Vaccine: X 20 (2024) 100560

Contents lists available at ScienceDirect

Vaccine: X

journal homepage: www.elsevier.com/locate/jvacx

Association of the belief in conspiracy narratives with vaccination status and recommendation behaviours of German physicians

Frederike Taubert [a,b,*], Philipp Schmid [a,b,c], Dawn Holford [d], Pierre Verger [e], Angelo Fasce [f], Linda C. Karlsson [i,j], Anna Soveri [j,k], Stephan Lewandowsky [d,g,h], Cornelia Betsch [a,b]

[a] Institute for Planetary Health Behavior, Health Communication, University of Erfurt, Nordhäuser Straße 63, 99089 Erfurt, Germany
[b] Implementation Research, Health Communication Working Group, Bernhard Nocht Institute for Tropical Medicine, University of Hamburg, Bernhard-Nocht-Straße 74, 20359 Hamburg, Germany
[c] Centre for Language Studies, Radboud University Nijmegen, Erasmusplein 1, 6500 HD Nijmegen, The Netherlands
[d] School of Psychological Science, University of Bristol, 12A Priory Road, Bristol BS8 1TU, United Kingdom
[e] Southeastern France Health Regional Observatory (ORS PACA), Faculty of Medicine, 2 Place Le Verrier, 13004 Marseille, France
[f] Southeastern Health Regional Observatory (ORS PACA), 13004 Marseille, France
[g] School of Psychological Science, University of Western Australia, 35 Stirling Hwy, Crawley, WA 6009, Australia
[h] Department of Psychology, University of Potsdam, Am Neuen Palais 10, 14469 Potsdam, Germany
[i] Department of Psychology and Speech-Language Pathology, University of Turku, 20014 Turku, Finland
[j] Department of Psychology, Åbo Akademi University, Tehtaankatu 2, 20500 Turku, Finland
[k] Department of Clinical Medicine, University of Turku, 20014 Turku, Finland

ARTICLE INFO

Keywords:
Physicians
Recommendations
COVID-19
Trust
Vaccine hesitancy
Conspiracy theories

ABSTRACT

Vaccine hesitancy has been identified as one of the top ten threats to global health by the World Health Organization (WHO). The belief in conspiracy narratives is repeatedly discussed as a major driver of vaccine hesitancy among the general population. However, there is a lack of research investigating the role of the belief in conspiracy narratives in vaccination decisions and recommendation behaviours of physicians. This is particularly relevant as physicians are one of the major and trusted sources of information for patients' vaccination decisions. This study therefore investigated the association between believing in COVID-19-related conspiracy narratives and physicians' own COVID-19 vaccination status and their recommendation behavior for COVID-19 and other vaccines (e.g., HPV or flu). In a cross-sectional survey among German physicians (N = 602, April 2022) two conspiracy narratives were assessed, stating that the coronavirus is a hoax or that it is human-made. Additional control variables included trust in health institutions, the rejection of complementary and alternative medicine (CAM), the 5C psychological antecedents of vaccination (confidence, complacency, constraints, calculation, and collective responsibility) and demographic variables. Hierarchical regressions indicated that greater belief in the conspiracy narrative claiming that the coronavirus is a hoax was associated with lower COVID-19 vaccination uptake and fewer COVID-19 vaccination recommendations among physicians. The results for recommendation behavior remain robust even when controlling for other variables. Contrary to our assumption, believing that the coronavirus is human-made was not related to vaccination status nor vaccine recommendation behavior. In conclusion, believing in conspiracy narratives that question the existence and thus also the danger of the virus is an important independent predictor of vaccine hesitancy among physicians that should be addressed in future public health interventions.

Introduction

Healthcare workers, especially physicians, are perceived as the most trustworthy source regarding information about health and vaccinations [1,2]. Thus, physicians can play a critical role in increasing the vaccination uptake among the public [3,4]. However, vaccine hesitancy – the delay or refusal of vaccination despite availability of vaccination services e.g. [5–8] – is not a niche problem among lay people [9,10]. A global review showed that COVID-19 vaccine acceptance is not assured among healthcare workers, including physicians and nurses. Vaccine

* Corresponding author at: Nordhäuser Straße 63, 99089 Erfurt, Germany.
E-mail address: Frederike.Taubert@uni-erfurt.de (F. Taubert).

https://doi.org/10.1016/j.jvacx.2024.100560
Received 7 September 2023; Received in revised form 18 September 2024; Accepted 18 September 2024
Available online 5 October 2024

acceptance within this group of professionals ranged in 2020 from 27.7 % in the Democratic Republic of the Congo to 78.1 % in Israel [10]. In Germany at the end of 2021, about 5 % physicians who worked in hospitals and took part in a monitoring project were not fully vaccinated against COVID-19 [11]. Furthermore, vaccine hesitancy is not limited to the COVID-19 vaccine. For example, results from a survey in 14 European countries showed that only around 56 % of healthcare workers, including physicians, have received a vaccination against influenza in the last 10 years [12]. In addition, Neufeind et al. (2020) reported that only around 60 % of German family physicians were vaccinated against influenza, pertussis and hepatitis B, which are all recommended by the Standing Commission on Vaccination (STIKO) [9].

Vaccine hesitancy among physicians is of particular concern because unvaccinated physicians are not only putting themselves at risk, but, because of their close contact with patients who may be contagious, physicians can be a critical point of pathogen transmission in nosocomial infections [13]. Moreover, physicians' vaccine hesitancy can affect the way they recommend vaccinations to their patients and their efforts regarding providing information about vaccination to hesitant patients [9,14]. Verger et al. (2015) showed that some physicians in France never recommended certain vaccinations. For example, 10.9 % never recommend vaccination against Hepatitis B to adolescents and 15.7 % never recommend vaccination against Meningococcal meningitis C to 12-month-old infants [14]. This can be pivotal because one of the most important factors that influences whether a person gets vaccinated is the recommendation from their physician [3,4]. For example, several studies summarized in a review indicated that recommendations from healthcare professionals were associated with parents' decisions to vaccinate their children against HPV [4]. Furthermore, a provider recommendation for the influenza vaccination was significantly associated with higher vaccination coverage among adults in a US sample [3]. Finally, physicians are leading by example, meaning that when they are vaccinated, they may also elicit intentions to vaccinate in patients [15,16]. Therefore, understanding reasons and correlates of vaccine hesitancy among physicians is important to improve vaccine uptake and recommendation behavior [9,17]—which is the aim of the present study.

Models of vaccine hesitancy suggest potential determinants of non-vaccination and non-recommendation among physicians [6,17,18]. For example, the 5C model proposes five psychological antecedents influencing vaccine decisions—confidence, complacency, constraints, calculation and collective responsibility [17,19,20]. According to this model, getting vaccinated is associated with higher confidence in the efficacy and safety of vaccines, as well as in the vaccine development process. It is also associated with higher collective responsibility, that is, a higher willingness to protect others through one's own vaccination. Furthermore, in the model, getting vaccinated is negatively related to complacency (i.e. to perceive low risks of vaccine-preventable diseases), constraints (like poor access to healthcare or practical barriers), and one's engagement in calculations (such as extensive information search) [17]. Empirical research among German physicians shows that four factors from the 5C scale were associated with physicians' vaccination status [9]. More specifically, it was associated with higher confidence, higher collective responsibility, lower constraints and lower complacency but not with calculation [9]. Other work similarly identifies doubts about the utility and the safety of vaccines and distrust in health authorities and related institutions as relevant influencing factors [9,14,21]. Additionally, the endorsement of complementary and alternative medicine (CAM) has already been investigated several times as another factor associated with vaccination hesitancy [22,23]. In a review, several studies were summarized which identified the occasional practice of CAM as an factor which is associated with fewer vaccination recommendations and lower confidence in vaccines among physicians [24]. Yet, none of these studies focused on the belief in conspiracy narratives as a potentially relevant factor affecting physicians' vaccine hesitancy.

Belief in conspiracy theories or narratives – the belief that multiple actors meet in secret in order to achieve a hidden goal [25] – increases among the public during societal crises such as pandemics [26]. Historically, this phenomenon was evident during the AIDS epidemic [27] or the Zika virus outbreak [28] and has become evident again during the COVID-19 pandemic [29]. For example, during the pandemic, conspiracy narratives emerged that the coronavirus is a hoax or a bioweapon [29]. Agreement with various conspiracy narratives related to COVID-19 varies between 19.5 % and 55 % among the German public [30] and between 14.8 % and 28.3 % among the US public [31]. Believing in conspiracy narratives can be harmful for individuals, groups, and society [32]. For example, belief in conspiracy narratives was shown to be associated with lower use of prevention measures like handwashing and keeping physical distance during the COVID-19 pandemic [29]. Moreover, several studies indicated a positive association between vaccine hesitancy and belief in conspiracy narratives [e.g. 5–8]. For example, people who believe that the government is hiding important information about the coronavirus and its cures had a lower COVID-19 vaccination acceptance [33].

As prior research about this issue focused on the general public, empirical data about physicians is rare. However, although physicians possess more knowledge and have a more positive attitude towards vaccination than the general population [34], it is essential to investigate whether they also believe in vaccine-related conspiracy theories and whether this is linked to their vaccination behavior. Additionally, whether physicians recommend a vaccination plays an essential role in the vaccination decision of their patients [3,4]. Thus, the present study aims to investigate the association of physicians' belief in conspiracy narratives with physicians' vaccine uptake and their recommendation behavior.

Overview

The present study investigates the association between German physicians' beliefs in COVID-19 conspiracy narratives and their vaccination status (against COVID-19) and their vaccination recommendation behavior. Firstly, we wanted to test to what extent belief in conspiracy narratives about the COVID-19-vaccination was associated with the recommendation behavior for exactly this vaccination, but also whether there is a further connection to other vaccination recommendations. Such a connection could be explained by a general endorsement of conspiracy narratives – a conspiracy mentality [35,36]. Conspiracy mentality might be associated with vaccine hesitancy that is not limited to one specific vaccine [37].

For the study, we preregistered four hypotheses and our analysis plan (https://aspredicted.org/qs4kc.pdf). We assumed that less COVID-19-vaccination uptake and less recommendation behavior (for COVID-19 and other vaccinations) is associated with more pronounced beliefs in conspiracy narratives claiming that the coronavirus is a hoax (H1), and that the coronavirus is human-made (H2), less trust in German health institutions (H3) and lower rejection of complementary and alternative medicine (CAM) (H4). In addition, with hierarchical regression models, we explored whether believing in COVID-19 conspiracy narratives explains independent proportions of variance after adding known psychosocial predictors such as trust in health institutions and endorsement of CAM, the components of the 5C model and demographic variables into the models. Finally, we explored the interaction effect of believing in conspiracy narratives claiming that the coronavirus is a hoax and believing in conspiracy narratives claiming that the coronavirus is human-made on the outcome variables. Based on findings that people often hold inconsistent conspiracy beliefs (Wood et al., 2012), we assumed that a small fraction of the respondents may believe in both narratives, even if they are mutually exclusive (if it is human-made, it exists) [43]. As a conspiracy mentality is associated with lower vaccination intention [38–40], believing both types of COVID-19 conspiracy narratives may be related to high vaccine hesitancy. By adding the

interaction term, we explored this pattern and isolated it from the main effects.

Methods

Ethic approval

Ethical approval was provided by the University of Erfurt (#20210713). The study was performed in accordance with "Guidelines to ensure good scientific practice" from the German Research Foundation. Informed consent was obtained from all participants prior to data collection.

Participants and procedure

In Germany, vaccines are mainly recommended and provided by general practitioners, gynecologists and pediatricians. Thus, we focused on these groups. We preregistered a target sample size of 600 physicians. Participants whose work duties did not include conversations about vaccinations were excluded from the study.

In early April 2022, cross-sectional survey data from N = 607 German physicians were collected via the German panel provider Schlesinger Group GmbH. The panel provider contacted potential participants and sent them an email including the link to the online survey. It was announced that the study was on vaccination. 695 recipients clicked on the link and were directed to the survey. Of this group, 17 did not start the survey at all, 19 were screened out because they were not eligible and 52 did not complete the survey. The remaining 607 gave informed consent, completed the survey and received financial compensation from the panel provider.

Measures

Own COVID-19 vaccination doses

Participants were asked how many COVID-19 vaccination doses they had received, ranging from 0 to 3 doses.

Recommendation behaviour

For recommendation behavior, participants indicated the percentage of patients from the related target group for whom they actively recommend a specific vaccine (COVID-19 for adults, adolescents, children and pregnant women; Pertussis; Human Papillomavirus (HPV); Influenza and Mumps Measles Rubella (MMR)). These vaccines were selected in line with STIKO's recommendations. At the time of the study, the German STIKO recommended vaccination against Pertussis, MMR for infants, vaccination against Human Papillomavirus for children above 9 years of age and vaccination against influenza for elderly people above 60 years of age [41]. Moreover, vaccination against COVID-19 was recommended (with different numbers of doses) for everyone over 5 years of age as well as pregnant women [42]. In Germany, all people were considered fully immunized after receiving two vaccines. For adults, it was recommended to get a booster dose six months after the second vaccine to maintain protection against COVID-19 [42]. Since March 2022, a mandatory vaccination for medical staff has been in force in Germany [43].

To answer the recommendation behavior question, participants could either give a response on a 11-point scale labelled in 10 % increments (ranging from 0 = *0 %* to 10 = *100 %*) or indicate that they do not treat patients of the relevant target group. If they did not treat this group, participants indicated their intention to recommend the vaccine to a patient of this group (on the scale ranging from 0 = *0 %* to 10 = *100 %*). For analysis, means of recommendation behavior for the COVID-19 vaccine and for other vaccines were calculated separately. If participants did not treat a specific group their response was excluded from the recommendation behavior mean for that vaccine. As a robustness check, we calculated a combined mean for recommendation behavior and recommendation intention for all vaccines—thus including data from all participants for this combined mean.

Belief in COVID-19 conspiracy narratives

Belief in COVID-19 conspiracies was measured using a scale from Imhoff and Lamberty [29], which differentiates between the belief that the coronavirus is a hoax (e.g., "The virus is intentionally presented as dangerous in order to mislead the public") and that it is human-made (e.g., "Corona was intentionally brought into the world to reduce the population"). Each subscale consists of three items with response alternatives from *1 = strongly disagree* to *7 = strongly agree*. Means for each subscale were calculated.

Trust in German health institutions

The survey included items to measure trust in German health institutions (Robert-Koch-Institute, Paul-Ehrlich-Institute, Federal Ministry of Health) with a 5-point scale, ranging from *1 = strongly disagree* to *5 = strongly agree*. For analysis, a mean of all three items was calculated.

Rejection of CAM

Participants received a scale to measure their rejection of CAM consisting of five items (e.g., "Complementary medicine can be dangerous in that it may prevent people getting proper treatment.") with response alternatives from *1 = strongly disagree* to *7 = strongly agree*. This scale was developed by Hyland et al. [44] and extended from Lewandowsky et al. [45] and includes three reverse-coded items. These three items were recoded so that all items captured rejection of CAM. To use CAM in the analysis, a mean of all five items was calculated.

In addition, the survey also included the validated short version of the 5C scale [17,19,20]. Finally, the survey assessed demographic variables and collected information about the physicians' professional activities. The complete questionnaire is available at OSF (https://osf.io/826yu/).

Statistical analyses

Statistical analyses were conducted with R (Version R 3.6.3). The analysis code and the full dataset are available at OSF (https://osf.io/826yu/). First, we calculated Pearson correlations to check whether believing in COVID-19 conspiracy narratives, trust in German health institutions and rejection of CAM were associated with the outcome variables. Furthermore, we used hierarchical linear regressions to test our hypotheses. For each outcome variable – own COVID-19 vaccination status, COVID-19 vaccination recommendation behavior and recommendation behavior for other vaccines – four models were analyzed. The first models tested whether belief in conspiracy narratives was associated with vaccination status and recommendation behavior among physicians (H1 and H2) and included the two variables on belief in COVID-19-related conspiracy narratives (hoax, human-made) and their interaction as predictors. For Model 2, trust in German health institutions and rejection of CAM were added to Model 1 to test their association with the outcome variables (H3 and H4, enter method). Additionally, in two regression models, we added in a stepwise manner the 5C items (Model 3) and demographic variables (age, gender, having children, Model 4), exploring whether believing in conspiracy narratives remained a significant predictor when controlling for known determinants of vaccine hesitancy and demographic variables. For all analyses, we used a Bonferroni-corrected alpha of 0.004 (0.05/12) to account for the number of analyses.

Results

Reliability of measurements

For the COVID-19 conspiracy beliefs scale, we calculated two means based on three items each. The hoax subscale showed an acceptable

reliability with Cronbach's a = 0.76, whereas the human-made subscale did not provide an acceptable reliability with Cronbach's a = 0.48 [46]. By excluding the third item of the scale ("I think it's nonsense that the virus was created in a laboratory", reverse-coded) the Cronbach's a for the human-made subscale increased to 0.81. When removing the reverse-coded item ("We should believe experts when they say that the virus is dangerous") from the hoax subscale the Cronbach's a increased to 0.89. We reran the regression models described below with the hoax subscale without the reverse-coded item and received similar results as with reversed coded item (for details, see OSF, R Supplement section 10).

The scale to measure rejection of CAM had acceptable reliability with Cronbach's a = 0.79. Also, the scale to measure trust in German health institutions showed good reliability with a Cronbach's a = 0.82. Cronbach's a across all items for COVID-19 vaccine recommendation behavior for different target groups was 0.78 and across all other vaccines 0.72. For the following analysis, the mean scores were used as planned, except for the human-made subscale where just the mean of the first two items were calculated. Table 1 displays the descriptive statistics for the measured variables.

Sample characteristics

Four participants were excluded from the final dataset because talking about vaccinations was not part of their job duties and one participant was excluded for providing an implausible age. The final dataset included 602 physicians: 410 general practitioners (68.1 %), 113 gynecologists (18.8 %) and 79 pediatricians (13.1 %). Participants were 28–82 years old (M = 52.65, SD = 10.36), including 372 males, 226 females and 2 non-binary individuals.

Variables associated with vaccination status and recommendation behavior

We calculated Pearson correlations with COVID-19 conspiracy narratives, trust in German health institutions as well as rejection of CAM, and the outcome variables. The results showed that all but one of the variables were significantly correlated with the number of own COVID-19 vaccine doses and vaccine recommendations for COVID-19 and other vaccines. Only the correlation between belief in the human-made conspiracy narratives and COVID-19 vaccine recommendations was not significant. The full correlation table is provided in the supplement (see OSF, R Supplement section 4).

Table 1
Descriptive information about the measured variables.

	Number of items	Range	Mean	Median	Standard Deviation
Own COVID-19 vaccination doses	1	0–3	2.88	3	0.47
COVID-19 vaccine recommendation behavior	4	0–100	72.48	77.5	23.72
Other vaccine recommendation behavior	4	0–100	86.34	92.5	17.71
Belief in hoax conspiracy narratives	3	1–7	1.89	1.33	1.26
Belief in human-made conspiracy narratives	2	1–7	1.53	1	1.98
Rejection of CAM	5	1–7	5.34	5.4	1.28
Trust in German health institutions	3	1–5	4.12	4.33	0.82
Confidence (5C)	1	1–7	5.84	6	1.45
Constraint (5C)	1	1–7	1.78	1	1.47
Complacency (5C)	1	1–7	1.49	1	1.30
Calculation (5C)	1	1–7	5.63	6	1.71
Collective (5C)	1	1–7	1.49	1	1.24

Test for multicollinearity

There was no indication of multicollinearity, such as a strong correlation between the predictor variables in the regression models (all VIFs < 3; for details, see OSF, R Supplement section 5–7).

Own COVID-19 vaccination status

554 participants (92.0 %) reported being vaccinated three times, in accordance with the officially recommended vaccination schedule at the time of the study. 34 participants (5.7 %) had received two doses, four participants (0.7 %) had received one dose and ten participants (1.7 %) stated that they had not received the COVID-19 vaccine.

Model 1 (shown in Table 2, first column) indicated that believing that the coronavirus is a hoax was negatively related to the number of COVID-19 vaccine doses, $\beta = -0.39$, $t\,(598) = -5.6$, $p < 0.001$. Contrary to our assumption, we did not find a significant association between believing that the coronavirus is human-made and the outcome. When adding trust and rejection of CAM to the model, the results showed that physicians' uptake of COVID-19 vaccine doses was only associated with higher levels of trust in German health institutions, $\beta = 0.19$, $t\,(596) = 4.45$, $p < 0.001$. When trust and rejection of CAM were added into the model, believing that the coronavirus is a hoax was no longer significantly associated with the number of vaccine doses. Model 3 and 4 show no additional significant associations from the 5C scale or the demographic variables.

In the preregistered regression models described above, we included the interaction term of both conspiracy narratives. Indeed, none of our models indicated a significant interaction between the two types of conspiracy beliefs. We explored the results of the regressions without the interaction term to focus on the main effects (for details see OSF, R Supplement section 5). Contrary to the previously reported regressions, believing the conspiracy narratives claiming that the coronavirus is a hoax was negatively associated with the number of vaccine doses even after adding other predictors into the model, $\beta = -0.30$, $t\,(589) = -5.38$, $p < 0.001$ (Model 4), when the interaction term was excluded.

COVID-19 vaccination recommendation behavior

On average, the physicians recommended the COVID-19 vaccination to 72.49 % of their patients. It was most frequently recommended to adults (M = 89.49, SD = 18.99, n = 589), followed by pregnant women (M = 74.49, SD = 32.20, n = 541) and adolescents (M = 71.71, SD = 31.13, n = 584). Vaccination was least frequently recommended to

Table 2
Standardized Regression Coefficients of physicians' own number of COVID-19 vaccine doses (hierarchical regressions).

	Model 1	Model 2	Model 3	Model 4
Hoax	−0.39*	−0.22	−0.21	−0.22
Human-made	0.18	0.24	0.25	0.25
Hoax*Human-made	−0.11	−0.21	−0.23	−0.22
Trust		0.19*	0.20*	0.20*
Rejection of CAM		0.09	0.10	0.10
Confidence			−0.003	−0.005
Constraint			0.05	0.05
Complacency			−0.03	−0.03
Calculation			−0.05	−0.05
Collective			0.05	0.05
Age				−0.013
Gender				−0.02
Has child				−0.03
Observations	602	602	602	602
R^2	0.14	0.18	0.19	0.19

Note: *p < 0.004.

children (M = 48.40, SD = 35.36, n = 486).

We conducted the same hierarchical regressions for the mean of physicians' COVID-19 vaccination recommendation behavior as outcome variable (Table 3). This showed that recommendation behavior was associated with lower beliefs in the narrative that the coronavirus is a hoax, $\beta = -0.58$, $t(598) = -8.42$, $p < 0.001$. Similar to the first analysis, the results indicated no significant association with believing that the coronavirus is human-made. Model 2 showed that more frequent recommendation behavior was related to higher levels of trust in German health institutions, $\beta = 0.34$, $t(596) = 8.38$, $p < 0.001$ and with a higher rejection of CAM, $\beta = 0.13$, $t(597) = 3.35$, $p < 0.001$. Regression Model 3 and 4 did not provide any other significant association. Moreover, lower beliefs in the narrative that the coronavirus is a hoax was still significant associated with more frequent recommendation behavior after adding the other variables.

Furthermore, we repeated these regression models without the interaction term to focus on the main effects (for details see OSF, R Supplement section 6). Here, believing in the hoax conspiracy narratives was negatively related to all dependent variables in all models, $\beta = -0.27$, $t(588) = -3.79$, $p < 0.001$ (e.g., Model 4) and believing in the human-made conspiracy narratives was positively related until adding demographical variables into the model, $\beta = 0.20$, $t(592) = 4.31$, $p < 0.001$ (Model 3).

Finally, we reran the regression models with combined mean of recommendation behavior and recommendation intention as a robustness check. Running the analytical models on this combined mean showed similar results as the primary analysis (for details, see OSF, R Supplement section 8).

Recommending other vaccinations

Participants recommended other vaccinations (Pertussis, HPV, Influenza and MMR) on average to 86.34 % of their patients. The data showed that the physicians recommended the MMR vaccine for infants most frequently (M = 92.10, SD = 19.63). The vaccination against influenza for adults over 60 years (M = 85.21, SD = 21.17), the vaccination against Pertussis for mothers (M = 85.08, SD = 24.86) and the vaccination against HPV for girls and boys (M = 84.39, SD = 24.87) were recommended to a somewhat lesser degree.

Table 4 shows the results from the regression models with other vaccine recommendations as the outcome; in Model 1 neither COVID-19 related conspiracy narrative was related to recommendation behavior for other vaccines. The results of Model 2 indicate that more recommendation behavior was associated with higher levels of trust, $\beta = 0.22$, $t(595) = 4.81$, $p < 0.001$ and with a higher rejection of CAM, $\beta = 0.19$, $t(595) = 4.33$, $p < 0.001$. Model 3 and Model 4 indicated no further significant association.

Table 3
Standardized Regression Coefficients of physicians' COVID-19 vaccination recommendation behavior (hierarchical regressions).

	Model 1	Model 2	Model 3	Model 4
Hoax	−0.58*	−0.28*	−0.27*	−0.27*
Human-made	0.12	0.21	0.21	0.20
Hoax*Human-made	0.15	−0.02	−0.02	−0.01
Trust		0.34*	0.34*	0.34*
Rejection of CAM		0.13*	0.13*	0.13*
Confidence			−0.08	−0.08
Constraint			−0.01	−0.01
Complacency			−0.08	−0.08
Calculation			0.009	0.002
Collective			0.09	0.09
Age				−0.10
Gender				0.0009
Has child				0.09
Observations	602	602	602	602
R^2	0.18	0.29	0.30	0.31

Note: *p > 0.004.

Table 4
Standardized Regression Coefficients of physicians' recommendation behavior of other vaccinations (hierarchical regressions).

	Model 1	Model 2	Model 3	Model 4
Hoax	−0.16	0.06	0.06	0.06
Human-made	0.06	0.16	0.16	0.14
Hoax*Human-made	−0.16	−0.29	−0.29	−0.27
Trust		0.22*	0.21*	0.21*
CAM		0.19*	0.19*	0.19*
Confidence			−0.07	−0.07
Constraint			−0.04	−0.04
Complacency			−0.11	−0.11
Calculation			0.03	0.02
Collective			0.14	0.14
Age				−0.08
Gender				0.07
Child				0.07
Observations	601	601	601	601
R^2	0.07	0.13	0.14	0.16

Note: *p > 0.004.

Again, we additionally calculated these models without the interaction term. These models showed similar results as the models with the interaction term, except that believing in the hoax conspiracy narratives was significantly and negatively associated with recommendation behavior in Model 1, $\beta = -0.22$, $t(598) = -4.29$, $p < 0.001$.

The robustness check using hypothetical recommendation intentions in place of missing values from the behavior item led to similar results (for details, see OSF, R Supplement section 8).

Discussion

To reduce vaccine hesitancy, it is important to understand why some physicians are unvaccinated and why they sometimes do not recommend vaccination to their patients even though it would be indicated. Indeed, our results showed that while the majority of physicians recommend vaccines to most of their patients, there are physicians who did not recommend certain vaccinations to all of their patients. Vaccination against COVID-19 was recommended less frequently than other vaccinations. Here, physicians reported that on average they only recommended vaccination to 75 % of patients who had no contraindications. For comparison, physicians indicated recommendation for other vaccines to around 85 % of patients. A potential explanation could be the novelty of the COVID-19 vaccination which had only been available for 16 months at the time of our study. In this case, vaccine hesitancy could decrease over time. Additionally, reducing vaccine hesitancy among physicians could lead to a higher vaccine uptake overall, as one of the most important factors that influences whether a person gets vaccinated or not is the recommendation of their physicians [3,4].

Previous studies already showed that factors from the 5C scale and factors like doubts about the utility and the safety of vaccines influence physicians' vaccine hesitancy [9,14]. However, there is a lack of studies about the impact of belief in conspiracy narratives among physicians. Therefore, it was relevant to assess whether conspiracies play a role in physicians' vaccine hesitancy as well – and our data show that, indeed, they do, at least to a small extent.

In general, our data showed that physicians in our sample had a very high COVID-19 vaccination uptake, with over 90 % being boosted (3 doses). In comparison, at the time of data collection, in Germany around 75 % of the general population had received at least two doses [47]. Moreover, only very few participants showed at least moderate agreement with COVID-19 conspiracy narratives —the mean of both conspiracy narratives subscales in our sample were lower than the means among the general public reported by Imhoff and Lamberty (2020) [29]. Yet, our data showed that there are some physicians who believe, at least partially, in COVID-19 related conspiracy narratives.

Furthermore, the results of our study showed that physicians' own vaccination behavior and their recommendation behaviors for the COVID-19 vaccine were negatively related to believing that COVID-19 is a hoax. The belief that the COVID-19 pandemic is a hoax further explained variance in the recommendation behavior beyond trust in health institutions and attitudes towards CAM. The results thus strengthen the assumption that conspiracy belief is an independent determinant of vaccine hesitancy—as was proposed by Geiger et al. [48] and previously identified within general population samples [8,33].

We did not find the same pattern for believing that the coronavirus is human-made. While believing that the coronavirus is a hoax was associated with recommendation behavior, believing that the coronavirus is human-made was not related to any of the outcomes in our primary analyses. A possible explanation for this could be that the perceived threat of COVID-19 could be weakened if somebody believes the coronavirus is a hoax which in turn could reduce their likelihood of recommending and accepting vaccination. In contrast, believing that it is human-made should not reduce the perceived threat of the disease [29] but may even lead to greater perceived threat if it is considered a biological weapon instead of a natural virus. The results of the regression models suggest that the relation between believing in a man-made virus and vaccination behavior may be weakly positive, although the association was mostly not significant.

Physicians' recommendation behavior of other vaccinations was not significantly associated with belief in COVID-19-related conspiracy narratives. Nevertheless, based on our results, we cannot conclude that there is no association between the recommendation of these vaccinations and the belief in other vaccine-related conspiracy narratives, e.g. about the assumed hidden link between vaccination and autism. Additionally, due to the very low levels of belief in conspiracy narratives in our sample, the effects on other recommendation behaviors may be too small to detect.

In line with our hypotheses, higher levels of trust in German health institutions were related to receiving more COVID-19 vaccine doses, an increase in COVID-19 vaccination recommendation behavior, and an increase in recommendation behavior for other vaccines. Furthermore, the rejection of CAM was associated with more COVID-19 vaccine recommendation and more recommendation behavior of other vaccinations. This association is in line with previous research [9] and is discussed in more detail in the article by Fasce et al. (2023) [49].

There are some limitations of our study. First, our sample included only a small number of unvaccinated physicians. Physicians' personal vaccination status could have been influenced by the mandatory vaccination for medical staff in Germany, which had been in force since March 2022 – one month before our data collection. Using vaccination status as a dependent variable could thus overestimate the actual vaccination intention of physicians. Furthermore, as we only used a convenience sample, our sample may not be representative of all physicians in Germany. The convenience sampling may also have resulted in a selection bias which could have distorted the effects as physicians with a strong opinion on vaccination may be more interested in participating in a study on this topic. As we have no information about how many physicians were invited to the study by the panel provider, we cannot estimate how high the rate of non-participation was.

Next, both subscales to measure belief in conspiracy narratives showed better reliability when excluding the reverse-coded items. It is possible that the participants did not pay enough attention to the wording of the items. For our analyses, we decided to exclude the reverse coded item for the human-made subscale. Since the Cronbach's Alpha for the hoax subscale was higher than 0.7 and analyses without the item did not substantially change the results, we decided to keep all three items.

Finally, as we collected correlational data, causal implications are not possible. Moreover, it is possible that other variables beyond those we measured also contribute to conspiracy beliefs and recommendation behavior, which should be explored by further research.

Despite the mentioned limitations, the study provides evidence highlighting the link between belief in conspiracy narratives and physician's vaccine hesitancy. Many interventions to reduce vaccine hesitancy in the general public aim to improve the communication techniques of physicians (e.g. motivational interviewing [50] or the empathetic refutational interview [51]). An important precondition for these techniques being effective is that the physician is willing to recommend a vaccine. Future studies should focus on the causal relationship between physician's trust in health institutions and their beliefs in conspiracy narratives and their recommendation behavior. Further, it is important to test interventions to build resistance against conspiracy narratives in this specific target group. Such interventions could be based on fact-based inoculation that include a warning of the conspiracy narrative as a targeted influential attack [52] or could be an adaption of already validated interventions like fake news online games that train users to recognize and resist false information [53].

Conclusion

As physicians play an important role in peoples' decision to vaccinate, it is essential to investigate physicians' attitudes and behaviors around vaccination. Our study showed that German physicians actively recommend the investigated vaccines to only 72–86 % of their patients. Moreover, our data indicated that less frequent COVID-19 vaccine recommendation behavior is related to higher belief in the conspiracy narrative claiming that COVID-19 is a hoax. Even if only a very low proportion of physicians believe in conspiracy narratives and therefore do not recommend a vaccination, this could have serious consequences on the vaccination decisions of their patients. There are already some promising interventions which can reduce the impact of conspiracy narratives [54]. Further research should focus on this issue and investigate the effect of interventions in this special target group.

Funding sources

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 964728 (JITSUVAX).

CRediT authorship contribution statement

Frederike Taubert: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Philipp Schmid:** Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Dawn Holford:** Conceptualization, Writing – review & editing. **Pierre Verger:** Conceptualization, Writing – review & editing. **Angelo Fasce:** Conceptualization, Writing – review & editing. **Linda C. Karlsson:** Conceptualization, Writing – review & editing. **Anna Soveri:** Conceptualization, Writing – review & editing. **Stephan Lewandowsky:** Conceptualization, Writing – review & editing. **Cornelia Betsch:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

All questionnaires, data, and analysis outputs are available online at OSF (https://osf.io/826yu/).

Acknowledgements

The study was part of the JITSUVAX Project, a joint project of University of Bristol, University of Erfurt, the Chancellor Masters and Scholars of the University of Cambridge, University of Turku, Regional Health Observatory in France and University of Coimbra.

References

[1] Bouder F, Way D, Löfstedt R, Evensen D. Transparency in Europe: a quantitative study: transparency in Europe. Risk Anal 2015;35:1210–29. https://doi.org/10.1111/risa.12386.
[2] Gopichandran V, Sakthivel K. Doctor-patient communication and trust in doctors during COVID 19 times—a cross sectional study in Chennai, India. PLoS ONE 2021;16:e0253497.
[3] Lu P, Srivastav A, Amaya A, Dever JA, Roycroft J, Kurtz MS, et al. Association of provider recommendation and offer and influenza vaccination among adults aged ≥18 years – United States. Vaccine 2018;36:890–8. https://doi.org/10.1016/j.vaccine.2017.12.016.
[4] Holman DM, Benard V, Roland KB, Watson M, Liddon N, Stokley S. Barriers to human papillomavirus vaccination among US adolescents: a systematic review of the literature. JAMA Pediatr 2014;168:76. https://doi.org/10.1001/jamapediatrics.2013.2752.
[5] Knobel P, Zhao X, White KM. Do conspiracy theory and mistrust undermine people's intention to receive the COVID-19 vaccine in Austria? J Community Psychol 2022;50:1269–81. https://doi.org/10.1002/jcop.22714.
[6] MacDonald NE. Vaccine hesitancy: definition, scope and determinants. Vaccine 2015;33:4161–4. https://doi.org/10.1016/j.vaccine.2015.04.036.
[7] Lo S-Y, Li S-C-S, Wu T-Y. Exploring psychological factors for COVID-19 vaccination intention in Taiwan. Vaccines 2021;9:764. https://doi.org/10.3390/vaccines9070764.
[8] Katoto PDMC, Parker S, Coulson N, Pillay N, Cooper S, Jaca A, et al. Predictors of COVID-19 vaccine hesitancy in South African local communities: the VaxScenes study. Vaccines 2022;10:353. https://doi.org/10.3390/vaccines10030353.
[9] Neufeind J, Betsch C, Habersaat KB, Eckardt M, Schmid P, Wichmann O. Barriers and drivers to adult vaccination among family physicians – insights for tailoring the immunization program in Germany. Vaccine 2020;38:4252–62. https://doi.org/10.1016/j.vaccine.2020.04.052.
[10] Sallam M. COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. Vaccines 2021;9:160. https://doi.org/10.3390/vaccines9020160.
[11] Robert Koch-Institut, KROCO – Krankenhausbasierte Online-Befragung zur COVID-19-Impfung, Rki; 2022. https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Projekte_RKI/KROCO.html [accessed March 21, 2023].
[12] Karnaki P, Baka A, Petralias A, Veloudaki A, Zota D, Linos A. HProImmune partnership, immunization related behaviour among healthcare workers in Europe: results of the HProImmune survey. Cent Eur J Public Health 2019;27:204–11. https://doi.org/10.21101/cejph.a5514.
[13] Shaukat N, Ali DM, Razzak J. Physical and mental health impacts of COVID-19 on healthcare workers: a scoping review. Int J Emerg Med 2020;13:40. https://doi.org/10.1186/s12245-020-00299-5.
[14] Verger P, Fressard L, Collange F, Gautier A, Jestin C, Launay O, et al. Vaccine hesitancy among general practitioners and its determinants during controversies: a national cross-sectional survey in France. EBioMedicine 2015;2:891–7. https://doi.org/10.1016/j.ebiom.2015.06.018.
[15] Rimmer A. Do doctors have to have the covid-19 vaccine? BMJ 2021;n810. https://doi.org/10.1136/bmj.n810.
[16] Laine C, Cotton D, Moyer DV. COVID-19 vaccine: promoting vaccine acceptance. Ann Intern Med 2021;174:252–3. https://doi.org/10.7326/M20-8008.
[17] Betsch C, Schmid P, Heinemeier D, Korn L, Holtmann C, Böhm R. Beyond confidence: development of a measure assessing the 5C psychological antecedents of vaccination. PLoS One 2018;13:e0208601.
[18] Thomson A, Robinson K, Vallée-Tourangeau G. The 5As: a practical taxonomy for the determinants of vaccine uptake. Vaccine 2016;34:1018–24. https://doi.org/10.1016/j.vaccine.2015.11.065.
[19] Betsch C, Bach Habersaat K, Deshevoi S, Heinemeier D, Briko N, Kostenko N, et al. Sample study protocol for adapting and translating the 5C scale to assess the psychological antecedents of vaccination. BMJ Open 2020;10:e034869.
[20] Betsch C, Böhm R, Chapman GB. Using behavioral insights to increase vaccination policy effectiveness. Policy Insights Behav Brain Sci 2015;2:61–73. https://doi.org/10.1177/2372732215600716.
[21] Hajure M, Tariku M, Bekele F, Abdu Z, Dule A, Mohammedhussein M, et al. Attitude towards COVID-19 vaccination among healthcare workers: a systematic review. IDR 2021;14:3883–97. https://doi.org/10.2147/IDR.S332792.
[22] Attwell K, Ward PR, Meyer SB, Rokkas PJ, Leask J. "Do-it-yourself": vaccine rejection and complementary and alternative medicine (CAM). Soc Sci Med 2018;196:106–14. https://doi.org/10.1016/j.socscimed.2017.11.022.
[23] Hornsey MJ, Lobera J, Díaz-Catalán C. Vaccine hesitancy is strongly associated with distrust of conventional medicine, and only weakly associated with trust in alternative medicine. Soc Sci Med 2020;255:113019. https://doi.org/10.1016/j.socscimed.2020.113019.
[24] Verger P, Botelho-Nevers E, Garrison A, Gagnon D, Gagneur A, Gagneux-Brunon A, et al. Vaccine hesitancy in health-care providers in Western countries: a narrative review. Expert Rev Vaccines 2022;21:909–27. https://doi.org/10.1080/14760584.2022.2056026.
[25] Zonis M, Joseph CM. Conspiracy thinking in the middle east. Polit Psychol 1994;15:443. https://doi.org/10.2307/3791566.
[26] van Prooijen J-W, Douglas KM. Conspiracy theories as part of history: the role of societal crisis situations. Mem Stud 2017;10:323–33. https://doi.org/10.1177/1750698017701615.
[27] Geissler E, Sprinkle RH. Disinformation squared: was the HIV-from-Fort-Detrick myth a Stasi success? Politics Life Sci 2013;32:2–99. https://doi.org/10.2990/32_2_2.
[28] Klofstad CA, Uscinski JE, Connolly JM, West JP. What drives people to believe in Zika conspiracy theories? Palgrave Commun 2019;5:36. https://doi.org/10.1057/s41599-019-0243-8.
[29] Imhoff R, Lamberty P. A Bioweapon or a Hoax? The Link Between Distinct Conspiracy Beliefs About the Coronavirus Disease (COVID-19) Outbreak and Pandemic Behavior. Social Psychological and Personality Science 2020;11:1110–8. https://doi.org/10.1177/1948550620934692.
[30] Altenbuchner A, Haug S, Schnell R, Scharf A, Weber K. Parents' willingness to vaccinate with a COVID-19 vaccine. Padiatr Padol 2021;56:230–4. https://doi.org/10.1007/s00608-021-00925-2.
[31] Romer D, Jamieson KH. Conspiracy theories as barriers to controlling the spread of COVID-19 in the US. Soc Sci Med 2020;263. https://doi.org/10.1016/j.socscimed.2020.113356.
[32] Douglas KM. Are conspiracy theories harmless? Span J Psychol 2021;24:e13.
[33] Lindholt MF, Jørgensen F, Bor A, Petersen MB. Public acceptance of COVID-19 vaccines: cross-national evidence on levels and individual-level predictors using observational data. BMJ Open 2021;11:e048172.
[34] Szmyd B, Bartoszek A, Karuga FF, Staniecka K, Błaszczyk M, Radek M. Medical students and SARS-CoV-2 vaccination: attitude and behaviors. Vaccines 2021;9:128. https://doi.org/10.3390/vaccines9020128.
[35] Imhoff R, Bruder M. Speaking (un–)truth to power: conspiracy mentality as a generalised political attitude. Eur J Pers 2014;28:25–43. https://doi.org/10.1002/per.1930.
[36] Wood MJ, Douglas KM, Sutton RM. Dead and alive: beliefs in contradictory conspiracy theories. Soc Psychol Personal Sci 2012;3:767–73. https://doi.org/10.1177/1948550611434786.
[37] Winter K, Pummerer L, Hornsey MJ, Sassenberg K. Pro-vaccination subjective norms moderate the relationship between conspiracy mentality and vaccination intentions. British J Health Psychol 2022;27:390–405. https://doi.org/10.1111/bjhp.12550.
[38] Kucukkarapinar M, Karadag F, Budakoglu I, Aslan S, Ucar O, Yay A, et al. COVID-19 vaccine hesitancy and its relationship with illness risk perceptions, affect, worry, and public trust: an online serial cross-sectional survey from Turkey. Psychiatry Clin Psychopharmacol 2021;31:98–109. https://doi.org/10.5152/pcp.2021.21017.
[39] Rozbroj T, Lyons A, Lucke J. Psychosocial and demographic characteristics relating to vaccine attitudes in Australia. Patient Educ Couns 2019;102:172–9. https://doi.org/10.1016/j.pec.2018.08.027.
[40] Scrima F, Miceli S, Caci B, Cardaci M. The relationship between fear of COVID-19 and intention to get vaccinated. The serial mediation roles of existential anxiety and conspiracy beliefs. Personality Individual Differences 2022;184:111188. https://doi.org/10.1016/j.paid.2021.111188.
[41] Robert Koch Institut, Impfkalender; 2023.
[42] Robert Koch-Institut, STIKO: 15. Aktualisierung der COVID-19-Impfempfehlung | SARS-CoV-2-Infektions- geschehen an Hamburgs Schulen, Epidemiologisches Bulletin; 2022.
[43] Bundesministerium für Gesundheit, Die einrichtungsbezogene Impfpflicht in medizinischen und pflegerischen Einrichtungen; 2022. https://www.bundesgesundheitsministerium.de/fileadmin/Dateien/3_Downloads/C/Coronavirus/Publikationen/210x297_BMG_Corona_einrichtungsbezogene_Impfpflicht_Leitfaden_bf.pdf.
[44] Hyland ME, Lewith GT, Westoby C. Developing a measure of attitudes: the holistic complementary and alternative medicine questionnaire. ComplementTher Med 2003;11:33–8. https://doi.org/10.1016/S0965-2299(02)00113-9.
[45] Lewandowsky S, Woike JK, Oberauer K. Genesis or evolution of gender differences? Worldview-based dilemmas in the processing of scientific information. J Cogn 2020;3:9. https://doi.org/10.5334/joc.99.
[46] Nunnally JC. Psychometric theory—25 years ago and now. Educ Res 1975;4:7–21.
[47] Bundesministerium für Gesundheit, Das offizielle Dashboard zur Impfkampagne der Bundesrepublik Deutschland; 2023. https://impfdashboard.de/ [accessed April 19, 2023].
[48] Geiger M, Rees F, Lilleholt L, Santana AP, Zettler I, Wilhelm O, et al. Measuring the 7Cs of vaccination readiness. Eur J Psychol Assess 2022;38:261–9. https://doi.org/10.1027/1015-5759/a000663.
[49] Fasce A, Karlsson L, Verger P, Mäki O, Taubert F, Garrison A, et al. Endorsement of alternative medicine and vaccine hesitancy among physicians: a cross-sectional study in four European countries. Hum Vaccin Immunother 2023;19:2242748. https://doi.org/10.1080/21645515.2023.2242748.
[50] Gagneur A. Motivational interviewing: a powerful tool to address vaccine hesitancy. Can Commun Dis Rep 2020;46:93–7. https://doi.org/10.14745/ccdr.v46i04a06.
[51] Holford D, Schmid P, Fasce A, Lewandowsky S. The empathetic refutational interview to tackle vaccine misconceptions: Four randomized experiments. Health Psychology 2024. https://doi.org/10.1037/hea0001354.

[52] Banas JA, Miller G. Inducing resistance to conspiracy theory propaganda: testing inoculation and metainoculation strategies: metainoculation strategies. Hum Commun Res 2013;39:184–207. https://doi.org/10.1111/hcre.12000.
[53] Roozenbeek J, van der Linden S. Fake news game confers psychological resistance against online misinformation. Palgrave Commun 2019;5:65. https://doi.org/10.1057/s41599-019-0279-9.
[54] O'Mahony C, Brassil M, Murphy G, Linehan C. The efficacy of interventions in reducing belief in conspiracy theories: a systematic review. PLoS One 2023;18:e0280902.