COVID−19 vaccination and associated factors in Turkish healthcare workers practicing chest medicine

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ABSTRACT

Objective: To evaluate the COVID-19 vaccination status and related characteristics of Turkish healthcare workers practicing chest medicine.

Methods: A cross-sectional online survey was conducted among the Turkish Thoracic Society members. The survey was started on May 17, 2021, and kept open for seven weeks. The 39-item survey included the COVID-19 vaccination status and demographic, clinical, and occupational characteristics.

Results: Of 378 healthcare workers participated in the survey, 354 (93.7%) reported receiving at least one dose of the COVID-19 vaccine. A total of 323 (91.2%) healthcare workers received CoronaVac *vs.* BioNTech/Pfizer in 31 (8.8%). In the CoronaVac group, 77 (23.8%) contracted COVID-19 when not fully vaccinated, and 13 (4.0%) when fully vaccinated; however, 16 (51.6%) healthcare workers in the BioNTech/Pfizer group got COVID-19 when not fully vaccinated, but any fully vaccinated participants did not contract COVID-19 (*P*=0.003). Regarding vaccine dosing, 328 (86.8%) were fully vaccinated, while 50 (13.2%) were not. Multiple regression analysis for being a non-fully vaccinated healthcare worker demonstrated a significant relationship with having any SARS-CoV-2 infection history (adjusted *OR* 9.57, 95% *CI* 3.93-23.26, *P*<0.001) and being a non-physician healthcare worker (adjusted *OR* 5.86, 95% *CI* 2.11-16.26, *P*=0.001), but a significant negative relationship with full-time working at the time of survey (adjusted *OR* 0.13, 95% *CI* 0.03-0.56, *P*=0.006).

Conclusions: Although a majority of healthcare workers were fully vaccinated, occupational and non-occupational characteristics were related to being non-fully vaccinated. Active surveillance regarding the COVID-19 vaccination in healthcare workers is necessary to address specific parameters as barriers to vaccination.

1. Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first detected at the end of 2019 before spreading globally and resulting in a pandemic. Since the initial days of the outbreak, healthcare workers (HCWs) have faced occupational risks of virus transmission, COVID-19 contraction, and even death. The World

> **Significance**
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> The healthcare workers practicing chest medicine were among the essential members of the COVID-19 management in Turkey; thus, this study evaluated their COVID-19 vaccination status and related parameters. Being non-fully vaccinated was associated with any COVID-19 history and being a non-physician healthcare worker but was inversely related to full-time work at the time of the survey. The results highlight the necessity of active surveillance regarding COVID-19 vaccination to address vaccination barriers.

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Health Organization estimated the number of deaths between January 2020 and May 2021 amongst HCWs due to COVID-19 to be 115 500[1].

The ways of protecting against SARS-CoV-2 transmission, particularly for HCWs, have been questioned, as the number of infected HCWs has been increasing tremendously. Several issues, including the urgent nature of the situation, the unpreparedness in engineering and organizational controls, and unknowns with regard to the virus and disease, were experienced during the early phase; thus, personal protective equipment (PPE) became crucial for the prevention of the virus[2]. However, shortages of PPE were experienced worldwide due to the initial huge demand[3]. Later, most problems were overcome, and national protocols for preventative measures with which to protect HCWs were determined according to suggestions from international organizations[4]. However, the effective primary protection against SARS-CoV-2, *i.e.*, COVID-19 vaccines, was only deemed to be safe for distribution almost one year after the discovery of the virus[5]. Following the launch of vaccination programs, most countries defined HCWs as one of the priority groups for COVID-19 vaccines. As a result, the vaccination of HCWs led to a decrease in new cases of COVID-19 amongst HCWs[6].

In Turkey, the date of diagnosis of the first COVID-19 case was March 11, 2020[7]. Soon after, Turkish HCWs began to contract COVID-19, with the number of HCW cases increasing rapidly thereafter, similar to the situation in other countries. The number of infected Turkish HCWs was above 120 000 during the first nine months of the pandemic, according to a press statement from the Ministry of Health[8]. HCWs are amongst the priority groups for the available COVID-19 vaccines in Turkey, and several studies have evaluated the attitudes of Turkish HCWs towards COVID-19 vaccination[9–13]. Turkish HCWs practicing chest medicine were amongst the essential members of the healthcare services during the pandemic[14], but data on their vaccination status and the related parameters are scarce. Therefore, the Turkish Thoracic Society (TTS) asked its members about their SARS-CoV-2 infection and vaccination status *via* an online survey. The current study aimed to evaluate the COVID-19 vaccination status and the related parameters of Turkish HCWs practicing chest medicine.

2. Subjects and methods

2.1. Study design

This is a survey-based cross-sectional study. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for reporting cross-sectional studies[15].

2.2. Setting

Data were collected through an online survey. An invitation message containing the weblink to the online survey was sent on May 17, 2021, to the TTS members' e-mail and communication platforms (*e.g.*, members' messaging group, Whatsapp messaging group, and Google group). The survey was conducted for seven weeks. Weekly reminder e-mails were sent only to the HCWs who were members of the society as of May 17, 2021.

2.3. Participants

The inclusion criterion was being a member of the TTS as of May 17, 2021. Exclusion criteria were repeated records of the same participant due to resubmitting and missing information regarding COVID-19 vaccination status.

2.4. Variables and data source

The survey was prepared by the TTS Occupational Lung Diseases Working Group and included 39 items on age, sex, civil status, smoking status, presence of any chronic diseases, occupational characteristics, COVID-19 vaccination status, history of one's own or any household member's SARS-CoV-2 infection, and characteristics of work-related COVID-19 exposure. The participants who reported a positive vaccination history were questioned about the type of vaccine (out of two available vaccines) during the data collection[16], namely the CoronaVac inactivated vaccine produced by Sinovac Life Sciences (Beijing, China) and the BioNTech/Pfizer mRNA COVID-19 vaccine BNT162b2, as well as the number of vaccine doses and timing according to the time of survey and SARS-CoV-2 infection history (if any). Occupational characteristics comprised the occupation, institution type, and working status (*i.e.*, full-time working and remote working) at the onset of the pandemic and at the time of the survey. The characteristics of work-related COVID-19 exposure included the status of work-related COVID-19 exposure according to the hospital division (outpatient clinic, ward, COVID-19 triage area, intensive care unit, emergency department, and other departments), the COVID-19 history in colleagues, and the use of PPE, namely disposable gloves, surgical masks, respirators, facial protectors, goggles, aprons, and gowns. A pre-test was performed on ten HCWs not practicing chest medicine, and

adjustments in the survey items were made accordingly to provide maximum clarity. The data from the pre-test were not included in the study results.

2.5. Study size

The sample size was calculated using StatCalc from Epi-info v.7.1.5 (Center for Disease Control, Atlanta, GA, USA). Several studies found the prevalence of COVID-19 vaccine reluctance among Turkish HCWs to be between 15% and 49.6%[9–13]. The total number of members of the TTS was 6 415 as of May 17, 2021. Inferring that the prevalence of being non-fully vaccinated would be 15%, with an error of 4% and a confidence level of 95%, we calculated the minimum necessary number of participants to be 292. Our final sample included 378 HCWs.

2.6. Statistical analysis

The descriptive statistics were presented as the median with the interquartile range (IQR) for age and as numbers and percentages for categorical variables. The vaccination status was accepted as being fully vaccinated if the participant reported a second dose of vaccination at least 14 days before the time of the survey. Unvaccinated participants, those who received one dose, those who received the second dose within 14 days before the time of the survey, and those who did not report the timing of the second dose despite receiving it were accepted as non-fully vaccinated. Participants' characteristics were compared according to the vaccination status (*i.e.*, non-fully vaccinated *vs.* fully vaccinated) and the type of the first vaccine dose (*i.e.*, CoronaVac *vs.* BioNTech/ Pfizer). The normality of the age variable was evaluated using the Shapiro-Wilk test, whilst the Mann-Whitney U test was employed for the comparison. Pearson's χ^2 test and Fisher's exact test compared the categorical variables. The characteristics showing a significant difference regarding distribution according to the vaccination status were analyzed for not being fully vaccinated using logistic regression. First, each variable was analyzed separately to calculate odds ratio (*OR*), together with 95% confidence interval (95% *CI*) values. In the multiple logistic regression analysis, these variables were analyzed altogether using a model that also included age and sex variables for the adjustment, and adjusted *OR* (a*OR*) values with 95% *CI*s were calculated. The type 1 error was accepted as 0.05 for every one of the analyses. All statistical analyses were performed using IBM SPSS for Windows v.22.0 (IBM Corp., Armonk, NY, USA).

2.7. Ethical considerations

The study was approved by the Ministry of Health General Directorate of Health Services and the Duzce University Ethics Board for Non-interventional Health Research (Decision date: February 22, 2022; Decision No.: 2022/35). Informed consent was obtained from the participants.

3. Results

The study analyzed the data of 378 HCWs (Figure 1) (female: male=248∶130), and the median age was 47 (IQR 38-53). As seen in Table 1, most participants were married, not living alone, never smokers, not having a chronic disease, physicians, and practicing in tertiary-care institutions (data were missing for 12 participants regarding the institution type). In total, 121 (32.0%) HCWs reported a positive history of COVID-19, while 326 (86.2%) reported a positive history of COVID-19 among colleagues. Seven (1.9%) participants also reported another second episode of SARS-CoV-2 infection. A history of SARS-CoV-2 infection in any family member was reported by 155 (41.0%) HCWs. Regarding working practice, 346 (91.5%) reported full-time working at the onset of the pandemic, 327 (86.5%) reported full-time working at the time of the survey, and 343 (90.7%) reported non-remote working at the time of the survey. The hospital division where COVID-19 contact occurred was outpatient clinics in 100 (26.5%) and inpatient wards in 91 (24.1%) participants. The frequencies of use of surgical masks and respirators were 85.2% and 69.3%, respectively.
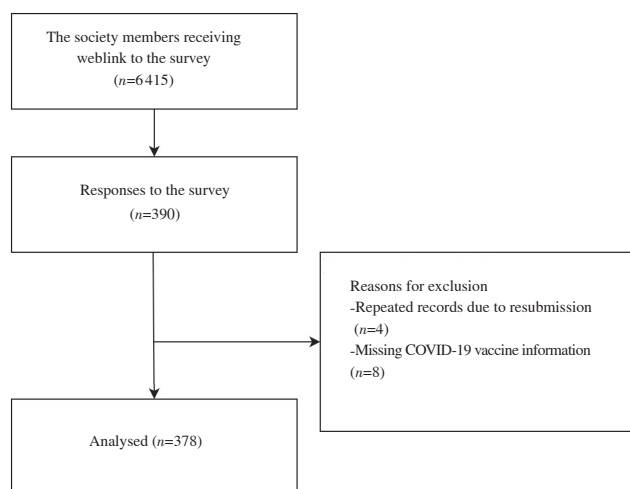

Figure 1. Flow chart of the study.

Table 1. Characteristics of participants according to vaccination status.

Variable	All participants (n=378)	Non-fully vaccinated (n=50)	Fully vaccinated (n=328)	P
Age, years[#]	47 (38-53)	44 (34-50)	47 (38-53)	0.121[†]
Male sex	130 (34.4)	21 (42.0)	109 (33.2)	0.224[‡]
Civil status				0.289[‡]
Single/Divorced/Separated	77 (20.4)	13 (26.0)	64 (19.5)	
Married	301 (79.6)	37 (74.0)	264 (80.5)	
Household size				0.448[§]
1	37 (9.8)	3 (6.0)	34 (10.4)	
>1	341 (90.2)	47 (94.0)	294 (89.6)	
Smoking status				0.596[‡]
Never smoker	257 (68.0)	34 (68.0)	223 (68.0)	
Ex-smoker	69 (18.3)	11 (22.0)	58 (17.7)	
Current smoker	52 (13.8)	5 (10.0)	47 (14.3)	
Any chronic disease				0.466[‡]
No	263 (69.6)	37 (74.0)	226 (68.9)	
Yes	115 (30.4)	13 (26.0)	102 (31.1)	
A positive SARS-CoV-2 infection history	121 (32.0)	32 (64.0)	89 (27.1)	**<0.001[‡]**
Any COVID-19 contact	298 (78.8)	38 (76.0)	260 (79.3)	0.598[‡]
SARS-CoV-2 infection in any family member	155 (41.0)	29 (58.0)	126 (38.4)	**0.009[‡]**
COVID-19 among the colleagues	326 (86.2)	47 (94.0)	279 (85.1)	0.087[‡]
Occupation				**<0.001[†]**
Other	42 (11.1)	14 (28.0)	28 (8.5)	
Physician	336 (88.9)	36 (72.0)	300 (91.5)	
Institution type^				0.173[†]
Other	150 (41.0)	24 (50.0)	126 (39.6)	
Tertiary care	216 (59.0)	24 (50.0)	192 (60.4)	
Working status at the onset of the pandemic				**0.001[‡]**
Other	32 (8.5)	11 (22.0)	21 (6.4)	
Full-time	346 (91.5)	39 (78.0)	307 (93.6)	
Working status at the time of the survey				**<0.001[†]**
Other	51 (13.5)	16 (32.0)	35 (10.7)	
Full-time	327 (86.5)	34 (68.0)	293 (89.3)	
Non-remote working at the time of the survey				**0.003[‡]**
No	35 (9.3)	11 (22.0)	24 (7.3)	
Yes	343 (90.7)	39 (78.0)	304 (92.7)	
COVID-19 contact place				
Outpatient clinic	100 (26.5)	12 (24.0)	88 (26.8)	0.673[‡]
Wards	91 (24.1)	14 (28.0)	77 (23.5)	0.486[‡]
COVID-19 triage division	15 (4.0)	1 (2.0)	14 (4.3)	0.704[‡]
Emergency department	39 (10.3)	7 (14.0)	32 (9.8)	0.358[‡]
Intensive care unit	61 (16.1)	10 (20.0)	51 (15.5)	0.425[‡]
Other settings of the workplace	5 (1.3)	1 (2.0)	4 (1.2)	0.510[§]
Usage of personal protective equipment				
Disposable gloves	212 (56.1)	27 (54.0)	185 (56.4)	0.750[‡]
Gowns	227 (60.1)	27 (54.0)	200 (61.0)	0.348[‡]
Aprons	57 (15.1)	6 (12.0)	51 (15.5)	0.514[‡]
Surgical masks	322 (85.2)	38 (76.0)	284 (86.6)	0.050[‡]
Respirators (N95/FFP2/FFP3)	262 (69.3)	27 (54.0)	235 (71.6)	**0.012[‡]**
Facial protectors	183 (48.4)	21 (42.0)	162 (49.4)	0.330[‡]
Googles	102 (27.0)	11 (22.0)	91 (27.7)	0.394[‡]

COVID-19: coronavirus disease 2019; FFP2: filters at least 94% of airborne particles; FFP3: filters at least 99% of airborne particles; IQR: interquartile range; N95: respirators block 95% of particles that are greater than 0.3 microns in size. [#]Data were expressed as median (IQR), others n (%). ^Data were missing for 12 (3.2%) participants regarding the institution type. Never smoker defines participants who have never smoked or smoked less than 100 cigarettes in their entire lifetime. Among the participants who have smoked at least 100 cigarettes, those who continue to smoke were current smokers, but those who had quit smoking at the time of the survey were categorized as ex-smokers. Bold P values indicate statistical significance. [†]Mann-Whitney U test; [‡]Pearson's χ^2 test; [§]Fisher's exact test.

Table 2. Characteristics of participants according to vaccine type.

Variable	Vaccinated participants (n=354)	CoronaVac (n=323)	BioNTech/Pfizer (n=31)	P
Age, years[#]	47 (38-53)	47 (38-53)	49 (40-51)	0.605[†]
Male sex	122 (34.5)	107 (33.1)	15 (48.4)	0.088[‡]
Civil status				0.649[‡]
Single/Divorced/Separated	69 (19.5)	62 (19.2)	7 (22.6)	
Married	285 (80.5)	261 (80.8)	24 (77.4)	
Household size				1.000[§]
1	36 (10.2)	33 (10.2)	3 (9.7)	
>1	318 (89.8)	290 (89.8)	28 (90.3)	
Smoking status				0.346[‡]
Never smoker	239 (67.5)	219 (67.8)	20 (64.5)	
Ex-smoker	64 (18.1)	60 (18.6)	4 (12.9)	
Current smoker	51 (14.4)	44 (13.6)	7 (22.6)	
Any chronic disease				0.797[‡]
No	244 (68.9)	222 (68.7)	22 (71.0)	
Yes	110 (31.1)	101 (31.3)	9 (29.0)	
SARS-CoV-2 infection history[&]				**0.003**[‡]
No infection	248 (70.1)	233 (72.1)	15 (48.4)	
Infection not fully vaccinated	93 (26.3)	77 (23.8)	16 (51.6)	
Infection fully vaccinated	13 (3.7)	13 (4.0)	-	
Any COVID-19 contact	277 (78.2)	257 (79.6)	20 (64.5)	0.052[‡]
SARS-CoV-2 infection in any family member	146 (41.2)	125 (38.7)	21 (67.7)	**0.002**[‡]
COVID-19 among the colleagues	329 (92.9)	301 (93.2)	28 (90.3)	0.711[§]
Occupation				0.105[§]
Other	35 (9.9)	29 (9.0)	6 (19.4)	
Physician	319 (90.1)	294 (91.0)	25 (80.6)	
Institution type[^]				0.268[‡]
Other	139 (40.5)	124 (39.6)	15 (50.0)	
Tertiary care	204 (59.5)	189 (60.4)	15 (50.0)	
Working status at the onset of pandemic				**0.026**[§]
Other	28 (7.9)	22 (6.8)	6 (19.4)	
Full-time	326 (92.1)	301 (93.2)	25 (80.6)	
Working status at the time of survey				**0.009**[§]
Other	45 (12.7)	36 (11.1)	9 (29.0)	
Full-time	309 (87.3)	287 (88.9)	22 (71.0)	
Non-remote working at the time of the survey				**0.012**[§]
No	31 (8.8)	24 (7.4)	7 (22.6)	
Yes	323 (91.2)	299 (92.6)	24 (77.4)	
COVID-19 contact place				
Outpatient clinic	94 (26.6)	86 (26.6)	8 (25.8)	0.921[‡]
Wards	84 (23.7)	78 (24.1)	6 (19.4)	0.549[‡]
COVID-19 triage division	15 (4.2)	14 (4.3)	1 (3.2)	1.000[§]
Emergency department	36 (10.2)	32 (9.9)	4 (12.9)	0.755[§]
Intensive care unit	54 (15.3)	51 (15.8)	3 (9.7)	0.446[§]
Other settings of the workplace	5 (1.4)	-	5 (1.5)	1.000[§]
Usage of personal protective equipment				
Disposable gloves	199 (56.2)	181 (56.0)	18 (58.1)	0.828[‡]
Gowns	215 (60.7)	200 (61.9)	15 (48.4)	0.141[‡]
Aprons	52 (14.7)	50 (15.5)	2 (6.5)	0.200[§]
Surgical masks	304 (85.9)	280 (86.7)	24 (77.4)	0.175[§]
Respirators (N95/FFP2/FFP3)	252 (71.2)	231 (71.5)	21 (67.7)	0.658[‡]
Facial protectors	171 (48.3)	161 (49.8)	10 (32.3)	0.061[‡]
Googles	97 (27.4)	91 (28.2)	6 (19.4)	0.293[‡]

COVID-19: coronavirus disease 2019; FFP2: filters at least 94% of airborne particles; FFP3: filters at least 99% of airborne particles; IQR: interquartile range; N95: Respirators block 95% of particles that are greater than 0.3 microns in size. [#]Data were expressed as median (IQR), others n (%). Bold P values indicate statistical significance. [^]Data were missing for 11 participants (3.1%) regarding the institution type. [&]The analysis included the first COVID-19 infection episode of seven participants who reported another second COVID-19 episode in the Coronavac group. [†]Mann-Whitney U test; [‡]Pearson's χ^2 test; [§]Fisher's exact test.

Table 3. Unadjusted and multiple logistic regression analysis for being non-fully vaccinated against COVID-19.

Variables	Unadjusted		Multiple	
	OR (95% *CI*)	*P*	*OR* (95% *CI*)	*P*
Age (1-year increase)	0.98 (0.95-1.01)	0.114	0.99 (0.95-1.02)	0.419
Male sex	0.69 (0.38-1.26)	0.226	0.82 (0.39-1.72)	0.592
A positive SARS-CoV-2 infection history	4.77 (2.55-8.93)	**<0.001**	9.57 (3.93-23.26)	**<0.001**
SARS-CoV-2 infection in any family member	2.21 (1.21-4.05)	**0.010**	1.22 (0.58-2.59)	0.601
Being a non-physician HCW	4.17 (2.01-8.64)	**<0.001**	5.86 (2.11-16.26)	**0.001**
Full-time working at the onset of pandemic	0.24 (0.11-0.54)	**0.001**	0.45 (0.15-1.31)	0.143
Full-time working at the time of survey	0.25 (0.13-0.51)	**<0.001**	0.13 (0.03-0.56)	**0.006**
Non-remote working at the time of survey	0.28 (0.13-0.62)	**0.002**	1.56 (0.33-7.39)	0.575
Use of respirators (N95/FFP2/FFP3)	0.47 (0.25-0.85)	**0.013**	0.53 (0.25-1.10)	0.087

CI: confidence interval; COVID-19: coronavirus disease 2019; FFP2: filters at least 94% of airborne particles; FFP3: filters at least 99% of airborne particles; HCW: healthcare worker; *OR*: odds ratio; N95: respirators blocking 95% of particles that are greater than 0.3 microns in size.

In terms of vaccine dosing, 328 (86.8%) participants were fully vaccinated, while 50 (13.2%) HCWs were not. The number of unvaccinated HCWs was 24 (6.3%), but 20 (5.3%) reported that they had not yet received the second dose, and five (1.3%) reported that they had received the second dose less than 14 days prior, with only one (0.3%) participant receiving the second dose but not reporting its timing. Nine HCWs (2.4%) who had received two doses of the inactivated vaccine also reported a third mRNA-type vaccine.

The comparison of characteristics between HCWs who were not fully vaccinated and those who were fully vaccinated, as shown in Table 1, revealed that HCWs who were not fully vaccinated exhibited higher frequencies of a SARS-CoV-2 infection history (64.0% *vs.* 27.1%, *P*<0.001), as did their family members (58.0% *vs.* 38.4%, *P*=0.009). Lower frequencies were observed in the non-fully vaccinated group for physicians regarding the occupation (72.0% *vs.* 91.5%, *P*<0.001), full-time working before the pandemic (78.0% *vs.* 93.6%, *P*=0.001), full-time working at the time of the survey (68.0% *vs.* 89.3%, *P*<0.001), non-remote working (78.0% *vs.* 92.7%, *P*=0.003) at the time of the survey, and the use of respirators (54.0% *vs.* 71.6%, *P*=0.012).

Overall, 354 (93.7%) HCWs reported that they received at least one dose of vaccine against COVID-19. Among them, the vaccine type was CoronaVac in 323 (91.2%) HCWs, while BioNTech/Pfizer in 31 (8.8%). The comparison of participants according to the vaccine type, as shown in Table 2, revealed a significant difference regarding the first episode of SARS-CoV-2 infection (*P*=0.003). In the CoronaVac group, 77 (23.8%) participants reported that they got COVID-19 when they were not fully vaccinated, but 13 (4.0%) contracted COVID-19 when they were fully vaccinated. In the BioNTech/Pfizer group, 16 (51.6%) participants reported that they got COVID-19 when they were not fully vaccinated, but no participants contracted COVID-19 when they were fully vaccinated. All seven participants with a history of the second episode of SARS-

CoV-2 infection reported a history of CoronaVac vaccination, three of which reported that the second episode occurred when they were still unvaccinated, but four reported a second episode when fully vaccinated. Those who received a CoronaVac had significantly lower frequencies of a COVID-19 history in their family members (38.7% *vs.* 67.7%, *P*=0.002) but higher frequencies of full-time working at the onset of the pandemic (93.2% *vs.* 80.6%, *P*=0.026) or at the time of the survey (88.9% *vs.* 71.0%, *P*=0.009), as well as non-remote working at the time of the survey (92.6% *vs.* 77.4%, *P*=0.012).

Table 3 demonstrates the unadjusted and multiple logistic regression analysis for being a non-fully vaccinated HCW. Although a majority of characteristics lost their significance after multiple regression analysis with age and sex adjustment, results revealed a significant relationship with having a SARS-CoV-2 infection history in HCWs (a*OR* 9.57, 95% *CI* 3.93-23.26, *P*<0.001) and with being a non-physician HCW (a*OR* 5.86, 95% *CI* 2.11-16.26, *P*=0.001), but a significant negative relationship with full-time working at the time of the survey (a*OR* 0.13, 95% *CI* 0.03-0.56, *P*=0.006).

4. Discussion

This study evaluated data collected from HCWs within six months of their being vaccinated against COVID-19 in Turkey. The results showed that 93.7% of the participants had received at least one dose of a COVID-19 vaccine, with the vast majority having been given the inactivated type. Several studies have investigated vaccination hesitancy amongst Turkish HCWs. İkiışık *et al*. demonstrated that 20.7% of participants refused a COVID-19 vaccine[10]. A similar percentage of 20.9% was observed in Yurttas *et al*'s study, which included HCWs practicing at a university hospital[11]. A study conducted in September 2020 showed that 11.4% of Turkish HCWs refused a COVID-19 vaccine, with 19.9% being indecisive[12]. Our

results imply that the remarkably lower percentage of unvaccinated HCWs may be related to our study period, with a wide range of availability of COVID-19 vaccines in comparison to those studies conducted prior to or during the initial days of the launch of the COVID-19 vaccination program. For example, the frequency of vaccine hesitancy was 15% in Yilmaz *et al*'s study[13], which was conducted in April 2021, a period close to that in our study. Another reason may be the inclusion of HCWs practicing chest medicine. A global cross-sectional study detected the frequency of willingness to get a COVID-19 vaccine among dental students as 63.5%[17]. A survey conducted in April 2021 showed the percentage of dentists vaccinated against COVID-19 to be 87.1%[18]. Moreover, a study showed that 74.7% of Turkish pharmacists intended to receive a COVID-19 vaccine[19]. As one of the primary specialties caring for COVID-19 patients, if HCWs practicing chest medicine are aware of the disease and its risks, this may lead to a greater vaccination percentage.

Our data demonstrated that in most of the participants, the first type of vaccine shot was the inactivated type (CoronaVac). Although the novelty of mRNA-type vaccines was shown to be related to lower acceptance[20], we consider this finding to be a result of the prioritization of HCWs in the vaccination program and the inactivated vaccine being the first available vaccine in Turkey. Kara Esen *et al*'s study evaluated a single university hospital's COVID-19 vaccination experience amongst HCWs and showed that the highest number of daily vaccinations was achieved at the beginning of the launch of the vaccination program[9]. This may also explain the higher frequencies of full-time working at the onset of the pandemic or at the time of the survey, and non-remote working at the time of the survey, *i.e.*, a higher perceived risk of infection, as well as the lower frequencies of one's own or a family member's SARS-CoV-2 infection amongst inactivated vaccine recipients. Kara Esen *et al.* also compared the characteristics of participants who were vaccinated after the introduction of the mRNA vaccine and did not observe any significant differences, except for surgery room personnel preferring the mRNA vaccine[9].

In our study, the multiple analysis for not being fully vaccinated showed a significant relationship with having a positive self-history of SARS-CoV-2 infection and with being a non-physician HCW, but a significant negative relationship with full-time working at the time of the survey. Several systematic reviews evaluated HCWs' attitudes towards COVID-19 vaccination and observed a wide range of significantly related factors, including the profession and occupational risk of transmission[21,22]. Despite conflicting findings, the majority of the included studies detected a higher positive attitude amongst physicians than in other health professions. A

similar finding was also observed in several other studies from Turkey[9,23–25]. Although not frequently asked in similar studies with HCWs, we consider full-time working at the time of the survey to be a marker amongst several other parameters for an increased occupational risk of COVID-19 contraction. In terms of the vaccination attitude of HCWs with a COVID-19 history, Askarian *et al.* found a similar finding to ours in a survey of 4 630 HCWs from 91 countries[26]. Our finding may also be a result of the delay in the application of vaccination after an episode of SARS-CoV-2 infection. Although not observed in the current study, it has also been shown that a fear of re-infection may lead to a willingness to undergo COVID-19 vaccination amongst HCWs[27].

Being a non-fully vaccinated HCW could be a result of either vaccine refusal or hesitation; the latter may be targeted to improve vaccination rates with some interventions[28]. In addition to studies[9–13] conducted before or at the beginning of the vaccination programs to address the hesitation for getting initial vaccine doses, recent studies[29–32] investigated COVID-19 vaccine booster hesitancy, which may be related to additional factors, including perceived effectiveness of initial or booster doses. Although booster doses were not introduced during our study period, future studies may focus on this issue in Turkish HCWs.

Our study's strengths include a broad representation due to participants deriving from different provinces in Turkey, an evaluation of participants' vaccination status after a reasonable time had passed since the launch of both vaccine types, and an analysis of a wide range of occupational and non-occupational characteristics related to the fully vaccinated status and the vaccine type.

However, the current study also has some limitations. Firstly, the online survey method has certain intrinsic constraints regarding the participation rate, data collection, and quality, despite a relatively longer duration for the data collection. These limitations may also lead to lower representativeness of the sample in terms of the wider population. Although a vast range of characteristics was investigated, the participants were not asked directly about the reason for their vaccination status or their vaccine type preference. Lastly, the survey questions did not assess the temporality and quantity of occupational and non-occupational risks, which may cause a limitation due to the increased probability of exposure to risks as the pandemic continues.

To conclude, the results of the current study demonstrated that amongst Turkish HCWs practicing chest medicine, being non-fully vaccinated was related to having a positive self-history of SARS-CoV-2 infection, being a non-physician HCW, and being non-full-time working at the time of the survey, despite a high percentage of vaccination. These results highlight the importance of monitoring the vaccination status of HCWs to address specific parameters

as barriers to vaccination. Future studies with larger HCW populations may focus on the vaccination status, including booster doses, together with participants' viewpoints, as well as planning intervention applications whilst also evaluating the effectiveness of those applications.

Authors' contributions

All authors substantially contributed to drafting and revising the article, as well as the final approval of the version to be submitted. A.S. and A.G.C. contributed to the conception and design of the study, acquisition of the data, and literature search. A.S. conducted the data analysis and A.S. and P.M.A. were the contributors to the interpretation of the data.

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