)	Generic conspiracy beliefs	Conspiracy of COVID-19 vaccine	Religious (1 yes, 0 no)	Age group	Education level
Vaccination intention						
Vaccination attitude						
Injunctive norms						
Support for restrictive measures						
Perceived risk of infection						
Personally disturbing of infected						
Trust in government						
Political orientation (left to right)	1					
Generic conspiracy beliefs	.10*	1				
Conspiracy of COVID-19 vaccine	.29*	.30*	1			
Religious (1 yes, 0 no)	.25*	.10*	.22*	1		
Age group	.13*	−.02	.05*	.09*	1	
Education level	−.18*	−.14*	−.26*	−.07*	−.18*	1

*refers to $p < .05$.

TABLE 2 Descriptive statistics of predictors and results of multilevel logistic regression for vaccination behavior

Predictors	Vaccinated ($n = 2186$)	Unvaccinated ($n = 477$)	OR (95% CI) for getting vaccinated	p value
Vaccination intention[a]	1.20	−0.28	2.97 (2.62–3.37)	<.001
Vaccination attitude (scaled)[a]	0.17	−0.82	2.77 (2.40–3.21)	<.001
Injunctive norms for COVID-19 prevention	2.23	1.71	1.47 (1.33–1.62)	<.001
Support for COVID-19 restrictive measures (scaled)	0.07	−0.30	1.65 (1.48–1.84)	<.001
Perceived risk of getting infected	3.86	3.48	1.30 (1.16–1.45)	<.001
How personally disturbing contracting the virus is	3.99	3.73	1.22 (1.09–1.35)	<.001
Trust in government regarding COVID-19	3.02	2.78	1.29 (1.14–1.47)	<.001
Political orientation (from left to right)	−30.47	−7.46	0.80 (0.72–0.90) (inversed OR: 1.25)	<.001
Generic conspiracy beliefs (scaled)	−0.08	0.37	0.63 (0.56–0.72) (inversed OR: 1.58)	<.001
COVID-19 vaccine conspiracy beliefs (scaled)[a]	−0.16	0.79	0.44 (0.39–0.50) (inversed OR: 2.27)	<.001
Religious (yes %)	35.9%	45.5%	0.75 (0.60–0.93) (inversed OR: 1.33)	.011
Age group (8 categories from 18 to 24 to >85 years old)	4.13	3.70	1.26 (1.18–1.36)	<.001
Gender (female %)	67.3%	66.5%	1.10 (0.87–1.39)	.438
Education level (7 categories from primary education to PhD degree)	4.69	4.26	1.32 (1.22–1.43)	<.001

Note: Continuous variables (mean) and categorical variables (%) are described by vaccination status; 13%, 19%, 14%, and 24% of participants had missing values in vaccination intention, vaccination attitude, COVID-19 vaccine conspiracy beliefs, and trust in government regarding COVID-19, respectively. Multilevel logistic regression was adjusted for age, gender and education level, and included country-level random intercept. Scaled odds ratios are presented for continuous predictors which quantify the OR of getting vaccinated per 1 SD increase of the predictor.

Abbreviations: OR = odds ratio; CI = confidence interval.

[a]These items were measured during the Wave 17–21 of the survey.

Correlations between candidate predictors of vaccination behavior

The pattern of correlations shown in Table 1 was consistent with expectations based on our earlier literature review: In line with the theories of reasoned action or planned behavior (Ajzen, 2005; Fishbein & Ajzen, 1975), vaccination *intention* and *attitude* were not only highly correlated, but at $r = .70$; their correlation was by far the highest observed between any of the variables assessed in this study. Both intention and attitude were also significantly correlated with all other predictors (Table 1). People who endorsed conspiracy beliefs—especially COVID-19 vaccine-specific conspiracy beliefs—held negative vaccination attitude and intention. This is hardly surprising, given that the specific conspiracy theories claim that the harmful

effects of vaccination were being covered up and that the vaccines changed people's DNA. Other negative predictors were right-wing political orientation, religiosity, and lower levels of education (Table 1).

In line with the literature reviewed earlier, respondents, who had higher *trust in government* regarding COVID-19, also held more positive vaccination attitude and intention (Larson et al., 2018; Lazarus et al., 2021; Murphy et al., 2021; Park et al., 2021). Right-wings also had somewhat higher trust in government than left-wings.

Most of the associations between *conspiracy beliefs* and theoretically relevant variables are in the expected direction. People who believed in conspiracy theories were less trusting of their government (Bruder & Kunert, 2022). They were also more likely to be religious and less educated (Lowicki et al., 2022; Tonković et al., 2021).

The associations between *political orientation* and other relevant variables are consistent with findings in the USA reported earlier (El-Mohandes et al., 2021; Huynh et al., 2021; Stroebe et al., 2021). Compared to left-wings, right-wings perceived their risk of getting infected somewhat lower, held more negative vaccination attitude and intention, and were more likely to believe in conspiracy theories.

Finally, consistent with the assumption that the *belief systems* that predict vaccination intention and behavior are stable and were earlier also predictors of respondents' compliance with previously recommended health behaviors, beliefs in injunctive norms and support for restrictive measures were positively correlated with vaccination attitude and intention (Table 1).

Multilevel logistic regression for vaccination behavior

We used multilevel logistic regression to assess the extent to which each of the variables assessed in this study predicted actual vaccination behavior—that is, increased (or decreased) odds that, individuals reported "yes" that they had gotten vaccinated against COVID-19. This analysis showed that vaccination intention (OR = 2.97, 95% CI: 2.62–3.37) and vaccination attitude (OR = 2.77, 95% CI: 2.40–3.21) had the strongest associations with subsequent vaccination behavior (Table 2, Figure 1).[2] This means 1 SD increase in vaccination intention or attitude could contribute to up to two folds increase in odds of getting vaccinated by July 2021. It is interesting to note that although most of those with the highest vaccination intention got vaccinated by July 2021 (94.4%), 36.8% of those with the lowest intention also got vaccinated (Figure 2).

Other predictors of adopting vaccination behavior included (lower) endorsement of COVID-19 vaccine conspiracy beliefs (OR = 2.27, 95% CI: 2.00–2.56) and general conspiracy beliefs (OR = 1.58, 95% CI: 1.39–1.79), more trust in government regarding COVID-19 (OR = 1.29, 95% CI: 1.14–1.47), left-wing political orientation (OR = 1.25, 95% CI: 1.11–1.39), not being religious (OR = 1.33, 95% CI: 1.08–1.67), support for COVID restrictive measures (OR = 1.65, 95% CI: 1.48–1.84), injunctive norms regarding how the community should behave to prevent COVID-19 (OR = 1.47, 95% CI: 1.33–1.62), perceived risk of getting infected (OR = 1.30, 95% CI: 1.16–1.45), perceived personal disturbance of contracting the virus (OR = 1.22, 95% CI: 1.09–1.35), older age (OR = 1.26, 95% CI: 1.18–1.36), and higher education level (OR = 1.32, 95% CI: 1.22–1.43). The exploratory analysis in Europe and North America separately showed some variations in the effect size of predictors (partially due to the smaller sample size), but the direction and main conclusions remained unchanged (Table S4).

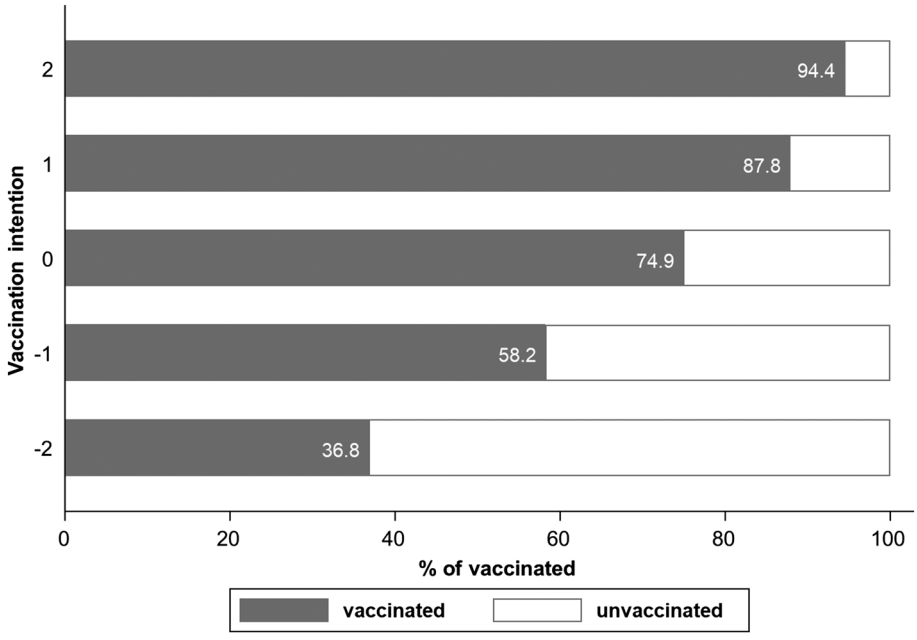

FIGURE 2 Proportion of participants vaccinated against COVID-19 by July 2021 according to earlier vaccination intention levels. *Note*: Vaccination intention was rated in a 5-point Likert scale from −2 (extremely unlikely) to 2 (extremely likely).

DISCUSSION

According to the health belief model (Janz & Becker, 1984), to make the decision to get vaccinated, people must believe that they are at risk of COVID-19 infection, that the consequences would be serious, and that getting vaccinated would protect them. Neither perceived risk nor perceived consequences of infection (i.e., how personally disturbing contracting the virus is) turned out to be strong predictors of (self-reported) vaccination behavior (Table 2). However, this association is still stronger than that reported by studies reviewed earlier, which often found no association between these variables (Chu & Liu, 2021; Huynh et al., 2021; Karlsson et al., 2021).

The attitude toward COVID-19 vaccines turned out to be a very strong predictor of actual vaccination behavior. Respondents with a positive attitude toward COVID-19 vaccines were nearly three times as likely to get vaccinated as those with less positive attitude. The attitude toward vaccines was nearly as strong a predictor of vaccination behavior as respondents' vaccination intention. As the pattern of the beliefs that formed the attitude measure showed (Table 3), the belief that getting vaccinated would protect them against getting a severe infection strongly predicted their vaccination behavior, whereas doubts in the effectiveness and safety of the vaccines or the fear that getting vaccinated would be an unpleasant experience considerably reduced people's willingness to get vaccinated. This pattern indicates that public health institutions are right in stressing the effectiveness of vaccines not only in preventing infections but particularly in reducing the risk of severe outcomes. But it is also important to stress that the vaccines are safe and have no severe side effects.

Consistent with theories of reasoned action and planned behavior (Ajzen, 2005; Fishbein & Ajzen, 1975), behavioral intention was still the best predictor of actual behavior in the present

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TABLE 3 Associations between individual vaccine belief items and vaccination behavior

Vaccine beliefs	Vaccinated ($n = 2186$)	Unvaccinated ($n = 477$)	OR (95% CI) for getting vaccinated	p value
The coronavirus vaccine would protect me from getting a severe case of the coronavirus.	1.46	0.03	2.47 (2.19–2.78)	<.001
The rapid development, testing, and approval process for the new COVID-19 vaccines make me think that the new vaccines may not be safe.	−0.32	1.19	0.42 (0.36–0.48) (inversed OR: 2.38)	<.001
The rapid development, testing, and approval process for the new COVID-19 vaccines make me think that the new vaccines may not be effective.	−1.17	0.03	0.46 (0.40–0.53) (inversed OR: 2.17)	<.001
The act of receiving the coronavirus vaccine would be an unpleasant experience.	−1.14	0.01	0.53 (0.46–0.60) (inversed OR: 1.89)	<.001

Note: Mean values of these items are described by vaccination status. Multilevel logistic regression was adjusted for age, gender and education level, and included country-level random intercept. Scaled odds ratios are presented which quantify the OR of getting vaccinated per 1 SD increase of the predictor.
Abbreviations: OR = odds ratio; CI = confidence interval.

study. An even stronger association between vaccination intention and actual behavior has been reported in a study conducted in Poland (Maciuszek et al., 2022). Like our findings, these researchers found that 96% of respondents, who declared an intention to get vaccinated just before the start of the vaccination campaign in Poland in February 2021, reported in a second interview in August 2021 that they had indeed gotten vaccinated. Yet, 22% of the respondents who had initially said that they would "definitely not" get vaccinated had changed their minds and also gotten vaccinated. This highlights the intention-behavior gap and implies that vaccination intention is not always a perfect proxy for actual vaccination behavior. According to an analysis of Sheeran (2002), the inconsistency between intention and behavior is mainly driven by inclined abstainers rather than disinclined actors. Our finding that a third of individuals who had no vaccination intention still got vaccinated, could be a result of the generally high vaccination rate (i.e., inclined actor) acting as a "social proof" effect: the fact that so many people get vaccinated indicates that this is the right thing to do (Cialdini, 2001). In addition, there could also be conformity pressure from family members who did get vaccinated. This pressure might not only be motivated by the wish that one's loved ones are safe but also by the knowledge that one's own risk of infection is lower if the people near to one are also vaccinated and thus somewhat less likely to get infected. Finally, proof of vaccination requirements for international travel may also have served as a motivator.

Conspiracy beliefs turned out to be the next best predictor of vaccination intention and behavior. Both the generic conspiracy beliefs and the COVID-19 vaccine-specific conspiracy beliefs had the highest negative correlations with vaccination attitude and intention (Table 1). People who did not believe in conspiracy theories had much higher odds to be vaccinated than those who did (Table 2). Although this is not unexpected with regard to the COVID-19 vaccine-specific conspiracy beliefs—after all, who wants their DNA being changed or microchips

implanted—it is somewhat surprising for the general conspiracy beliefs, which do not contain specific vaccine-related statements. However, given the negative correlation of general conspiracy beliefs with trust in government regarding COVID-19 ($r = -.25$), the association with vaccination behavior is likely to be at least partially mediated by respondents' distrust in government. Respondents, who expressed more trust in their government, were 30% more likely to get vaccinated than those with lower trust levels.

Religiosity was also a negative predictor of vaccination attitude, intention, and behavior. Respondents, who indicated that they were religious, were 25% less likely to be vaccinated than non-religious individuals. Because religiosity is robustly associated with both generic and COVID-19 vaccine-specific conspiracy beliefs (Table 1), it is plausible that their belief in conspiracy theories contributes to their reluctance to get vaccinated. Political orientation is also significantly associated with vaccination attitude, intention, and behavior. Respondents with a more right-wing political orientation were 20% less likely to get vaccinated than those with more left-wing views. Again, there is a relatively strong connection with both religiosity and conspiracy beliefs (Table 1). Right-wings tend to be more religious and more likely to accept conspiracy theories than their left-wing counterparts.

Research on factors associated with vaccination attitudes, intentions, and behavior is typically conducted in the hope of identifying potential determinants of that behavior that could be targeted with persuasion campaigns (Salali & Uysal, 2021). Our study provides information that could potentially be useful for such campaigns. The fact that neither the perceived risk of infection nor the severity of the expected consequences was strongly associated with vaccination intention or behavior suggests that focusing on that aspect in a persuasion campaign might not be very effective in changing people's vaccination intention or behavior. In contrast, that attitude toward COVID-19 vaccines emerged as a very strong predictor of vaccination behavior and indicated promising targets for persuasion. People were unlikely to get vaccinated if they doubted that the new vaccines would be safe or effective and if they believed that receiving the injection in healthcare settings would be an unpleasant experience (Freeman et al., 2021).

Yet, as a more important contribution, our study also highlights reasons why it is so difficult to change people's attitudes about the value of getting vaccinated. In our study, factors that were associated with vaccination attitudes, intentions, and behavior appear to be part of lifelong held belief systems and thus not very amenable to persuasion campaigns. In view of the fact that our predictor variables were assessed up to 15 months before the vaccination behavior was assessed, the strength and robustness of their associations with vaccination behavior suggests stability. Political orientation, religiosity, and generic conspiracy beliefs are likely to have predated the COVID-19 pandemic; and yet, they appear to have been major factors in shaping people's attitudes toward COVID-19 vaccines and apparent vaccine hesitancy. It is consistent with our assumption that the same factors associated with vaccination were already strongly associated with participants' previously reported willingness to comply with governmental health behavior recommendations made before vaccines were available.

Like most ambitious studies conducted under uncertain conditions, our research has some limitations. First, because this is an international study with data from 25 countries, heterogeneity across countries needs to be carefully addressed. In our analysis, we adopted multilevel regression with country as random intercept to account for the country-level differences. Second, we had missing data in the vaccination intention and attitude data collected directly after the vaccine became available (Wave 17). We therefore had to impute these missing values using the data provided between Wave 18 and 21. However, most imputed data were from Wave 18 (January 2021) and 19 (February 2021) with a relatively short time gap from Wave

17 (December 2020). Another limitation of our study is the difference in the number of participants who were successfully recruited for the initial cross-sectional survey (50,016 individuals in the 25 countries) and those who participated in the final wave of data collection in the longitudinal study in July 2021 (Wave 22). The difference in sample size is mainly due to the fact that participants in our cross-sectional survey did not sign up for a longitudinal study. However, this does not threaten the validity of our conclusions, because we are testing predictions about the association between variables rather than the strength with which variables are expressed in a representative sample (i.e., means).

It has been a great puzzle that despite the availability of vaccines that not only reduce the risk of getting infected with the SARS-COV-2 virus but are also highly effective in protecting individuals against needing hospitalization or intensive care in case of such an infection, sizeable numbers of people do not intend to be vaccinated. Our study, with a 15-month longitudinal follow-up of an international sample, offers at least a partial explanation: It seems that certain life-long held convictions make people distrustful of their government, likely to accept conspiracy beliefs, and therefore distrustful of governmental health information—including the recommendation to get vaccinated.

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CONFLICT OF INTEREST

All authors report no conflicts of interest.

ETHICS STATEMENT

The PsyCorona Survey was approved by the Ethical Committee of the University of Groningen (study code: PSY-1920-S-0390) and New York University Abu Dhabi (study code: HRPP-2020-42). All participants gave informed consent before taking the survey.

DATA AVAILABILITY STATEMENT

Data of the PsyCorona Survey have been deposited on the DataverseNL (https://doi.org/10.34894/PX5IVZ). Data from the PsyCorona Survey may only be used for scientific research purposes.

ORCID

Bang Zheng https://orcid.org/0000-0003-1814-6692
Georgios Abakoumkin https://orcid.org/0000-0002-1671-3561

ENDNOTES

[1] Political orientation was assessed using the image from the political compass (https://www.politicalcompass.org/analysis2). For the purposes of the present study, we used the economically left to economically right continuum. This measure was chosen for its adaptability across diverse political frameworks in the range of different countries from which the participants came. Participants were specifically prompted to click on a position on the graphic that represents their political orientation from economically left (−200) to economically right (+200).

[2] When we split the attitude measure into the four beliefs that formed the basis of the attitude (protection against infection, effectiveness, safety, and unpleasantness), the belief that getting vaccinated would protect against infection showed the strongest association with vaccination behavior (Table 3).

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SUPPORTING INFORMATION

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