

BMJ Open Adenovirus and RNA-based COVID-19 vaccines' perceptions and acceptance among healthcare workers in Saudi Arabia: a national survey

Mohamad-Hani Temsah ^{1,2}, Mazin Barry ^{1,3}, Fadi Aljamaan ^{1,4}, Abdullah Alhuzaimi,^{1,5} Ayman Al-Eyadhy ^{1,2}, Basema Saddik ^{6,7}, Abdulkarim Alrabiaah,^{1,2} Fahad Alsohime ^{1,2}, Ali Alhaboob ^{1,2}, Khalid Alhasan ^{1,2}, Ali Alaraj ^{8,9}, Rabih Halwani ^{6,7}, Nurah Maziad Alamro ^{1,10}, Fatimah S Al-Shahrani,^{1,3} Amr Jamal ^{1,10,11}, Sarah Alsubaie,^{1,2} Ziad A Memish ^{12,13}, Jaffar A Al-Tawfiq ^{14,15,16}

To cite: Temsah M-H, Barry M, Aljamaan F, *et al.* Adenovirus and RNA-based COVID-19 vaccines' perceptions and acceptance among healthcare workers in Saudi Arabia: a national survey. *BMJ Open* 2021;**11**:e048586. doi:10.1136/bmjopen-2020-048586

► Prepublication history and supplemental material for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2020-048586>).

M-HT and MB contributed equally.

Received 02 January 2021
Accepted 17 May 2021



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For numbered affiliations see end of article.

Correspondence to

Dr Amr Jamal;
med.researcher.2020@gmail.com

ABSTRACT

Objectives The aim of this study was to compare the perception, confidence, hesitancy and acceptance rate of various COVID-19 vaccine types among healthcare workers (HCWs) in Saudi Arabia, a nation with Middle East respiratory syndrome coronavirus experience.

Design National cross-sectional, pilot-validated questionnaire.

Setting Online, self-administered questionnaire among HCWs.

Participants A total of 2007 HCWs working in the Kingdom of Saudi Arabia participated; 1512 (75.3%) participants completed the survey and were included in the analysis.

Intervention Data were collected through an online survey sent to HCWs during 1–15 November 2020. The main outcome measure was HCW acceptance of COVID-19 candidate vaccines. The associated factors of vaccination acceptance were identified through a logistic regression analysis and via measurement of the level of anxiety, using the Generalised Anxiety Disorder 7 scale.

Results Among the 1512 HCWs who were included, 62.4% were women, 70.3% were between 21 and 40 years of age, and the majority (62.2%) were from tertiary hospitals. In addition, 59.5% reported knowing about at least one vaccine; 24.4% of the participants were sure about their willingness to receive the ChAdOx1 nCoV-19 vaccine, and 20.9% were willing to receive the RNA BNT162b2 vaccine. However, 18.3% reported that they would refuse to receive the Ad5-vectorized vaccine, and 17.9% would refuse the Gam-COVID-Vac vaccine. Factors that influenced the differential readiness of HCWs included their perceptions of the vaccine's efficiency in preventing the infection (33%), their personal preferences (29%) and the vaccine's manufacturing country (28.6%).

Conclusions Awareness by HCWs of the several COVID-19 candidate vaccines could improve their perceptions and acceptance of vaccination. Reliable sources on vaccine efficiency could improve vaccine uptake, so healthcare authorities should use reliable information to decrease vaccine hesitancy among frontline healthcare providers.

Strengths and limitations of this study

- The research is among the first studies to explore the perception, confidence, hesitancy and acceptance rates of various COVID-19 vaccine types among healthcare workers (HCWs).
- This is a national, cross-sectional survey among HCWs.
- The press release on the efficacy of the BNT162b2 vaccine coincided with ongoing data collection about the HCWs' willingness to vaccinate.
- Being a self-reported and survey-based study highlights that observational studies on the HCWs' actual acceptance of various COVID-19 vaccines are warranted in the nearest future.
- The convenience sample could limit the generalisability; therefore, further research is warranted.

INTRODUCTION

The COVID-19 pandemic has severely disrupted normal societal and economic activities worldwide and is expected to continue imposing strains and burden on health systems in most of countries. Globally, the COVID-19 pandemic remains out of control.¹ The existing measures to control COVID-19 are detrimental to the global economy² and result in significant impairment in physical and psychological well-being.³ To keep COVID-19 under control, there is a strong need for an effective vaccine. Without COVID-19 vaccination, healthcare workers (HCWs) will likely be at risk and are likely to serve as reservoir inside health institutes, which would undermine efforts to end the pandemic. According to the WHO, there are 56 and 166 candidate vaccines in clinical and preclinical evaluation by 17 December 2020.⁴



These include JNJ-78436735, an adenovirus vaccine (Ad26.COV2.S);^{5,6} mRNA-1273, an mRNA vaccine;⁷ AZD1222, an adenovirus vaccine (ChAdOx1 nCoV-19);⁸ BNT162b1, an mRNA vaccine;⁹ NVX-CoV2373, a full-length recombinant SARS-CoV-2 glycoprotein nanoparticle vaccine adjuvanted with Matrix M;¹⁰ Ad5-nCoV, an adenovirus vaccine.^{11–14} Encouraging news is that several vaccines had been released and many are in phase III clinical trials and showing promising effectiveness.¹⁵ As some safe and efficacious vaccines became available, policymakers need to ensure a successful large-scale uptake of COVID-19 vaccines to achieve community immunisation. However, the success of COVID-19 vaccination programmes will largely depend on people's acceptance of the vaccine. A recent global survey suggested that nearly 30% of participants would be hesitant to take a COVID-19 vaccine when it is available.¹⁶ A systematic review on acceptance of a COVID-19 vaccine based on nationally representative surveys in 20 nations indicates that vaccine acceptance rate in most nations would not reach 67% that is necessary for achieving population immunity.¹⁷ Mathematic modelling suggested that if a COVID-19 vaccine efficacy was 80%, the coverage must achieve at least 75% to extinguish the ongoing pandemic.¹⁸ Therefore, a timely understanding of community responses to the forthcoming COVID-19 vaccines would be important for policymaking and service planning.

Extant literature has explored vaccine acceptance and identified a few demographic and psychosocial correlates such as gender, age, trust in research, knowledge, and concerns about the novel vaccine, as well as people's judgement and perceptions regarding risk of COVID-19.^{19–21} Risk exposure to the disease is one of several essential issues that directly shape people's assessment to their vulnerability and risk. Even being weaponed with personal protective equipment, healthcare providers and other essential workers are considered to have high risk exposures to COVID-19 and given priority in vaccine allocations. Several studies suggest that being an HCW or being involved in the care of patients with COVID-19 is positively associated with COVID-19 vaccine acceptance.^{22–24}

The lessons learnt from previous infectious disease pandemics and outbreaks, including SARS, H1N1, Middle East respiratory syndrome coronavirus (MERS-CoV) and Ebola demonstrate the important role that health information has on disease control and vaccine acceptance.²⁵ Source of health information can affect the manner and frequency of the utilisation of such information. The degree to which the information source is trusted can have a remarkable impact on the acceptance of information.²⁶ If HCWs distrust the source, they will doubt the information regarding different COVID-19 vaccines, and this doubt will in turn shape their attitudes, perceptions and potential actions they take toward various COVID-19 vaccines.

The Kingdom of Saudi Arabia (KSA) is one of the top 30 countries with the highest reported COVID-19 cases:

360 690 laboratory-confirmed cases and 6101 deaths as of 19 December 2020.²⁷ Acceptance of a potential COVID-19 vaccine assessed among HCWs in KSA in a survey of 2007 participants showed an acceptance rate of 70%,²⁸ which is slightly higher than the acceptance rate found in public survey among 992 participants of general population (acceptance rate of 65%).²⁹ Perception, confidence, and hesitancy for various COVID-19 vaccines in the context of emerging viral infections and pandemics and manufacturing company and the different sources of information are principal factors in assessing vaccine acceptance of various types. To the best of our knowledge, none of published surveys specifically targeted and compared HCWs' perception, confidence and hesitancy toward different types of COVID-19 candidate vaccines. While our previous research showed that most (70%) HCWs are willing to receive COVID-19 vaccines once available,²⁸ we aimed in this study to compare the perception, confidence, hesitancy and acceptance rate of various COVID-19 vaccine types among HCWs.

METHODS

Data collection

This study was a national cross-sectional survey among HCWs in Saudi Arabia during COVID-19 pandemic. Data were collected during 4–14 November 2020. At the time of data collection, at least seven COVID-19 vaccine candidates had been reported in the scientific literature. HCWs were screened for their awareness of any of the seven published vaccines.²⁸ Participants were invited using a convenience sampling technique. We used several social media platforms and email lists to recruit participants for direct invitation. The survey was a pilot-validated, self-administered questionnaire that was sent to HCWs online through SurveyMonkey, a platform that allows researchers to deploy and analyse surveys via the internet.³⁰ This was an English questionnaire (as invited participants were multinational and all were English speakers) (online supplemental appendix 1)³¹ with modifications and additions related to the potential COVID-19 vaccine.

The questions included the demographic characteristics of respondents (job category, age, sex, years of clinical experience and work area), and any previous exposure to MERS-CoV or to patients with COVID-19 (either suspected or confirmed). We assessed the following outcomes related to the seven COVID-19 vaccine candidates that had been reported in the scientific literature: knowledge, perceived awareness and readiness to receive each type of COVID-19 vaccine candidate. In addition, we assessed factors affecting respondents' readiness to receive various COVID-19 vaccine candidates and the HCW's sources of information about COVID-19 vaccines.

Before participation, the purpose of the study was explained in English at the beginning of the online survey. The respondent was given the opportunity to ask questions via a dedicated email address. A waiver for signed consent was obtained because the survey presented no

more than a minimal risk to participants and involved no procedures for which written consent is usually required outside the study context. To maximise confidentiality, personal identifiers were not required.

HCWs were screened for their awareness of any of the seven published vaccines. Notably, Pfizer announced during the study that the efficacy of their vaccine in the first interim analysis was more than 90%.³²

Patient and public involvement

While this study did not have a direct patient or public involvement, its aim was directed at the HCWs' perceptions about the acceptance of COVID-19 vaccines. However, these HCWs are in the frontline of the pandemic, serving to save the lives of thousands of patients worldwide. Therefore, safeguarding HCWs becomes among healthcare and patients' priorities. No patients were directly involved in this research. The results of the study were published as a preprint that was shared with study participants.

Statistical analysis

Descriptive statistics approaches, with means and SDs, were applied to continuous variables, and percentages were used for dichotomous variables. The two-sample t-test was used to evaluate continuous scores, and the Z test was used to compare proportions.

A multivariable logistic regression model was used to explore associations between the outcome variable of HCW knowledge about the available COVID-19 vaccine candidates and HCW demographic, belief toward vaccine candidates, and level of anxiety. The association between predictors and the outcome was expressed as the OR and 95% CI. SPSS (V.21; IBM Corp) was used for the data analysis, Excel (Microsoft) was used for creating figures and depictions, and statistical significance was set at $p=0.050$.³³

RESULTS

A total of 2007 HCWs agreed to participate, and 1512 participants (75.3%) completed the survey and were included in the analysis. Almost quarter of respondents did not complete the survey and were excluded from analysis. The participants' sociodemographic characteristics are shown in table 1.

Women comprised most of the population (62.4%), most participants (70.3%) were between 21 and 40 years of age, 68.6% were married—though only 47.3% were living with their families—and 76.2% reported not having any chronic illnesses.

Respondents' working areas were distributed almost evenly across different sectors of health institutions, but the majority were from the public/governmental (47.1%) sectors and tertiary institutions (62.2%). In terms of awareness of potential vaccine candidates reported in the literature, the majority (59.5%) reported knowing about at least one vaccine.

Table 1 Respondents' sociodemographic and professional characteristics (N=1512)

Characteristic	N (%)
Sex	
Male	568 (37.6)
Female	944 (62.4)
Age (years), mean (SD)	
21–30	385 (25.5)
31–40	677 (44.8)
41–50	298 (19.7)
≥50	152 (10.1)
Marital status	
Single	435 (28.8)
Married, living with family	715 (47.3)
Married, living alone	322 (21.3)
Widowed or divorced	40 (2.6)
Any chronic illness	
No	1152 (76.2)
Yes	360 (23.8)
Clinical role	
Physician	637 (42.1)
Nurse	757 (50.1)
Other healthcare providers*	118 (7.8)
Working area	
Intensive care unit: adults and paediatrics	331 (21.9)
Emergency department	152 (10.1)
General ward	406 (26.9)
Isolation ward	57 (3.8)
Outpatient area	319 (21.1)
Other specialised units: dialysis, lab, pharmacy, radiology	206 (13.6)
Hospital administrative	41 (2.7)
Hospital category	
Private	350 (23.1)
Governmental	712 (47.1)
University hospital	450 (29.8)
Hospital level of care	
Primary healthcare centre	210 (13.9)
Secondary care hospital	361 (23.9)
Tertiary hospital	941 (62.2)

*Other healthcare providers include technicians, respiratory therapists and pharmacists.

The ChAdOx1 nCoV-19 vaccine was the vaccine recognised the most by HCWs (39.3%), followed by the Gam-COVID-Vac vaccine (31.9%) and the RNA BNT162b2 vaccine (30.8%). The least well-known vaccine

**Table 2** Perceived awareness of and readiness to receive various COVID-19 vaccine candidates by healthcare workers

Vaccine candidate	No (%) knows about vaccine*	No (%) willingness to take the vaccine		
		Never	Maybe	Sure
AstraZeneca (Oxford University: British/Swedish) non-replicating viral vector (chimpanzee adenovirus vectored vaccine (ChAdOx1 nCoV-19))	594 (39.3)	159 (10.5)	984 (65.1)	369 (24.4)
Gamaleya (Russia)-Sputnik V non-replicating viral vector adenovirus (Gam-COVID-Vac)	482 (31.9)	271 (17.9)	1100 (72.8)	141 (9.3)
Pfizer RNA (BNT162b2; USA): nucleoside-modified messenger RNA (modRNA)	466 (30.8)	154 (10.2)	1042 (68.9)	316 (20.9)
Johnson and Johnson (USA; adenovirus type 26 vector; Ad26.COV2-S)	422 (27.9)	154 (10.2)	1108 (73.3)	250 (16.5)
CanSino (China; adenovirus type 5; Ad5-vectored)	397 (26.3)	277 (18.3)	1103 (72.3)	132 (8.7)
Novavax (USA) protein subunit (full-length recombinant SARS CoV-2 glycoprotein nanoparticle vaccine adjuvanted with Matrix M; NVX-CoV2373)	364 (24.1)	166 (11)	1139 (75.3)	208 (13.8)
Moderna RNA (USA; mRNA-1273)	301 (19.9)	170 (11.2)	1142 (75.5)	200 (13.2)

*Percentage expressed of total sample (N=1512 healthcare workers).

among HCWs was the mRNA-1273 vaccine (19.9%; table 2).

HCWs were asked to indicate their readiness to receive each type of COVID-19 vaccine with response categories of 'never, maybe or sure' (ie, willing to receive). The respondents reported 'maybe' in (65.1%) for the (AstraZeneca) vaccine and up to (75.5%) for the (Moderna), while they were 'sure' to receive the vaccine if it was (CanSino) in (9.3%) but up to (24.4%) if the (AstraZeneca) one, on the other hand they answered 'never receive' for the (Johnson and Johnson) or (Pfizer) vaccines in (10.2%) but up to (18.3%) for the (CanSino) (table 2).

In determining factors influencing differential readiness of HCWs to receive vaccine candidates, a multiple-response dichotomies analysis showed that respondents' perception of the vaccine candidate as being more efficient in preventing infection was the most influencing factor (33%) in their decisions, followed by their personal preferences (29%) and the vaccine's manufacturing country (28.6%). The least influential factors were media and social media coverage (12.3%) and trustworthiness (4.2%; table 3).

Table 3 Factors affecting respondents' readiness to receive COVID-19 vaccine candidates (N=1512)

	N (%)
This COVID-19 vaccine(s) seems more efficient in preventing the infection	499 (33)
Personal preference	439 (29)
Manufacturing country	433 (28.6)
Possibly fewer adverse effects from this vaccine	417 (27.6)
Vaccine availability	394 (26.1)
Company's reputation	395 (26.1)
Media coverage	186 (12.3)
Trustworthiness	64 (4.2)

The HCW's sources of information about COVID-19 vaccines are shown in table 4. The WHO website was the most used source for information (51.1%), followed by social media networks (48.3%), the Saudi Ministry of Health (MOH) website (43.8%) and official press releases (38.3%). The Centers for Disease Control and Prevention website was used by only one-third of participants (table 4).

A substantial number of HCWs in this study (n=612, 40.5%) reported unawareness of some vaccine candidates reported in scientific literature as of the time of the study. Therefore, as a secondary analysis, the generalised linear multivariate gamma regression analysis was used to explain the predictors of how likely the surveyed HCWs were to be aware of the different scientifically reported vaccine candidates. These results are presented in table 5 and show that women knew significantly less than men about the different vaccine candidates (p=0.016). Older age correlated significantly and positively with more knowledge (p=0.027). Also, physicians knew significantly

Table 4 Respondents' sources of information about COVID-19 vaccine types (N=1490)

	N (%)
WHO website	762 (51.1)
Social networks (eg, YouTube, Facebook, Twitter, WhatsApp)	719 (48.3)
MOH website	652 (43.8)
Official statements or press releases from MOH (eg, through SMS or newspapers)	570 (38.3)
Hospital announcements (eg, roll-ups or newsletters)	543 (36.4)
Other internet resources	537 (36.0)
CDC website	501 (33.6)

CDC, Centres for Disease Control and Prevention; MOH, Ministry of Health; SMS, short message service.

Table 5 Generalised linear modelling analysis of the healthcare workers' knowledge of the available COVID-19 vaccine candidates

Parameter	Exponentiated (β) coefficient	95% CI for exponentiated (β)		P value
		Lower	Upper	
(Intercept)	1.936	1.442	2.600	<0.001
Sex=female	0.900	0.826	0.981	0.016
Age (years)	1.005	1.001	1.009	0.027
Clinical role=physician	1.267	1.101	1.458	0.001
Clinical role=nurse and midwife	0.855	0.747	0.979	0.023
Hospital set-up type=primary	0.847	0.763	0.940	0.002
Hospital set-up type=secondary	0.904	0.830	0.984	0.020
Hospital sector=private	0.910	0.825	1.003	0.057
Hospital sector=governmental	0.961	0.884	1.045	0.355
Generalised anxiety, mean score	1.002	0.995	1.010	0.565
Worry level from getting COVID-19 viral infection, mean score	0.961	0.920	1.005	0.080
Worry level from transmitting COVID-19 viral infection to family, mean score	1.029	0.991	1.069	0.133
Believes the vaccine can stop the disease spread	1.073	1.018	1.132	0.009
Believes vaccination prevents COVID-19 complications	1.046	0.994	1.100	0.087
Does not interact with COVID-19-infected family members	0.907	0.836	0.983	0.018

Dependent variable was the total number of vaccines the healthcare workers knew about. The exponentiated (β) coefficient was interpreted as a rate.

more about vaccine candidates than other HCWs did ($p=0.001$), and the HCWs from primary and secondary health centres knew of significantly fewer COVID-19 vaccine candidates than did HCWs from tertiary medical centres ($p=0.002$ for primary, $p=0.02$ for secondary). The participant's belief in the ability of COVID-19 vaccines to stop the pandemic predicted significantly higher knowledge of the available vaccine candidates ($p=0.009$). HCWs who did not interact with COVID-19-infected

family members knew significantly less about the available vaccine candidates ($p=0.018$). Other specific worry/anxiety levels and beliefs were assessed, as reported in [table 5](#).

Our analysis ([figure 1](#)) showed a significantly higher percentage rate of HCW readiness to receive any COVID-19 vaccine relative to the refusal rate after the Pfizer announcement compared with before it ($\chi^2(1)4.56$, $p=0.032$). In addition, the percentage of HCWs accepting

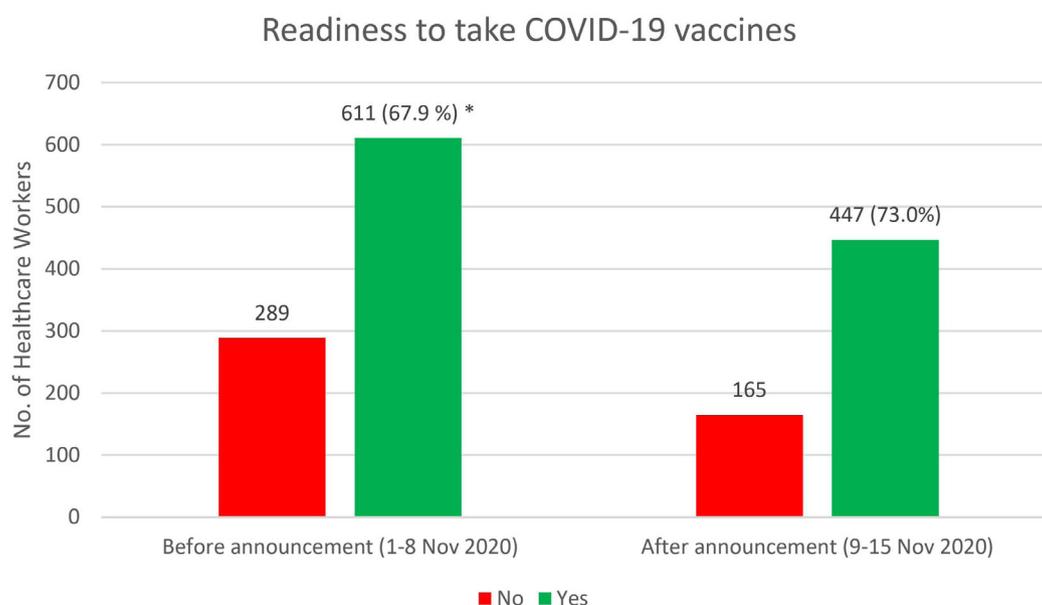


Figure 1 Readiness to take COVID-19 vaccines, as reported before and after the interim report of the efficacy rate of BNT162b2. * $P=0.032$.

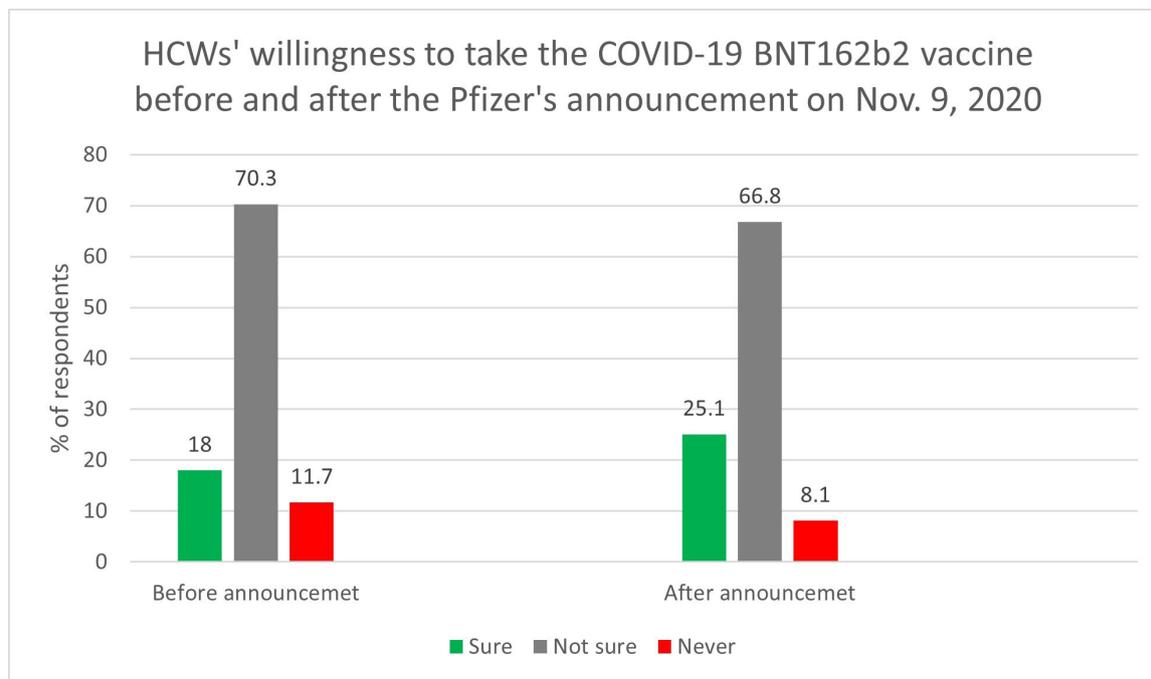


Figure 2 The percentage of healthcare workers (HCWs) willing to receive the BNT162b2 vaccine after its efficacy announcement.

to take the BNT162b2 vaccine increased from 18% to 25.1%, and proportion of those who stated they will never take the BNT162b2 vaccine dropped from 12% to 8.1% following Pfizer's announcement (figure 2).

DISCUSSION

Since the beginning of the pandemic, an unprecedented global effort to develop a vaccine has been underway; research and development of different technologies have been applied for different vaccine candidates. The effort resulted in several types of vaccine candidates developed with various technologies, including adenovirus and RNA-based vaccines, all of which are novel and have not been developed for wide clinical use in other infectious diseases. Gaining knowledge of such new vaccines, with the rapid evolution of the development process, may be challenging: only 40% of study participants were aware of the ChAdOx1 nCoV-19 vaccine,^{5-9 11 34 35} and only one-third were aware of the BNT162b2, Gam-COVID-Vac and Ad26.COV2-S vaccines. Only a quarter of participants knew about the remaining vaccines. To our knowledge, data about HCW knowledge of vaccine candidates have not been published elsewhere.

The acceptance rate of COVID-19 vaccines is variable. In a global survey in 19 countries about the potential acceptance of a COVID-19 vaccine among the public, 71.5% reported they would very or somewhat likely agree to receive a vaccine; respondents from China gave the highest proportion of positive responses (631 (88.6%) of 712 respondents) and the lowest proportion of negative responses (5 (0.7%) of 712) when asked if they would take a proven, safe and effective vaccine. Respondents

from Poland reported the highest proportion of negative responses (182 (27.3%) of 666), whereas Russian respondents gave the lowest proportion of positive responses (373 (54.9%) of 680). Data are available about other diseases with multiple vaccine types as well. In a parental survey on acceptance of an intranasal, live, attenuated influenza vaccine, 81% preferred this version compared with the injectable inactivated influenza vaccine.³⁶ During the H1N1 pandemic, 50 of 161 HCWs (31.1%) were willing to take the 2009 H1N1 vaccine.³⁷ In a cross-sectional survey conducted in Riyadh in 2019 on influenza vaccine uptake, results showed an acceptance rate of 71% with hesitancy attributed to concerns on adverse events in 50% of participants.³⁸ It was also noted that people in the Middle East generally have low acceptance rate of COVID-19 vaccines and such acceptance was 23%–66%.^{29 39 40} However, no such acceptance rate has been evaluated among HCWs.⁴¹

It is interesting to note that, of all the HCW respondents asked about taking a COVID-19 vaccine, only 20% or 24% preferred to receive the AstraZeneca or the Pfizer vaccine, respectively. This low response to acceptance of any vaccine in development may indicate variability in the knowledge and understanding about the different vaccines. Vaccine knowledge is an area that needs more study to understand variables contributing to acceptance or rejection of each type of vaccine according to different development platforms used. This understanding would aid policymakers in the development of appropriate educational materials to boost confidence in various vaccine platforms.

Many factors affect the choice to receive vaccines. In this study, the top reason for choosing a vaccine was that

the vaccine seems more effective at preventing infection (33%). A previous study found that 50% vaccine efficacy was associated with a 51% rate of acceptance.⁴²

The manufacturing country was another reason given for accepting the vaccine (in 28.6% of respondents). This finding is similar to results from a US survey related to hypothetical vaccines. The surveyed individuals had lower acceptance of the vaccine if it originated from a country outside the USA.⁴² Other contributing factors, such as fewer adverse effects, were also reported in this study.⁴² Understanding these factors is important to build strategies for vaccine acceptance in any community. Strategies should address concerns, contributing factors and misconceptions.⁴³ Trustworthiness was indicated by approximately 4% of the respondents as a factor in accepting a COVID-19 vaccine. This is quite different when compared with the general population in the USA, in which trust and perceptions of local COVID-19 vaccination norms were the strongest predictors of COVID-19 vaccine acceptance.⁴⁴ The difference might be the fact that our study included only HCWs who may have better understanding of the disease and the vaccination. It is important to note that trust is an important modifiable element of any successful vaccine campaign. Trustworthiness was strongly associated with acceptance of a COVID-19 vaccine,⁴⁵ and this factor was also related to acceptance of other vaccines, such as H1N1, SARS and MERS-CoV vaccines.²⁵

The most-reported sources of information for HCWs were the WHO website and social networks (as expected in a pandemic). Previously, Alsubaie *et al*⁴⁶ reported results from the same HCW population, which showed that hospital announcements and MOH official statements were more commonly sought for information about the MERS-CoV national outbreak. In the case of the general public, the source of knowledge and information about COVID-19 was official government social media and Twitter.⁴⁷ And another study showed 85.8% of the public in Saudi Arabia used the internet and social media for information regarding COVID-19. In a study from the USA, 45%–66% of HCWs used social media as a source of information.^{48 49} These findings suggest that HCWs in Saudi Arabia use social networking sites differently than their US counterparts, which is important for other studies that look at social media and knowledge. Seeking knowledge from reliable sources about the pandemic and vaccinations could significantly impact the HCWs' perceptions of vaccine acceptance.⁵⁰ Misinformation about the COVID-19 vaccine was associated with decreased vaccination acceptance among those who would otherwise definitely vaccinate.⁵¹

It is interesting to note the differences in knowledge about vaccines by level of training. Physicians knew significantly more about vaccine candidates than other HCWs did ($p=0.001$) (table 5). Similarly, in a study from the USA, general COVID-19 knowledge among physicians was higher than other HCW, but non-physicians who work in healthcare did not have greater knowledge

than the public.⁴⁹ Noteworthy, HCWs working in tertiary and academic centres were more knowledgeable about various vaccine candidates compared with HCWs working in primary and secondary centres. This result may be explained by more scientific activity and educational campaigns typically associated with teaching hospitals. This increased knowledge was especially common among physicians in our study, like other studies; in a cross-sectional survey conducted in Italy among HCWs to assess their knowledge, attitudes, and practices about vaccinations, physicians and those who had received information about vaccinations from scientific journals, educational activities, or professional associations were more likely to have adequate knowledge.⁵² The knowledge differences identified between centres and types of providers highlight the importance of academic activities and keeping up to date with the scientific literature during the COVID-19 pandemic.

Remarkably, after the Pfizer and BioNTech announcement about the efficacy rate of BNT162b2, the HCWs in our study demonstrated significantly more willingness to undergo vaccination.³² This change was despite simultaneous negative news on some COVID-19 vaccination trials, such as the halting of clinical studies with the CoronaVac vaccine by the Brazilian national sanitary regulator (Anvisa) due to a serious adverse event.⁵³ Vaccine acceptance is a multifactorial issue, but having positive COVID-19 vaccine trial results circulating in the news and social media for several days after the press release on the efficacy of BNT162b2 could improve the HCWs' willingness to vaccinate.

This study has the limitation of being self-reported and survey based, so future observational studies on the HCWs' actual acceptance of various COVID-19 vaccines are warranted. As a cross-sectional survey promoted on social media, it is not possible to calculate a response rate, and results may not be generalisable over time; therefore, further research is warranted. Another aspect is the national design that needs further research for external validity in other countries.

CONCLUSION

HCW awareness of the several COVID-19 candidate vaccines could improve perception and acceptance of vaccination. Reliable sources on vaccine efficiency could improve vaccine uptake, and healthcare authorities should use these sources to decrease vaccine hesitancy among frontline healthcare providers.

Author affiliations

¹College of Medicine, King Saud University, Riyadh, Saudi Arabia

²Pediatric Department, King Saud University Medical City, Riyadh, Saudi Arabia

³Department of Internal Medicine, King Saud University Medical City, Riyadh, Saudi Arabia

⁴Critical Care Department, King Saud University Medical City, Riyadh, Saudi Arabia

⁵Cardiac Science Department, King Saud University Medical City, Riyadh, Saudi Arabia

⁶Sharjah Institute for Medical Research, University of Sharjah, Sharjah, UAE

⁷College of Medicine, University of Sharjah, Sharjah, UAE
⁸Department of Medicine, Qassim University, Buraidah, Saudi Arabia
⁹Dr.Suliman Alhabib Medical Group, Riyadh, Saudi Arabia
¹⁰Department of Family and Community Medicine, King Saud University Medical City, Riyadh, Saudi Arabia
¹¹Evidence-Based Health Care & Knowledge Translation Research Chair, King Saud University, Riyadh, Saudi Arabia
¹²King Saud Medical City, Ministry of Health & Alfaisal University, Riyadh, Saudi Arabia
¹³Hubert Department of Global Health, Emory University Atlanta, Atlanta, Georgia, USA
¹⁴Specialty Internal Medicine and Quality Department, Johns Hopkins Aramco Healthcare, Dhahran, Saudi Arabia
¹⁵Infectious Disease Division, Department of Medicine, Indiana University School of Medicine, Indianapolis, Indiana, USA
¹⁶Infectious Disease Division, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Acknowledgements We thank all the healthcare workers who participated in this survey and all those in the COVID-19 front lines. We also thank hodhodata.com for their statistical analysis and support.

Contributors M-HT, MB, JAA-T, ZAM and FAlsohime were involved in conception, analysed the data and wrote the manuscript. AAlhuzaimi, AA-E, FAljamaan, BS, AAlrabiaah and NMA contributed to the study design; collected, analysed and interpreted data; and edited the manuscript. AAlhuzaimi, FSA-S, KA, AAlrabiaah, AAlaraj, AAlhaboob and SA supervised data collection, analysed data and edited the manuscript. AA-E, RH and AJ interpreted the data and wrote the manuscript. All authors reviewed and approved the final version of the manuscript.

Funding The authors are grateful to the Deanship of Scientific Research, King Saud University, for funding through the Vice Deanship of Scientific Research Chairs. Award/grant number is not applicable.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The institutional review board at the College of Medicine and King Saud University Medical City approved the study (approval #20/0065/IRB).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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ORCID iDs

Mohamad-Hani Temsah <http://orcid.org/0000-0002-4389-9322>
 Mazin Barry <http://orcid.org/0000-0003-2274-007X>
 Fadi Aljamaan <http://orcid.org/0000-0001-8404-6652>
 Ayman Al-Eyadhy <http://orcid.org/0000-0002-6051-9125>
 Basema Saddik <http://orcid.org/0000-0002-4682-5927>
 Fahad Alsohime <http://orcid.org/0000-0002-4979-3895>
 Ali Alhaboob <http://orcid.org/0000-0003-2126-7874>
 Khalid Alhasan <http://orcid.org/0000-0002-4291-8536>
 Ali Alaraj <http://orcid.org/0000-0002-7706-2328>
 Rabih Halwani <http://orcid.org/0000-0002-6516-7771>
 Nurah Maziad Alamro <http://orcid.org/0000-0001-9489-3994>
 Amr Jamal <http://orcid.org/0000-0002-4051-6592>
 Ziad A Memish <http://orcid.org/0000-0002-5099-0714>

Jaffar A Al-Tawfiq <http://orcid.org/0000-0002-5752-2235>

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COVID-19 Vaccination perceptions of HCWs

*** 1. Greetings dear healthcare provider,**

We would like you to imagine a situation where a number of vaccines for COVID-19 have been developed. These vaccines have undergone all required testing and have received regulatory approval for use in humans from the health authorities in Saudi and in other countries. Vaccination has also been recommended by the World Health Organisation (WHO).

Kindly take 5 minutes to answer, keeping in mind that all your answers are confidential. This will also give you more insight into several COVID vaccines that are currently in Phase 3 trial.

The study was approved by the Institutional Review Board at the College of Medicine, King Saud University (approval # 20/0065/IRB).

Thank You!

Dr. Hani Temsah, Dr. Mazin Barry
mtemsah@ksu.edu.sa

- I am a healthcare worker in Saudi Arabia, and I **ACCEPT** to participate in this Survey
- I do **NOT accept** to participate in this Survey

*** 2. Region:**

- Riyadh region
- Makkah region
- Madinah region
- Qassim region
- Eastern Region
- Asir
- Tabuk
- Hail
- The Northern Border region
- Jazan
- Najran
- Al Baha
- Al Jouf

COVID-19 Vaccination perceptions of HCWs

Please Choose Your Answers then Press "Next"

* 3. You are

- Consultant
- Assistant consultant
- Resident
- Nurse
- RT
- Other (please specify)

* 4. What is your age?

Age in years:

* 5. What is your gender?

- Female
- Male

* 6. Are you now married, widowed, divorced, separated, or have you never been married?

- Married and living with children
- Married but living alone
- Widowed
- Divorced
- Never married

* 7. At what Hospital area do you work usually most of the time?

- Pediatric ICU
- Adult ICU
- Pedia ER
- Adult ER
- Isolation ward
- General ward
- OPD
- Other (please specify)

8. Do you have a chronic medical condition?

(like Hypertension, DM, chronic kidney disease, Heart disease, Asthma, COPD, Cancer, Immunocompromised state, SCD, Obesity)

- No
- Yes (please specify)

* 9. Your hospital setting and type of practice?

Hospital/healthcare center Type

Practice Level

Hospital Setting:

* 10. Have you been previously in contact with Corona (proven or suspected COVID) patients?
(Please choose all that apply)

- Yes: With COVID-Infected Patient
- Yes: With COVID-positive family member or friend
- Yes: With MERS-CoV Patient
- No: No contact at all

* 11. Have you been infected with laboratory-confirmed COVID-19 yourself?

- Yes
- No

COVID-19 Vaccination perceptions of HCWs

* 12. Did you take the influenza vaccine during the last 2 years?

Yes

No

* 13. If an approved MERS-CoV vaccine became available in Saudi Arabia this year, would you take it yourself?

Yes

No

* 14. If an approved COVID vaccine became available in Saudi Arabia this year, would you take it yourself?

Yes

No

* 15. If a COVID vaccine became available when will you take it?

Get one as soon as possible

Delay getting it for few months

Never get one

COVID-19 Vaccination perceptions of HCWs

16. You choose not to get the COVID Vaccine:
What are your reasons for not taking the vaccine?
(Choose what apply)

- Inadequate data about the safety of a new vaccine
- I am against vaccine in general (or I avoid medications whenever possible)
- Vaccine administration is painful or inconvenient
- I already had COVID infection
- A concern of adverse effects of the vaccine
- A concern of acquiring Covid19 from the vaccine
- A concern of vaccine being ineffective
- Prior adverse reaction to the vaccine
- I perceive myself not at high risk to acquire Covid19 infection
- I perceive myself not at high risk to develop complications if I get infected with Covid19 infection
- Other (please specify)

COVID-19 Vaccination perceptions of HCWs

COVID Vaccine

* 17. If a COVID vaccine is announced this year in 2020, would your first thoughts be:

- It is a scientific achievement to find a vaccine that fast
- It was probably rushed without enough testing
- Other (please specify)

* 18. COVID vaccine is the most likely way to stop this pandemic.

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

* 19. Once the vaccine is available and approved; it would be safe.

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

* 20. The best way to avoid the complications of COVID is by being vaccinated

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

* 21. From the following COVID vaccines in phase 3 trials, which do you know?

	I do not know this vaccine	I know about this vaccine
AstraZeneca: (OxfordUniversity: British/Swedish Non-Replicating Viral Vector (chimpanzee adenovirus vectored vaccine (ChAdOx1 nCoV-19)	<input type="radio"/>	<input type="radio"/>
Johnson and Johnson (USA): (adenovirus type 26 vector Ad26.COV2-S)	<input type="radio"/>	<input type="radio"/>
Pfizer RNA (BNT162b2 (USA): nucleoside-modified messenger RNA modRNA)	<input type="radio"/>	<input type="radio"/>
Novavax (USA): protein subunit (Full length recombinant SARS CoV-2 glycoprotein nanoparticle vaccine adjuvanted with Matrix M)	<input type="radio"/>	<input type="radio"/>
Moderna RNA (USA): mRNA-1273	<input type="radio"/>	<input type="radio"/>
CanSino (China) (Adenovirus type 5)	<input type="radio"/>	<input type="radio"/>
Gamaleya (Russia): Sputnik V non replicating viral vector Adenovirus	<input type="radio"/>	<input type="radio"/>

* 22. From the following COVID vaccines in phase 3 trials, how likely would you accept each one:

	I will never accept to take	Not sure	Surely I will accept
AstraZeneca: (OxfordUniversity: British/Swedish Non-Replicating Viral Vector (chimpanzee adenovirus vectored vaccine (ChAdOx1 nCoV-19)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Johnson and Johnson (USA): (adenovirus type 26 vector Ad26.COV2-S)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pfizer RNA (BNT162b2 (USA): nucleoside-modified messenger RNA modRNA)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Novavax (USA): protein subunit (Full length recombinant SARS CoV-2 glycoprotein nanoparticle vaccine adjuvanted with Matrix M)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Moderna RNA (USA): mRNA-1273	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
CanSino (China) (Adenovirus type 5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gamaleya (Russia): Sputnik V non replicating viral vector Adenovirus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* 23. What factors affected your choice your answer to the above question?

- This COVID vaccine(s) seem more efficient on preventing the infection
- Vaccine availability
- Company's reputation
- Manufacturing country
- Possibly lessor side effects from this vaccine
- from the Media coverage
- Personal preference
- Other (please specify)

COVID-19 Vaccination perceptions of HCWs

Changes after Corona (MERS)

Please Choose Your Answers then Press "Next"

* 24. What is/are your usual source(s) of information about COVID vaccine?

(Check all that apply)

- Hospital announcements (e.g. roll-ups or newsletters)
- Official statements or press release from MOH (e.g. through SMS or newspapers)
- MOH website
- WHO website
- CDC Website
- Other internet resources
- Social Networks (like YouTube, Facebook, Twitter, WhatsApp)

COVID-19 Vaccination perceptions of HCWs

* 25. On a scale from 1 to 5, please rate how much worry you experienced over the past 2 weeks about contracting COVID19 Infection yourself:

1- Not worried at all 2- Little worried 3- Somewhat worried 4- Very worried 5- Extremely worried

<input type="radio"/>				
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* 26. On a scale from 1 to 5, please rate how much worry you experienced over the past 2 weeks about transmitting the COVID19 Infection to your family:

1- Not worried at all 2- Little worried 3- Somewhat worried 4- Very worried 5- Extremely worried

<input type="radio"/>				
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* 27. Over the last 2 weeks, how often have you been bothered by the following problems?

Not at all Several days More than half the days Nearly every day

Feeling nervous,
anxious or on edge

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Not being able to stop
or control worrying

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Worrying too much
about different things

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Trouble relaxing

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Being so restless that it
is hard to sit still

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Becoming easily
annoyed or irritable

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Feeling afraid as if
something awful might
happen

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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