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Factors associated with COVID-19 vaccination among healthcare workers in an Algerian University Teaching Hospital: A cross-sectional study

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ARTICLE INFO	A B S T R A C T			
<i>Keywords:</i> COVID-19 Vaccination Algeria Reluctance	<i>Background:</i> The global COVID-19 pandemic has deeply impacted health systems, emphasizing the need for effective vaccination campaigns. However, vaccine hesitancy, particularly among healthcare workers, challenges achieving comprehensive immunization coverage. The primary objective of this study is to elucidate the factors influencing COVID-19 vaccine uptake among healthcare workers at an Algerian University Teaching Hospital. <i>Methods:</i> A cross-sectional survey was conducted at the University Teaching Hospital of Oran, Algeria, from February 17 to April 11, 2022. We investigated factors associated with COVID-19 vaccine uptake among 196 hospital staff members, including 98 physicians and 98 nurses. Factors independently associated with vaccination were identified using a multivariable logistic regression analysis, and adjusted odds ratios with 95% confidence intervals were provided. <i>Results:</i> The COVID-19 vaccination rate among HCWs was 32.1%. Several factors were significantly associated with COVID-19 vaccination in the multivariable analysis. These include the belief that even healthy individuals should be vaccinated against COVID-19 (20R = 3.13; 95% CI: 1.13–8.63), the perception that comprehensive vaccination coverage against COVID-19 could support the healthcare system in future epidemics (aOR = 4.15; 95% CI: 1.68–10.23), endorsement of mandatory COVID-19 vaccination (aOR = 4.37; 95% CI: 1.42–13.45), and adherence to all recommended vaccines for HCWs or compliance with the recommended immunization schedules for their children (aOR = 4.75; 95% CI: 1.47–15.36). <i>Conclusion:</i> This study highlights key beliefs influencing COVID-19 vaccine uptake among healthcare workers, including the necessity of vaccinating healthy individuals, the perceived importance of comprehensive vaccination in supporting the healthcare system during future epidemics, agreement with mandatory vaccination policies, and adherence to recommended vaccine schedules.			
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Background

The COVID-19 pandemic, caused by the novel coronavirus Severe Acute Respiratory Syndrome 2 (SARS-CoV-2), emerged in late 2019 and swiftly evolved into a global crisis, being declared a pandemic by March 2020 [1]. Worldwide, as of November 21, 2022, over 634 million confirmed cases of COVID-19, including more than 6.5 million deaths, have been reported to the World Health Organization (WHO) [2]. During the early stages, when vaccines were unavailable and effective treatments were scarce, non-pharmaceutical interventions [3], such as limiting mass gatherings, implementing stay-at-home orders, and wearing face masks, were the primary means of curbing the spread of the virus. These strategies effectively reduced case numbers and decelerated virus transmission [4,5].

However, the definitive resolution to the pandemic depends on achieving herd immunity through widespread vaccination [6]. This realization led to the prioritized development and global distribution of efficacious vaccines, symbolizing hope for a return to pre-pandemic normalcy [7].

By late 2020, the WHO recommended prioritizing vaccination for healthcare workers (HCWs), the frontline defenders against the virus, recognizing that their acceptance could significantly influence public perceptions and trust in immunization [8].

It is reasonable to expect that HCWs would generally express

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significant support for a COVID-19 vaccine due to its potential to offer personal protection and mitigate the spread, severity, and mortality rates associated with the virus. Nevertheless, previous research conducted prior to the implementation of the vaccination distribution revealed a significant level of reluctance among HCWs which was already observed in the context of flu vaccinations prior to the pandemic [9].

Research has identified various demographic factors as predictors of COVID-19 vaccine uptake. These include being male, being of older age, having a history of receiving seasonal influenza vaccines, and being a physician, each associated with a higher likelihood of accepting the vaccine. Conversely, a previous history of COVID-19 infection has been found to negatively influence vaccine uptake. In addition to these demographic factors, hesitations about vaccination among HCWs predominantly relate to concerns about the vaccine's safety, efficacy, and overall effectiveness [10–12].

Globally, acceptance rates for receiving the COVID-19 vaccine among HCWs varied considerably, ranging from 27.7% to 77.3%, as observed in a systematic review up to February 2021 [10]. In the US, data monitoring from more than 2,000 healthcare institutions revealed that by mid-March 2021, at least half of the healthcare workforce had received vaccinations [13]. Despite this, a considerable portion of HCWs remained unvaccinated, with the overall vaccination rates stalling at around 70% in September 2021. This rate saw a gradual increase to just 77% by December 2021 [14].

In the Arab world, a study by Qunaibi et al. revealed a notably low COVID-19 vaccine acceptance rate among healthcare workers (HCWs), with only 25.8% indicating a willingness to be vaccinated. The level of reluctance varies significantly across the region, with Algeria displaying the lowest acceptance rate, falling below 10% among HCWs [11].

At the University Teaching Hospital of Oran (UTHO) in Algeria, the vaccination rate among HCWs was 13.8% as of December 2022 [15]. This presents a critical issue, given the essential role of HCWs in pandemic response and their influence on public vaccination perceptions. The under-researched nature of vaccine hesitancy among HCWs necessitates an in-depth investigation into the underlying reasons for this reluctance.

Therefore, the primary objective of this study is to explore the factors contributing to the low COVID-19 vaccine uptake among HCWs at UTHO and to propose context-specific strategies to enhance vaccine adoption, addressing a crucial gap in the current understanding of vaccine hesitancy at the UTHO.

Methods

Study population

A cross-sectional survey was conducted at the UTHO from February 17, 2022, to April 11, 2022.

A sample of 196 hospital staff (98doctorsand98nurses) was selected to study the factors associated with completing a COVID-19 vaccination.

The study was conducted through direct interviews with HCWs. After obtaining their consent, the interviewer went directly to the various departments and interviewed the first four physicians or nurses. Participation in the study was voluntary and without any incentives.

The following information was collected: demographic information such as age and sex, profession (physician or nurse), experience, and presence of chronic disease.

To understand the reasons that led them to receive the COVID-19 vaccination, the surveyed HCWs were required to answer the following questions:

Do you trust vaccines as a means of preventing infectious diseases?
Do you trust the information you receive about vaccination from health authorities?
Have you accepted all the vaccines you should take or recommended for your child's immunization schedule?
Would developing immunity through vaccination rather than

contracting a disease be preferable? (5) Do you get the annual influenza vaccine? (6) Do you think COVID-19 is a severe disease? (7) How do you assess your knowledge about the COVID-19 vaccination? (8) Do you think even healthy individuals should be vaccinated against COVID-19? (9) Do you consider vaccination to be a good thing? (10) Do you believe the COVID-19 vaccination will allow us to return to normal? (11) Do you think high vaccination coverage against COVID-19 can help the healthcare system cope with a future epidemic wave of COVID-19? (12) Do you agree with the mandatory COVID-19 vaccination? (13) Do you agree with the mandatory COVID-19 vaccination in schools? (14) If you are vaccinated, what were the reasons that motivated you to receive the COVID-19 vaccine? (15) Why did you refuse the COVID-19 vaccine if you are not vaccinated? For questions 14 and 15, respondents were presented with statements and asked to indicate their agreement with each statement with a "yes" or "no" response.

The study was conducted after obtaining approval from the ethics committee of the UTHO while adhering to the principles of the Helsinki Declaration regarding anonymity and protection of the privacy of survey participants.

Therefore, the collected data were processed and analyzed confidentially.

Sample size calculation

To estimate the minimum sample size, we utilized "OpenEpi" [16] with the following parameters: a population of 2762 hospital HCWs, an estimated proportion of 13.8% [15], a desired precision of estimate (margin of error) of 5%, and a 95% confidence level. Through these calculations, we determined that a minimum of 172 participants would be needed for this study.

Statistical analysis

In the descriptive analysis, categorical variables were presented as frequencies and percentages, while continuous variables were summarized as means with their standard deviations.

The dependent variable in this study was the COVID-19 vaccination status, categorized into two groups: vaccinated or in progress (category 1) and not vaccinated (category 2). Independent variables included sex, profession, experience, and HCWs' attitudes and beliefs toward vaccination in general and COVID-19 vaccination specifically.

As an initial step, the variables associated with the COVID-19 vaccination status were evaluated using univariate logistic regression, providing crude odds ratios (OR) and 95% confidence intervals (CI). All independent variables were represented in binary form.

In the second step, potential multicollinearity between the independent variables was assessed using the variance inflation factor (VIF) before performing a multivariable logistic regression analysis using the Entry Method. All covariates with a p-value < 0.20 were included to identify independently associated covariates with the COVID-19 vaccination status, providing adjusted odds ratios (aOR) with 95% confidence intervals (CI).

All statistical tests were two-tailed; a p-value <0.05 was considered statistically significant.

Data entry and analysis were carried out using SPSS software version 20.

Results

In this study, 210 healthcare workers (HCWs) were invited to participate, including 104 nurses and 106 physicians. Of these, 14 declined to participate: eight physicians and six nurses. The primary reason for non-participation, cited by seven respondents, was lack of time. The overall participation rate was 93.3%, with 196 HCWs taking part.

Characteristics of the study respondents

A total of 196 HCWs participated in the study, including 98 physicians and 98 nurses. The study population exhibited a significant female predominance, with 157 female participants representing 80.1% of the total. The overage age was 30.7 ± 7.7 years. The most prevalent age group was 21 to 30 years, representing 62.2% of the study population (Table 1).

Among the HCWs, 47 (24.0%) reported having chronic diseases requiring treatment. Only 17 (8.7%) reported receiving the influenza vaccine the previous year.

The COVID-19 vaccination rate among the study population was 32.1% (63outof196). Among the vaccinated HCWs, 53 had completed the COVID-19 vaccination regimen by receiving at least two doses. Additionally, 2 HCWs had received the single-dose Johnson & Johnson vaccine and were categorized as vaccinated. In contrast, 8 HCWs had initiated the COVID-19 vaccination regimen by receiving the first dose and were awaiting the administration of the second dose at the time of the survey (Table 1).

Factors associated with the COVID-19 vaccine uptake

In univariate analysis, the COVID-19 vaccine uptake was significantly associated with the following non-modifiable risk factors: male sex (OR = 2.8; 95% CI: 1.36–5.73), being 30 years or older (OR = 2.29; 95% CI: 1.24–4.23), and being treated for chronic disease (OR = 2.06; 95% CI: 1.05–4.05). Physicians were significantly more likely to accept the COVID-19 vaccine than nurses (OR = 2.5; 95% CI: 1.34–4.63).

The following general beliefs were significantly associated with a COVID-19 vaccine uptake: believing that vaccination is a good thing (OR = 2.32; 95% CI: 1.15–4.70); trusting vaccines as a means of preventing infectious diseases (OR = 2.56; 95% CI: 1.38–4.74); and accepting all recommended vaccines for HCWs or adhering to the recommended immunization schedules for their children (OR = 3.94; 95%

Table 1

Characteristics of the stud	v respondents	and their attitude	s toward vaccination

Variable	Category	n	(%)
Age (years)	\leq 20 21–30	3 122	(1.5) (62.2)
	31–40	50	(25.5)
	41–50	15	(7.7)
	51-60	5	(2.6)
	>60	1	(0.5)
Sev	Male	30	(10.0)
5CA	Female	157	(19.9)
	remaie	157	(00.1)
Are you being treated for a chronic	Yes	47	(24.0)
illness?	No	149	(76.0)
The second s	Var	17	(0.7)
Have you taken the flu vaccine in the past	Yes	170	(8.7)
year?	INO	179	(91.3)
Have you taken the COVID-19 vaccine?	Yes	63	(32.1)
-	No	133	(67.9)
If yes, what types of vaccines were given?	Sinovac	31	(49.2)
	Sputnik V	19	(30.2)
	AstraZeneca	6	(9.5)
	Sinopharm	5	(7.9)
	Johnson &	2	(3.2)
	Jonnson		
Total number of doses administered	One dose	10	(15.9)
	Two doses	50	(79.4)
	Three doses	3	(4.8)

CI: 1.57–9.89). However, receiving the annual influenza vaccine was not associated with the COVID-19 vaccine uptake (OR = 1.17; 95% CI: 0.41–3.31).

Regarding attitudes and beliefs toward COVID-19 vaccination, the following factors were significantly associated with COVID-19 vaccine uptake: HCWs who perceived themselves to have good knowledge about the COVID-19 vaccine (OR = 2.22; 95% CI: 1.16-4.27), believing that even healthy individuals should be vaccinated against COVID-19 (OR = 3.09; 95% CI: 1.44-6.24); being convinced that COVID-19 vaccination will allow us to return to a normal situation (OR = 4.20; 95% CI: 2.04-8.6). However, believing that good vaccination coverage against COVID-19 could help the healthcare system in future COVID-19 waves epidemic was the belief most significantly associated with COVID-19 vaccination (OR = 6.15; 95% CI: 3.13-12.06).

In multivariable analysis, the following factors were significantly associated with COVID-19 vaccination: believing that even healthy individuals should be vaccinated against COVID-19 (aOR = 3.13; 95% CI: 1.13–8.63); considering that good vaccination coverage against COVID-19 could help the healthcare system in future COVID-19 waves (aOR = 4.15; 95% CI: 1.68–10.23); agreeing with mandatory vaccination against COVID-19 (aOR = 4.37; 95% CI: 1.42–13.45) and accepting all recommended vaccines for HCWs or adhering to the recommended immunization schedules for their children (aOR = 4.75; 95% CI: 1.47–15.36) (Table 2).

Motivations for receiving the COVID-19 vaccine

Among the vaccinated HCWs (n = 63), the primary motivations for receiving the COVID-19 vaccine were self-protection (82.5%) and the protection of close contacts (79.4%). Additionally, the goals of achieving herd immunity and preventing disease transmission to patients and colleagues were cited by 61.9% and 54.0% of respondents, respectively (Fig. 1).

Reasons for refusing the COVID-19 vaccine

Among the HCWs who declined the vaccine (n = 133), 75.2% expressed concerns about the shortened research period. Fear of potential side effects was cited by 66.9%. Additionally, 65.4% doubted the vaccine's efficacy, 59.4% felt they lacked sufficient information about it, and 56.4% were uncertain about the duration of its protection (Fig. 2).

Discussion

COVID-19 vaccine uptake

Conducted during the onset of Algeria's fourth COVID-19 wave, this study observed a vaccination rate of 32.1% among the study population. Considering their high-risk exposure during the pandemic, one might anticipate a higher vaccination inclination among HCWs.

A study conducted by Qunaiby et al. in January 2021 reported a 26.7% vaccine acceptance rate among HCWs [11]. This acceptance rate varied among Arab countries, with a low of 8.6% in Algeria and a high of 50.9% in Kuwait.

A subsequent study from August 20 to September 28, 2021, documented a 38.6% vaccination rate among the wider Algerians, aligning closely with our findings for HCWs [17].

On a global front, a *meta*-analysis [12] encompassing 25 studies and 555,561 HCWs up to August 25, 2022, indicated an average vaccine uptake of 77.3% among HCWs. Regional discrepancies were evident: North America led with 85.6%, followed by Asia (79.5%), Europe (72.8%), and Africa (65.6%). Factors driving these disparities likely include regional healthcare policies, vaccine availability, and differing perceptions of vaccination among HCWs.

Table 2

Factors associated with COVID-19 vaccination among HCWs in univariate and multivariable analysis.

	COVID-19 vaccination		Value from ^a :			
	Vaccinated * (N = 63)	Unvaccinated (N = 133)	Univariate analysis		Multivariable analysis	
Factors	n (%)	n (%)	OR (95% CI)	P value	aOR (95% CI)	P value
Demographic characteristics						
Sex						
Male	20 (51.3)	19 (48.7)	2.8 (1.36–5.73)	0.004	1.62 (0.57–4.64)	0.36
Female	43 (27.4)	114 (72.6)	Ref		Ref	
Age (years)						
\geq 30 years	38 (41.8)	53 (58.2)	2.29 (1.24-4.23)	0.007	3.11 (0.98–9.79)	0.053
< 30 years	25 (23.8)	80 (76.2)	Ref		Ref	
Profession						
Physician	41 (41.8)	57 (58.2)	2.5 (1.34-4.63)	0.04	2.24 (0.93-5.40)	0.07
Nurse	22 (22.4)	76 (77.6)	Ref		Ref	
Experience (second)						
> 4 years	42 (36.8)	72 (63.2)	1 69 (0 9-3 17)	0.1	1.34 (0.41-4.33)	0.62
< 4 years	21 (25.6)	61 (74.4)	Ref	011	Ref	0101
Are you being treated for a chronic	alsease?	26 (55 3)	2 06 (1 05 4 05)	0.035	2 08 (0 81 5 32)	0.12
No	42 (28.2)	20 (33.3)	2.00 (1.03–4.03) Ref	0.035	2.08 (0.81–3.32) Ref	0.15
	12 (2012)	107 (7110)				
Attitudes and beliefs toward vaccino	ution in general					
Do you trust vaccines as a means of	preventing infectious diseases?	40 (E4 8)	2 56 (1 29 4 74)	0.002	1 25 (0 51 2 50)	0.54
No or only to certain vaccines	30 (24.4)	40 (34.8) 93 (75.6)	2.30 (1.38–4.74) Ref	0.003	Ref	0.54
	00 (2)	<i>y</i> e (<i>i</i> ele)				
Do you consider vaccination to be a	good thing?					
Yes	50 (37.6) 13 (30.6)	83 (62.4)	2.32 (1.15–4.70)	0.02	0.79 (0.28–2.21)	0.66
No, of I doll t know.	13 (20.6)	50 (79.4)	Rei		Kei	
Do you trust the information you re	ceive about vaccination from he	alth authorities?				
Yes	21 (45.7)	25 (54.3)	2.16 (1.09-4.27)	0.025	0.98 (0.32–2.95)	0.97
No or sometimes	42 (28.0)	108 (72.0)	Ref		Ref	
Have you accepted all the vaccines	you should take or recommende	d for your child's immunization s	chedule?			
Yes	57 (37.7)	94 (62.3)	3.94 (1.57–9.89)	0.002	4.75 (1.47–15.36)	0.009
No, or sometimes	6 (13.3)	39 (86.7)	Ref		Ref	
Would developing immunity through	vaccination rather than contra	cting a disease he preferable?				
Yes	37 (38.5)	59 (61.5)	1.78 (0.97-3.27)	0.060	0.60 (0.25-1.43)	0.25
No, or sometimes	26 (26.0)	74 (74.0)	Ref		Ref	
Do you get the annual influence you	cino?					
Yes	6 (35.3)	11 (64.7)	1.17 (0.41-3.31)	0.770		
No	57 (31.8)	122 (68.2)	Ref			
	10					
Attitudes and beliefs toward COVID Do you think COVID-19 is a severe.	-19 vaccination disease?					
Yes	58 (34.9)	108 (65.1)	2.68 (0.97-7.38)	0.05	1.27 (0.34-4.7)	0.72
No	5 (16.7)	25 (83.3)	Ref		Ref	
How do you assess your knowledge	about the COVID-19 vaccinatio	n?				
Good or average	46 (38.7)	73 (61.3)	2.22 (1.16-4.27)	0.01	1.56 (0.66-3.68)	0.31
Low	17 (22.1)	60 (77.9)	Ref		Ref	
Do you think mon harkles in divide	de chould be used and and	COVID 102				
Yes	53 (38.7)	84 (61.3)	3.09 (1.44-6.24)	0.003	3.13 (1.13-8.63)	0.03
No, or I don't know.	10 (16.9)	49 (83.1)	Ref		Ref	
		10				
Do you believe the COVID-19 vacci	nation will allow us to return to	normal?	1 20 (2 04 9 6)	~ 10-3	164 (0 59 4 66)	0.25
No, or I don't know.	39 (25.2)	116 (74.8)	Ref	< 10	Ref	0.33

(continued on next page)

Table 2 (continued)

	COVID-19 vaccination		Value from ^a :			
	Vaccinated * (N = 63)	Unvaccinated (N = 133)	Univariate analysis		Multivariable analysis	
Factors	n (%)	n (%)	OR (95% CI)	P value	aOR (95% CI)	P value
Can high vaccination coverage against COVID-19 help the healthcare system in future COVID-19 waves?						
Yes	47 (52.2)	43 (47.8)	6.15 (3.13-12.06)	<10 ⁻³	4.15 (1.68–10.23)	0.002
No, or I don't know.	16 (15.1)	90 (84.9)	Ref		Ref	
Do you agree with the mandatory CO	VID-19 vaccination?					
Yes	29 (74.4)	10 (25.6)	10.5 (4.65–23.65)	$< 10^{-3}$	4.37 (1.42–13.45)	0.01
No, or I don't know.	34 (21.7)	123 (78.3)	Ref		Ref	
Do you agree with the mandatory CO	VID-19 vaccination in schools?	,				
Yes	15 (62.5)	9 (37.5)	4.3 (1.77–10.49)	0.001	0.93 (0.22–3.86)	0.92
No, or I don't know.	48 (27.9)	124 (72.1)	Ref		Ref	

*Vaccinated or in progress.

^aOR, crude odds ratio; aOR, adjusted odds ratio; Ref, reference category.



Fig. 1. Motivations for Receiving the COVID-19 Vaccine.



Fig. 2. Reasons for refusing the COVID-19 vaccine.

Vaccine hesitancy among HCWs prior to COVID-19

Numerous studies conducted before the COVID-19 pandemic have extensively explored the phenomenon of vaccine hesitancy among healthcare workers (HCWs), with a significant focus on seasonal influenza vaccines [18,19]. Before the emergence of COVID-19, a notable proportion of HCWs showed reluctance towards vaccination, driven by concerns similar to those prevalent during the pandemic. These included doubts regarding vaccine safety, widespread mistrust of healthcare employers and governmental authorities, and concerns over personal autonomy infringement [18,19]. The 2009 H1N1 influenza pandemic serves as a close parallel to the current COVID-19 crisis, especially in terms of its global spread and the rapid development and deployment of vaccines [20]. Interestingly, hesitancy among HCWs towards the H1N1 vaccine was notable, mainly attributed to concerns over its hurried production and potential implications for safety and efficacy [21], a sentiment similar to that observed with the COVID-19 vaccine.

Predictors of COVID-19 vaccine uptake

This study found a significant association between the acceptance of COVID-19 vaccination among HCWs and their general propensity to accept all recommended vaccines for themselves or their children. Numerous studies [15,16] have consistently observed a robust relationship between HCWs' historical vaccination behaviors and their likelihood of taking the COVID-19 vaccine. Such findings underscore that HCWs with favorable views on vaccinations might be more predisposed to trust emerging vaccines' safety and efficacy.

Furthermore, our data indicates that HCWs advocating for the widespread vaccination of even the healthy population believed that extensive COVID-19 vaccination could bolster the healthcare system's defenses against subsequent epidemics. Those supporting mandatory COVID-19 vaccination were also more likely to have been vaccinated. A study by Lounis et al. [17] on Algeria's general population found similar results. Notably, a significant factor motivating vaccine acceptance in HCWs and the general population is a deep trust in the vaccine's efficacy as a pivotal defense against COVID-19.

In this study, the main driving factors for HCWs to get the COVID-19 vaccine encompassed a desire to shield themselves and their immediate contacts, foster herd immunity, curtail the epidemic's spread, and halt disease transmission to patients and peers. These motivations represent an amalgamation of self-protection, dedication to broader public health, and professional accountability.

Conversely, vaccine-reluctant HCWs voiced apprehensions regarding the truncated vaccine research timeline, potential adverse reactions, perceived vaccine inefficacy, lack of comprehensive vaccine information, and uncertainties about the longevity of its protective effect. These reservations resonate with the findings of the systematic review by Petros Galanis and colleagues [12]. Addressing these concerns through thorough and current vaccine information, alongside vigilant safety surveillance systems, might assuage some of these hesitations.

A systematic review by Biswas et al. [17], encompassing 35 studies, found that male HCWs, older individuals, and doctors were more inclined to accept the COVID-19 vaccine. While our univariate analysis aligned with these findings, these trends did not maintain statistical significance in the multivariable analysis. The observed differences could be due to the significant impact of other variables within our model or potential limitations in our sample size, which might affect the power to detect nuanced associations.

Interestingly, while various studies [11–12,22] have highlighted a discernible link between influenza vaccination history and COVID-19 vaccine uptake, our data diverged from this observation. Only six of the 17 HCWs who routinely opted for influenza vaccinations also got vaccinated for COVID-19. This disparity highlights the need for a more in-depth investigation into the distinct factors influencing COVID-19 vaccine perceptions within this subset and the development of tailored

strategies to address their vaccine hesitations.

Study limitations

When interpreting the results of this study, several limitations warrant attention:

Firstly, this study concentrated solely on physicians and nurses. By broadening the scope and including a broader range of professional categories, we might have provided a more comprehensive insight into vaccination rates across different professional groups.

Secondly, despite the actual predominance of nurses in our hospital, our sample equally represented doctors and nurses. Such a balance could lead to the overrepresentation of doctors, thus influencing the generalizability of our findings to the broader HCWs community.

On a related note, there's a potential self-selection bias. HCWs who were eager to participate might predominantly be those already vaccinated. This bias could lead to overestimating the vaccination rate.

Moreover, given our focus on a single hospital, the findings might only partially reflect the sentiments of the broader populations of doctors and nurses. It's essential to remember that individual hospitals may have unique contextual factors that aren't mirrored elsewhere.

Interestingly, HCWs who had previously contracted COVID-19 might have felt less inclined to get vaccinated due to their perceived existing immunity. This oversight could sway the observed relationships between certain beliefs or factors and COVID-19 vaccine uptake.

Lastly, while this study did not delve deeply into the psychological motivations behind vaccine acceptance, an external study from China provides an enlightening perspective. This research demonstrated that unvaccinated individuals scored notably higher on the Depression, Anxiety, and Stress Scale than those vaccinated. Focusing on psychological factors, this angle could offer further insights into the broader context of vaccine acceptance [23].

Conclusion

This study has identified a range of beliefs significantly associated with COVID-19 vaccine uptake among HCWs. These include the acceptance of recommended vaccines for themselves and their children, the recognition of the benefits of widespread vaccination in healthy individuals, the understanding of vaccination's role in supporting the healthcare system during future COVID-19 waves, and agreement with the idea of mandatory vaccination. These findings highlight the intricate relationship between individual beliefs and vaccine uptake, indicating the necessity of nuanced strategies to enhance vaccination rates among HCWs.

To effectively address vaccine hesitancy, public health authorities should focus on building trust with HCWs. This could be achieved through targeted awareness campaigns, using communication channels tailored to HCWs like emails, social media, and webinars. Additionally, organizing online forums and workshops with policymakers can offer a platform for HCWs to express their concerns and have them directly addressed.

Furthermore, our study points to the need for a more in-depth understanding of the personal, cultural, and contextual factors influencing HCWs' vaccination decisions. Future research should aim to uncover these underlying barriers to vaccination, providing insights that can guide more effective public health strategies.

Ethics approval and consent to participate

The study was carried out after approval from our medical and care activities department. They concluded that the research does not require further support from the ethical research committee.

Authors' contributions

Study design: Abdessamad Dali-Ali, Nori Midoun.

Data collection, management, and quality control: Imène Beneddine, Abdessamad Dali-Ali.

Data analysis: Abdessamad Dali-Ali, Imène Beneddine.

Manuscript draft: Asmaa OUKEBDANE and all authors revised and approved the final manuscript.

All authors attest that they meet the ICMJE criteria for authorship.

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While preparing this work, the authors used CHAT GPT-4 to improve the text, enhance its quality, and rectify grammatical errors. After using this tool/service, the author(s) reviewed and edited the content as needed and took full responsibility for the publication's content.

CRediT authorship contribution statement

Abdessamad Dali-Ali: Conceptualization, Formal analysis, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. Imene Beneddine: Data curation, Investigation, Validation, Writing – original draft. Nori Midoun: Investigation, Methodology, Writing – original draft. Asmaa Oukebdane: Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

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

Data availability

The database link is mentioned in the article

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