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# Why do people consent to receiving SARS-CoV-2 vaccinations? A representative survey in Germany

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## ABSTRACT

**Objective** To answer the question: Why do people consent to being vaccinated with novel vaccines against SARS-CoV-2?

**Design** Representative survey.

**Setting** Online panel.

**Participants** 1032 respondents of the general German population.

**Method** A representative survey among German citizens in November/December 2021 that resulted in 1032 complete responses on vaccination status, sociodemographic parameters and opinions about the COVID-19 situation.

**Results** Almost 83% of the respondents were vaccinated. The major motivation was fear of medical consequences of an infection and the wish to lead a normal life again. The major motivation to be not vaccinated was the fear of side effects and scepticism about long-term effectiveness and safety. Sixteen per cent of vaccinated respondents reported some serious side effect, while more than 30% reported health improvements, mostly due to the relief of psychological stress and social reintegration. We also validated a 'Corona Orthodoxy Score—COS' consisting of seven items reflecting opinions on COVID-19. The scale is reliable (alpha=0.76) and unidimensional. The COS was a highly significant predictor of vaccination status and readiness to be vaccinated in a multivariable logistic regression model. Those who were vaccinated were more likely to live in smaller households (OR=0.82, p=0.024), had a higher income (OR=1.27, p<0.001), a higher COS score (OR 1.4, p<0.0001) and used less alternative media (OR=0.44, p=0.0024) and scientific publications (OR=0.42, p=0.011) as information sources.

**Conclusions** The major motives for being vaccinated are fear of medical symptoms and the wish to lead a normal life. Those not wanting to be vaccinated cite a lack of knowledge regarding long-term safety and side effects as reasons. This can likely only be overcome by careful and active long-term efficacy and safety monitoring.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ We used a previously validated Corona Orthodoxy Score, a scale that measures adherence to the mainstream narrative about the corona virus pandemic, which is reliable and unidimensional.
⇒ We conducted logistic regression analyses to predict whether someone is willing to be vaccinated or vaccinated.
⇒ A limitation is the fact that complete representativity is difficult to achieve with online panels.

## INTRODUCTION

In Germany and elsewhere, public discourse about how to deal with the SARS-CoV-2 pandemic has been dominated from the beginning by the opinion that it is important to achieve a high number of COVID-19 vaccinations in the population. Politicians and media presented these novel vaccinations as beneficial and receiving them as an act of solidarity and respect for others. In parallel, politicians and other stakeholders have talked about restricting access to public participation for those that are not vaccinated. This increases implicit pressure on persons that have hitherto refused to be vaccinated to finally assent to being vaccinated. This also introduces novel motives that are no indication for vaccinations, as a medical indication for a vaccination would be the prevention of a severe or fatal disease.

Research regarding 'vaccine hesitancy' shows that globally roughly 60%–70% of the population assent to being vaccinated or have already received it,[1 2] while 20%–25% are against it, and the rest is undecided,[3–7] although estimates depend on the population being studied and the particular phase of the pandemic. The international cross-sectional iCARE study revealed that during the first year of the pandemic, vaccination hesitancy (defined as not being extremely likely to be vaccinated) increased significantly from 25.6% to 29.9% overall, with some countries such as France or Turkey even exceeding 50%.[2] This study also found that significant predictors of less vaccination hesitancy were demographic factors such as being male, being older than 65 years, having a higher income and living in an urban area or city, but notably also various fears including social/

economic or financial concerns and health concerns about oneself or others. Other drivers of vaccination hesitancy discussed in the literature include the belief in putative misinformation and so-called conspiracy theories,[8] and the fact that all COVID-19 vaccines have only received emergency use authorisation instead of full approval.[9] As COVID-19 vaccines are built on new mRNA technology, they have undergone an expedited review and have received express approval.[10 11] This also means that the safety tests have not been conducted, as with other vaccines, before approval, but have been conducted in parallel together with clinical testing.[12–14] These studies were 'observer-blind' and thus had the potential of biased effects,[15] especially given that the results had a marginal absolute risk reduction of 0.025% only.[16] Thus, various authors reach contradictory conclusions about the safety of these substances.[13 17] This insecurity is transmitted to the population via different messages transported by classical and alternative media, which are often contradictory and could promote vaccination hesitancy. For example, a study conducted in Northern Nigeria found that women refusing to be vaccinated did so because they believed the vaccine to be painful (73.3%), not necessary (56.7%), harmful (30.0%) and not effective (26.7%).[18] In addition, certain groups have trust issues with the government and/or pharmaceutical companies which also appears to be a main driver of vaccination hesitancy.[8 19] For example, the Nigerian population still remembers a controversial drug trial from 1996 conducted by the company Pfizer during which 11 children died and many more developed severe disabilities[20]; hence, in a sample of 1079 Nigerian citizens, a significant fraction of vaccine hesitant individuals reported fears about the safety of the vaccines, not only due to their hasty production and roll out (62.9%), but also being harmful on purpose to serve as a population control strategy (19.9%) or to contain 'hidden chips" (19.3%).[21]

In summary those surveys show that not only medical, but also social and political factors including the nature of information sources are reasons for vaccination hesitancy. This is likely due to the fact that the mainstream narrative about the COVID-19 and the threat it poses has been transported by the public media and has been frontloaded with political meaning.[22 23] We have seen in our own survey of German immunologists that those immunologists agreeing with the mainstream narrative were younger, were scientifically very active but more junior and did inform themselves mainly by public channels and not by their own analyses or perusal of the scientific literature.[24]

We are not aware of any scientific survey data in Germany that would have looked at motivation and assent to SARS-CoV-2 vaccinations. We, therefore, conducted such a survey. The study was designed to answer the question: Why do people consent to being vaccinated with novel vaccines against SARS-CoV-2?

## METHOD

We conducted a survey in a sample representative for the German population in the most important sociodemographic parameters (such as age, gender, income, education, size of household) that was implemented by a specialised market research company, Debaro in Munich. The survey used an existing panel of approximately 30'000 respondents. The aim was to receive 1000 complete data sets that approximate representativity of the German population. To achieve this, 3223 respondents were invited who were preselected by demographic markers such as age, income, education and size of household to match the German population to make the sample representative according to those variables. The survey was closed when 1023 respondents had answered it, conforming to the predefined criteria. The survey was implemented online, and representativity was achieved by aligning the respondents according to the above-mentioned known socioeconomic strata of the German population. The protocol of the study, including the analysis plan, was posted before commencement on the Open Science Framework platform (https://osf.io/8djbs/). The survey questions are presented in online supplemental information. There was one inadvertent protocol change: The items of group 7 in the protocol (online supplemental table 1) were originally meant to be answered by all participants, but were only presented to the unvaccinated. Therefore, they are reported in online supplemental file but not considered further.

We had developed and described a 'Corona Orthodoxy Score—COS' in our previous survey of immunologists, where it is presented in detail.[24] Briefly, it consists of seven statements describing the mainstream narrative about COVID-19 ('The virus is more infectious, more dangerous, leads to higher mortality than influenza, poses a stronger challenge to the health system than influenza, and can only be overcome by vaccination; vaccines should be developed in an expedited process' (table 1). The first four items are coded on a four-point scale, the others are transformed into 1–0 coded items. The items are summed to yield a summary score. The original psychometric analysis yielded a unidimensional scale with reasonable reliability (alpha=0.74; item-intercorrelation=0.26), with approximately normal distribution and one main factor. This COS scale describes how strongly a respondent assents to the mainstream narrative about COVID-19. We did a second psychometric analysis of the reliability and dimensionality of the items pertaining to COS.

Theoretical range: 4—18; Cronbach's alpha=0.76; 4 meaning maximum deviance from the orthodox narrative; 18 meaning maximum support for orthodox narrative; the scaling can be changed to 0–3 for items 1 to 3 and to 0–2 for item 5 in which case the theoretical range would be from 0 to 14.

### Statistics

Survey data were analysed descriptively. We were primarily interested in describing the reasons for or against

Table 1 The Corona Orthodoxy Score—items and scaling

| Item | Scaling | Action |
|---|---|---|
| 1. SarsCov2 is less infectious (1), equally (2), more infectious (3), much more infectious (4) than seasonal influenza | 1–4 | Use score |
| 2. Infection fatality rate is lower than influenza (1), equal (2), higher (3), much higher (4) | 1–4 | Add score to sum |
| 3. The challenge to the health system with COVID-19 is less (1), equal (2), higher (3), much higher (4) than with influenza | 1–4 | Add score to sum |
| 4. Altogether, with SARS-CoV2 the immune system (0) is more important, or the virus (1)? | 0/1 | Add score to sum |
| 5. With vaccine development, one should have followed the normal sequence (2), it was good to speed up (3); no vaccines are necessary (1) | 1–3 | Add score to sum |
| 6. Altogether, more damage was done by the virus (no/yes) | 0/1 | Add score to sum |
| 7. Altogether, more damage was done by the non-pharmaceutical Interventions (no/yes) | 0/1 | Reverse code and add score to sum |

vaccinations. In addition, the subgroup of vaccinated was analysed descriptively in terms of their health status (better, equal, worse than before). There were no missing data.

Motivation for or against the vaccination was then related to demographical variables and to opinions regarding SARS-CoV-2.

We also constructed a logistic regression model for predicting vaccination status (unvaccinated=0; vaccinated=1) as well as readiness to be vaccinated (unvaccinated and not intending to get vaccinated=0; vaccinated or intending to get vaccinated=1) for an individual $i$:

$$y_i = \frac{\exp\left(\beta_0 + \sum_{j=1}^{p} \beta_j x_j\right)}{1+\exp\left(\beta_0 + \sum_{j=1}^{p} \beta_j x_j\right)}, \; y_i \in \{0,1\}, \quad i = 1, \ldots, N \qquad (1)$$

Putative predictors $x_j$ were selected from the following 14 variables: Age, gender, income (graded, quasi-continuous), education (graded, quasi-continuous), household size (continuous), a total of eight different information sources and COS. In order to balance overfitting and model parsimony, we fitted a series of models, each with a different number of maximum allowable predictors $p \in \{1, \ldots, 14\}$ and chose the 'best' model as the one having minimum bias-corrected Akaike information criterion (AICc).[25] For a given number of allowed predictors, we applied the least absolute shrinkage and selection operator (LASSO) method to select the best predictors from the full set of 14 predictors.[26] LASSO performs variable selection by shrinking the regression coefficients of less important predictors to zero and is preferred over forward or backwards variable selection procedures.[27] Prior to fitting the LASSO model, all continuous predictor variables were standardised to mean 0 and SD 1. For each number of allowed predictors, LASSO selected the ones that maximised the area under the receiver-operator-characteristic (ROC) curve of the logistic regression model, and the AICc of the model was used to compare it against all other models with a different number of predictors. The optimal model was then chosen as the one having minimal AICc, and this model was refit to obtain regression coefficients and their standard errors. Finally, the optimal model was used to predict an outcome for each individual in the dataset. This allowed us to estimate prediction performance (sensitivity, specificity, area under the ROC curve) on the training set.

Besides AICc, we also measured model adequacy by a Kullback-Leibler divergence-based $R^2$ measure which was developed for generalised linear models and can be interpreted analogous to linear regression models as variance explained by the predictors.[28]

All analyses were calculated with R V.4.0.2, and statistical significance was defined as p values <0.005 to account for the exploratory nature of this analysis.[29]

### Patient and public involvement

The survey was planned by us as members of the concerned public and discussed with other members of the public before mounting it.

## RESULTS

The study was run during the last week of November and the first week of December 2021. The final sample comprised 1032 respondents and is described in table 2 according to vaccination status. Eighty-two per cent of the respondents were vaccinated (n=855), 12.5% were unvaccinated and intended to stay so and 4.6% were unvaccinated and intended to be vaccinated in the near future. For questions referring to unvaccinated participants these latter two groups were combined (n=177). The reasons for vaccination are given in table 3. These could be ranked by each participant according to the first three most important reasons. Reasons for not wanting to be vaccinated are presented in table 4 in rank order. We asked those who have been vaccinated (n=855) for their health status since vaccination, compared with before: 34 (4.0%) reported an improved health status, 50 (5.8%) a worse health status, while the majority (90.2%) reported a similar health status. Furthermore, we asked

Table 2 Sociodemographic description of the survey sample

| Variable | Unit | Overall cohort (n=1'032) | Vaccinated (n=855) | Unvaccinated, not wanting to become vaccinated (n=129) | Unvaccinated, intending to become vaccinated (n=48) | P value |
|---|---|---|---|---|---|---|
| Age | Years: median (range) | 52 (16–88) | 54 (16–88) | 50 (16–78) | 39 (17–74) | <0.0001* |
| | Years: mean±SD | 49.6±17.8 | 50.6±17.7 | 45.6±18.1 | 41.3±16.3 | |
| Gender | Male | 512 (49.6%) | 432 (50.5%) | 57 (44.2%) | 23 (47.9%) | 0.6 |
| | Female | 517 (50.1%) | 420 (49.3%) | 72 (55.8%) | 25 (52.1%) | |
| | Diverse | 3 (0.3%) | 3 (0.3%) | 0 | 0 | |
| Education | In training | 11 (1.1%) | 8 (0.9%) | 2 (1.55%) | 1 (2.1%) | 0.577 |
| | No school leaving certificate | 6 (0.6%) | 4 (0.5%) | 2 (1.55%) | 0 | |
| | Basic schooling | 223 (21.6%) | 186 (21.8%) | 28 (21.7%) | 9 (18.8%) | |
| | GCSE | 375 (36.6%) | 310 (36.3%) | 50 (38.8%) | 15 (31.3%) | |
| | A-level | 188 (18.2%) | 150 (17.5%) | 25 (19.4%) | 13 (27.1%) | |
| | University degree | 213 (20.6%) | 183 (21.4%) | 20 (15.5%) | 10 (20.8%) | |
| | PhD | 16 (1.6%) | 14 (1.6%) | 2 (1.55%) | 0 | |
| Income strata | <€1300 | 145 (14.0%) | 112 (13.1%) | 23 (17.8%) | 10 (20.8%) | 0.084 |
| | €1300–€2000 | 183 (17.7%) | 147 (17.2%) | 27 (20.9%) | 9 (18.8%) | |
| | €2001–€2600 | 171 (16.6%) | 136 (20.0%) | 24 (18.6%) | 11 (22.9%) | |
| | €2601–€3600 | 216 (20.8%) | 180 (21.1%) | 26 (20.2%) | 10 (20.8%) | |
| | €3601–€5000 | 193 (18.7%) | 175 (20.5%) | 14 (10.9%) | 4 (8.3%) | |
| | >€5000 | 124 (12.0%) | 105 (12.3%) | 15 (11.6%) | 4 (8.3%) | |
| No of persons in household (as categorical variable) | 1 | 324 (31.4%) | 268 (31.3%) | 42 (32.6%) | 14 (29.2%) | 0.00050* |
| | 2 | 351 (34.0%) | 311 (36.4%) | 34 (26.4%) | 6 (12.5%) | |
| | 3 | 191 (18.5%) | 154 (18.0%) | 27 (20.9%) | 10 (20.8%) | |
| | 4 | 121 (11.7%) | 89 (10.4%) | 19 (14.7%) | 13 (27.1%) | |
| | 5 | 29 (2.8%) | 22 (2.6%) | 3 (2.3%) | 4 (8.3%) | |
| | 6 | 13 (1.2%) | 9 (1.1%) | 3 (2.3%) | 1 (2.1%) | |
| | 7 | 3 (0.3%) | 2 (0.2%) | 1 (0.8%) | 0 | |
| No of persons in household (as continuous variable) | Median (range) | 2 (1–7) | 2 (1–7) | 2 (1–7) | 3 (1–6) | 0.013 |
| | Mean±SD | 2.3±1.2 | 2.2±1.2 | 2.4±1.3 | 2.8±1.4 | |

Kruskal-Wallis test and Fisher's exact test with simulated p values were used to test for differences among the three groups in continuous and categorical variables, respectively.
*P<0.005 (statistically significant).
GCSE, General Certificate of Secondary Education .

the vaccinated whether they had a positive COVID-19 test since being vaccinated, and about potential side effects and benefits.

These data are presented in table 5. We asked those who were unvaccinated for positive COVID-19 tests, COVID-19 disease, health system use and problems they might have had because of various issues. This is presented in online supplemental table 1. Table 6 presents opinion items on SARS-CoV-2 that also form the basis for the construction of our COS (see table 1) and table 7 presents data on information sources of the participants.

We used our previously reported COS that consists of the items asking about the opinion on SARS-CoV-2 (table 1).[24] We replicated its internal consistency or reliability as alpha=0.76 with a mean item-intercorrelation of $r_{it}$=0.32. The scale was unidimensional, explaining 42.8% of the variance.

We calculated two logistic regression models to predict vaccination status (model 1: unvaccinated=0, vaccinated=1) and readiness to be vaccinated (model 2: not willing=0; willing=1). The results are presented in table 8, and the predictive performance is shown in figure 1. A

Table 3 Reasons for vaccination—three most important reasons—frequencies (per cent)—vaccinated persons or those with intention to be vaccinated only (n=903)

| Reason | First rank | Second rank | Third rank |
|---|---|---|---|
| I fear the health consequences of an infection with the corona virus | 542 (60.0%) | 115 (12.7%) | 98 (10.8%) |
| I want to be able to lead a normal life | 163 (18.5%) | 266 (29.5%) | 272 (30.1%) |
| I want to contribute to eradicating the virus | 93 (10.3%) | 268 (29.7%) | 233 (25.8%) |
| I want to travel again | 71 (7.9%) | 150 (16.6%) | 143 (15.8%) |
| My social environment exerts pressure | 29 (3.2%) | 78 (8.6%) | 85 (9.4%) |
| I do it because others do it as well | 5 (0.5%) | 26 (2.9%) | 72 (8.0%) |

total of seven variables were selected into the optimal model for predicting vaccination status (according to the minimum AICc), while only three variables were needed to optimise the model for predicting the readiness to be vaccinated. The latter model also resulted in slightly better overall prediction performance as judged by both KL-$R^2$ and the area under the ROC curve (figure 1B). The specificity, that is, the ability to achieve a true positive prediction for a vaccinated person or a person intending to be vaccinated, respectively, was high for both models (81.8% and 89.9%, respectively), but sensitivity was only moderate. Overall prediction accuracy was>75%. The COS was the major predictor of vaccination outcome in both models, and on its own able to explain about 17.4% and 24.2% of the variance in model 1 and 2, respectively, according to the KL-$R^2$ value. Higher income, being older, and public television (TV) and radio use were positively associated with vaccination status, while greater household size and the use of alternative media and use of scientific original publications as information source were negatively associated with being vaccinated. The use of public TV and radio as information source was also a positive predictor of readiness to be vaccinated, while reading original scientific publications decreased the odds of a past or a future vaccination.

We did an additional exploratory analysis that analysed the difference between those vaccinated participants who gave, as a major reason for vaccination, the fear of the medical consequences of an infection (n=523 of altogether 855 vaccinated participants), and all others (n=332) who cited any kind of social reasons. We constructed a third logistic regression model which is presented in table 9. Five variables emerged as predictors. Those who had a medical motivation were older (OR=1.20 for each decade) and had a very strong belief in the mainstream narrative, as the COS emerged as the strongest predictor (OR=1.28). Paradoxically, they believed less than those with a social motivation that the vaccination prevented the disease (OR=0.73), but believed that it prevented from passing on the infection (OR=1.30). From all other sociodemographic or information source variables, only exchanging information with friends was selected into the model and was associated with receiving the vaccination for social rather than medical reasons (OR=0.50).

## DISCUSSION

### Fear of health consequences of COVID-19

To our knowledge, this is the first representative survey in Germany on the motivation to be vaccinated or not with COVID-19 vaccines. More than 80% of our respondents were vaccinated at the time of the survey, end of November and first week of December 2021. The major reason for vaccination was fear of health consequences (about 60%). The average age of the population in this survey is 49.6 years and the infection fatality rate for this age group is between 0.01% and 0.1%.[30] This fear is likely due to media coverage and consumption,[31] and we know from psychoneuroendocrinological research that fear, stress and negative emotions impair natural immunity.[32] The second most important reason was the desire to be able to lead a normal life, to be able to travel, go to restaurants, bars, concerts and other social events (about 46%). This major driver is probably influenced by the various restrictions people had to endure because of non-pharmacological interventions (NPIs) imposed by

Table 4 Reasons for not wanting to be vaccinated—three most important reasons—frequencies (per cent)—unvaccinated persons only (n=129)

| Reason | First rank | Second rank | Third rank |
|---|---|---|---|
| I do not want to be treated with vaccinations whose long-term effects are unknown | 52 (40.3%) | 47 (36.4%) | 13 (10.1%) |
| I am afraid of side effects | 47 (36.4%) | 43 (33.3%) | 18 (13.9%) |
| I don't think we need a vaccination | 12 (9.3%) | 10 (7.7%) | 30 (23.2%) |
| I have received many terrible informations | 7 (5.4%) | 20 (15.5%) | 47 (36%) |
| I principally don't do what others do | 8 (6.2%) | 6 (4.6%) | 11 (8.5%) |
| I have had COVID-19 and am immune | 3 (2.3%) | 3 (2.3%) | 10 (7.7%) |

Table 5 In vaccinated only (n=855): COVID-19 positive test, potential side effects and potential improvements (yes answers only), beliefs

| | Yes | No* |
|---|---|---|
| COVID-19+ test since vaccination | 84 (9.8%) | 771 (90.2%) |
| Potential side effects… | | |
| Thrombosis or embolies | 12 (1.4%) | |
| Psychological stress | 60 (7.0%) | |
| Other problems with blood vessel | 22 (2.6%) | |
| Lack of stamina | 66 (7.7%) | |
| Immunological problems | 23 (2.7%) | |
| None of the above | 721 (84.3%) | |
| Better since vaccination because of… | | |
| Relief | 126 (14.7%) | |
| More stamina | 28 (3.3%) | |
| Other physical problems disappeared | 20 (2.3%) | |
| Better social integration | 127 (14.8%) | |
| Better immune function | 42 (4.9%) | |
| None of the above | 595 (69.6%) | |
| Vaccination protects from infecting others with COVID-19 | 608 (71.1%) | 247 (28.9%) |
| Vaccination protects oneself from contracting COVID-19 | 301 (35.2%) | 554 (64.8%) |

*Frequencies of no answers are given where forced entry avoided missing data, else only yes answers provided and the rest is due to missing data, because the answer was not forced to be either yes or no.

political decisions. Whether such NPIs are at all effective is questionable.[33–39] A third reason was to help eradicate the virus. Recent data show that the vaccines do not help break transmissions chains and thus cannot really eradicate the virus.[40 41]

### Long-term safety issues and side effects

Those who were not vaccinated gave as major reason the lack of knowledge of long-term efficacy and safety. A secondary reason was the fear of side effects. This is in line with the fact that the incidence of reported side effects just within the last year of using these vaccines is at least 20 times higher than for other vaccines together over the last 20 years. For instance, the German Adverse Reaction Database of the Paul-Ehrlich-Institute reports 456 cases of deaths and 54'488 reports altogether for all vaccinations, excluding COVID-19 vaccines, since 2000 (http://52625146fm.pei.de/fmi/webd/#UAWDB, accessed on 20 December 2021) The PEI has taken its adverse reaction database offline as of 30th April 2022 in order to adapt it to the security standards necessary; it

Table 6 Opinions regarding SARS-CoV-2—items of the 'Covid Orthodoxy Score' (marked with asterisk; n=1'032)

| SARS-CoV-2 compared with seasonal influenza in terms of | Less | Similar | More | Much more |
|---|---|---|---|---|
| Infectivity* | 35 (3.4%) | 199 (19.3%) | 248 (24.0%) | 550 (53.3%) |
| Infection fatality rate* | 67 (6.5%) | 229 (22.2%) | 263 (25.5%) | 473 (45.8%) |
| Challenge to the health system* | 35 (3.4%) | 216 (20.9%) | 293 (28.4%) | 488 (47.3%) |
| More important is* | the immune system | the virus | | |
| | 662 (64.1%) | 370 (35.8%) | | |
| Vaccine development* | Not necessary | Normal order and sequence should be kept | Expedited development necessary | |
| | 64 (6.2%) | 518 (50.2%) | 450 (43.6%) | |
| Most damage was done by# | The virus* | NPIs* | Media | Fake News |
| | 479 (46.4%) | 453 (43.9%) | 298 (28.9%) | 482 (46.7%) |

#Multiple answers possible.
NPIs, non-pharmacological interventions.

**Table 7** My information sources during the pandemic are mainly

| Source | Yes |
|---|---|
| No information | 75 (7.3%) |
| Public TV and radio | 461 (44.7%) |
| Social media (Twitter, Facebook, etc) | 66 (6.4%) |
| Scientific original publications | 65 (6.3%) |
| Alternative media (Websites, Youtube, alternative newspapers on the internet) | 102 (9.9%) |
| Own analysis of publicly available data (eg, RKI, CDC, ECDC, PEI) | 79 (7.6%) |
| Traditional newspapers and magazines (eg, SZ, SZ-online, Spiegel, Spiegel-online) | 117 (11.3%) |
| Exchange with colleagues and friends | 55 (5.3%) |
| Other sources* | 12 (0.1%) |

*Mix of all of them, RKI, web.de, other news, school, mix of scientists in media and TV.
CDC, Centers for Disease Control and Prevention; ECDC, European Centre for Disease Prevention and Control; PEI, Paul Ehrlich Institut; RKI, Robert Koch Institut; SZ, Süddeutsche Zeitung; TV, television.

will 'soon' be online again; it does not say when 'soon' will be, while the cases of deaths reported after COVID-19 vaccines amount to 1'802 among 171'415 total reports in the most recent report of 30 September 2021 (https://www.pei.de/SharedDocs/Downloads/DE/newsroom/dossiers/sicherheitsberichte/sicherheitsbericht-27-12-20-bis-30-09-21.pdf?__blob=publicationFile&v=10, accessed 20 December 2021). Thus, the reports of side effects for

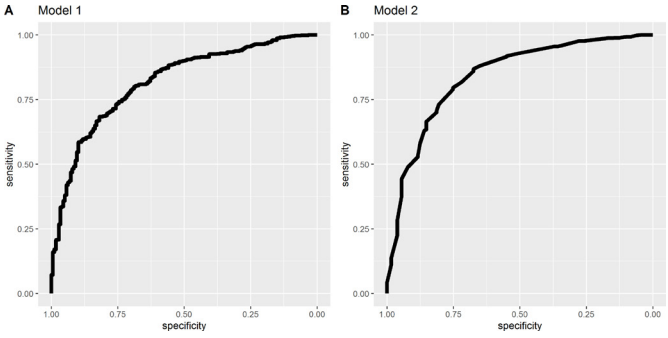


**Figure 1** Receiver-operator-characteristics curves for model 1 (predicting vaccination status) and 2 (predicting willingness to be vaccinated).

all vaccinations together per year over the past 20 years are 1.6% of the number of reports due to COVID-19 vaccines over the last year until end of September in Germany.

Slightly more of those vaccinated, namely 5.8% said that, after vaccination, their health status was worse than before, while 4% said it was better. This would put the strategy to advocate these vaccines into question. Nearly 10% had a positive SARS-CoV-2 test after vaccination. This tallies with recent information that a majority of symptomatic COVID-19 cases in Germany is vaccinated.[42] In the most recent data, the German Public Health Authority Robert-Koch-Institut (RKI) reports 9,068.8 COVID-19 cases per 100'000 in the unvaccinated, and 10,703.9 COVID-19 cases per 100'000 in the vaccinated for the year 2022 up to the first week of May (https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Daten/Inzidenz_Impfstatus.xlsx?__blob=publicationFile, accessed on 11 May 2022). In our sample, 16% of those

**Table 8** Optimal logistic regression models to predict vaccination outcomes

| Model | 1: Vaccination status | | | 2: Willingness to be vaccinated | | |
|---|---|---|---|---|---|---|
| **Predictor** | **Estimate±SE** | **P value** | **OR (95% CI)** | **Estimate±SE** | **P value** | **OR (95% CI)** |
| Orthodoxy Score | 0.33±0.03 | **$<2\times10^{-16}$*** | 1.39 (1.30 to 1.47) | 0.41±0.04 | **$<2\times10^{-16}$ *** | 1.50 (1.40 to 1.62) |
| Income | 0.236±0.064 | **0.00025*** | 1,27 (1.12 to 1.44) | – | – | – |
| Alternative media use | −0.81±0.27 | **0.0024*** | 0.44 (0.26 to 0.75) | – | – | – |
| Scientific original publications use | −0.88±0.35 | 0.011 | 0.42 (0.21 to 0.82) | −0.60±0.37 | 0.104 | 0.55 (0.27 to 1.13) |
| Size of household | −0.193±0.085 | 0.024 | 0.82 (0.70 to 0.97) | – | – | – |
| Age (10 years) | 0.094±0.059 | 0.114 | 1.01 (1.0 to 1.02) | – | – | – |
| Public TV and radio use | 0.15±0.23 | 0.513 | 1.16 (0.74 to 1.84) | 0.51±0.26 | 0.046 | 1.67 (1.01 to 2.75) |
| AICc | 756.4 | | | 588.7 | | |
| Adj. KL-$R^2$ | 0.212 | | | 0.251 | | |
| Sensitivity | 0.684 | | | 0.669 | | |
| Specificity | 0.819 | | | 0.899 | | |
| Accuracy | 0.752 | | | 0.784 | | |
| AUC | 0.818 | | | 0.844 | | |

Intercept calculated but omitted. Sensitivity and specificity are those that maximise the overall accuracy of classification.
*significant predictors.
Adj. KL-$R^2$, adjusted Kullback-Leibler-$R^2$; AICc, bias-corrected Akaike information criterion; AUC, area under the curve.

Table 9 Additional exploratory logistic regression model predicting the probability that a vaccinated participant has chosen to be vaccinated for a medical reason (n=523) vs a social reason (n=332)

| Predictor | Estimate±SE | P value | OR (95% CI) |
|---|---|---|---|
| Orthodoxy score | 0.248±0.029 | $<2\times10^{-16}$ | 1.28 (1.21 to 1.35) |
| Age (10 years) | 0.181±0.044 | $4.48\times10^{-5}$ | 1.20 (1.10 to 1.31) |
| Belief that vaccination protects from disease | −0.400±0.181 | 0.0274 | 0.67 (0.47 to 0.96) |
| Belief that vaccination protects against infecting others | 0.265±0.172 | 0.124 | 1.30 (0.93 to 1.83) |
| Information from exchange with friends | −0.691±0.368 | 0.0604 | 0.50 (0.24 to 1.03) |
| AICc | 1004.3 | | |
| Adj. KL-$R^2$ | 0.126 | | |
| Sensitivity | 0.704 | | |
| Specificity | 0.651 | | |
| Accuracy | 0.677 | | |
| AUC | 0.621 | | |

Intercept calculated but omitted. Sensitivity and specificity are those that maximise the overall accuracy of classification.
Adj. KL-$R^2$, adjusted Kullback-Leibler-$R^2$; AICc, Akaike information criterion; AUC, area under the curve.

vaccinated described some kind of serious side effect, such as thrombosis, immunological dysfunction, psychological stress or lack of stamina. The official rate of all side effect reports according to the Paul-Ehrlich-Institut safety reports is 1.6 reports in 1000 vaccinations, or 0.16%. This is close to the 0.1% found by a systematic review of all safety data to date.[43] However, the definition in those official databases of a 'severe side effect' is likely more restricted, compared with the descriptive one we adopted for our survey. Thus, our figure is about 100 times as high, which tallies with empirical studies that show that only 1% of all side effects are reported in adverse reaction databases.[17 44–46] A review of 37 studies providing estimates of underreporting yielded a median underreporting rate of 94%.[47] Taking into consideration that 16% of all vaccinated people in Germany would face serious side effects, this would amount to roughly 12 million cases. Roughly 30% of our respondents felt better, in very general psychological terms, after the vaccination. (This was a different question to the one asking about improved or worsened health status; see above.) We assume this is because of psychological relief and better social integration.

These figures could also mean that our sample represents a special group of people, as online panels are somehow semiprofessional opinion providers and hence may have some bias towards the socially acceptable; this would explain the slightly higher percentage of vaccinated persons compared with official figures at the time (see below), but not the higher percentage of severe side effects reports.

### Predicting motivation and corona orthodoxy scale

The logistic regression models were able to predict vaccination status as well as readiness to be vaccinated with more than 75% accuracy (table 8 and figure 1). Persons living in smaller households, with higher income, with a stronger adherence to the mainstream narrative, and with less usage of alternative media and scientific papers, were more likely to be vaccinated. Likewise, a higher readiness to be vaccinated was mainly predicted by a stronger adherence to the mainstream narrative, more usage of public, and less usage of scientific information sources. This is similar to findings of an Australian survey, where the willingness to be vaccinated was lower in better educated participants and in infrequent users of traditional media.[48] Our findings are in accord with other studies regarding willingness to be vaccinated.[2 48 49]

While income plays a role in the decision of being vaccinated, education does not. The most important predictor is the adherence to the mainstream narrative, a high 'orthodoxy score' calculated from our opinion items. This scale, already developed in another study,[24] was psychometrically reliable with a reasonable alpha=0.76 and unidimensional. This was the most powerful predictor in our logistic regression models to predict vaccination status and the readiness to be vaccinated. In addition, alternative media use also plays an important role, as does the reading of scientific papers. Persons who were vaccinated used scientific information and alternative media less. During the pandemic, it could be observed how opinions divergent from the mainstream narrative drifted into alternative media channels, and were less represented by mainstream media. This probably occurred also in other countries worldwide and could partly explain why vaccination hesitancy increased significantly over time.[2] Most notably, social media did not play a role in influencing the motivation for vaccination in our sample which is similar to other findings,[48] nor did it differentiate between those who were vaccinated for medical reasons and those who did so for social reasons. Mainstream media such as TV and newspapers were not significantly associated with the outcomes either, which is, however, contrary to other findings.[50] This is probably due to the fact that most of

this variance is absorbed by the orthodoxy score. This reflects the mainstream opinion that is also propagated by mainstream media. Sources of information were irrelevant for predicting the motivation for vaccination for those vaccinated for medical reasons.

It is interesting to observe that persons citing a medical reason for vaccination can be distinguished from those with a social reason. Paradoxically, they believe less that the vaccination prevents disease but that it helps to not infect others. But the most important predictor is again the COS: these persons adhere more strongly to the mainstream narrative. Bluntly speaking: Those that were vaccinated for social reasons did not so much believe the narrative, but wanted their life back. This creates cognitive dissonance. And in agreement with the theory of cognitive dissonance they changed their belief system, it seems, and now believe more strongly that the vaccination prevents disease.[51] Those that were vaccinated for medical reasons believed into the narrative and hence one would not expect cognitive dissonance. It is interesting to note that these groups are not different in terms of sociodemographic, economic or educational status, nor in the information sources they were using.

## Observations

We note that benefits from the vaccination are reported by 30% of the respondents. These are very likely psychological and social in nature. Psychologically speaking, these are negative reinforcements: by being relieved of a punishment, such as social distancing and psychological stress.

It is understandable that people unwilling to be vaccinated cite potential long-term safety issues as the most important reason for their hesitancy. As these are probably more likely to be represented in alternative media channels this makes plausible that alternative media use is a strong predictor in our logistic regression model. This problem might be solved by careful, longitudinal and proactive efficacy and safety monitoring that is the only method to eventually prove vaccine safety, but it is currently missing.[43]

We also note that more than 70% of the respondents think they can stop the spread of the virus by being vaccinated and 35% believe they can protect themselves from the disease (table 5). Thus, the group of the respondents appears to be socially adjusted and thus likely to follow the altruistic motive of protecting others which was advertised publicly during the COVID-19 vaccination campaign. However, data show that both beliefs that were originally propagated as major reasons for vaccinations have turned out to be partially wrong. Severe cases and mortality seem to be reduced, as epidemiological studies from Germany show.[52] Nevertheless, the efficacy of the COVID-19 vaccine wanes quickly[53 54] and is gone after 6 months.[55] The vaccination level is unrelated to the increase in new cases.[56] Also, it is not yet known if the vaccines have any effects against new mutations.

Obviously, misleading information led to wrong perceptions of safety and illusion of control, a deeply rooted human motive.[57] This might inform decisions based on wrong assumptions. In such a situation informed consent between a physician and patient, as justification for any medical intervention, might be critically compromised and poses risks for doctors, for example, insurance exits, criminal investigations and limitations to work as a doctor. This might be even more critical in so called 'vaccination centres' with very limited time to inform patients about the probable benefits and possible risks of the intervention.

A majority of our respondents, 64%, similar to the 52% of all immunologists surveyed by us, find that the immune system is more important than the virus in this pandemic. Political strategies have not at all respected this potentially crucial point. Lockdowns, social isolation, fear, uncertainty and stress hamper immunological competency. Perhaps it would be more fruitful to spend energy on campaigns improving immune competency than on combating a virus, for instance by improving vitamin D levels in the population[58 59] or by encouraging exercise and activity in the open air.

Along the same line, a naturally conveyed immunity by contracting the virus and having the disease seems to be immunologically much more potent, and thus also more beneficial from a public health perspective than artificially produced immunity.[60–62]

## Limitations

Our survey was only approximately representative. It arose from a professional market survey panel of respondents that are remunerated and are used to giving their opinion. This might be psychologically a special group, more prone to be socially adapted, even though they were representative from a sociodemographic point of view. We sampled 82% of vaccinated persons at a time where the official figure of fully vaccinated persons in Germany was 69.3% (https://impfdashboard.de/ accessed on 9 December 2021) or 72.3% according to the data of the German Public Health authority RKI (https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Daten/Impfquotenmonitoring.xlsx?__blob=publicationFile accessed on 9 December 2021), similar to another recent survey in the UK.[49] This is probably due to the fact that we did not differentiate between single and double shot vaccination, because we were interested in the willingness and reasons to be vaccinated in principle, and not in the vaccination status as such. The representativeness of data for the German population can be approximated with about 1000 respondents, but will of course suffer at the margins. By predefining the most important structural parameters of representativeness we have reduced bias, but bias can never be fully excluded with online panels.

One block of additional items (online supplemental table 1) was originally meant for all participants but was

only presented to those not vaccinated due to a programming oversight.

## CONCLUSION

The motivation to be vaccinated is mainly due to fear of medical consequences of an infection with SARS-CoV-2, followed by the wish to have a normal life. The motivation to stay unvaccinated is driven by worries regarding long term safety aspects of the vaccines and fear of side effects. Persons who have been vaccinated are more likely to be economically better off, to live in smaller households, follow the mainstream narrative about SARS-CoV-2 and less likely to use alternative media or original scientific papers as information sources.

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**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

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**Data availability statement** Data are available on reasonable request. We are happy to make the data available and will upload them on the project site with OSF.



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