

Healthcare workers' (HCWs) attitudes and related factors towards COVID-19 vaccination: a rapid systematic review

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ABSTRACT

Herd immunity through vaccination is a key measure to control COVID-19 pandemic. However, vaccine hesitancy remains a public health threat, which is still common among healthcare workers (HCWs). This systematic review aimed to synthesise evidence on HCWs' attitudes towards COVID-19 vaccination and analyse associated factors to provide information for vaccine policy development and practice. We searched PubMed, Embase, ScienceDirect, Web of Science and three Chinese databases for literature published on 12 February 2021. Two researchers screened the literature independently, and 13 studies were included in the systematic review. Vaccine acceptance varied widely and ranged from 27.7% to 77.3%. HCWs had positive attitudes towards future COVID-19 vaccines, while vaccine hesitancy was still common. Demographic variables such as men, older age and physicians were positive predictive factors. Women and nurses had more vaccine hesitancy. Previous influenza vaccination and self-perceived risk were facilitators. Concerns for safety, efficacy and effectiveness and distrust of the government were barriers. Influences of direct (COVID-19) patient care towards vaccination intention were less conclusive. Tailored communication strategies were needed to increase the uptake rate of COVID-19 vaccines among HCWs. More importantly, more data and information on the safety and efficacy of vaccines should be provided with transparency.

INTRODUCTION

Vaccination is an important measure to control the global pandemic of COVID-19. The most hopeful way of controlling COVID-19 could be universal vaccination to achieve herd immunity.¹ Adequate COVID-19 vaccination coverage is the guarantee of herd immunity. Studies indicate that when basic reproduction number (R0) is estimated to be three, the threshold of herd immunity for COVID-19 is approximately 67%.^{2,3} This means that when acquired immunity of population is over 67%, the incidence of COVID-19 infection will begin to decline. The public's attitudes towards vaccine were unclear and affected by many factors, making the achievement of herd immunity a challenge.^{4,5} Among the public, healthcare workers (HCWs) will be key to the success of COVID-19 vaccination.⁶ Serving as a trusted source of vaccination information, HCWs' recommendations play a major role in patients' vaccination decisions. During the COVID-19 pandemic, HCWs are at high risk of

infection.⁷ Vaccination of all HCWs will play a key role in avoiding sickness from this preventable disease, which can protect not only HCWs themselves but also patients against infection.⁸ Based on the Strategic Advisory Group of Experts on Immunisation values framework, WHO identified HCWs as a high-priority group for COVID-19 vaccination.⁹ To date, many countries have initiated COVID-19 vaccination campaigns for priority populations including HCWs. Vaccine hesitancy is a behaviour that includes refusal of vaccines or delay of vaccination despite available services.¹⁰ The WHO regarded vaccine hesitancy as a global health threat in 2019.¹¹ Vaccine hesitancy in public has also been linked to the level of vaccine hesitancy among HCWs. Since early 2020, many studies regarding HCWs' intention to be vaccinated against COVID-19 have been published.^{12,13} However, attitudes, intentions and factors associated with vaccine hesitancy among HCWs in these studies have not been systematically reviewed. Therefore, the aims of this rapid systematic review are to assess attitudes towards COVID-19 vaccination among HCWs and analyse factors pertaining to COVID-19 vaccine concerns and intention.

MATERIALS AND METHODS

A rapid systematic review approach¹⁴ was conducted to provide timely evidence to inform decision-making in COVID-19 vaccination campaigns. Adhering to the essential principles of systematic reviews, the rapid systematic review is a simplified process, which includes limiting searches to English and Chinese studies, without searching for grey literature, and not registering the protocol.

Literature search strategy

PubMed, Embase, ScienceDirect, Web of Science, China National Knowledge Infrastructure (CNKI), VIP and Wanfang Data were searched for literature published on 12 February 2021. CNKI, VIP and Wanfang Data are authoritative comprehensive literature retrieval databases in China. The retrieval strategies were customised for different databases. Search terms mainly included (healthcare workers OR Health Personnel OR medical students) AND (COVID-19 OR SARS-CoV-2 OR 2019-ncov) AND (vaccines OR vaccination OR vaccinated) AND (survey OR questionnaire OR poll). More information on search strategies can be found in online supplemental appendix 1.

Study selection

EndNote library (V.X9) was used to import search results from all databases and remove duplicates. After duplicate removal, two researchers screened titles, abstracts and full text of the results independently; differences were resolved through joint discussions or consultations with a third party.

Inclusion criteria

1. Population : HCWs were defined as all individuals employed or studying in a healthcare setting, including physicians, nurses, allied HCWs and medical students, as well as ancillary staffs (eg, healthcare administration and support staffs).
2. Study design: They were primary studies that included structured or semistructured surveys.
3. Outcomes: Studies examined attitudes to COVID-19 vaccination and analysed related factors.
4. Language: English and Chinese.

Exclusion criteria

1. Population: The public, not HCWs.
2. Study design: Qualitative design such as qualitative interview and focus group.
3. Outcomes: Studies did not assess the attitudes toward and COVID-19 or analyse related factors.
4. Language: Not English and Chinese.
5. Others: Retraction, not peer-reviewed and so on.

Data extraction and quality assessment

Data from the studies were extracted independently by two researchers, and a third researcher was consulted when there were disagreements. According to the characteristics of the study, we extracted author, country, data collection period, sample size, study design, HCW population, acceptance, factors associated with intention to take COVID-19 vaccine and reasons for vaccine hesitancy (table 1). Due to the nature and heterogeneity of these studies, they were not suitable for a meta-analysis. Therefore, this review conducted an integrated approach. We used the Joanna Briggs institute prevalence checklist to assess the quality of cross-sectional studies (online supplemental appendix 2).¹⁵

RESULTS

As shown in figure 1, our initial literature search yielded 900 articles from seven Chinese and English database. After removing duplications, 726 were left; then following the above inclusion criteria, 13 articles were identified.^{12 13 16–26} Thirteen publications consisting of one article in press,²³ one accepted manuscripts²⁰ and three brief research report were included in the review.^{21 24 26}

Survey characteristics

The earliest research started at the end of February 2020. Studies were conducted primarily prior to authorisation of the COVID-19 vaccine, so studies analysed attitudes or intention towards future COVID-19 vaccines by assuming that the vaccine would be available. One survey was completed immediately after the authorisation of the COVID-19 vaccine, so 8.6% HCWs had received COVID-19 vaccine.²⁴ Thirteen surveys covered seven countries, and most studies were conducted in the USA. A study conducted a cross-border survey of three countries: France, Belgium and Canada.¹⁹ The sample size for studies ranged from 168 to 8243 participants. Nine of the 13 studies had a sample size of more than 1000. The proportion of those intending to

receive COVID-19 vaccine among HCWs ranged from 27.7% to 77.3% (table 1). The sample population also had some differences, but most studies include physicians, nurses or both. The sample population of many studies enrolled academic, administrative and support staffs in medical institutions and medical schools. Most surveys of included studies were conducted by online self-administered questionnaires, but part of the data of one survey¹⁷ were collected on site. Participants were recruited by the researchers themselves through SMS, email, Twitter and other ways. All studies were cross-sectional surveys, while three studies also included qualitative comments to provide additional vaccination views and perspectives, which enriched study content.^{16 20 23}

Quality assessment

Quality assessment results of these studies are presented in online supplemental appendix 2. Overall, the quality of the included studies was good, with common quality problems including non-random sampling and unreported response rates. Sampling methodology in all studies had a high risk of bias because of convenience sampling method. Studies mainly recruited participants through social media, such as email, Twitter and text messages. The response rate of all surveys was not higher than 70%. Due to the recruitment of participants through social media and anonymity, response rates were not clear in five studies.^{12 17 18 22 25} The sample sizes of one study were inadequate with less than 200 participants.¹⁶

Factors associated with intention to take COVID-19 vaccine

Demographic characteristics

Factors associated with intention to take COVID-19 vaccine were analysed in 13 studies, and six studies used multivariate regression analysis to account for confounding factors. Several demographic characteristics were found to be associated with COVID-19 vaccination, such as gender, age, occupation and race. Studies^{17 20–26} indicated that male sex was a positive predictor of COVID-19 vaccination acceptance compared with female sex. Six studies^{16 20–23 26} found that older HCWs were more inclined to take COVID-19 vaccine, while two studies^{12 25} found the opposite. Participants in these two studies were predominantly woman, accounting for 89.71% and 72.5%. Physicians had higher receptivity towards COVID-19 vaccine compared with other HCWs.^{17 18 20 26} Nurses were less willing to be vaccinated than other HCWs, especially physicians.^{17 20 21 26} Research scientists also had higher willingness to be vaccinated.²⁰ Compared with African-Americans, Caucasians had higher willingness to accept the vaccine.^{20 21} Asian were more willing to be vaccinated compared with other groups in two studies,^{20 22} while another study found Asians (23.9%) were less likely to accept vaccination immediately on availability.²⁶ In addition, HCWs with chronic conditions were prone to receive COVID-19 vaccine.^{13 22} One study found higher vaccine acceptance was associated with increasing education and income level.²² Political identification also affected vaccine acceptance that 42% Democrat/Liberal would take the vaccine.²²

Other factors

Several studies found that previous influenza vaccination was closely related to the likelihood of taking COVID-19 vaccination, which was a strong predictor.^{13 19 22 25} On the contrary, the likelihood of getting an influenza shot among HCWs has increased because of COVID-19.¹³ Self-perceived risk of COVID-19^{17 22 24} and perceived impact on health²³ were also

Table 1 Overview of study characteristics

Author	Country	Data collection period	Sample size (n)	Study design	HCW population	Acceptance (%)	Factors associated with intention to take COVID-19 vaccine	Reasons for vaccine hesitancy
Kwok <i>et al</i> ¹²	China	Mid-March to late April 2020	1205	Cross-sectional	Nurses	63%	Positive factors: Younger age, 5C psychological antecedents, greater work stress (mediator), COVID-19-related work demands (indirect effects)	Not mentioned
Wang <i>et al</i> ¹³	China	26 February to 31 March 2020	806	Cross-sectional	Nurses	40%	Positive factors: Male, having chronic conditions, in private sector, encountering with suspected or confirmed COVID-19 patients, previous influenza vaccination	Suspicion on efficacy, effectiveness and safety Believing it is unnecessary No time to take it
Lucia <i>et al</i> ¹⁶	USA	Not mentioned	168	Cross-sectional Qualitative comments	Medical students	77.3%	Negative factor: Concern for serious vaccine side effects	Concerns for serious vaccine side effects, distrusting the information from public health experts Qualitative: concerns about vaccine safety/efficacy, rapid development/implementation of vaccine, politicisation
Gagneux-Brunon <i>et al</i> ¹⁷	France	26 March to 2 July 2020	2047	Cross-sectional	Physicians, pharmacists, nurses, assistant nurses, midwives, physiotherapists, other HCWs	75%	Positive factors: Older age, male, physicians, fear about COVID-19, perceived individual risk, influenza vaccination during previous season	Not mentioned
Nzaji <i>et al</i> ¹⁸	Congo	March to 30 April 2020	613	cross-sectional	Doctors, nurses, midwives and laboratory technicians	27.7%	Positive factors: Male, doctors, having a positive attitude towards a COVID-19 vaccine	Not mentioned
Verger <i>et al</i> ¹⁹	France Belgium Canada	October to November 2020	2678	Cross-sectional	General practitioners, nurses	72.4% (high acceptance: 48.6%; moderate acceptance: 28.4%)	Positive factors: History of influenza vaccination	Vaccine safety concerns Distrusting the ministry of health to ensure vaccine safety
Shaw <i>et al</i> ²⁰	USA	23 November to 5 December 2020	5287	Cross-sectional Two qualitative questions	Clinical and non-clinical staff, researchers and trainees	57.5%	Positive factors: Physicians and research scientists, older, men, Caucasian, Asian	Concerns: Vaccine safety, adverse events, efficacy and speed of vaccine development
Unroe <i>et al</i> ²¹	USA	14–17 November 2020	8243	Cross-sectional	Nursing home staff	69% (immediately: 45%; in the future: 24%)	Positive factors: Age over 60, man, Caucasian race	Concerns for side effects, health concerns, questioning the effectiveness, religious reasons, too new, a lack of trust, the need for more research, it was too political
Shekhar <i>et al</i> ²²	USA	7 October to 9 November 2020	3479	Cross-sectional	Physician, resident, medical student and so on	36% (immediately)	Positive factors: Increasing age, education and income levels Male, Asian, south, Democrat/Liberal, previous influenza vaccine, direct medical providers (eg, physician/resident/medical student), with chronic medical conditions, self-perceived risk	Concerns: safety, effectiveness, side effects, speed of development/approval Distrust of the government and regulatory authorities
Manning <i>et al</i> ²³	USA	10 August to 14 September 2020	1212	Cross-sectional Qualitative comments	Student nurses, full-time faculty and clinical adjunct faculty	46.1%	Faculty, age of 60 and greater, male, whether providing direct patient care, whether their colleagues acquired COVID-19, perceived impact on their own health	Developed too quickly to be safe Side effects
Kocielek <i>et al</i> ²⁴	USA	21 December 2020 to 13 January 2021	4448	Cross-sectional	Clinical and non-clinical staff	59.8% (8.6% had received the vaccine)	Positive factors: Male, not black, not Hispanic/Latinx, concerns about severe COVID-19	Concerns about vaccine safety Too political Distrusting the FDA and CDC
Kose <i>et al</i> ²⁵	Turkey	17–20 September 2020	1138	Cross-sectional	Physician, nurse/midwife, student (medicine and nurse), others	68.6%	Positive factors: Male, students, younger age group, with a previous influenza shot	Worrying about side effects, distrusting the vaccine, the vaccine will not work, trusting their own immune system, be protected from the disease, not afraid of getting sick
Gadoth <i>et al</i> ²⁶	USA	24 September to 16 October 2020	609	Cross-sectional	Prescribing clinicians, nurses, other personnel with direct patient contact, personnel without patient contact	33.1%	Fast-tracked development timeline, novel and unfolding science of SARS-CoV-2, political climate Positive factors: aged of 50 years or older, prescribing clinicians, male	Concerns about fast-tracking regulatory procedures (21.9%) and a lack of transparency and/or publicly available information on newly developed vaccines (19.7%)

CDC, Centers for Disease Control and Prevention; FDA, Food and Drug Administration; HCWs, healthcare workers.

a predictor of vaccination willingness. Those HCWs having a higher risk of COVID-19 infection such as involvement in isolation rooms,¹² encountering suspected or confirmed COVID-19 patients,¹³ providing direct patient care,²² caring for COVID-19 patients²² and working clinically²⁴ had higher intention to be vaccinated against COVID-19. However, several studies had

counterintuitive results.^{20 22–24} Direct care providers (54%) and COVID-19 patient care providers (52%) had lower vaccine acceptance than non-direct care providers (62.4%) and providers without caring for COVID-19 patients (60.6%), respectively.²⁰ In the second study,²³ 45.4% of HCWs with direct patient care intended to be vaccinated, while HCWs without direct patient

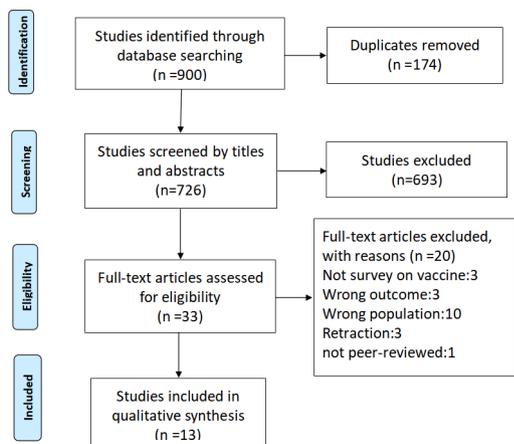


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

care had slightly higher vaccine acceptance (47.9%). In addition, HCWs providing direct patient care (23%) had higher rates of vaccine refusal than that of non-direct patient care (16.6%). Kociolek *et al*²⁴ found that HCWs with high-risk medical conditions and have confirmed or suspected history of COVID-19 had more vaccine hesitancy. In another study,²² HCWs (including direct medical provider (DMP) and direct patient care provider (DPCP)) involved in direct patient care had higher vaccine acceptance in general. In the study subgroup, DPCP (eg, nurse, paramedic and rehabilitation therapists) had the lowest acceptance towards vaccine (27%) compared with other HCWs. Kwok *et al*¹² found that more confidence, less complacency and more collective responsibility (5C psychological antecedents) were associated with stronger COVID-19 vaccination intention, and greater work stress was a mediator between COVID-19-related demands and vaccination intention. One study²² found that increasing education and income levels of HCWs made a higher proportion willing to take the vaccine. Contextual factors play an important role in shaping HCW vaccination intention, such as fast speed of vaccine development, novel and unfolding science of SARS-CoV-2 and political environment.²⁶ Qualitative analysis of one study²⁰ found that HCWs' vaccination decision was influenced by medical literature research, family, experts, employers and the government but mainly by themselves. Manning *et al*²³ found that the reasons for willingness to be vaccinated were to protect their families, self, patients and the community.

Reasons for vaccine hesitancy

Nine studies mentioned that the most common concern for vaccination among HCWs was vaccine safety, which was also the most important drivers for vaccine hesitancy. Concerns for safety mainly included potential side effects, especially long-term side effects. The rapid development and Emergency Use Authorisation of COVID-19 vaccines had caused concerns and distrust^{16 20 22–24 26}; 40.88% believed that the safety of vaccines developed in an emergency could not be guaranteed.¹⁹ Meanwhile, there were also concerns about efficacy and effectiveness of COVID-19 vaccine.^{13 16 20–22} Moreover, of those who did not accept and were undecided, 76.4% expressed doubt about the efficacy, effectiveness or safety of the vaccine.¹³ Some HCWs distrusted the governments and regulatory authorities, while they were concerned about whether fast-tracking regulatory procedures could ensure the safety of vaccines.^{16 19 22 24 26} With lack of knowledge and information about the vaccine, HCWs

were reluctant to get vaccinated as soon as available.²⁶ They would prefer to wait for reviewing more data, see how the vaccine affects others and desire for more information about safety and effectiveness of vaccines.^{16 20 22 23 26} Distrusting the information provided by public health experts was also one reason for vaccine hesitancy among HCWs, while those willing to take the vaccine were inclined to trust public health experts.¹⁶ HCWs who hesitate to get vaccinated neither trusted the vaccine nor did they believe that vaccine would work. They trusted their own immune system and believed they can be protected from the disease.^{22 25}

DISCUSSION

This rapid systematic review was to examine attitudes of HCWs towards COVID-19 vaccination and related factors. The proportion of HCWs intending to be vaccinated against COVID-19 varies widely in different countries or different regions of the same country, which was influenced by many factors. We found that vaccine hesitancy in other vaccines was also prevalent among HCWs.^{27–29} Vaccine hesitancy is a barrier to COVID-19 vaccination,^{30 31} listed as one of the top ten threats to global health by the WHO.¹¹ The attitude of HCWs towards COVID-19 vaccine would affect the public's vaccination decision. Recommendations from HCWs are a facilitator for the public to get vaccinated.^{6 32 33} HCWs' attitudes towards vaccines could influence whether they recommend the vaccine to friends, families and their patients.^{22 34–36} Since HCW vaccination coverage rate was suboptimal in other vaccines, some countries have implemented mandatory vaccination policies among HCWs towards vaccine-preventable diseases.³⁷ The USA had widely adopted a mandatory influenza vaccination programme for HCWs in healthcare facilities with excellent results (uptake rate of >90%).³⁸ In this review, several studies found that people willing take the vaccine were more likely to agree with mandatory vaccination.^{16 20 22} However, many people were opposed to mandatory vaccination and still advocated voluntary vaccination.²³ Furthermore, considering the high concerns and anxiety caused by the rapid development of the COVID-19 vaccine, the mandatory vaccination method may not be appropriate.

The influence of demographic characteristics

We found that several demographic characteristics were associated with a higher willingness to vaccinate. Compared with women, men were more likely to be vaccinated, as also evident in the general public.^{30 39 40} Inclination for risk taking, an increased risk perception and being prone to practice pharmaceutical measures are likely to link with more reception in men.^{18 41 42} Conversely, women are more willing to adopt non-pharmaceutical behaviours (eg, masking, sanitation and hand washing).^{41 43} Women are usually caregivers in families, and they tend to seek more health-related information to make smarter healthcare decisions for their family members.²⁰ One study found that having a child was the strongest negative predictor for getting vaccinated against COVID-19.³⁰ Besides, HCWs were more cautious than the general population about whether they vaccinated their children, and they were less willing to have their children vaccinated.³⁰ It is not surprising that older age had higher vaccine acceptance. This finding can be explained by the increased risk of infection associated with age. Age is a known risk factor for COVID-19. Comorbidity is common in older adults, which puts them at greater risk of COVID-19 infection. Older people were also associated with higher rates of COVID-19 incidence and mortality compared with younger

people.⁴⁴ Therefore, older HCWs are more willing to be vaccinated against COVID-19 because of more consideration of health benefits and risks. HCWs with chronic illness had higher vaccination intention because comorbidity has association with severity and poor prognosis of COVID-19, which can increase the risk of death.^{13 22 45 46}

The influence of occupational role

Compared with other HCWs, physicians have stronger willingness to receive COVID-19 vaccines. Several global studies on influenza vaccines for HCWs also had the same findings that physicians among HCWs had higher vaccination coverage.^{47–49} One study pointed out that physicians generally had a positive attitude towards vaccines and were more likely to receive influenza vaccine, so the coverage rate of vaccination among them was higher.⁵⁰ Besides, physicians had more confidence in vaccines than nurses, and they usually had higher degree of medical training, which contributed to increase uptake of vaccines.^{51 52} Nurses usually have more direct and longer contact with patients,⁵³ but it is concerning that they are less likely to be vaccinated than doctors.^{20 21} There may be some reasons for this phenomenon such as misunderstanding of vaccines, nurses being mainly women, lower risk perception than doctors and less fear of COVID-19. More research is needed to explore the reasons why other HCWs, including nurses, are less willing to receive the vaccine. Low willingness to be vaccinated among nurses may have a negative impact on vaccination adherence in other populations, especially their patients. Accordingly, educational information about vaccination mobilisation should be tailored to personal preferences and emphasise the risks of COVID-19 to individuals. Furthermore, more research could further explore the possible link between profession and vaccination willingness and behaviour.

The influence of influenza vaccination, self-perceived risk and trust

Influenza vaccination history and perceived risk were important facilitators for taking COVID-19 vaccine, which are consistent with other studies on vaccines.^{30 32 54 55} Distrusting the government could lead to vaccine hesitancy.⁵⁶ Previous influenza vaccination behaviour was a strong predictor of intention to accept COVID-19 vaccine. The likelihood of influenza vaccination was correlated with the likelihood of COVID-19 vaccination, suggesting a possible correlation between vaccination intention and behaviour among different vaccines.^{13 19 22 25} This also may indicate that taking the vaccine could be a habit of an individual and vaccination habit may affect the vaccination intention and behaviour with other vaccines.^{13 57} HCWs were more inclined to be vaccinated when they perceived themselves to be at risk of infection with COVID-19.²² One study found that HCWs in COVID-19 sectors had less hesitancy about receiving COVID-19 vaccine than those in non-COVID-19 sectors.³⁰ This also demonstrates that perceived risk affects HCWs' vaccination decisions. When there was less concern about infection risk of severe COVID-19, they showed refusal or delayed vaccination.²⁴ Vaccine acceptance may be promoted by the perceived susceptibility and seriousness of infectious disease,⁵⁸ and this association was also found in the general public.⁵ Moreover, the COVID-19 pandemic has also contributed to influenza vaccination.¹³ This may be explained by the increase of self-perceived risk during the pandemic. However, several studies found that DPCPs had lower vaccine acceptance than others without direct patients caring.^{20 22 23} These counterintuitive results need more research to explore the complex vaccination decision behaviours. Previous research has shown that distrusting the government was associated with vaccine refusal.^{59 60} Vaccine hesitancy might be related to public confidence in governments since

vaccination is a government-led public health intervention.⁵⁶ Of note, HCWs who reported poor trust in the government were less likely to be vaccinated.^{22 61} Hence, it is essential to enhance the credibility of the government in the vaccination campaign. Supervising the development, approval and use of vaccines and ensuring the transparency of vaccine information may help the government gain public trust.

The influence of confidence and education

Concerns about the safety, efficacy and effectiveness of vaccines were the main reasons for vaccine hesitancy, and same concerns had been reported in other studies.^{62–64} The rapidity of development/approval has raised HCWs frequent concerns about vaccine safety and efficacy.^{16 20 22–24 26} Knowledge and perception of HCWs about benefits and risk of vaccines can predict their vaccination decision behaviour and influence whether they recommend vaccines to patients or not.⁵¹ In line with other studies, people with more vaccine confidence had more likelihood to accept a vaccine.^{60 65} Studies found that HCWs' confidence in the safety and benefit of vaccines was related to their educational level.^{22 51 66} Medical training that HCWs have received is associated with vaccine confidence, which may contribute to higher vaccine uptake. Meanwhile, this review found that insufficient knowledge about such new vaccines increased apprehension of taking vaccinated; hence, they need more safety data before being vaccinated.^{16 20 22 23 26} In addition, the HCWs of Congo had the lowest willingness to get vaccinated (27.7%). One reason may be that rumours of COVID-19 vaccine information conveyed by mass media made HCWs lack confidence in the vaccine.⁶⁷ Another reason may be related to the fact that they had less opportunity (41.9%) to attend COVID-19 lectures and discussions. This suggests that we may need to provide HCWs with more vaccine-related training and education to increase their confidence in vaccines. Compared with the general public, HCWs have a higher educational level, so they are more likely to make vaccination decisions based on published scientific literature of vaccine safety and efficacy.²² This also shows that disseminating scientific data regarding vaccine safety and efficacy to HCWs will be crucial. Therefore, tailored communication strategies were needed to disseminate more safety data to increase HCWs' confidence in COVID-19 vaccine, which will contribute to enhance the uptake of the vaccine among HCWs.

Limitation and future directions

This review may have several limitations. Due to the rapid review and publication in this field, the literature we retrieved may not include the latest studies of HCWs' vaccination attitudes. We did not search the grey literature. Studies were conducted primarily in the USA and may not be exhaustive. All included studies were cross-sectional studies, which are descriptive studies, so causal inferences cannot be obtained. The surveys were mainly conducted through online recruitment, and the response rates were generally low. In addition, participants were voluntary, which may introduce potential selection bias. Vaccine acceptance was collected by self-reporting, so it is possible to have reporting bias especially social desirability bias. Due to selection bias and social desirability bias, participants may be more interested in vaccination or may report results based on social expectations rather than their actual thoughts; thus, this may lead to an overestimation of reported COVID-19 vaccine acceptance. Vaccination intention is not an actual vaccination behaviour, and vaccination decision is influenced by many factors. Intention can predict behaviour, but there is still a gap between intention and behaviour,⁶⁸ so it may not directly predict actual vaccination behaviour in the future. Further studies, such as retrospective

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studies, can be carried out to analyse the differences between actual vaccination behaviour and prevaccination intention. Cross-sectional studies were limited to a single point in time or period during the COVID-19 pandemic, and people's willingness and attitudes to be vaccinated may change over time influenced by the morbidity and mortality of the pandemic and more available safety data of vaccines. Finally, included studies used

different analytical methods, such as univariate and/or multivariate analyses, which may affect the interpretation of the results.

Main messages

- ▶ This review indicates that vaccine hesitancy is in prevalence among HCWs.
- ▶ The acceptance of COVID-19 vaccines among HCWs varied widely in different countries.
- ▶ We suggest tailored communication strategies towards HCWs rather than mandatory vaccination.

Current research questions

- ▶ Why is vaccine hesitancy towards COVID-19 so common among HCWs?
- ▶ What factors would influence the attitudes of COVID-19 vaccination among HCWs?
- ▶ What are the reasons for refusal of taking the COVID-19 vaccine among HCWs?

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Self-assessment questions

- ▶ Previous influenza vaccination was a facilitator of taking the COVID-19 vaccine. True/false
- ▶ Physicians were more inclined to get vaccinated compared with nurses. True/false
- ▶ Women had more willingness of receiving the COVID-19 vaccine compared with men. True/false
- ▶ Direct patient care was a positive factor to get vaccinated against COVID-19. True/false
- ▶ This rapid systematic review conducted a way of qualitative synthesis to synthesise evidence. True/false

CONCLUSIONS

This review examined HCWs' attitudes towards COVID-19 vaccination and related factors to inform vaccine policies and practices. Receptivity of vaccine had demographic and regional differences in these studies. Men, older age, physicians, previous influenza vaccination and self-perceived risk were positive predictive factors. Concerns for safety, efficacy and effectiveness and distrust of the government were barriers. There were different conclusions about the influences of caring for patients on vaccination intention, and more studies are needed to explore this in greater depth. Like the public, HCWs had vaccine hesitancy in face of a new vaccine. Given the critical role of HCWs in vaccination, it is urgent to eliminate vaccine hesitancy among HCWs. Developing vaccination campaign strategies should be based on the social, political and economic context of the country. Meanwhile, monitoring the HCWs' response during vaccination and ongoing adjustment of vaccination interventions based on HCWs' response should be considered.

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Answers

1. True; 2. True; 3. False; 4. False; 5. True

Appendix A – Search Strings

Pubmed: 170

#1 (865,726)

("healthcare"[All Fields] OR "health-care"[All Fields] OR "health-care"[All Fields] OR "health"[All Fields] OR "medical"[All Fields]) AND ("worker"[All Fields] OR "workers"[All Fields] OR "professional"[All Fields] OR "professionals"[All Fields] OR "personnel"[All Fields] OR "staff"[All Fields] OR "providers"[All Fields])

#2 (1,496,812)

"clinician"[All Fields] OR "clinicians"[All Fields] OR "paediatrician"[All Fields] OR "paediatricians"[All Fields] OR "pediatrician"[All Fields] OR "pediatricians"[All Fields] OR "doctor"[All Fields] OR "doctors"[All Fields] OR "physician"[All Fields] OR "physicians"[All Fields] OR "nurse"[All Fields] OR "nurses"[All Fields] OR "dentist"[All Fields] OR "dentists"[All Fields] OR "pharmacist"[All Fields] OR "pharmacists"[All Fields] OR "midwife"[All Fields] OR "midwives"[All Fields] OR "practitioner"[All Fields] OR "practitioners"[All Fields]

#3 (227,558)

("student"[All Fields] OR "students"[All Fields]) AND ("medical"[All Fields] OR "med"[All Fields] OR "dental"[All Fields] OR "nurse"[All Fields] OR "nursing"[All Fields] OR "midwifery"[All Fields] OR "physical therapy"[All Fields] OR "healthcare"[All Fields] OR "health-care"[All Fields] OR "health-care"[All Fields])

#4 (587,805)

"health personnel"[MeSH Terms] OR "students, medical"[MeSH Terms] OR "students, health occupations"[MeSH Terms]

#5 (2,289,474)

#1 OR #2 OR #3 OR #4

#6 (117,462)

"covid 19"[MeSH Terms] OR "SARS-CoV-2"[MeSH Terms] OR "coronavirus"[MeSH Terms] OR "coronavirus"[All Fields] OR "coronaviruses"[All Fields] OR "covid 19"[All Fields] OR "2019-ncov"[All Fields] OR "ncov"[All Fields] OR "SARS-CoV-2"[All Fields] OR "SARS-2"[All Fields] OR "severe acute respiratory syndrome coronavirus 2"[All Fields] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]

#7 (404,115)

"vaccines"[MeSH Terms] OR "vaccination"[MeSH Terms] OR "vaccination"[All Fields] OR "vaccinable"[All Fields] OR "vaccinal"[All Fields] OR "vaccinate"[All Fields] OR "vaccinated"[All Fields] OR "vaccinates"[All Fields] OR "vaccinating"[All Fields] OR "vaccinations"[All Fields] OR "vaccination's"[All Fields] OR "vaccinator"[All Fields] OR "vaccinators"[All Fields] OR "vaccines"[All Fields] OR "vaccined"[All Fields] OR "vaccines"[All Fields] OR "vaccine"[All Fields] OR "vaccins"[All Fields] OR "vaccin"[All Fields]

#8 (9,781)

#6 AND #7

#9(1,748,462)

"surveys and questionnaires"[MeSH Terms] OR "survey"[All Fields] OR "surveys"[All Fields] OR "survey's"[All Fields] OR "surveyed"[All Fields] OR "surveying"[All Fields] OR ("surveys"[All Fields] AND "questionnaires"[All Fields]) OR "surveys and questionnaires"[All Fields] OR

("questionnaire"[All Fields] OR "questionnaire's"[All Fields] OR "surveys and questionnaires"[MeSH Terms] OR ("surveys"[All Fields] AND "questionnaires"[All Fields]) OR "surveys and questionnaires"[All Fields] OR "questionnaire"[All Fields] OR "questionnaires"[All Fields] OR "poll"[All Fields])

#10 (170)

#5 AND #8 AND #9

Embase: 113

#1 (636,118)

(healthcare:ti,ab,kw OR 'health care':ti,ab,kw OR health:ti,ab,kw OR medical:ti,ab,kw) AND (worker:ti,ab,kw OR workers:ti,ab,kw OR professional:ti,ab,kw OR professionals:ti,ab,kw OR personnel:ti,ab,kw OR staff:ti,ab,kw OR providers:ti,ab,kw)

#2 (1,554,966)

clinician:ti,ab,kw OR clinicians:ti,ab,kw OR paediatrician:ti,ab,kw OR paediatricians:ti,ab,kw OR pediatrician:ti,ab,kw OR pediatricians:ti,ab,kw OR doctor:ti,ab,kw OR doctors:ti,ab,kw OR physician:ti,ab,kw OR physicians:ti,ab,kw OR nurse:ti,ab,kw OR nurses:ti,ab,kw OR dentist:ti,ab,kw OR dentists:ti,ab,kw OR pharmacist:ti,ab,kw OR pharmacists:ti,ab,kw OR midwife:ti,ab,kw OR midwives:ti,ab,kw OR practitioner:ti,ab,kw OR practitioners:ti,ab,kw

#3 (152,932)

(student:ti,ab,kw OR students:ti,ab,kw) AND (medical:ti,ab,kw OR med:ti,ab,kw OR dental:ti,ab,kw OR nurse:ti,ab,kw OR nursing:ti,ab,kw OR midwifery:ti,ab,kw OR 'physical therapy':ti,ab,kw OR healthcare:ti,ab,kw OR 'health care':ti,ab,kw)

#4 (1,660,366)

'health care personnel'/exp OR 'medical student'/exp

#5 (2,865,041)

#1 OR #2 OR #3 OR #4

#6 (126,333)

coronaviruses OR 'covid 19'/exp OR 'covid 19' OR (('covid'/exp OR covid) AND 19) OR 'sars 2' OR 'severe acute respiratory syndrome coronavirus 2'/exp OR 'severe acute respiratory syndrome coronavirus 2' OR (severe AND acute AND respiratory AND ('syndrome'/exp OR syndrome) AND ('coronavirus'/exp OR coronavirus) AND 2) OR '2019 ncov'/exp OR '2019 ncov' OR 'sars cov 2'/exp OR 'sars cov 2' OR (('sars'/exp OR sars) AND cov AND 2) OR 'coronavirus'/exp OR coronavirus OR cov

#7 (534,997)

'vaccine'/exp OR vaccine OR 'vaccines'/exp OR vaccines OR 'vaccin'/exp OR vaccin OR vaccins OR 'vaccination'/exp OR vaccination OR vaccinations OR vaccinator OR vaccinators OR vaccinable OR vaccinal OR vaccinate OR vaccinated OR vaccinates OR vaccinated

#8 (10,966)

#6 AND #7

#9 (1,070,302)

survey:ti,ab,kw OR surveyed:ti,ab,kw OR surveying:ti,ab,kw OR surveys:ti,ab,kw OR questionnaire:ti,ab,kw OR questionnaires:ti,ab,kw OR (surveys:ti,ab,kw AND questionnaires:ti,ab,kw) OR poll:ti,ab,kw OR polls:ti,ab,kw

#10 (113)

#5 AND #8 AND #9

Web of science: 166

#1 (1,052,978)

(('healthcare' OR 'health AND care' OR 'health-care' OR 'health' OR 'medical') AND ('worker' OR 'workers' OR 'professional' OR 'professionals' OR 'personnel' OR 'staff' OR 'providers'))

#2 (2,029,931)

'clinician' OR 'clinicians' OR 'paediatrician' OR 'paediatricians' OR 'pediatrician' OR 'pediatricians' OR 'doctor' OR 'doctors' OR 'physician' OR 'physicians' OR 'nurse' OR 'nurses' OR 'dentist' OR 'dentists' OR 'pharmacist' OR 'pharmacists' OR 'midwife' OR 'midwives' OR 'practitioner' OR 'practitioners'

#3 (252,195)

(('student' OR 'students') AND ('medical' OR 'med' OR 'dental' OR 'nurse' OR 'nursing' OR 'midwifery' OR 'physical AND therapy' OR 'healthcare' OR 'health-care' OR 'health AND care'))

#4 (2,797,217)

#1 OR #2 OR #3

#5 (11,229)

('2019-ncov' OR 'covid 19' OR 'sars cov 2' OR 'Coronavirus' OR 'coronaviruses' OR 'SARS-2' OR 'severe acute respiratory syndrome coronavirus 2' OR 'cov') AND ('vaccination' OR 'vaccin' OR 'vaccinable' OR 'vaccinal' OR 'vaccinate' OR 'vaccinated' OR 'vaccinates' OR 'vaccinating' OR 'vaccinations' OR 'vaccination's' OR 'vaccinator' OR 'vaccinators' OR 'vaccines' OR 'vaccined' OR 'vaccine' OR 'vaccins')

#6 (18,056)

(Vaccine OR Vaccination OR Vaccinations) AND (hesitancy OR intention OR attitude OR attitudes OR acceptability OR acceptance OR willingness OR readiness)

#7 (166)

#4 AND #5 AND 6

ScienceDirect: 388

("Healthcare worker" OR "Healthcare personnel" OR clinician OR physician OR nurse OR "medical students") AND COVID-19 AND (Vaccination) AND survey

CNKI: 6

(Title/Keywords/Abstract: 2019-ncov OR COVID-19) AND (Title/Keywords/Abstract: vaccine) AND (Title/Keywords/Abstract: willingness OR intention OR attitude)

VIP: 7

All Fields=(2019-ncov OR COVID-19) AND All Fields=(vaccine OR vaccination) AND All Fields=(survey OR attitude OR willingness OR acceptance)

Wanfang Data: 50

Subject:(2019-ncov OR COVID-19 OR SARS-CoV-2) AND Subject: (vaccine OR vaccination) AND Subject: (survey OR attitude OR willingness OR acceptance)

Appendix B. Quality of Cross-sectional studies (JBI Checklist for Prevalence Studies)

Study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size adequate?	Were the study subjects and the setting described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?
Kwok et al. ¹²	+	-	+	+	+	+	+	+	?
Wang et al. ¹³	+	-	+	+	+	+	+	+	+
Lucia et al. ¹⁶	+	-	-	+	?	+	+	+	-
Gagneux-Brunon et al. ¹⁷	+	-	+	+	+	+	+	+	?
Kabamba et al. ¹⁸	+	-	+	+	+	+	+	+	?
Verger et al. ¹⁹	+	-	+	+	+	+	+	+	-
Shaw et al. ²⁰	+	-	+	+	+	+	+	+	+
Unroe et al. ²¹	+	-	+	+	+	+	+	+	+
Shekhar et al. ²²	+	-	+	+	+	+	+	+	?
Manning et al. ²³	+	-	+	+	+	+	+	+	-
Kociolekr et al. ²⁴	+	-	+	+	+	+	+	+	-
Kose et al. ²⁵	+	-	+	+	+	+	+	+	?
Gadoth et al. ²⁶	+	-	+	+	+	+	+	+	-