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Gender Differences in Health Care Workers' Risk-Benefit Trade-Offs for COVID-19 Vaccination

Maria Ada Presotto[a] Rudolf A. Jörres[b] Wolfgang Gesierich[c] Jörn Bullwinkel[d] Klaus F. Rabe[d] Konrad Schultz[e] Franziska Kaestner[f] Dominik Harzheim[f] Michael Kreuter[a] Felix J. F. Herth[a] Franziska Christina Trudzinski[a]

[a]Department of Pneumology and Critical Care Medicine, Translational Lung Research Center Heidelberg (TLRCH), German Center for Lung Research (DZL), Thoraxklinik University of Heidelberg, Heidelberg, Germany; [b]Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine, Comprehensive Pneumology Center Munich (CPC-M), German Center for Lung Research (DZL), Ludwig Maximilians University (LMU), Munich, Germany; [c]Asklepios-Fachkliniken München-Gauting, Comprehensive Pneumology Center Munich (CPC-M), German Center for Lung Research (DZL), Munich, Germany; [d]LungenClinic Grosshansdorf, Airway Research Center North (ARCN), German Center for Lung Research, Großhansdorf, Germany; [e]Clinic Bad Reichenhall, Center for Rehabilitation, Pneumology and Orthopedics, Bad Reichenhall, Germany; [f]Waldburg Zeil Kliniken Gmbh & Co. KG, Fachkliniken Wangen, Lungenzentrum Süd-West, Klinik für Pneumologie, Beatmungsmedizin und Allergologie, Wangen im Allgäu, Germany

Keywords
COVID-19 pandemic · Health care workers · Vaccination · Specialized lung clinics · Perceived infection risk

Abstract
Background: Gender differences in vaccine acceptance among health care workers (HCWs) are well documented, but the extent to which these depend on occupational group membership is less well studied. We aimed to determine vaccine acceptance and reasons of hesitancy among HCWs of respiratory clinics in Germany with respect to gender and occupational group membership. ***Methods:*** An online questionnaire for hospital staff of all professional groups was created to assess experiences with and attitudes towards COVID-19 and the available vaccines. Employees of five clinics were surveyed from 15 to 28 March 2021. ***Results:*** 962 employees (565 [72%] female) took part in the survey. Overall vaccination acceptance was 72.8%. Nurses and physicians showed greater willingness to be vaccinated than members of other professions (72.8%, 84.5%, 65.8%, respectively; $p = 0.006$). In multivariate analyses, worries about COVID-19 late effects (odds ratio (OR) 2.86; $p < 0.001$) and affiliation with physicians (OR 2.20; $p = 0.025$) were independently associated with the willingness for vaccination, whereas age <35 years (OR 0.61; $p = 0.022$) and worries about late effects of vaccination (OR 0.13; $p < 0.001$) predicted vaccination hesitancy; no differences were seen with respect to gender. In separate analyses for men and women, only for men worries about COVID-19 late effects were relevant, while among women, age <35 years, worries about late effects of vaccination and worries about COVID-19 late effects played a role. ***Conclusions:*** There was no overall difference in vaccination acceptance between male and female HCWs, but there were gender-specific differences in the individual reasons on which this decision-making was based.

Karger@karger.com
www.karger.com/res

Correspondence to:
Maria Ada Presotto, mariaada.presotto@med.uni-heidelberg.de
Franziska Christina Trudzinski, franziska.trudzinski@med.uni-heidelberg.de

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Introduction

Since December 2019, the novel coronavirus SARS-CoV-2 (Severe Acute Respiratory Syndrome-Corona Virus-2) has been spreading worldwide. In March 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic. According to the WHO, to date more than 207 million cases with positive tests have been registered, of which 5–20% involve health care workers (HCWs) [1–5]. The Standing Committee on Vaccination (STIKO) of the Robert Koch Institut (RKI) in Germany as well as the WHO have identified HCWs as the highest priority group for COVID-19 vaccination. The willingness for this vaccination among HCWs has been reported to range from 28% to 78% [6]. Male sex, affiliation to physicians, older age, perceived individual risk of infection, and flu vaccine during the previous season were reported as positive acceptance factors for COVID-19 vaccination [6–9]. On the other hand, concerns about the safety of vaccination and possible side effects could contribute to vaccination hesitancy. Several studies investigating the general population as well those HCWs identified male gender as important factor for vaccination acceptance [6]. Similar findings were obtained for nurses [6, 10]. In these analyses, however, gender-specific associations with occupational groups were scarcely taken into account.

In view of the increasing availability of COVID-19 vaccines, the question of vaccination acceptance has an important social significance. As the success of vaccination not only relies on its efficacy but also on the coverage of vaccination, it is crucial to understand the factors influencing acceptance or reluctance. The staff members of pulmonary clinics are at particular risk for SARS-CoV-2 infection due to their special role in the care of COVID-19 patients. Consequently, they were among the first ones who had to make a decision on vaccination.

Based on this and the known differences in attitudes towards risks and benefits, it is of interest to investigate the individual reasons of HCWs for or against vaccination, considering gender-specific aspects and occupational group membership. We therefore performed this type of analysis in a number of specialized lung clinics in Germany in the spring of 2021.

Materials and Methods

Subjects and Sampling

A study-specific, 30-item questionnaire was created to conduct the survey (online suppl. material; for all online suppl. material, see www.karger.com/doi/10.1159/000522518). Four German lung clinics (Thoraxklinik Heidelberg, Asklepios-Fachkliniken München-Gauting, LungenClinic Grosshansdorf, Fachkliniken Wangen) and one lung rehabilitation clinic (Rehaklinik Bad Reichenhall) took part in this multi-centre study. All HCWs, including administrative personnel, were invited by e-mail to participate in the survey. In addition, a total of 900 flyers were distributed within the clinics. To take part in the survey, it was required to access the link sent by e-mail or to scan a QR code. An information sheet about scope of the study and data management was included at the beginning of the questionnaire. A second e-mail was sent as a reminder 1 week after the first invitation e-mail. Data were collected anonymously via the online survey system LimeSurvey® from 15 March 2021 to 28 March 2021.

The questionnaire addressed: (1) demographical characteristics (age, gender, profession, hospital and department, history of SARS-CoV-2 infection, previous vaccination against SARS-CoV-2), (2) perceived risk of infection (high risk-working area, contact to patients), (3) effect of work-related risk of infection on private life, (4) concerns about COVID-19, (5) intention to get vaccinated against SARS-CoV-2, (6) concerns about SARS-CoV-2 vaccination. Some answers were recorded as binary variable (e.g., "Do you have or have you had COVID-19 yourself"?), others by a five-point Likert scale: "fully applies, applies, applies partially, rather not applies, does not apply" (online suppl. material).

Data Analyses

The analysis aimed at demographic and attitudinal factors of the participants. To identify suitable variables for regression modelling, we first conducted univariate analyses using χ^2 statistics and Student's t tests. Results were reported as absolute numbers, percentages, and odds ratios (ORs) with 95% confidence interval (95% CI). Variables with significant correlations or differences in univariate analyses ($p \leq 0.05$) were included in multiple (logistic) regression models. As it was possible to skip items of the questionnaire, invalid answers (i.e., "no answer") were possible; these data were excluded from the analysis for each question independently. To analyse the willingness for vaccination, we defined a binary variable comprising "applies" and "fully applies" from the Likert scale as positive vaccination acceptance. Moreover, to compare professions of direct patient care, such as physicians and nurses, with other professional groups, we defined a summary variable ("group 1") including administration, cleaning service, laundry, patient transport, kitchen, casino, technical department, pharmacy, and clinical lab. Statistical analysis was performed using SPSS version 27.0 software, and p values <0.05 were considered as statistically significant.

Ethical Considerations

This study was approved by the Ethics Committee of the Medical Faculty, University of Heidelberg (Number: S-042/2021) and all regional Ethics Committees (Medical Faculty, Ludwig-Maximilians-University München; Medical Faculty, University of Lübeck). The regional scientific Ethics Committee of the State Medical Association of Baden-Württemberg concluded that this study did not require an additional scientific ethical approval. Before the approval by the Ethics Committees, the questionnaire was submitted to each workers' council of the participating clinics for review. The e-mail invitation provided participants with additional information on data processing. By clicking on the link and filling in the questionnaire, the participants agreed to the anonymous processing of the data provided.

Table 1. Demographic characteristics of responders to the survey

Demographic characteristics	*N* (%)
Gender (information provided)	785
Male	220 (28)
Female	565 (72)
Age group (information provided)	772
18–25 years	60 (7.8)
26–35 years	169 (21.9)
36–45 years	193 (25.0)
46–55 years	196 (25.4)
56–65 years	147 (19.0)
>65 years	7 (0.9)
Profession (information provided)	762
Nursing service	234 (30.7)
Medical service	148 (19.4)
Pharmacy/clinical lab	17 (2.2)
Cleaning service, laundry, patient transport, kitchen, casino	8 (1.0)
Technical department	22 (2.9)
Administration	119 (15.6)
Others	214 (28.1)
Lung clinic (information provided)	762
Thoraxklinik Heidelberg	303 (39.7)
Asklepios Gauting	114 (14.9)
Klinik Bad Reichenhall	41 (5.3)
LungenClinic Grosshansdorf	113 (14.8)
Fachkliniken Wangen	191 (25.0)
Working department (information provided)	643
Anaesthesia	36 (5.5)
Thoracic surgery	48 (7.4)
Pneumology	215 (33.4)
Thoracic oncology	57 (8.8)
Clinical research	29 (4.5)
Others (physiotherapists, social services)	258 (40.1)

Results

Demographic Characteristics of Participants

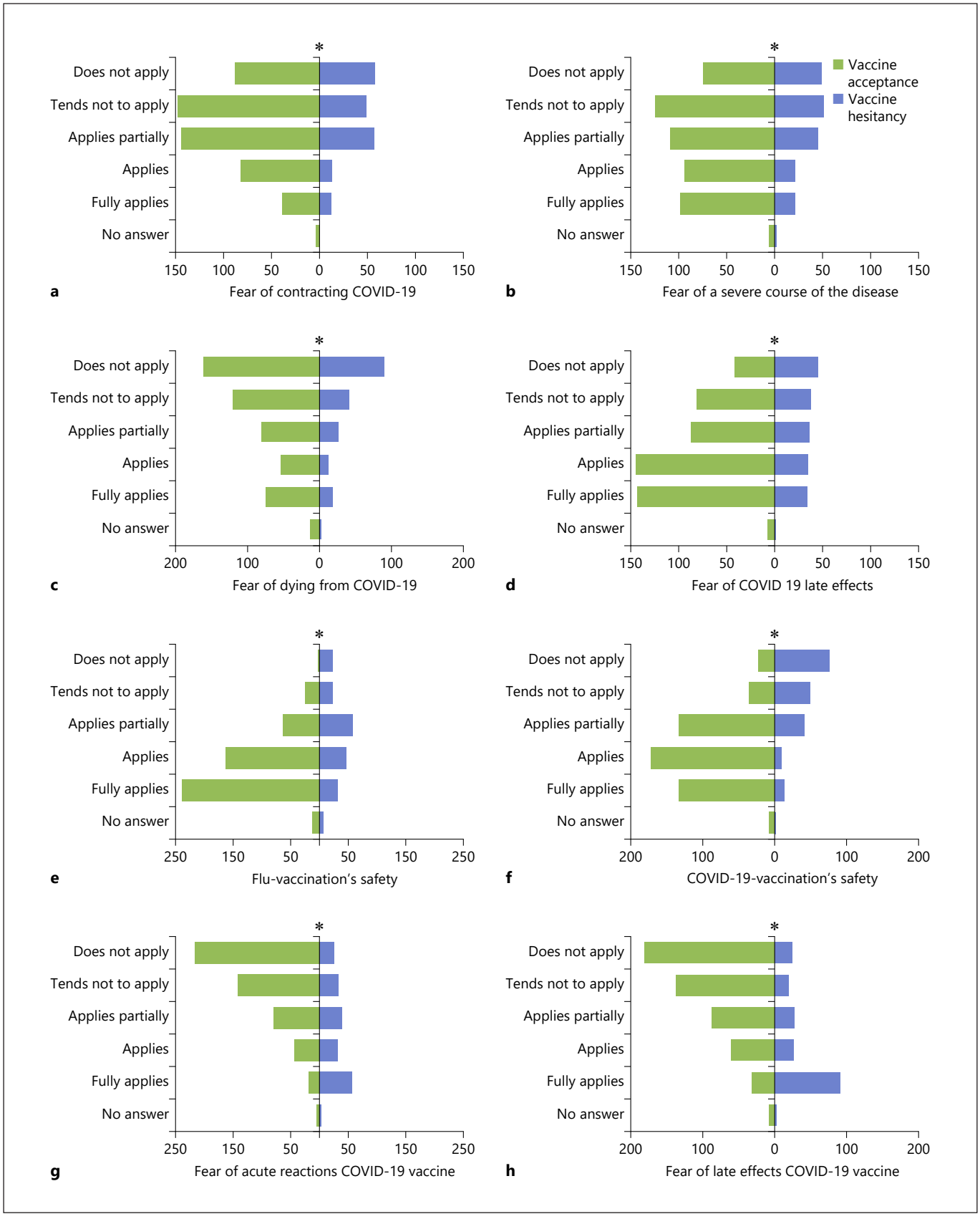
By 28 March 2021, 962 HCWs including administrative staff participated in the survey. Their demographic characteristics are displayed in Table 1. Information on male or female gender was available for 785 participants; 565 (72%) were female. Regarding professions, 235 (30.7%) were part of the nursing service, 148 (19.4%) of the medical staff, 17 (2.2%) of pharmacy and laboratory staff, 22 (2.9%) of technical departments, 119 (15.6%) of administration, 8 (1.0%) of cleaning service, laundry, and patient transport, and 214 (28.1%) from other departments (physiotherapists, respiratory therapists, social services, psychologists, medical-technical assistants, medical assistants, medical students). A total of 525 (65.9%) participants were patient-facing HCWs, and 315 (39.6%) operated in high-risk areas (i.e., intensive care unit, endoscopy, operating room, COVID-19 department, smear test ambulance).

Worries About COVID-19 Disease and COVID-19 Vaccine

For all items addressing worries about infection and possible consequences of COVID-19 disease, there was a significant relationship between perceived risk and vaccine acceptance (Fig. 1a–d). Worries about late effects of COVID-19 was strongly associated with the intention to undergo vaccination ($p < 0.001$; Fig. 1d), while high ratings of the chance of allergic reactions ($p < 0.001$) and worries about late effects of vaccination ($p < 0.001$) correlated with vaccination hesitancy (Fig. 1g, h). Concerns about safety also affected vaccination acceptance ($p < 0.001$), although participants still showed a high rate of willingness for vaccination (Fig. 1f).

Vaccine Acceptance/Vaccine Hesitancy

The overall vaccination acceptance was 72.8%, and 571 participants (68.5%) reported to have been vaccinated. We compared participants with versus those without acceptance of vaccination. For those working in high-risk



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areas, vaccination acceptance reached 77.9% (p = 0.009; Table 2), while it was lower among those not involved in direct patient care (66.8%, p = 0.002). Regarding occupational groups, overall rates of willingness for vaccination were 98/116 (84.5%) in physicians, 150/206 (72.8%) in nurses, 141/185 (76.2%) in other HCWs involved in patient care, and 100/152 (65.8%) in group 1 (p = 0.006). The willingness to undergo vaccination increased with age (p = 0.006), except for respondents of age >65 years, who, however, represented only a small number of subjects. Gender did not significantly correlate with vaccine acceptance (females 72.2%, males 77.5%; p = 0.095; Table 2).

In multiple logistic regression analyses, worries about COVID-19 late effects (OR 2.86; 95% CI: 1.88–4.34; p < 0.001) and affiliation with physicians (OR 2.20; 1.10–4.38; p = 0.025) were associated with increased willingness to be vaccinated. In contrast, age <35 years (OR 0.61; 0.40–0.93; p = 0.022) and fear of late effects of vaccination (OR 0.13; 0.08–0.16; p < 0.001) predicted vaccination hesitancy (Table 3). When analyses were stratified by gender (online suppl. Table S1, S2), age <35 years correlated with vaccine hesitancy in females (OR 0.57; 95% CI: 0.35–0.93; p = 0.025) but not in males (OR 0.73; 95% CI: 0.29–1.81; p = 0.493). Worries about COVID-19 late effects were related to higher vaccination willingness in females (OR 3.68; 95% CI: 2.28–5.94; p < 0.001) but not in males (OR 1.70; 95% CI: 0.69–4.17; p = 0.248). There was only a tendency in male physicians to be more inclined to accept vaccination (OR 2.84; 95% CI: 0.81–9.97; p = 0.104). The fear of possible late adverse effects of the SARS-CoV-2 vaccine was associated with vaccine hesitancy irrespective of gender but tended to be stronger in males (Fig. 2a, b).

Table 2. Demographic characteristics and answers to 4 questions of the survey stratified for vaccine acceptance or hesitancy

	All	Ready to be vaccinated, %	Not ready to be vaccinated, %	p value
Gender (female/male)	486/187	72.2/77.5	27.8/22.5	0.095
Age groups				
18–25 years	56	53.6	46.4	**0.006**
26–35 years	151	72.8	27.2	
36–45 years	164	77.4	22.6	
46–55 years	163	73.0	27.0	
56–65 years	126	78.6	21.4	
>65 years	6	66.7	33.3	
Unknown	28	57.1	42.9	
Professional groups				
Group 1*	152	65.8	34.2	**0.006**
Nurses	206	72.8	27.2	
Physicians	116	84.5	15.5	
Others	185	76.2	23.8	
Questions				
Do you have or have you had COVID-19 yourself? (yes/no)	59/635	69.5/73.1	30.5/26.9	0.325
Are you involved in direct patient care? (yes/no)	340/159	76.7/66.8	23.3/33.2	**0.002**
Have you had contact with patients with COVID-19 in the last 3 months? (yes/no)	325/210	75.4/69.5	24.6/30.5	0.072
Do you work in a "high-risk area"? (yes/no)**	291/208	77.9/70.3	22.1/29.7	**0.009**

Statistical comparisons between the two groups were based on contingency tables and χ^2 statistics. Statistically significant differences (p < 0.05) are marked in bold type. * Group 1: administration, cleaning service, laundry, patient transport, kitchen, casino, technical department, pharmacy, clinical lab. ** Risk area: operating theatre, endoscopy, COVID ward, intensive care unit, tests ambulance, emergency room.

Fig. 1. Fears about COVID-19 disease and COVID-19 vaccine. **a–d** Histograms for fears about COVID-19 disease. I am very afraid of contracting COVID-19 (p < 0.001) (**a**), I am very afraid about a severe course of the disease (p = 0.004) (**b**), I am afraid that I might die from COVID-19 (p < 0.001) (**c**), I am afraid of COVID 19 late effects (p < 0.001) (**d**). *p value ≤0.05. **e–h** Histograms for fears about COVID-19 vaccine. I consider the vaccinations against other viruses such as influenza to be sufficiently tested (p < 0.001) (**e**), I consider the currently available vaccines against COVID-19 to be sufficiently tested (p < 0.001) (**f**), I have concerns about possible allergic reactions to the vaccination (p < 0.001) (**g**), I have concerns about possible late effects of vaccination (p < 0.001) (**h**). *p value ≤0.05.

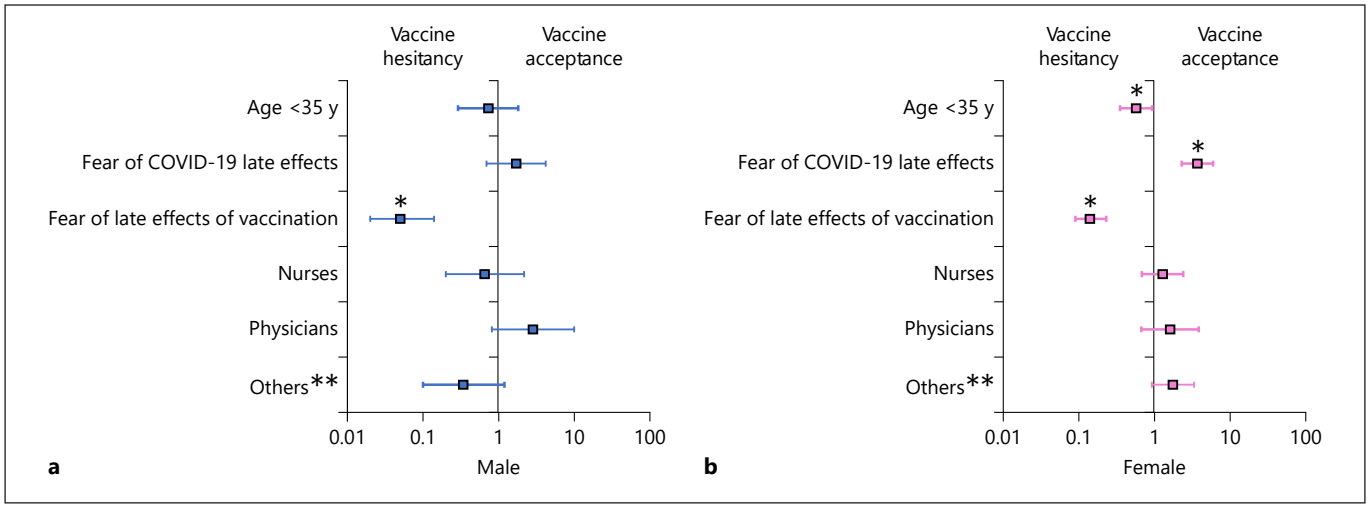

Fig. 2. a, **b** Vaccination acceptance and hesitancy. ORs according to multiple logistic regression analyses in males (**a**, see online suppl. Table S1) and females (**b**, see online suppl. Table S2) illustrating the effect of several individual characteristics on vaccination acceptance. Fear of COVID-19 late effects was a positive predictor of vaccine acceptance, fear of late effects of vaccination a negative predictor. Moreover, younger age (<35 years) was a negative predictor, and being a physician a positive predictor but not all of these were statistically significant ($p < 0.05$), and there were differences between males and females. Professional groups were analysed relative to group 1 (**administration, cleaning service, laundry, patient transport, kitchen, casino, technical department, pharmacy, clinical lab).

Table 3. Determinants of vaccination acceptance in multiple binary logistic regression analysis for men and women ($n = 654$)

Predictor	B	SE	OR	95% CI for OR		*p* value
				lower	upper	
Gender male/female	0.05	0.25	1.05	0.65	1.71	0.842
Age <35 years	−0.50	0.22	0.61	0.40	0.93	**0.022**
Fear of COVID-19 late effects	1.05	0.21	2.86	1.88	4.34	**<0.001**
Fear of late effects of vaccination	−2.07	0.21	0.13	0.08	0.19	**<0.001**
Professional groups (overall)						0.136
Relative to group 1*	–	–	–	–	–	–
Nurses	0.14	0.27	1.15	0.67	1.97	0.615
Physicians	0.79	0.35	2.20	1.10	4.38	**0.025**
Others	0.32	0.28	1.38	0.79	2.41	0.258

Predictors were gender, age <35 years, fear of COVID-19 late effects, fear of late effects of vaccination, and professional groups. B, unstandardized estimate; SE, standard error; OR, odds ratio (= exp [B]); 95% CI, 95% confidence interval of OR. * Group 1: administration, cleaning service, laundry, patient transport, kitchen, casino, technical department, pharmacy, clinical lab. Statistically significant differences ($p < 0.05$) are marked in bold type.

Discussion

This study aimed to determine the degree of vaccine acceptance and the reasons of acceptance and hesitancy among employees of lung clinics in Germany and to analyse these for their relationship to occupational group membership and gender. Almost three-quarters of responders were willing to become vaccinated against COVID-19, with the highest rate in HCWs employed in high-risk areas. These results are consistent with previous reports [7, 8, 11]. We hypothesized that the confrontation with COVID-19 and the burden of caring for COVID-19

patients in lung clinics would be especially suited to reveal attitudes and motivations regarding COVID-19 and vaccination in HCWs and to study the role of both occupation group and gender for this. We tried to cover a broad panel of motivations including the desire to avoid the consequences of infection for the own health and that of relatives, colleagues, and patients, but also concerns and expectations regarding vaccination.

The willingness to get vaccinated differed between professional groups. Administrative staff and employees in cleaning service, laundry, patient transport, and kitchen were less inclined towards vaccination, but these data should be considered with caution, given the small number of participants in these groups. On the contrary, patient-facing activity and employment in high-risk areas were positively related to vaccine acceptance. However, when interpreting these data, it has to be considered that the number of survey respondents was unevenly distributed across occupational groups; in fact, 50% of respondents were split between physicians and nurses, possibly leading to misinterpretation. This survey also detected a difference in acceptance between physicians and nurses (84.5% vs. 72.8%), in line with previous studies on vaccine acceptance among HCWs [7, 8].

However, different from previous reports [11], after adjustment for covariates some differences in acceptance with respect to gender turned insignificant. If stratified by gender, the professional role was no more a major determinant of the attitude pro or con vaccination, and other factors became relevant which differed between men and women. In men, only the fear of COVID-19 late effects was important, whereas in women of age <35 years, fear of late effects of vaccination and fear of COVID-19 late effects played a role. In our survey, about one-third of respondents reported concerns about the safety of the SARS-CoV-2 vaccine. Among these, 21.3% fear potential allergic reactions and 53.9% considered the available vaccines as insufficiently tested. For all items concerning worries about COVID-19, female respondents tended to rate these higher than males, suggesting that women were more likely to accept vaccination because of their fear of COVID-19 disease. In contrast, males were less influenced by possible complications of the COVID-19 disease and more afraid of short-term side effects of vaccination. This demonstrates that the absence of a difference in vaccination acceptance between male and female HCWs does not allow the conclusion that the reasons were the same. Our findings also underline that occupational exposure to COVID-19 patients and awareness of the implications of SARS-CoV-2 infections lead to increased acceptance of vaccination and outweighs assumed risks irrespective of the role in the health care system.

When interpreting the results, the time during which the investigation was conducted should be considered. At the beginning of March 2021, newspapers and television in Germany began reporting on a possible correlation between the AstraZeneca COVID-19-vaccine and cerebral venous thrombosis. In this phase, employees of participating clinics were offered the possibility of becoming vaccinated with one of two drugs, i.e., Vaxzevria® (AstraZeneca) or Comirnaty® (Biontech/Pfizer), depending on availability. The official recommendation to limit the administration of Vaxzevria® to people above 60 years of age was not published until 30 March 2021 [12], i.e., two days after the closure of our survey. It might be that the availability of such information would have influenced vaccination acceptance among the participants. It is also clear that the public attention led to a dynamic situation regarding the evaluation of risks from COVID-19 as well as vaccination. Still, it seems likely that the gender difference in the reasons reported by the HCWs was not critically dependent on this. Nevertheless, the role of the media has to be taken into account in further investigations, although it might be difficult to assess in each individual case.

Our study has several limitations. First, the number of survey participants was unequally distributed across occupational groups, with 50% of respondents employed in nursing and medical service, 72% female, and only 0.9% over 65 years old. Furthermore, due to data safety restrictions, it was not possible to collect clinical information of participants (e.g., comorbidities, smoking habits, pregnancy) and data could not be adjusted for demographic characteristics, potentially leading to confounding. Our survey was conducted anonymously, so we had no opportunity to check the veracity of the participants' statements. As reliability of anonymous online reports is well studied [13, 14], we are inclined to believe that the answers of the participants are trustworthy. It also should be considered that vaccination acceptance is likely to be a snapshot and related to the time and place at which the data are collected. This also refers to the recommendation for Vaxzevria® regarding age. As reported for Italy [15], vaccine acceptance might be greater in regions highly affected by the pandemic, but we considered our data as not sufficiently detailed to address this question. There are no hints that our findings regarding gender have been influenced by this.

In conclusion, we observed a high rate of vaccination acceptance among HCWs in lung clinics in Germany, es-

pecially among those employed in high-risk- and patient-facing areas. The perception of risks from COVID-19 and from vaccination was dependent on gender. When stratified by gender, the significant differences in vaccination acceptance between nurses and physicians disappeared. These findings demonstrate that it is important to differentiate according to both occupational group and gender in analyses that aim to describe and understand the individual attitudes towards COVID-19 and SARS-CoV-2 vaccination.

Statement of Ethics

This study was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. This study was approved by the Ethics Committee of the Medical Faculty, University of Heidelberg (Number: S-042/2021) and all regional Ethics Committees (Medical Faculty, Ludwig-Maximilians-University München; Medical Faculty, University of Lübeck). The regional scientific Ethics Committee of the State Medical Association of Baden-Württemberg concluded that this study did not require an additional scientific ethical approval. The study was registered in the German Clinical Trial Register (Number: DRKS00024462). Informed consent was obtained from all participants being included in the study. By clicking on the link and filling in the questionnaire, the participants agreed to the anonymous processing of the data provided.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

M.A. Presotto: investigation, formal analysis, data curation, and writing – original draft and visualization; R.A. Jörres: formal analysis, methodology, supervision, and writing – review and editing; W. Gesierich, J. Bullwinkel, K.F. Rabe, K. Schultz, F. Kaestner, D. Harzheim, M. Kreuter, and F.J.F. Herth: writing – review and editing; F.C. Trudzinski: conceptualization, methodology, formal analysis, supervision, project administration, funding acquisition, and writing – review and editing. All authors have reviewed and approved the final version of the manuscript.

Data Availability Statement

All data generated or analysed during this study are included in this article or its supplementary material files. Further enquiries can be directed to the corresponding author.

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