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Correlates of COVID-19 vaccination intentions: Attitudes, institutional trust, fear, conspiracy beliefs, and vaccine skepticism

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ABSTRACT

Successful campaigns to combat the COVID-19 pandemic depend, in part, on people's willingness to be vaccinated. It is therefore critical to understand the factors that determine people's vaccination intentions. We applied a reasoned action approach - the theory of planned behavior - to explore these factors. We used data from an online survey of adults (18–74 years; n = 5044) conducted in Germany between April 9 and April 28, 2021 and found that attitudes toward getting vaccinated predicted vaccination intentions, while normative and control beliefs did not. In turn, positive attitudes toward getting vaccinated were supported by trust in science and fear of COVID-19 whereas negative attitudes were associated with acceptance of conspiracy theories and skepticism regarding vaccines in general. We advise policymakers, physicians, and health care providers to address vaccination hesitancy by emphasizing factors that support positive attitudes toward getting vaccinated, such as prevention of serious illness, death, and long-term health detriments, as opposed to exerting social pressure or pointing to the ease of getting vaccinated.

1. Introduction

Vaccination is deemed a key to successfully combat the COVID-19 pandemic (e.g., Das et al., 2020; Pandey et al., 2020; Sarwar et al., 2020). Effective vaccines have been rapidly developed and have become readily available in most developed countries in 2021 (Kashte et al., 2021; see also https://ourworldindata.org/covid-vaccinations). However, vanquishing the pandemic depends not only on the availability of effective and safe vaccines but also on peoples' willingness to be vaccinated (e.g., Dror et al., 2020). Although in most developed countries a considerable proportion of the eligible population has by now been vaccinated, vaccination acceptance rates vary greatly both between and within countries (e.g., Neumann-Böhme et al., 2020; Sallam, 2021). To date, the goal of achieving herd immunity appears out of reach as many individuals are reluctant to be vaccinated or are outright hostile to vaccination campaigns.

The vaccination campaign in Germany began officially on December 27, 2020 (Federal Ministry of Health, 2021). People from the highest priority group (e.g., people aged 80 and above, people with pre-existing conditions, residents and staff of care facilities, medical and nursing staff) were the first to get vaccinated. Beginning in April 2021 (with some variations among German states), individuals belonging to the second priority group (e.g., individuals over age 70, people with trisomy 21, dementia patients, people who have undergone organ transplants, police and law enforcement personnel, close contacts of people in need of care, pregnant women, and people living or working in refugee or homeless facilities) were vaccinated. Vaccination was organized via an appointment system of the German federal states and carried out by mobile vaccination teams in nursing homes, in state-organized vaccination centers, or – later – also by general practitioners. The national supervisory authority (Robert Koch-Institute; www.rki.de/EN/Home/) reports that, despite the ready availability of vaccines, the rate of COVID-19 vaccination in Germany decreased considerably during the summer of 2021. Measures proposed to counteract vaccination resistance included incentives to get vaccinated, preferential treatment of vaccinated persons, and sanctioning of those who refused to be

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vaccinated. However, developing effective intervention strategies requires a better understanding of the factors that determine people's willingness (or unwillingness) to be vaccinated (Michie et al., 2021; Van Bavel et al., 2020).

To explore the factors that determine vaccination intentions, the current study relies on the theory of planned behavior (TPB; Ajzen, 1991; 2012), a reasoned action approach (Fishbein and Ajzen, 2010). The conceptual framework of the TPB considers attitudes, subjective norms, and perceived behavioral control to be direct antecedents of intentions and also allows us to examine more distal background factors. The latter include beliefs about the coronavirus, concerns regarding the available vaccines, trust in institutions, religious and left-right political orientations (see Piurko et al. 2011; Wojcik et al., 2021), and socio-economic and demographic factors.

In the following section we provide a brief description of the theory of planned behavior and a review of the major findings from the international literature on vaccination intentions and hesitancy.

2. Intentions to receive a vaccination against COVID-19

2.1. The theory of planned behavior

As in other "reasoned action" approaches (see Fishbein and Ajzen, 2010), the immediate antecedent of behavior in the TPB is the *intention* to perform the behavior in question. The stronger the intention, the more likely it is that the behavior will follow. Thus, all else equal, intentions to get vaccinated should be predictive of actual behavior (for a general discussion of the relation between intention and behavior, see Fishbein and Ajzen, 2010, pp. 43–64).

According to the TPB, three kinds of considerations guide the formation of intentions. One set of considerations are instrumental and experiential beliefs about the performance of the behavior (*behavioral beliefs*). For example, people may believe that getting vaccinated reduces the likelihood of contracting the coronavirus (a positive consequence) but, at the same time, also believe that getting the shot is painful (a negative experience). In their aggregate, behavioral beliefs lead to the formation of a favorable or unfavorable *attitude toward the behavior* (for a general discussion of beliefs as the basis of attitudes, see Fishbein and Ajzen, 2010, pp. 96–103).

A second type of consideration are beliefs about the expectations and behaviors of significant social referents (e.g., spouse or partner, family, close friends, coworkers), which produce perceived social pressure to engage or not to engage in the behavior, or *subjective norm* (for a general discussion of beliefs as the basis of subjective norms, see Fishbein and Ajzen, 2010, pp. 134–148). Thus, for example, people may believe that their physicians think they should get vaccinated against COVID-19 (an injunctive normative belief supportive of the behavior) but that most of their friends do not intend to get the vaccine (a deterring descriptive normative belief).

Finally, the third type of consideration are beliefs about factors that may facilitate or impede performance of the behavior (*control beliefs*), which result in *perceived behavioral control* or a sense of *self-efficacy* (Bandura, 1997). Thus, people may believe that getting vaccinated is time consuming (an impeding control belief) but that a family member will provide a ride to a vaccination center (a facilitating control belief) (for a general discussion of control beliefs as a basis of perceived behavioral control, see Fishbein and Ajzen, 2010, pp. 170–177).

Due to space limitations in the questionnaire, in the present study we operationalized only the three direct predictors of intentions, i.e., attitudes, subjective norms, and perceived behavioral control, but not the behavioral, normative, and control beliefs that, from a theoretical perspective, provide the basis for these predictors. In most applications of the TPB, the three direct predictors of intentions have been treated as additive factors, although in the original formulation of the theory Ajzen (1985) discussed the possibility that perceived behavioral control moderates the effects of attitudes and subjective norms on intentions. Indeed, in the theory's most recent formulation (Fishbein and Ajzen, 2010), favorable attitudes and supportive subjective norms are assumed to *motivate* people to perform the behavior, but this motivation leads them to form an intention to engage in the behavior only to the extent that they believe that they can perform the behavior in question. Several empirical studies have provided evidence in support of the proposed interaction effects (e.g., Hukkelberg et al., 2014; La Barbera and Ajzen, 2020; Yzer & van den Putte, 2014).

The TPB has been used to predict and explain a variety of behaviors among which health-related behaviors are the most frequently studied domain (e.g., Bosnjak et al., 2020; Fishbein and Ajzen, 2010; Steinmetz et al., 2016; Winkelnkemper et al., 2018). A meta-analysis (Winkelnkemper et al., 2018) has shown that health-related behavioral intentions are the strongest predictors of health-related behaviors and that these intentions are predicted by attitudes, subjective norms, and perceived behavioral control (see also Godin and Kok, 1996; McEachan et al., 2011). Of direct relevance to the present study, the TPB has been applied to explain vaccination intentions concerning diseases other than COVID-19 (e.g., Agarwal, 2014; Fisher et al., 2013) showing that attitudes, subjective norms, and perceived behavioral control are consistently related to behavioral intentions, with attitudes often being the strongest predictor. This result was also found for COVID-19 vaccine uptake intentions in studies that tested the TPB (e.g., Guidry et al., 2021; Wolff, 2021) or integrated approaches using some of the TPB's predictor variables (e.g., Chu and Liu, 2021; Graupensperger et al., 2021; Mo et al., 2021; Shmueli, 2021).

2.2. Background factors relevant to COVID-19 vaccination intentions

Various factors that are not an integral part of the TPB may be related indirectly to intentions to get vaccinated against COVID-19. These *background factors* can be personal in nature (e.g., general attitudes, personality traits, values, emotions), informational (e.g., experience, knowledge, media exposure), and demographic (e.g., age, gender, race, ethnicity, education, income, religion). These factors are assumed to have no direct effects on intentions but can influence them indirectly via the more proximal antecedents of intentions specified in the theory (Fishbein and Ajzen, 2010). Thus, exploration of background factors can greatly enhance our understanding of the sociological and social psychological foundation of vaccination intentions, its primary predictors, and associated health outcomes (see also Godin et al., 2010; Hagger and Hamilton, 2021; de Leeuw et al., 2015; McKinley et al., 2020).

Institutional trust. Institutional trust refers to citizens' beliefs that institutions (e.g., government, the justice system, the medical establishment, science) act in a predictable, equitable, fair, and transparent manner and in ways that serve the citizens' interests (e.g., Fukuyama, 1995; Putnam et al., 1993). Trust in institutions is related to perceived legitimacy of institutions (Khodyakov, 2007) and compliance with formal and informal norms (Tyler, 2006). Thus, people who trust their institutions may be expected to have a more positive attitude toward getting vaccinated against COVID-19, because they are more likely to believe that official information regarding the safety and effectiveness of vaccines is accurate. By way of contrast, institutional distrust is linked to many negative outcomes such as political extremism (Algan et al., 2017), deviant behavior (Lindström, 2008), and legal permissiveness (Marien and Hooghe, 2011). People who distrust institutions may therefore be more likely to reject vaccination because they may question the safety and effectiveness of vaccines. Recent studies have found that trust in both political institutions and science were associated with positive attitudes toward the COVID-19 vaccination and a higher willingness to be vaccinated (Allington et al., 2021; Jennings et al., 2021; Jensen et al., 2021; Petravić et al., 2021; Thaker, 2021; Troiano and Nardi, 2021). In contrast, distrust in science has been found to be associated with negative attitudes and vaccination hesitancy (Al-Qerem and Jarab, 2021; Byrne et al., 2021; Chen et al., 2021; Guidry et al., 2021; Janssens et al., 2021; Jennings et al., 2021; Karlsson et al., 2021;

Kreps et al., 2021; Latkin et al., 2021c; Machida et al., 2021; Malesza and Wittmann, 2021; Mo et al., 2021; Paul et al., 2021; Petravić et al., 2021; Sherman et al., 2021; Soares et al., 2021; Thaker, 2021; Troiano and Nardi, 2021).

Fear of COVID-19. The COVID-19 pandemic has severe detrimental effects on peoples' physical and mental health (Giuntella et al., 2021). The severity of the disease, the required precautionary measures, and the possibility of being hospitalized and die are associated with increased feelings of anxiety and perceptions of threat from COVID-19, especially among vulnerable people, such as older adults, healthcare workers and caregivers, immigrants, victims of domestic violence, and people with mental health conditions or disabilities (Quadros et al., 2021; Rodríguez-Hidalgo et al., 2020). Thus, people who feel anxious about COVID-19 may be more likely to have a positive attitude toward getting vaccinated, simply because the vaccine can effectively reduce fear by providing protection from a severe or even deadly course of the disease. Recent studies have shown that the fear of infection and perceived vulnerability are indeed positively related with attitudes toward getting vaccinated against COVID-19 and vaccination intentions (Bendau et al., 2021; Chu and Liu, 2021; Fridman et al., 2021; Guidry et al., 2021; Jennings et al., 2021; Karlsson et al., 2021; Kourlaba et al., 2021; Malesza and Wittmann, 2021; Ruiz and Bell, 2021; Troiano and Nardi, 2021).

Conspiracy beliefs, denial of COVID-19 and skepticism toward vaccines. Conspiracy beliefs are narratives "in which the ultimate cause of an event is believed to be due to a plot by multiple actors working together with a clear goal in mind, often unlawfully and in secret" (Swami and Furnham, 2014, p. 220). Such beliefs are reinforced by confirmation bias (McHoskey, 1995), the tendency to search for and accept arguments and evidence that confirm one's own position on a subject while disregarding contradictory evidence. Similarly, denialism refers to rejection of the consensus on well-established scientific propositions, which is characterized by rejecting data and scientific literature, accusing scientists of conspiracy, relying on fake experts, selective picking and quoting, creating exaggerated expectations of science to scientific uncertainty, and using misrepresentation and logical fallacies (Diethelm and McKee, 2009). Conspiracy beliefs and denialism are most prevalent among people with extreme political positions (Washburn and Skitka, 2018) and those who distrust science (Lewandowsky et al., 2013). Thus, people who believe that COVID-19 is the result of a conspiracy and reject scientific consensus on the health dangers of the virus and the effectiveness and safety of vaccines are likely to have a more negative attitude toward vaccination. Recent studies have found that conspiracy beliefs and denialism regarding COVID-19 and vaccinations are related to negative attitudes and lower intentions to be vaccinated (Allington et al., 2021; Bertin et al., 2020; Freeman et al., 2021; Jensen et al., 2021; Kourlaba et al., 2021; Ruiz and Bell, 2021; Sallam et al., 2021; Sherman et al., 2021).

Socioeconomic and demographic factors, self-rated health, religiosity and left-right political orientation. Socioeconomic status is related to health behaviors such as getting vaccinated via the "barriers to immunization" mechanism (Link and Phelan, 1995; Ward and Raude, 2014). A lower socioeconomic status (e.g., low education and income, immigration background) may limit access to healthcare services and lead to poor health, lower life-expectancies, delayed vaccination, and opposition to vaccination (Kawachi et al., 1997; Peretti-Watel et al., 2014; Prislin et al., 1998; Wilkinson and Pickett, 2006; Winston et al., 2006). Indeed, recent studies indicated that higher education and other demographic factors such as older age, being male, and marriage are associated with a more positive attitude toward COVID-19 vaccination and higher vaccination intentions, while negative attitudes and vaccination hesitancy were reported for people with lower income, living with children, and having an immigrant background (Alabdulla et al., 2021; Allington et al., 2021; Byrne et al., 2021; Green et al., 2021; Kourlaba et al., 2021; Latkin et al., 2021b, 2021c; Machida et al., 2021; Paul et al., 2021; Petravić et al., 2021; Robertson et al., 2021; Ruiz and Bell, 2021; Sallam et al., 2021; Salmon et al., 2021; Soares et al., 2021; Thaker, 2021; Troiano and Nardi, 2021). Moreover, religiosity and right-wing political orientation are found to be related to negative attitudes and a lower willingness to get vaccinated against COVID-19 (Latkin et al., 2021a, 2021b; Ruiz and Bell, 2021; Troiano and Nardi, 2021), while pre-existing health conditions are related to a higher vaccination likelihood (Ruiz and Bell, 2021).

2.3. Hypotheses

We derive the following hypotheses regarding vaccination intentions based on the TPB and the background factors discussed above.

- Intentions to get vaccinated against COVID-19 can be predicted from attitude toward getting vaccinated (*H1*), subjective norm regarding this behavior (*H2*), and perceived behavioral control (*H3*).
- Perceived behavioral control moderates the relation between attitude and intention (*H4*) and between subjective norm and intention (*H5*). The strength of these relations increases with perceived behavioral control.

As noted, in the TPB, background factors are assumed to affect vaccination intentions indirectly. The following hypothesized correlations of background factors with intentions are therefore expected to be mediated by the intentions' proximal antecedents, that is, by attitude, subjective norm, and/or perceived behavioral control with respect to getting vaccinated.

- Institutional trust (*H6*) and fear of COVID-19 (*H7*) correlate positively with vaccination intentions.
- Conspiracy beliefs/denial of COVID-19 (*H8*) and skepticism toward vaccines (*H9*) correlate negatively with vaccination intentions.
- Poor health (*H10*) correlates positively with vaccination intentions.
- Religiosity (*H11*) and right-wing orientation (*H12*) correlate negatively with vaccination intentions.
- Older age (*H13*), being male (*H14*), high education (*H15*) and income (*H16*), being married or living in a partnership (*H17*) correlate positively with vaccination intentions.
- Living with children (*H18*) and immigrant background (*H19*) correlate negatively with vaccination intentions.

3. Data, measures, and methods of analysis

3.1. Data

An ongoing German online access panel by the market research institute Respondi AG (https://www.respondi.com/EN/) was used to collect the data. Panel participants were recruited online through various channels (campaigns, marketers and by self-recruitment) and, after registering, were invited by an e-mail from the company to take part in the study. The sample for the current study included 5044 participants aged 18 to 74 residing in Germany. Quotas were implemented to achieve rates for gender, age, education, income, and immigration background comparable to those in the German population (German Federal Statistical Office, 2021). With the exception of immigration background (17% in the sample, 25% in the German microcensus data) the quotas were met. Participation was voluntary and participants did not sign a separate consensus form for this study. They were paid 75 cents for their participation. The survey was conducted between April 9 and April 28, 2021 in Germany, with the approval of the ethics committee of the Faculty of Management, Economics and Social Sciences, University of Cologne, Germany (reference: 210005DS).

At the time of the survey, 19.4% of the respondents reported that they had already received at least one vaccine against COVID-19, which matched the official vaccination rate reported by the Robert Koch-Institute (e.g., 19.6% on April 17). The remaining 80.6% (n = 4061) of participants who were not yet vaccinated responded to the part of the questionnaire that contained the indicators for the TPB. We deleted careless participants (Meade and Craig, 2012) who took less than 5 min to complete the questionnaire or who gave the same answer repeatedly. The median survey completion duration was 19 min, and the final sample size included 3532 respondents.

3.2. Measures

All TPB-related questions were presented to the respondents with the request that they assume they can get an appointment for a vaccination quickly. Intentions, attitudes toward the behavior, subjective norms, and perceived behavioral control were measured using several reflective indicators for each construct.

The dependent variable *intention to receive a vaccination (INT)* against COVID-19 was measured by three indicators (int1-int3). *Attitude (ATT)*, *subjective norm (SN)*, and *perceived behavioral control (PBC)* were measured by four indicators each (att1-att4, sn1-sn4, pbc1-pbc4). All answers were given on 7-point scales.

The survey contained measures of various background factors: *COVID-19 conspiracy beliefs (CCB* – 8 indicators*)*, *general conspiracy mindedness (GCM* – 5 indicators*)*, *skepticism toward vaccines (SKV* - 3 indicators*)*, *skepticism toward doctors (SKD* – 3 indicators*)*, *fear of COVID-19 (FCV* – 3 indicators*)*, *trust in politics (TPO* – 6 indicators*)* and *trust in science (TSC* – 4 indicators*)*. In addition, we measured self-rated health, self-rated risk of a severe course of COVID-19, religiosity, political orientation and socioeconomic and demographic variables (age, gender, education, income, immigration background, partnership status, living with children). The indicators measuring the constructs, the socioeconomic and demographic variables, and descriptive statistics are shown in the Online Appendix (A1).

3.3. Methods of analysis

We applied exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to test the relationships between the unobserved latent variables and measured indicators (Brown, 2015) and structural equation modeling (Bollen, 1989) to test the substantive hypotheses. The latent interaction effects were estimated using the residual centering approach (Little et al., 2006; Steinmetz et al., 2011). For calculations we used R 3.6.1 (R Core Team, 2019) and the packages lavaan (Rosseel, 2012), psych (Revelle, 2021), and semTools (Jorgensen et al., 2021). Post-hoc power analysis was carried out using the semPower package (Moshagen and Erdfelder, 2016). We used maximum likelihood estimation with standard errors and test statistics (Satorra and Bentler, 1994; Yuan and Bentler, 2000) that are robust with respect to non-normality in the data (MLR in lavaan) and we treated missing values (whose rate was low for most variables) using full information estimation. The data used in this analysis and R codes can be retrieved from https://osf.io/7rjmp/. In addition, codes and outputs are available in the Online Appendix.

4. Results

4.1. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA)

We performed EFA for the TPB constructs and background factors and kept indicators that demonstrated high factor loadings and no cross-loadings (see Online Appendix A2). CFA models for the constructs fitted the data well and all standardized factor loadings were above 0.70 (see Online Appendix A3). Although we observed strong correlations among some constructs, they still exhibited acceptable discriminant validity (correlations below 0.85, Brown, 2015). Omega coefficients (McDonald, 1999) were satisfactory with the exception of the value for skepticism toward doctors, which was somewhat lower: $\omega_{TPO} = 0.957$, $\omega_{CCB} = 0.943$, $\omega_{ATT} = 0.940$, $\omega_{SKV} = 0.925$, $\omega_{TSC} = 0.907$, $\omega_{GCM} = 0.895$, $\omega_{FCV} = 0.841$, $\omega_{SN} = 0.816$, $\omega_{PBC} = 0.776$, $\omega_{SKD} = 0.720$.

4.2. Structural equation models

We estimated three models to test our hypothesis (see Figs. 1 and 2).

The first model (Model 1) only considered the prediction of vaccination intentions from attitudes, subjective norms, and perceived behavioral control. The results are presented in Table 1 (see also Online Appendix A4). According to standard SEM goodness of fit statistics (West et al., 2012) the model fitted the data well ($\chi^2 = 27.274$, df = 9, p = 0.001; CFI = 0.999; RMSEA = 0.026; SRMR = 0.006). Attitudes predicted intentions, and the standardized coefficient ($\beta = 0.795$) indicated a strong effect. Thus, the more favorable people's attitudes toward getting vaccinated, the stronger their intentions. Subjective norms had a significant and negative but very weak effect on intentions ($\beta = -0.094$), which could indicate a suppression effect due to the high correlation between subjective norms and attitudes ($r = 0.849$).

In a second model (Model 2) we tested the hypothesized interaction effects between perceived behavioral control and attitudes as well as between perceived behavioral control and subjective norms. The model fitted the data well ($\chi^2 = 255.015$, df = 65, p = 0.000; CFI = 0.993; RMSEA = 0.043; SRMR = 0.032). However, we found no indication of interactions (see Online Appendix A8). Thus, for the current sample hypothesis *H1* was supported, whereas hypotheses *H2* to *H5* were not. This shows that readiness to get vaccinated against COVID-19 was largely a matter of personal attitudes toward vaccination, and that perceived social pressures and barriers were of minor importance.

In the third model (Model 3), we retained attitudes as the only TPB predictor of vaccination intentions and entered the background factors as predictors of both attitudes and intentions (general conspiracy mindedness was omitted due to collinearity among predictors). In this way, we were able to test whether the background factors were indirect predictors of vaccination intentions, as postulated in the TPB, or had direct effects. The fit of the model was acceptable ($\chi^2 = 5357.172$, df = 701, p = 0.000; CFI = 0.931; RMSEA = 0.050; SRMR = 0.061). Consistent with the theory, attitudes were the only direct predictor of vaccination intentions exerting a strong effect ($\beta = 0.709$), and no other variable had a significant direct impact (Table 2). However, several background factors influenced attitudes toward getting a COVID-19 vaccination. Fear of COVID-19 ($\beta = 0.262$) and trust in science ($\beta = 0.337$) had positive and moderately sized effects on attitudes supporting our hypotheses *H6* and *H7*. The resulting (standardized) indirect effects were positive and significant and moderate in size ($\beta = 0.186$ and $\beta = 0.239$, respectively; Online Appendix A9 shows the decomposition of the effects). By way of contrast, beliefs in a COVID-19 conspiracy ($\beta = -0.143$) and skepticism toward vaccines ($\beta = -0.211$) had weak and moderate negative effects on attitudes, empirically supporting our hypotheses *H8* and *H9*. Their indirect effects on intention were significant and weak ($\beta = -0.101$ and $\beta = -0.149$, respectively). Older people had more positive attitudes than younger people with weak and moderate effects, respectively (age 30 to 59: $\beta = 0.132$, age 60 and above: $\beta = 0.220$, *H13*). Compared to females, males had more positive attitudes (with a weak effect of $\beta = 0.144$, *H14*). People with high levels of education had more positive attitudes than those with low education levels (with a very weak effect of $\beta = 0.059$, *H15*). Immigrants (*H19*) had slightly more negative attitudes than non-immigrants (with a very weak effect of $\beta = -0.089$). The indirect effects of some of these sociodemographic factors were statistically significant, small in size, and positive (age 30 to 59: $\beta = 0.094$, age 60 and above: $\beta = 0.156$, compared to individuals younger than 30; males: $\beta = 0.102$; high education: $\beta = 0.042$). The indirect effect of immigration background was significant, weak, and negative ($\beta = -0.063$). In sum, the results show that several background factors correlated, as predicted, with vaccination intentions and that these correlations were fully mediated by attitudes.

Model 3 (the most comprehensive model) was also tested with regard

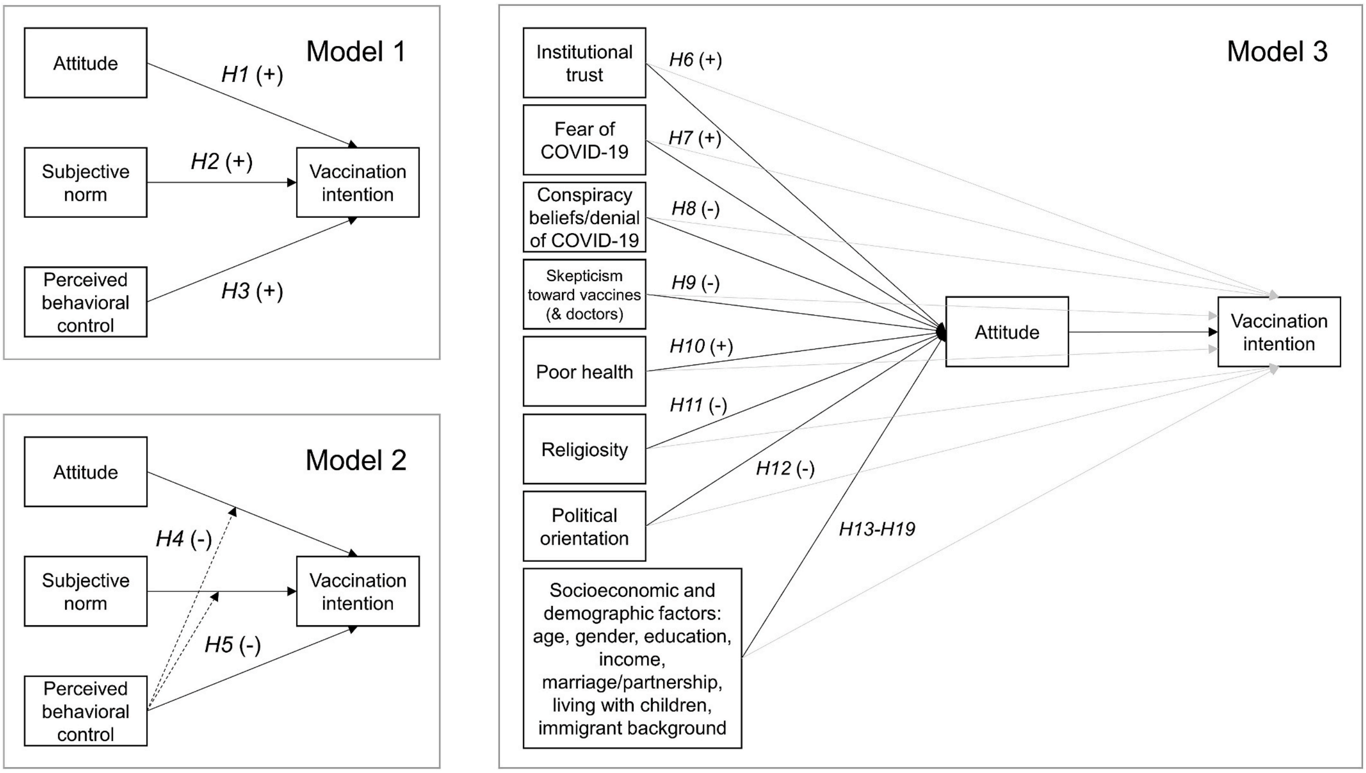

Fig. 1. Models specified to test hypotheses *H1–H19*. Solid black arrows indicate direct relationships between constructs. Dashed black arrows (Model 2) indicate moderation of relationships. Solid gray arrows (Model 3) indicate direct relationships between background factors and vaccination intention (not expected to be significant based on the TPB).

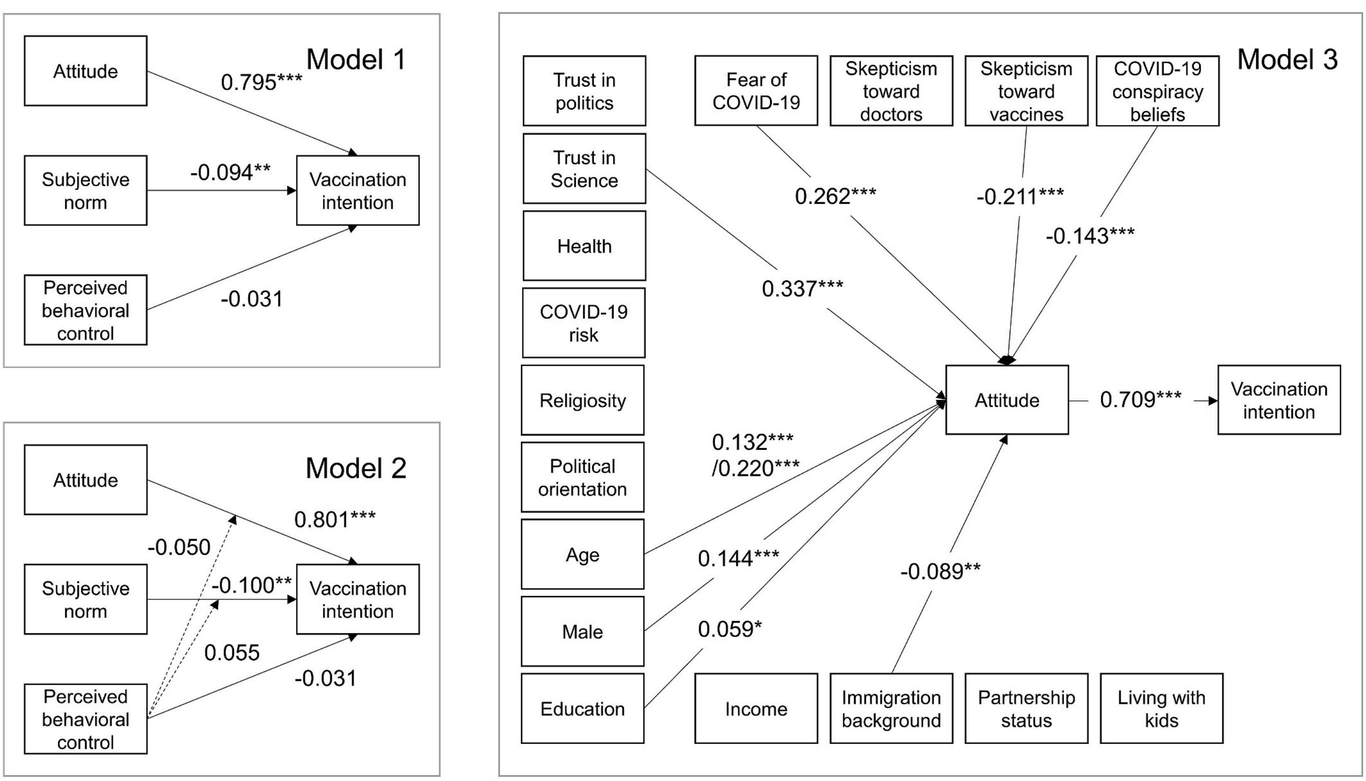

Fig. 2. SEM results (standardized coefficients), model 1: n = 3507, model 2: n = 3507, model 3: n = 3110. Different sample sizes are due to missing values on indicators (model 1 and model 2) and predictors (model 3). For clarity, correlations among predictors are not shown and only significant paths are shown for model 3. *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001.

Table 1
SEM estimates predicting vaccination intention.

Path coefficients predicting INT	Estimate	Std. Err.	z-value	P (>|z|)	Standardized estimate
ATT	1.002	0.050	20.022	0.000	0.795
SN	−0.133	0.046	−2.880	0.004	−0.094
PBC	−0.053	0.043	−1.212	0.226	−0.031
Covariances/ correlations among predictors	**Estimate**	**Std. Err.**	**z-value**	**P (>|z|)**	**Standardized estimate**
ATT ↔ SN	2.880	0.077	37.581	0.000	0.849
ATT ↔ PBC	2.210	0.084	26.326	0.000	0.796
SN ↔ PBC	1.710	0.074	23.090	0.000	0.690

Notes: n = 3507 (25 cases had missing values on all indicators), estimator = MLR, INT = intention, ATT = attitude, SN = subjective norm, PBC = perceived behavioral control.

to statistical power (Moshagen and Erdfelder, 2016). First, we assessed the achieved power of an effect (post-hoc power analysis), i.e., the probability of correctly rejecting a model when it is actually wrong. We defined the effect in terms of the RMSEA fit statistic (Steiger, 1990), which is assumed to indicate a non-acceptable discrepancy between observed and estimated covariances if RMSEA >0.05. Given the effect, the sample size and complexity of Model 3 (N = 3110; df = 701), and an alpha error level of 0.05 the estimated power was >0.999. Thus, the probability to correctly rejecting an ill-fitting model is very high. Second, we assessed a critical value of the χ^2 test statistic (compromise power analysis), which provides a decision rule about whether the estimated model is in line with the null hypothesis (i.e., perfect fit) or the alternative hypothesis (i.e., RMSEA >0.05). Given proportional alpha and beta error probabilities and the sample size and complexity of Model 3 the analysis returned a critical value of $\chi^2 = 13964.40$, which was above the observed value ($\chi^2 = 5357.172$). This suggests that the estimated model is in line with the null hypothesis of no (or negligible) discrepancy between observed and estimated covariances (for details see Online Appendix A11).

Finally, we specified four additional models to test how COVID-19 conspiracy beliefs, skepticism toward vaccines, fear of COVID-19, and trust in science are related to the socioeconomic and demographic factors, health variables, political orientation, and religiosity (see Online Appendix A12). COVID-19 conspiracy beliefs were prevalent among participants who believed that they were at moderate risk of suffering severe sickness from an infection (β = 0.103) as well as among religious individuals (β = 0.082) and those on the right of the political spectrum (β = 0.197), among people with an immigrant background (β = 0.147), and people living with children (β = 0.174). People of older age (age 30 to 59: β = −0.131, age 60 and above: β = −0.279), with a higher education (β = −0.304), and with higher income (β = −0.297) were less likely to endorse such beliefs. Skepticism toward vaccines was higher for religious people (β = 0.050), those on the right of the political spectrum (β = 0.185), people with an immigration background (β = 0.150), and people living with children (β = 0.112). People with higher education (β = −0.382) and those with a higher income (β = −0.261) were less skeptical of vaccines. Fear of COVID-19 was higher for people who believed that they were at medium or high risk of a severe course of the sickness (β = 0.306 and β = 0.543, respectively), religious people (β = 0.092), people with higher education (β = 0.205), and people living with a partner (β = 0.152). Fear was lower for people with better health (β = −0.151), those on the right of the political spectrum (β = −0.141), males (β = −0.091), and people living with children (β = −0.103). Trust in science was higher for people with better health (β = 0.071), people at medium risk of severe course of the sickness (β = 0.091), people in the oldest age group (β = 0.210), males (β = 0.198), and with higher education (β = 0.394) and income (β = 0.206). Trust was lower for those on the right of the political spectrum (β = −0.196) and people living with children (β = −0.152). Several robustness analyses are reported in the Online Appendix (A5-A7, A10).

Table 2
SEM estimates predicting intention and attitude.

Path coefficients predicting INT	Estimate	Std. Err.	z-value	P (>|z|)	Standardized estimate
ATT	0.895	0.032	28.358	0.000	0.709
CCB	0.062	0.039	1.603	0.109	0.030
SKV	−0.015	0.042	−0.368	0.713	−0.009
SKD	0.026	0.048	0.534	0.593	0.012
FCV	0.020	0.032	0.644	0.519	0.013
TPO	0.014	0.031	0.458	0.647	0.011
TSC	−0.065	0.056	−1.164	0.244	−0.035
health	0.013	0.043	0.306	0.759	0.005
risk2[a]	−0.003	0.080	−0.041	0.968	−0.001
risk3[a]	−0.142	0.115	−1.227	0.220	−0.058
rel	−0.001	0.018	−0.080	0.936	−0.001
pol	0.009	0.017	0.521	0.602	0.007
age2[b]	−0.043	0.089	−0.477	0.633	−0.017
age3[b]	0.087	0.116	0.748	0.455	0.036
male[c]	−0.105	0.069	−1.522	0.128	−0.043
edu[d]	0.024	0.087	0.270	0.787	0.010
inc[e]	0.017	0.084	0.205	0.838	0.007
imm[f]	−0.041	0.093	−0.442	0.658	−0.017
part[g]	−0.042	0.074	−0.577	0.564	−0.017
kids[h]	0.024	0.082	0.297	0.766	0.010
Path coefficients predicting ATT	**Estimate**	**Std. Err.**	**z-value**	**P (>|z|)**	**Standardized estimate**
CCB	−0.232	0.034	−6.803	0.000	−0.143
SKV	−0.292	0.037	−7.861	0.000	−0.211
SKD	−0.045	0.036	−1.227	0.220	−0.026
FCV	0.334	0.027	12.199	0.000	0.262
TPO	0.016	0.022	0.747	0.455	0.015
TSC	0.503	0.047	10.667	0.000	0.337
health	−0.032	0.033	−0.969	0.333	−0.015
risk2[a]	0.020	0.058	0.337	0.736	0.010
risk3[a]	0.122	0.086	1.428	0.153	0.063
rel	−0.013	0.014	−0.958	0.338	−0.013
pol	0.017	0.014	1.200	0.230	0.017
age2[b]	0.255	0.070	3.653	0.000	0.132
age3[b]	0.425	0.088	4.834	0.000	0.220
male[c]	0.278	0.051	5.483	0.000	0.144
edu[d]	0.113	0.056	2.020	0.043	0.059
inc[e]	0.071	0.058	1.235	0.217	0.037
imm[f]	−0.171	0.067	−2.574	0.010	−0.089
part[g]	−0.013	0.056	−0.225	0.822	−0.007
kids[h]	−0.116	0.061	−1.908	0.056	−0.060

Notes: n = 3110 (422 cases had missing values on predictors), estimator = MLR, INT = intention, ATT = attitude, CCB=COVID-19 conspiracy beliefs, SKV = skepticism toward vaccines, SKD = skepticism toward doctors, FCV = fear of COVID-19, TPO = trust in politics, TSC = trust in science, health = self-rated health, risk2 & risk3 = COVID-19 risk, rel = religiosity, pol = political orientation, age2 & age3 = age, male = gender, edu = education, inc = income, imm = immigration background; part = partnership status, kids = living with kids. Reference categories (see also Online Appendix A1): [a] low risk, [b] age <30, [c] female, [d] below tertiary, [e] ≤ 4000€, [f] no immigration background, [g] single/divorced/widowed, [h] no. Correlations among predictors are not shown (see Online Appendix A9). Standardized estimates for binary predictors are standardized with respect to the dependent variable only ("std.nox" in lavaan).

5. Summary and discussion

Achieving a high rate of vaccination is deemed a key to successfully combat the COVID-19 pandemic. Efforts have been made in many countries to distribute vaccines against the virus to people at high risk of a severe or fatal course of the disease as well as to the rest of the population (Mullard, 2020; Sharma et al., 2021). However, high vaccination rates are not solely the result of availability, effectiveness, and safety of vaccines, but also of people's willingness to get vaccinated. Based on the theory of planned behavior, we assessed the factors that contribute to people's vaccination intentions with data from Germany that reflect the situation in the second half of April 2021 in which the vaccination campaign "had picked up speed". Vaccination intentions were assumed to be a function of people's attitudes toward the vaccination, perceived social pressures to get vaccinated, and perceived barriers to vaccination. Moreover, background factors such as institutional trust, fear of COVID-19, conspiracy beliefs, denial of COVID-19, skepticism toward vaccines, health-status, religiosity, political orientation, and socioeconomic and demographic characteristics were hypothesized to influence vaccination intentions indirectly via attitudes, subjective norms, and/or perceived behavioral control.

The only direct predictor of vaccination intention was the attitude toward getting vaccinated and no interaction was found between attitudes and perceived behavioral control and between subjective norm and perceived behavioral control. These findings imply that the formation of an intention to get or not get vaccinated may largely be based on personal beliefs that performance of the behavior will result in positive or negative outcomes. This implication derives from the TPB's "expectancy-value-model of attitudes" (Fishbein, 1963, 1967; Fishbein and Ajzen, 1975, 2010), according to which a person's attitude toward a behavior is a function of readily accessible behavioral beliefs, i.e., of the perceived likelihood that performing the behavior will lead to certain valued outcomes and experiences. Specifically, the perceived likelihood of each anticipated outcome or experience is weighted (multiplied) by its subjective value, and the resulting products are summed (Fishbein and Ajzen, 2010, pp. 96–103). When the behavior is perceived to produce mostly positive outcomes and experiences, the attitude will be favorable and the likelihood of forming an intention to perform the behavior increases. When most behavioral beliefs are negative, however, the attitude will not be in favor of the behavior and the likelihood of forming an intention to perform the behavior decreases (Fishbein and Ajzen, 2010, pp. 203–205).

Contrary to our second hypothesis, subjective norms were found to make no significant contribution to the prediction of intentions to get vaccinated. This is somewhat surprising considering the important role often attributed to social media in shaping people's readiness to get vaccinated. However, it is conceivable that exposure to social media merely provides information (correct or misleading) on which people's attitudes are based. It is also possible, however, that in the case of a behavior that is of great personal significance, such as getting vaccinated, other people's wishes and behaviors decline in importance.

Perceived behavioral control also had no significant effect on intentions to get vaccinated and, contrary to our hypotheses IV and V, it did not moderate the effects of attitude or subjective norm on intentions (see also Hagger et al., 2021). However, recall that in this particular study all TPB-related questions were presented to participants with the request to assume that they can get an appointment for a vaccination quickly. In retrospect, these instructions may have led the respondents to discount any perceived barriers to vaccination and may thus have reduced the potential impact of perceived behavioral control.

Consistent with the TPB and our hypotheses, none of the background factors directly affected vaccination intentions. However, several factors had an indirect effect via their direct effects on attitudes toward getting vaccinated. We found that people who hold COVID-19 conspiracy beliefs and people who are skeptical toward vaccines were less favorably inclined toward getting vaccinated against COVID-19. Thus, conspiracy beliefs and vaccine skepticism have the potential to reduce vaccination readiness, especially in segments of society where these ideas are prevalent. The results indicate that this may be the case among people on the political right, immigrants, people with less education and lower income, younger people, and people with children in kindergarten or school. Conspiratorial ideas and opposition to vaccination have been promoted by parties and representatives of the far political right in Germany, which may have affected their followers. This may go along with a general tendency to resist governmental efforts to contain the pandemic (including the vaccination campaign), which can be observed in the so-called "Querdenker" movement that tends to be open to radical right-wing positions and science denialism (Nachtwey et al., 2020). Conspiracy beliefs and vaccination skepticism were also somewhat more common among people with an immigrant background (although this particular effect was very weak), presumably among those who have limited health care access due to a lack of knowledge of the health care system and language and cultural barriers (Crawshaw et al., 2021). Information deficits may also explain the effect of low education (and income). Moreover, younger people may be more skeptical of vaccines because their risk of serious symptoms is low. At the same time, they are strongly affected by the measures to contain the pandemic (contact restrictions, curfews, and school closures), increasing their risk of suffering from mental health problems (Batra et al., 2021; Meherali et al., 2021). The negative effects of parenthood may be explained by parents' concerns about vaccine safety and the low risk of children to suffer severely from the disease. To date, the role of children and schools as drivers of the pandemic is controversial (Oh et al., 2021) and may lead parents to adopt a defensive stance regarding vaccination of their children.

The results also confirm that people who are more trusting in science and fear suffering from COVID-19 are in favor of getting the vaccination. People with higher education (and income) and of older age had more trust in science, and people identifying with the far political right were less trusting. In line with the argumentation on conspiracy beliefs and skepticism toward vaccines, we connect the lower trust in science with a right-wing political orientation. People with a higher level of education are more inclined to believe in science because of their educational experience, whereas older people may be more trusting because they are more likely to have experienced successful medical treatments with the passage of time. Finally, more highly educated people and those at a high risk of getting seriously ill are more concerned about COVID-19 and thus are more likely to have a positive attitude toward getting vaccinated.

Our findings outline several implications for both policy makers and health care providers (for an overview in the UK, see Michie et al., 2021). First, the effect of attitudes toward getting vaccinated on vaccination intentions suggests that people are particularly concerned with personal benefits of vaccination (as opposed to collective benefits). Thus, efforts to fight vaccination hesitancy should highlight protection from serious illness, hospitalization, death, and long-term health detriments (see also Ashworth et al., 2021; Freeman et al., 2021). Approaches that emphasize social norms to get vaccinated or the ease of obtaining the vaccine may turn out to be less effective, but this may change in later stages of the pandemic, for instance, if mandatory vaccination and sanctions for noncompliance are implemented.

Second, the effect of trust in science on attitudes towards getting vaccinated suggests that messaging should be scientifically credible, precise, and persuasive, and at the same time easy to understand. Especially in the context of public debates (e.g., in the media), scientists and active researchers should be (even more) involved to support knowledge transfer. However, the development and systematic tests of such theory-driven and evidence-based interventions are still underdeveloped (Ajzen and Schmidt, 2020; Michie et al., 2021).

5.1. Limitations

The current study is not without limitations. First, we were unable to control for unobserved confounding factors (e.g., personality traits, medical preconditions), because our data was cross-sectional. Thus, randomization (as in experiments) or elimination of stable confounding variables (as with panel data) was impossible. Second, it is impossible to empirically distinguish our models from equivalent models that may be estimated with the same data (MacCallum et al., 1993). Although the structure of our analytical models was based on established theoretical considerations and alternative models may contradict theory, many alternatives may exist that could equally well fit the data and result in different conclusions. In fact, causal inference (with cross-sectional data) may be problematic. For example, contrary to the assumed mechanism, unfavorable vaccination intentions may induce a selective search for information about negative consequences of vaccination and therefore influence attitudes (reversed causality). Third, our sample may be selective in terms of who was willing to participate (Schaurer and Weiβ, 2020) and with regard to the age of the respondents (adults aged 74 and above were not considered). These factors may limit the generalizability of our findings. Finally, it remains to be seen if intentions to get vaccinated will result in people carrying out the behavior once they have the opportunity. Even though it is theoretically plausible that intentions to get vaccinated are predictive of actual behavior, unforeseen events or other barriers to performing the behavior during the pandemic may weaken the effect of intention on behavior.

Credit author statement

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.114981.

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