Vaccine 61 (2025) 127403

Contents lists available at ScienceDirect

Vaccine

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

Attitudes towards conventional and non-conventional medical approaches and their relation to COVID-19 vaccination: Insights from Germany

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ARTICLE INFO

Keywords:
Attitudes
COVID-19
Mandatory vaccination
TCIM
Vaccination uptake

ABSTRACT

The main objective of this study is to investigate whether different medical attitudes relate to COVID-19 vaccination uptake and approval of vaccine mandates. The theory of planned behavior and the health belief model suggest that individual attitudes towards medical approaches are important for vaccination uptake. We use data from a German online cross-sectional study comprising 4065 respondents conducted between September and October in 2022 on the use and acceptance of five pre-defined medical approaches: conventional medicine, Traditional European Medicine (*Naturheilkunde*), complementary medicine, integrative medicine, and alternative medicine. The two main outcome measures are: (1) COVID-19 vaccination uptake, differentiating between (a) rejected, (b) socially pressured and (c) endorsed vaccination; (2) attitudes towards mandatory COVID-19 vaccination, i.e., whether or not individuals endorse vaccination mandates. We employ logistic and multinomial logistic regressions to calculate average marginal effects (AME) and to account for the influence of different medical attitudes and for confounding variables. While vaccination uptake in general is high (91.0 % in the analytical sample), our multivariate results reveal that individuals with a positive disposition towards Traditional European Medicine (AME = 0.05; $p < 0.01$) and alternative medicine (AME = 0.02; $p < 0.10$) were, comparatively, more likely to reject COVID-19 vaccination. A positive disposition towards conventional medicine is associated with higher vaccination uptake (AME = 0.17; $p < 0.001$). Positive attitudes towards alternative medicine correlate with increased levels of feeling socially pressured into accepting the vaccination (AME = 0.05; $p < 0.01$). Approval levels for universal mandatory vaccination are low (43.9 %). Positive attitudes towards alternative (AME = -0.03; $p < 0.1$) and Traditional European Medicine (AME = -0.04; $p < 0.05$) negatively correlate with approval of vaccination mandates, while positive attitudes towards conventional medicine (AME = 0.05; $p < 0.01$) increase approval. Our findings suggest that different medical attitudes are simultaneously associated with vaccination uptake and mandate approval. This provides important knowledge for policy makers when designing vaccination schemes and for health professionals when consulting their heterogeneous group of patients.

1. Introduction

Vaccination against communicable diseases is responsible for improving health and reducing health inequalities – and thus economic inequalities – around the world, and as such it is seen as one of the greatest triumphs of modern medicine [1]. However, as anti-vaccination attitudes are becoming increasingly prevalent, and vaccination uptake among children and adults continues to decrease in modern societies, this triumph appears to slowly be eroding, or is at least being widely called into question (e.g., [2,3,4]). In this vein, research indicates that

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https://doi.org/10.1016/j.vaccine.2025.127403
Received 31 October 2024; Received in revised form 12 June 2025; Accepted 12 June 2025
Available online 18 June 2025

over the last two decades, influenza pandemics have counter-intuitively contributed to increased levels of under-vaccination, instead of increasing trust in a strategy paramount to securing public and individual health during health emergencies (e.g., [5]).

When investigating the determinants of (influenza) vaccination uptake, research indicates that uptake depends on configurations of health systems, on vaccine provider characteristics, and on individual-level determinants [6]. Important individual-level determinants include age, education, ethnicity, income, social class, trust, and health beliefs [6]. Interestingly, research also indicates that the associations between individual-level determinants and vaccination uptake can be modified by contextual conditions like environmental factors, when individuals are exposed to health risks or vaccination information, and the influence of individuals' social circles [7,8]. One major contextual factor of increasing importance is the political climate. Research indicates that vaccination uptake appears to be becoming increasingly politicized, which induces polarization in vaccination by political attitudes (e.g., [9,10,11,12]).

When the extent of COVID-19 pandemic became clear, research immediately started to investigate determinants of COVID-19 vaccination intentions (i.e., the willingness to accept a COVID-19 vaccine upon availability), uptake (i.e., whether individuals actually received at least one COVID-19 vaccination shot), and hesitancy (i.e., a psychological state of indecision concerning vaccination uptake) [13]). Interestingly, research identified that the social determinants and socio-cultural factors affecting COVID-19 vaccine uptake [14] were similar to those found in earlier work on, for instance, influenza [6]. Moreover, research on COVID-19 vaccination also identified that uptake depends on factors such as general concerns regarding the safety and efficiency of vaccines; doubts about the vaccine's country of origin or the severity of the diseases; and individual beliefs about immunization, as well as a lack of trust in both health and science authorities and in vaccine producers and providers [14].

Factors less researched are how attitudes towards different medical approaches relate to COVID-19 vaccination uptake. Thus far, research only provides evidence on vaccination intentions and hesitancy. Evidence from Denmark suggests that an individual believing that natural immunity is better than vaccination is the second most relevant factor for vaccine hesitancy ([15], p. 782). In Germany, a study by Dotter et al. [16] finds that attitudes towards alternative medicine reduce the willingness to get vaccinated against COVID-19 independent of socio-demographics, individuals' perception of the risk of infection, conspiracy beliefs, past vaccination experiences, and peer pressure. These results provide provisional evidence that attitudes towards medicine and medical approaches play an independent role in attitudes towards COVID-19 vaccination. However, existing research on TCIM and COVID-19 vaccination is yet to investigate actual uptake or attitudes towards mandatory COVID-19 vaccination, and does not differentiate between attitudes that favor a combination of medical approaches within the conventional and non-conventional medical spectrum.

To study how medical attitudes relate to COVID-19 vaccination uptake and approval of mandatory vaccination, we use data from a German online access panel (4065 respondents aged 18–75) conducted in late 2022: The survey is unusual in that it differentiates between attitudes on conventional medicine, Traditional European Medicine (*Naturheilkunde*), integrative medicine, complementary medicine, and alternative medicine. Based on logistic and multinomial logistic regressions, we investigate how attitudes towards these conventional and non-conventional medical approaches relate to COVID-19 vaccination uptake and approval of mandatory vaccination.

2. COVID-19 vaccination and the role of medical attitudes

2.1. Medical attitudes and vaccination

For our specific research questions, two models of behavior change offer relevant theoretical arguments: the theory of planned behavior (TPB) and the health belief model (HBM). TPB predicts health behavior through intentions, which are shaped by three interconnected factors: attitudes towards the behavior, subjective norms, and perceived behavioral control [17]. HBM states that certain individual beliefs influence health behavior: perceptions of one's individual risk for a disease (susceptibility), of the seriousness of the disease (severity), and of the potentially positive outcomes (benefits) and material and immaterial costs (barriers) of an action that reduces the threat of the disease, with cues to action and self-efficacy as additional central elements [18,19].

Studies testing TPB show that attitudes towards COVID-19 vaccines were strong predictors of vaccination intention and behavior (e.g., [20,21,22]). Further, social norms also positively correlate with vaccination intention (e.g., [22]). Research based on HBM shows that perceived individual benefits and barriers affect vaccination intention (e.g., [23,24,25]). Additionally, perceived susceptibility to the disease relates to vaccination intention (e.g., [24]). In conclusion, studies confirm that certain beliefs and attitudes, as well as social norms, affect COVID-19 vaccination behavior and intention.

However, little is known to date about what shapes these beliefs and attitudes. We argue that different medical approaches convey different beliefs and attitudes concerning the severity of infectious diseases, the ability of the body to heal and protect itself, the advantages and risks connected to vaccines, and the best ways to look after the body. Findings from sociological research show that notions also related to the preference for TCIM are influential for inducing vaccination hesitancy or rejection in individuals. In particular, many forms of trust (e.g., trust in science or medicine, but also generalized trust) are important determinants of vaccination behavior (e.g., [26,25]).

The extent to which individuals trust conventional or non-conventional medicine depends on their socialization processes and on life course experiences [27,28]. Among the main drivers for developing distrust in conventional medicine are feelings and perceptions that physicians within the conventional system do not take patients' interests and worries seriously enough ([27]: 2). In addition, research stresses the role of TCIM physicians, who are perceived by patients as investing more time in their needs and as taking their worries more seriously in contrast to physicians who practice conventional medicine (e.g., [29]).

In this context, research also shows patients favoring TCIM are increasingly turning to other, often unregulated sources of information, in addition to medical professionals, to educate themselves about health matters [30]. Nevertheless, in the case of vaccination, health care providers are key [7]. In addition to trust or skepticism towards conventional medicine (or the 'system'), an 'individualist epistemology' or a strong affinity for nature (expressed, for instance, in a belief in 'natural immunity' as a primary health strategy) are also important factors associated with nonconventional medical attitudes and vaccination decisions (e.g., [31,32,33,34]).

2.2. TCIM and COVID-19 vaccination in Germany

Germany constitutes an interesting test case for the study of how medical beliefs relate to COVID-19 vaccination because it has one of the highest rates of utilization of TCIM (in existing literature often referred to as CAM) in Europe [35]. Regarding the usage of TCIM, several studies have documented the increasing inclination of individuals towards TCIM – specifically in Germany (e.g., [36,37,38,[39]]). In the [40], of 21 European countries (including Israel), Germany was found to be one of the top five countries – with a prevalence rate of 23 % – for the utilization of physical TCIM practices (acupuncture, acupressure, chiropractic, osteopathy, and reflexology) and/or consumable TCIM practices (homeopathy and herbal treatments) [35]. Research furthermore indicates that TCIM is increasingly used by patients with severe illnesses such as cancer [41]. In the general population, however, TCIM is mainly employed for minor ailments, often as a self-help strategy; only a small fraction of individuals relies solely on natural healing methods to cure

diseases [38].

In Germany, certain TCIM practices are partly integrated into the statutory health care system. For example, health insurers will pay for acupuncture under specific indications, and some forms of phytotherapy and anthroposophic medicine are included in selective contracts. Additionally, Germany has a system of treatment pluralism in medicine: Licensed physicians can obtain certified postgraduate qualifications in areas such as naturopathy and acupuncture, regulated by regional medical associations. Integrative medicine is also gaining institutional presence, with dedicated university chairs, research centers, and clinical departments. Despite this, full integration into mainstream biomedical practice remains selective and varies across regions and institutions.

With the increasing prevalence of TCIM usage in society and in the medical system, attitudes towards medical approaches have diversified as well. Studies on TCIM in Germany ([39; 42]) show that while a majority within society still favors evidence-based medical treatments (like vaccination), a considerable proportion of the population also favors a combination of conventional medicine with TCIM approaches; only a minority rejects conventional medicine altogether. Additionally, TCIM proponents with a critical stance towards conventional medicine have a more restricted intake of pharmaceuticals compared to moderate proponents of conventional methods and TCIM [42], which indicates potentially lower likelihoods of accepting vaccinations among individuals with a strong inclination towards TCIM.

Additionally, vaccine skepticism is more common among professional TCIM practitioners compared to the group of physicians employing only conventional methods (e.g., [43,29]). For Germany, a study using latent profile analysis identified a substantial group of physicians with vaccination responsibilities who endorse TCIM (24 %); this group's recommendation rates for and confidence in vaccines is still high, albeit below average [44]. Thus, the broader use of certain TCIM approaches, attitudes towards TCIM, and skepticism towards conventional medicine may play an important role in explaining vaccine uptake in Germany, which is high when comparing COVID-19 vaccination rates between Germany and other western, central, and northern European countries [40].

In this study, we argue that attitudes towards TCIM also relate to attitudes towards mandatory COVID-19 vaccination. Based on notions from the HBM and TPB, we would expect that favoring alternative medicine or rejecting conventional medicine, for instance, should negatively affect the perceived benefits associated with a COVID-19 vaccination and should also influence individuals' perception of COVID-19 vaccination being an optimal health strategy. As the empirical literature on vaccine mandates shows that unvaccinated individuals are less likely to support vaccine mandates (e.g., [45,46]) and positive attitudes towards alternative medicine negatively relate to COVID-19 vaccination intentions [16], attitudes towards TCIM should also affect attitudes towards mandatory vaccination.

In general, existing research on vaccine mandates indicates that support among health professionals is rather low (e.g., [47]); research on mandatory COVID-19 vaccination in Germany suggests that the general population, too, was strongly divided on the issue [46]. Results for Germany suggest that support for mandatory vaccination depends on the individual willingness to be vaccinated, age, gender, residency in former East or West Germany, the personality trait neuroticism, and individual beliefs regarding the severity of the disease [46]. Research on whether medical attitudes relate to attitudes towards mandatory COVID-19 vaccination in Germany is scant.

One specific development that influenced public attitudes in Germany towards mandatory vaccination was the fact that, although at the beginning of the pandemic politicians had promised that COVID-19 vaccination would remain voluntary, although confidence in this political statement started to erode as early as the beginning of 2021 – on the governmental level but also within society. At the end of 2021 only about half of the population was in favor of an unconditional mandatory vaccination scheme [48]. In December 2021, the German parliament (*Bundestag*) introduced a "facility-based" mandatory vaccination scheme intended to protect particularly vulnerable populations, and from March 16, 2022, onwards employees of clinics, nursing homes, and similar facilities had to submit proof of vaccination or recovery to their employer to continue their employment [49].

However, this "facility-based" mandatory vaccination was repealed as of January 1, 2023, and there were apparently very few sanctions against violations [50]. Shortly after the introduction of the "facility-based" mandatory vaccination in January 2022, there was an initial debate in German parliament on a more general mandatory vaccination for all adults or adults over age 50, followed by the first reading on various initiatives on the subject on March 17, 2022 [51]. The vote on all suggested legislative drafts failed a month later.

3. Empirical approach

3.1. Data and sample

This study uses cross-sectional data from an online survey on the Use and Acceptance of TCIM in Germany, which took place in September and October 2022. The survey included questions on TCIM and related medical approaches, and encompassed attitudes towards – and knowledge, experiences, and application of – these approaches. In addition to its core focus on TCIM, the survey collected information on general attitudes, current health status, medical history, and socio-demographics, as well as modules on nutrition, Sinus milieu indicators, and the EQ-5D-5 L quality of life questionnaire (see Jeitler et al. [39] for an overview of the survey). Additionally, the survey also included a question on COVID-19 vaccination and on attitudes towards mandatory COVID-19 vaccination, which we use in this study.

The commissioned research institutes Sinus and respondi collected the data using an online access panel with quota sampling. The panel is certified under ISO 26362, which monitors the quality of online sampling. This includes quality procedures that continuously check response behavior. To adhere as closely as possible to the requirements of a representative sample, respondi requires double opt-in registration, with experts monitoring and managing the panel. The study was approved by the Charité University ethics committee (ClinicalTrials.go NCT05530720), and participants gave informed consent before taking part. Initially, 8821 respondents started the survey, with a final response rate of 21.5 %. From the 8821 respondents who started the survey, 453 cases (5.1 %) were excluded based on criteria such as lack of consent and age. Additionally, the research institute deleted information from 2845 respondents (32.3 %) because of filled quotas, and from another 313 cases (3.5 %) due to failed internal quality checks. 1000 (11.3 %) individuals did not complete the survey.

As the quota sampling was effective only for the age group of 18–75-year-olds, the final gross sample includes 4065 respondents. The final analytical sample comprises 3578 individuals aged between 18 and 75. The divergence in case numbers is primarily the result of our decision to recode one dependent variable (i.e., we drop 384 cases for analytical reasons) and missing values (i.e., we drop 103 cases due to missing values). Table A3 in the online supplement indicates no significant differences across the gross and analytical sample. In the next section, we provide more details on the operationalization of our vaccination variable that accounts for the majority of excluded cases.

3.2. Measures

3.2.1. Dependent variables

This study employs two dependent variables. The first variable of interest is the *COVID-19 vaccination behavior*. The survey asked respondents the following question: "Have you been vaccinated against SARS-CoV-2?" Respondents could choose one possibility from the following list: (1) "Yes, because I was certain it was the right thing to do." (2) "Yes, after careful consideration." (3) "Yes, because I felt forced

to." (4) "Yes, for other reasons." (5) "No, I wouldn't do that as a matter of principle." (6) "No, I'm still waiting for the right vaccine." (7) "No, because I'm not allowed to for health reasons." (8) "No, for other reasons." (9) "I'm currently in the process." As we are interested in those respondents making deliberate, opinion-based choices for or against vaccination, our dependent variable consists of three values: (0) rejected COVID-19 vaccination (answer categories five and six), (1) socially pressured COVID-19 vaccination (answer category three), (2) endorsed COVID-19 vaccination (answer categories one and two). Thus, we excluded respondents who gave "other reasons" both for choosing to get vaccinated or refraining from it, who could not get vaccinated for health reasons, or who were currently in the process.

The second dependent variable of interest constitutes the *attitude towards mandatory vaccination*, which we analyze using answers to the following survey question: "What do you think of mandatory vaccination against COVID-19?". Answer options include "I think compulsory vaccination makes sense in principle"; "I think compulsory vaccination makes sense for certain sections of the population"; "I don't think compulsory vaccination makes sense"; "don't know". From these answers, we construct a binary indicator excluding "don't know" answers and collapsing positive statements towards mandatory vaccination into one category.

3.2.2. Independent variables

Respondents rated each medical approach on a 5-point scale ranging from (1) "very positive", (2) "positive", (3) "neutral", (4) "mainly negative", to (5) "very negative". Alternatively, respondents could also use the "don't know" option. For the multivariate analyses, the extreme answer options were combined, resulting in (1) "(very) positive", (2) "neutral", (3) "(very) negative" and (4) "don't know". To reduce heterogeneity in answering behavior due to information asymmetries, the medical approaches were presented using the following descriptions: *Conventional medicine*: the socially established 'conventional medicine' taught at medical faculties. *Traditional European Medicine (*German: *Naturheilkunde)*: health aids or treatments with natural healing methods, e.g. phytotherapy, fasting and a healthy diet, exercise and a healthy lifestyle, or Kneipp water treatments (hydrotherapy). *Complementary medicine*: traditional diagnostic and therapeutic methods from western cultures that complement conventional medicine, but also from traditional Chinese or Indian medicine, for example. *Integrative medicine*: the combination of conventional medicine with evidence-based traditional European medicine and complementary medicine. *Alternative medicine*: scientifically unsupported healing methods which, by definition, are used as an alternative to conventional medicine, often because users reject conventional methods.

3.2.3. Confounding variables

Socio-demographics: The study controls for *gender* (categorical indicator: (0) male, (1) female, (2) diverse gender), *age* (linear and quadratic term), a dummy indicator for *German citizenship*, *education* ("low", "medium", "high"), employment status ((1) "full-time", (2) "part-time", (3) "unemployed", (4) "in school", (5) "retraining/parental leave", (6) "retired"), and the *socioeconomic position of the parents* (measured via occupational status, captured here by a variable where respondents could state whether or not one or both of their parents was a high-level civil servant). Additionally, the study controls for *monthly household income* (captured by 18 categories) and the *number of persons living in the household*. A categorical variable for *German federal states* (*Bundesländer*) captures regional differences.

Knowledge on vaccination in general and medical attitudes: We take into account individuals' *medical training* (differentiating between (1) "no medical training", (2) "vocational medical training", (3) "healing practitioner" (*Heilpraktiker*), and (4) "university medical training") and *subjective health status* ((1) "excellent", (2) "very good", (3) "good", (4) "modest", (5) "bad").

Trust: Our study accounts for *trust in democracy* ((1) "I trust unconditionally", (2) "I mostly trust", (3) "neither trust nor distrust", (4) "I tend to distrust", (5) "I have no trust at all") and *trust in conventional medicine* (dummy for agreement/disagreement with the statement: "I view medications used in conventional medicine with skepticism because it's primarily about profit").

General beliefs: We account for general beliefs by including *party preferences* ((1) the mainstream German parties (the conservative CDU/CSU, the social democrats (SPD), the Green party, and the liberals (FDP)), (2) Germany's largest left-wing party (Die Linke), (3) its largest right-wing party (AfD), (4) other parties, and (5) no answer), *level of spirituality* ((1) "not at all", (2) "not really", (3) "neither nor", (4) "somewhat", (5) "very much", (6) "don't know") and *religious community affiliation* ((1) "Christian", (2) "non-Christian", (3) "no religious affiliation/atheist").

3.3. Method

To test the association between attitudes towards medical approaches and a trichotomized outcome variable on vaccination behavior, we apply multinomial logistic regressions. First, we test the effects of each attitude on vaccination behavior separately without control variables. Second, we test all five attitudes together in a joint model without control variables, and third, we apply a full model with control variables. To interpret regression coefficients, we computed the average marginal effects (AME) and average discrete changes (ADC). We visualize predicted probabilities with conditional effect plots.

To analyze how medical attitudes relate to attitudes towards mandatory vaccination, we use logistic regression models. In the results section, we first present results from a model that includes each attitude towards the medical approaches without adding any control variables. To test whether relationships depend on the omission of confounding variables, we also include the full set of control variables. As for the multinomial regression, we present results from the logistic regression as AMEs.

4. Results

Table 1 presents the associations between medical attitudes and the COVID-19 vaccination rate. The descriptive results already indicate that attitudes towards medical approaches are associated with vaccination uptake and approval of mandatory vaccination. While positive attitudes towards conventional and integrative medicine positively correlate with vaccination uptake, negative attitudes towards these medical approaches negatively correlate with vaccination uptake. Conversely, a positive attitude towards Traditional European Medicine or alternative medicine is associated with reduced vaccination rates, when compared with a negative attitude towards these approaches. Interestingly, when excluding individuals who stated they felt socially pressured into getting vaccinated, vaccination uptake gradients within and across medical beliefs increase. The data on attitudes towards mandatory vaccination given in Table 1 indicate rather low approval ratings, especially when investigating attitudes towards an unrestricted mandatory vaccination scheme. Moreover, the patterns observed in favor of mandatory vaccination reflect the results describing the vaccination rates.

When turning to the results based on multinominal logistic regression models, the separate models (M1a–M1e) presented in Table 2 reveal that rejection of vaccination is significantly lower for respondents with a neutral or positive stance on conventional medicine. Conversely, rejection is significantly higher when Traditional European Medicine is viewed positively and when attitudes on alternative medicine are neutral or positive. Analogously, COVID-19 vaccination uptake is significantly higher when conventional medicine, but also integrative medicine, is not regarded negatively. In contrast, non-negative views on alternative medicine significantly decrease vaccination uptake. Looking at the outcome of feeling pressured to get vaccinated, it turns out that especially people with a non-aversive attitude towards alternative

Table 1
Medical attitudes, vaccination rates, and attitudes towards mandatory vaccination, N = 3578.

	Percent	Vaccination rate	Vaccination rate without pressured	Pro mandatory vaccination	Pro unrestricted mandatory vaccination
Conventional medicine					
negative	4.0	64.8	37.3	46.4	22.5
neutral	27.3	86.4	63.4	63.0	35.6
positive	66.1	94.5	83.2	75.1	48.7
don't know	2.6				
Traditional European Medicine					
negative	7.3	94.2	75.0	71.9	51.5
neutral	37.0	93.1	78.7	74.3	46.0
positive	52.5	88.8	73.5	67.3	41.1
don't know	3.2				
Complementary medicine					
negative	6.8	92.6	77.4	78.6	51.4
neutral	44.6	91.9	75.7	70.5	43.6
positive	35.8	88.8	75.1	67.8	42.4
don't know	12.8				
Integrative medicine					
negative	5.0	87.7	68.1	68.2	46.4
neutral	40.2	90.5	75.3	70.7	44.5
positive	42.7	91.4	76.9	70.0	42.7
don't know	12.1				
Alternative medicine					
negative	23.7	96.2	86.1	77.8	50.7
neutral	43.0	90.3	74.6	70.9	44.0
positive	25.4	87.0	68.6	63.4	38.5
don't know	7.9				

Note: Results for the answer category "don't know" are not shown. Raw vaccination rate without imposing sample and coding restriction: 86.9 %. Overall vaccination rate in sample: 91.0 %. These deviations occur due to coding decisions. For further explanations on these decisions refer to the subsection "Measures". Data: Survey on Use and Acceptance of TCIM in Germany 2022. Authors' own calculations.

medicine felt pressured into getting vaccinated: This association is not visible for proponents of Traditional European Medicine, however. Again, we find no relationship between complementary medicine and vaccination behavior. Controlling for each attitude in a joint model (M2) does not change coefficient size and significance notably.

Model M3, the full model, adjusts for control variables to depict possible confounding effects. While the drop in the coefficient size of certain variables shows that there is some confounding link between attitudes and COVID-19 vaccination due to background information, they do not fully explain the association between attitudes on medical approaches and vaccination behavior. To illustrate this result more clearly, we present conditional effect plots in Fig. 1. The upper part of Fig. 1 illustrates the predicted probabilities for COVID-19 vaccination behavior by the type of attitude towards conventional medicine and integrative medicine. As the upper part of Fig. 1 indicates, both approaches show similar associations with vaccination behavior. A negative versus a positive attitude towards conventional medicine accounts for an almost 20 percentage point differential in vaccination uptake. For integrative medicine the difference is somewhat smaller but still amounts to around 8 percentage points. A more positive view on conventional medicine also corresponds with a lower predicted probability of feeling pressured into vaccination. However, this is not the case for integrative medicine.

The lower part of Fig. 1 illustrates the opposite: When attitudes towards Traditional European Medicine and alternative medicine are positive, we see that the predicted probability of rejecting the COVID-19 vaccination is higher, by about 10 percentage points. When examining the motivations for getting vaccinated, distinct differences emerge between supporters of Traditional European Medicine and alternative medicine. Specifically, those favoring alternative medicine evince a higher likelihood of being vaccinated due to social pressure. This association is not observed for supporters of Traditional European Medicine.

Fig. 2 presents average marginal effects from logistic regression models relating medical attitudes to attitudes towards mandatory vaccination. When individuals state that they have negative attitudes towards conventional medicine, they are around 16 percentage points less likely to endorse mandatory vaccination compared to individuals who have no strong positive or negative attitude towards this approach. In contrast, individuals who endorse conventional medicine are around 12 percentage points more likely compared to 'neutral' individuals to favor mandatory vaccination. When introducing important control variables such as trust in conventional medicine and other factors, the observed associations become substantially smaller. While the association for the rejection of conventional medicine becomes statistically insignificant, the association for positive attitudes is reduced to around 5 percentage points and remains statistically significant. Thus, positive attitudes towards conventional medicine appear to independently predict being in favor of mandatory vaccination.

Turning to attitudes towards Traditional European Medicine, Fig. 2 suggests a smaller association between positive and negative attitudes when comparing the estimates to those of attitudes towards conventional medicine. Individuals with both negative and positive attitudes towards Traditional European Medicine, when compared to more indifferent individuals, appear to have lower approval levels for mandatory vaccination. However, the observed association for negative attitudes appears to be due to confounding, while positive attitudes towards Traditional European Medicine appear to be independently negatively associated (around 4 percentage points) with approval of mandatory vaccination when compared to more indifferent individuals.

While Fig. 2 suggests that individuals' views on mandatory vaccination do not differ between individuals with positive or neutral attitudes towards complementary medicine, approval levels differ for individuals with negative attitudes towards complementary medicine. The association without control variables is comparable to the estimate

Table 2
Multinomial logistic regression models of attitudes by vaccination choice.

	M1a–M1e AME/DC			M2 AME/DC			M3 AME/DC		
	rejected COVID-19 vaccination	pressured COVID-19 vaccination	endorsed COVID-19 vaccination	rejected COVID-19 vaccination	pressured COVID-19 vaccination	endorsed COVID-19 vaccination	rejected COVID-19 vaccination	pressured COVID-19 vaccination	endorsed COVID-19-vaccination
Conventional medicine (ref.: negative)									
neutral	**−0.22*****	0.05	**0.26*****	**−0.19*****	0.05	**0.25*****	**−0.07***	0.01	**0.08***
positive	**−0.30*****	**−0.16*****	**0.46*****	**−0.27*****	**−0.16*****	**0.43*****	**−0.10*****	**−0.07***	**0.17*****
Traditional European Medicine (ref.: negative)									
neutral	0.01	**−0.05**$^{+}$	0.04	0.01	**−0.07***	**0.06**+	0.02	**−0.05**$^{+}$	0.02
positive	**0.05****	0.04	0.02	**0.05****	**−0.06**$^{+}$	0.01	**0.05****	0.04	0.01
Complementary medicine (ref.: negative)									
neutral	0.01	0.01	0.02	0.01	0.03	0.04	0.01	0.02	0.01
positive	0.04	0.02	0.02	0.03	0.01	0.02	0.02	0.02	0.00
Integrative medicine (ref.: negative)									
neutral	0.03	0.04	**0.07***	0.05	0.04	**0.08***	0.02	0.02	0.05
positive	0.04	0.05	**0.09****	**−0.08***	0.01	**0.09***	**−0.05**$^{+}$	0.01	0.06
Alternative medicine (ref.: negative)									
neutral	**0.06*****	**0.06*****	**−0.12*****	**0.05*****	**0.04****	**−0.10*****	**0.03****	0.02	**−0.05****
positive	**0.09*****	**0.08*****	**−0.18*****	**0.06*****	**0.09*****	**−0.15*****	**0.02**$^{+}$	**0.05****	**−0.08*****
Controls	no	no	no	no	no	no	yes	yes	yes

Note: Average Marginal Effects, N = 3578; ***p < 0.001; **p < 0.01; *p < 0.05; $^{+}p < 0.10$. Coefficients for "no opinion" on medical attitude not displayed. Controls: gender, age, age squared, level of education (low, medium, high), German citizenship, household income, number of persons in the household, socioeconomic position of parents, medical training, subjective health status, trust in democracy, trust in conventional medicine, party preference, spirituality, religious community affiliation, German federal states. Table A1 in the Online Appendix contains the complete multinomial logistic regression for model M3. Data: Survey on Acceptance and Use of TCIM in Germany 2022. Authors' own calculations.

of individuals who endorse conventional medicine.

While Fig. 2 suggests only small, statistically insignificant associations between attitudes towards integrative medicine and attitudes towards mandatory vaccination, statistically significant associations for alternative medicine are present. While the positive association between approval of mandatory vaccination and negative attitudes towards alternative medicine can be ascribed to confounding, our results suggest that individuals who favor alternative medicine are on average around 3 percentage point less likely than neutral individuals to endorse mandatory vaccination.

5. Conclusion and discussion

This study found that COVID-19 vaccination behavior is linked to attitudes towards different medical approaches, regardless of socioeconomic and demographic factors, religious and spiritual beliefs, and trust in institutions and conventional medicine. While general COVID-19 vaccination levels in our sample are fairly high, supporters of Traditional European Medicine and alternative medicine are more likely to reject vaccination, while those favoring integrative and conventional medicine are more likely to be vaccinated. Furthermore, proponents of alternative medicine are often vaccinated due to perceived external pressures rather than personal choice. This is evidence of higher levels of skepticism towards vaccination among proponents of alternative medicine. Attitudes towards medical approaches also correlate with approval of mandatory vaccination: Positive attitudes towards conventional medicine tend to increase support for mandatory vaccination, while negative attitudes towards conventional medicine and positive attitudes towards Traditional European Medicine and alternative medicine tend to decrease approval.

These findings are based on a unique data set from a large cross-sectional study, enabling us to offer novel insights on attitudes towards medicine and vaccination; however, some limitations of the data at hand should stimulate further research. First, although our study addresses many potential confounding variables, future analyses based on longitudinal data are warranted to further strengthen the correlations we observe between attitudes towards different medical procedures and vaccination. Second, the largest vaccination gap found in this sample amounted to only around seven percentage points. However, it should be remembered that the survey was conducted in late 2022, towards the end of the COVID-19 pandemic: Notably, when considering individuals who felt pressured to get the vaccination, we see large differences of around 15 percentage points between individuals who favor conventional medicine compared to Traditional European or alternative medicine, which indicates the importance of employing more nuanced measures of vaccination behavior and approval. Third, although our study was conducted in September and October 2022, we were not able to distinguish between numbers of vaccination doses and timing of vaccination uptake. Discrepancies in the timing of vaccinations and a lower number of doses are likely to be pivotal factors when trying to control the spread of a virus [52]. Consequently, future research should analyze the role of medical attitudes for the exact timing of the vaccination uptake, which could further increase our understanding of how differences in medical attitudes can affect public health during health emergencies.

Fourth, we were not able to measure vaccination attitudes. Consequently, we were not able to test whether medical attitudes directly relate to attitudes towards vaccination (e.g., attitudes about costs and benefits, fears of side effects, efficacy etc.). Instead, our study effectively demonstrates that different medical attitudes simultaneously relate to

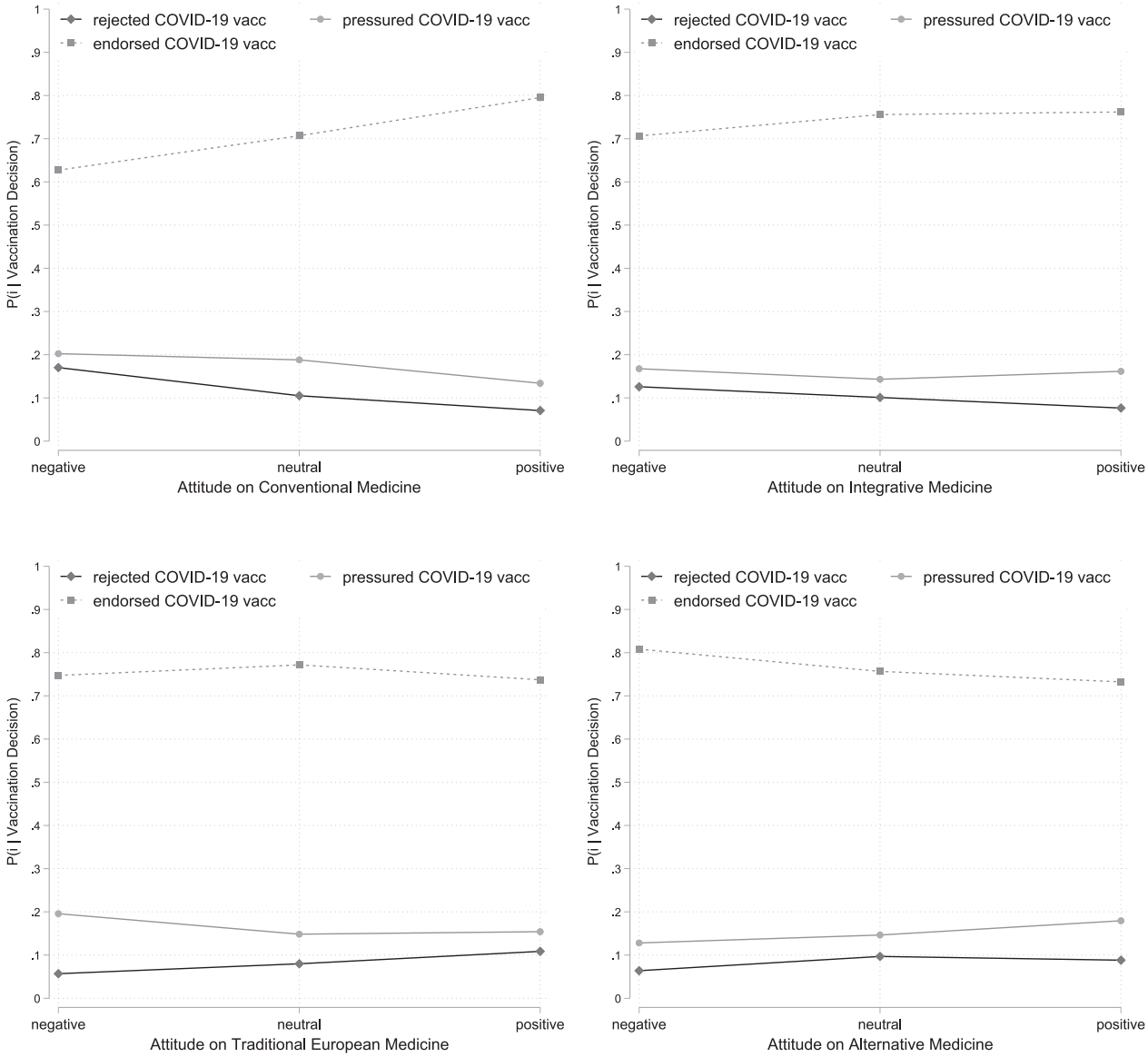

Fig. 1. Vaccination outcomes by medical attitudes. Note: Results from multinomial logistic regressions. Predictive Margins, $N = 3578$. Coefficients for "no opinion" on medical attitude not displayed. Controls: gender, age, age squared, level of education (low, medium, high), German citizenship, household income, number of persons in the household, socioeconomic position of parents, medical training, subjective health status, trust in democracy, trust in conventional medicine, party preference, spirituality, religious community affiliation, German federal states. Data: Survey on Use and Acceptance of TCIM in Germany 2022. Authors' own calculations.

COVID-19 vaccination uptake conditioned on a vast set of potentially confounding variables. Future research has to clarify whether and how medical attitudes shape vaccination attitudes and how these disparities in attitudes translate into differences in vaccination uptake. Based on the health belief model, we can expect that some TCIM attitudes, such as favoring alternative medicine, might influence the perceived benefits associated with COVID-19 vaccination. Moreover, when drawing on notions from the theory of planned behavior, medical attitudes probably strongly shape the attitudes of individuals towards vaccination (such as perceiving a COVID-19 vaccination as necessary); because medical attitudes can be reinforced by an individual's social circle, they may also influence the enforcement of social norms (e.g., [53]).

A fifth limitation might stem from the sampling procedure employed here. As research has pointed to potential drawbacks of non-probability-based sampling in the context of descriptive research (e.g., [54]), future work would benefit from replicating our study on a probability-based sample. However, data from high quality online access panels are able to deliver reliable results (in particular in multivariate regression models) because panelists regularly take part in surveys and have experience in answering (complex) survey questions. Moreover, as the employed survey includes many questions about respondents' health status and history, the online mode is particularly effective at reducing social desirability bias. Considering together the sensitivity of medical information, the social desirability affecting questions on vaccination, and the complicated nature of some of the questions (see measures section), the utilization of an online access panel represents an ideal strategy to achieve high data quality. Moreover, as we restricted our sample to 18–75-year-olds, we assume that the exclusion of people with no internet access or little interest in digitalization in general is not substantial, as these 'off-liners' are mostly found among the very oldest age groups.

Generally, despite differences in preferences towards diverse medical approaches, our findings imply that distrust in conventional medicine appears to somewhat reduce vaccination uptake and is related to

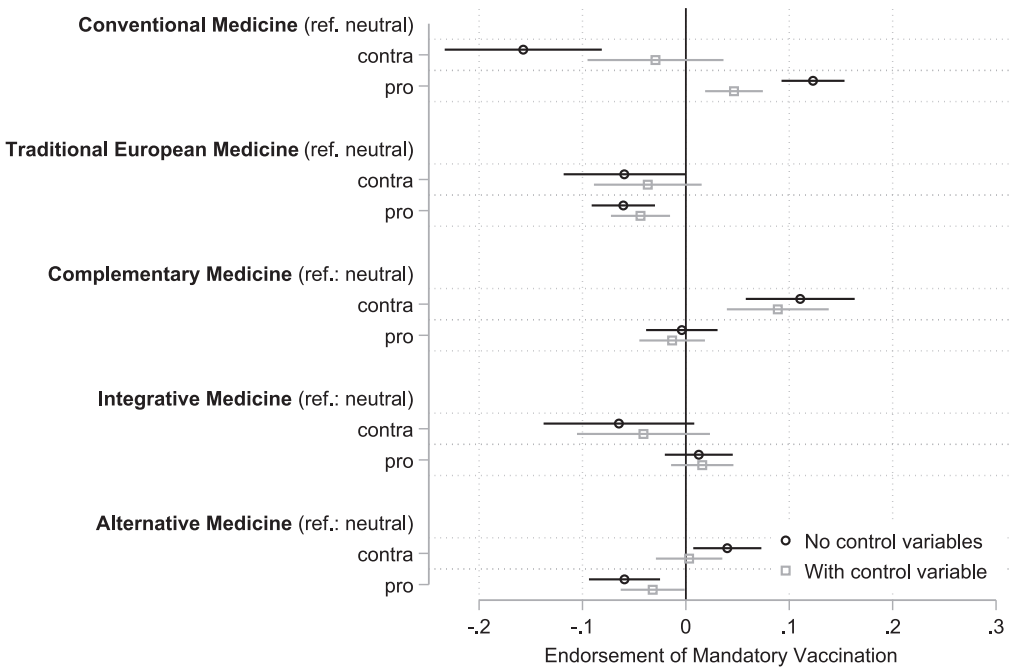

Fig. 2. Medical attitudes and attitudes towards mandatory COVID-19 vaccination. Note: Results from logistic regressions; Average Marginal Effects, N = 3578. The black circles represent point estimates, and the black lines 90 % confidence intervals, of a model that includes all attitudes towards medicine simultaneously without control variables; the gray squares and lines present results from a model that adjusts for confounding factors. Coefficients for "no opinion" on medical attitude not displayed. Controls: gender, age, age squared, level of education (low, medium, high), German citizenship, household income, number of persons in the household, socioeconomic position of parents, medical training, subjective health status, trust in democracy, trust in conventional medicine, party preference, spirituality, religious community affiliation, German federal states. Table A2 in the Online appendix contains the results of the logistic regression model. Data: Survey on Use and Acceptance of TCIM in Germany 2022. Authors' own calculations.

lower levels of approval for mandatory vaccination. In contrast, when interpreting positive attitudes towards conventional medicine as trust in more evidence-based medical approaches, our findings suggest that evidence-based beliefs are associated with higher levels of vaccination uptake, lower levels of pressured vaccination, and higher approval levels for mandatory vaccination. As we are able to exclude confounding associations in our cross-sectional analysis between vaccination behavior and trust in both medicine and in institutions, our results may be also interpreted in a way that shows that believing in natural remedies or the inherent healing power of the body are crucial for attitudes towards COVID-19 vaccination. Thus, and in contrast to earlier work (e.g., [55]), our study's results indicate that different attitudes towards medicine in general are independently associated with vaccination behavior, which indicates that studies on TCIM should carefully distinguish between attitudes towards different medical approaches.

Furthermore, our results indicate that vaccination strategies could be more effective when specifically addressing potential vaccine recipients who feel they can rely solely on their body's 'natural' abilities to overcome a potentially severe disease – in addition to the more scientific, evidence-based focus of typical vaccination programs. However, although our cross-sectional results indicate that positive attitudes towards conventional medicine (and therefore most likely also evidence-based motives for vaccination) are important drivers of vaccination uptake, strategies aiming to increase vaccination levels have to find the right balance between emphasizing the utility of conventional approaches to prevent illness and death, on the one hand, and the utility of complementary medical procedures to (for instance) mitigate possible side effects on the other. Moreover, our results imply that approval levels for mandatory vaccination are low. Thus, it remains questionable whether future debates on vaccination schemes can be successful when focusing on making vaccination mandatory.

Our cross-sectional study also shows that medical attitudes correlate with feeling pressured into getting vaccinated. We argue that this analytical step makes our results transferable to the post-pandemic context, and thus perhaps to other, related vaccines (like influenza): One mechanism might be that individuals who felt pressured to be vaccinated during an international pandemic would have been less likely to be vaccinated for other illnesses in less extreme situations. This effect might be particularly relevant in the context of the COVID-19 vaccination, because research indicates negative spillovers of anti-COVID-19 vaccination attitudes to other vaccination scenarios in which, for example, parents decide whether to vaccinate their children [56].

Overall, our study identified that attitudes towards medical approaches induced heterogeneity in COVID-19 vaccination behavior and attitudes towards mandatory vaccination, independent of central decision-relevant factors like trust in institutions and conventional medicine. Thus, our study informs the scientific literature on vaccination and also provides important knowledge for policy makers and health professionals when consulting their heterogeneous groups of patients on vaccination.

Confirmation by corresponding author

I, Alexander Patzina, confirm written permission has been obtained from all persons named in the Acknowledgments.

Acknowledgement of prior presentations

Presentation at the ECSR conference "COVID-19 and Social Inequality in Well-being" in Bamberg, Germany, 08/2023.

Acknowledgement of financial support/grants

The study was funded by the Karl and Veronica Carstens Foundation, and we would like to thank them for their support. The funder had no

role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

CRediT authorship contribution statement

Alexander Patzina: Writing – original draft, Visualization, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Miriam Trübner:** Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Judith Lehmann:** Writing – original draft, Validation. **Benno Brinkhaus:** Writing – review & editing, Validation. **Christian S. Kessler:** Writing – review & editing, Validation, Funding acquisition. **Rasmus Hoffmann:** Writing – review & editing, Validation.

Ethical approval statement

The study was approved by the Charité Ethics Committee and registered with ClinicalTrails.gov (NCT05530720).

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Christian Kessler reports financial support was provided by Karl and Veronica Carstens Foundation. Christian Kessler reports a relationship with Medical Doctors' Association for Ayurveda-Medicine that includes: board membership. Christian Kessler reports a relationship with company Bruno Zimmer that includes: board membership. Christian Kessler reports a relationship with Ayurveda at Sonne und Mond, Berlin that includes: speaking and lecture fees. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We thank Vanessa Kunze for excellent student assistance. Thanks to the market research institutes involved, especially to Matthias Arnold. Thanks to the planning group involved in designing the questionnaire—in particular to: Tobias Esch, Stefanie Joos, Gustav Dobos, Holger Cramer, Jost Langhorst, Georg Seifert, Michael Teut, Anna Paul, Cosima Hötger. Thanks also to Daniela Koppold, Melanie Dell Oro, Etienne Hanslian, Gunda Loibl, and Peter Kalinowski. Moreover, we want to thank Will Tayler for excellent proof reading.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2025.127403.

Data availability

Data will be made available on request.

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