Cultural and social attitudes towards COVID-19 vaccination and factors associated with vaccine acceptance in adults across the globe

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Cultural and social attitudes towards COVID-19 vaccination and factors associated with vaccine acceptance in adults across the globe: A systematic review☆

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ABSTRACT

Objectives: To identify and synthesise evidence on cultural and social attitudes towards coronavirus disease 2019 (COVID-19) vaccination and factors associated with vaccine acceptance in the adult population.
Design: Systematic review.
Data sources: Six electronic databases were searched (CINAHL, Coronavirus Research Database, Embase, MEDLINE, Nursing and Allied Health Database, and Web of Science Core Collection). Additional studies were identified through Google Scholar and hand searching the reference lists of all studies included in the review.
Method: The searches were conducted to identify all relevant studies published in English, from December 2019 to December 2021. The Critical Appraisal Skills Programme (CASP) and Appraisal tool for Cross-Sectional Studies (AXIS tool) were used to critically appraise the quality of included studies. Data were extracted and synthesised narratively.
Results: 1260 records were identified, of which 38 studies were included in the review. Low COVID-19 vaccination acceptance rates were found among young people, females, non-medical students, and even some healthcare workers, which were associated with misinformation obtained through social media platforms, unknown side effects, questionable conspiracy theories, and doubts about efficacy and safety. Higher COVID-19 vaccination acceptance rates were due to recommendations from healthcare professionals and government sources, and the perceived increased risk of contracting COVID-19.
Conclusion: COVID-19 vaccine acceptance varies across the globe. To increase the acceptance rate of the COVID-19 vaccine, public health education programmes should be promoted effectively and target specifically the groups who are most hesitant to receive the vaccine such as young people, females, and non-medical students. Vaccine hesitancy among healthcare workers can affect vaccination rates as the majority of the population views them as a trustworthy source for vaccine-related knowledge. Staff training is important to enhance their confidence and communication skills in providing information about COVID-19 vaccination to combat the misunderstanding of the public and encourage vaccine uptake.
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1. Introduction

The outbreak of the coronavirus disease 2019 (COVID-19) emerged in December 2019 in Wuhan, China [1] and was declared a pandemic on 11th March 2020 by the World Health Organization (WHO). [2] COVID-19 is a new strain of coronavirus caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). [3] It is an infectious disease and most people infected with the COVID-19 virus experience mild to moderate respiratory illness. Older people and those with underlying medical conditions such as cardiovascular disease, diabetes, chronic

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respiratory disease, or cancer are more likely to develop serious illnesses. [4] A total of 703,472,179 confirmed COVID-19 cases and 6,984,550 deaths have been reported as of 19th February 2024 across the globe [5].

Immediate preventative measures were initiated worldwide to help control the spread of the virus, including frequent handwashing, social distancing, face masks, school and workplace closures, and national lockdowns. [6] However, a systematic review suggested that such preventative measures could help to reduce the spread but more than 75% of asymptomatic cases could be missed. [7] School closures in China, Hong Kong, and Singapore were found to be an ineffective measure to contribute towards controlling the spread of COVID-19. [8] Mental health issues, including anxiety and depression, became more common among people who experienced lockdown and isolation. [9] Furthermore, the pandemic led to a significant fall in the workforce, with both unemployment and economic inactivity rising worldwide [10].

As another form of precautionary measure, the COVID-19 vaccines were developed as they contain the antigens that provoke an immune response by the vaccinated. [11] Several vaccines were authorised for emergency use in late December 2020 and first administered in the United Kingdom (UK) in January 2021. [12] Although vaccination against COVID-19 is important to reduce the impact on communities, the speed at which the COVID-19 vaccines were developed and approved has raised some concerns about the vaccine's safety. [13] It was expected that herd immunity would help contain the virus's spread. However, the virus evolved through mutations, leading to the emergence of prominent variants with varying transmission rates including the Alpha, Beta, Delta, and Omicron. [14] Observed reinfections and breakthrough infections among vaccinated individuals prompted concerns regarding the effectiveness of different vaccines [15].

Between 14th December 2020 and 13th March 2021, Pfizer-BioNTech (BNT162b2) and Moderna (Mrna-1273) vaccines demonstrated 90% effectiveness on preventing COVID-19 among fully vaccinated individuals and up to 80% effectiveness among partially vaccinated individuals across eight locations in the United States (US). [16] Additionally, in a retrospective cohort study, BNT162b2 vaccine effectiveness against SARS-CoV-2 infections was 73% for fully vaccinated individuals. [17] The significant impact of the vaccination campaign was found to avert a large number of deaths in the US, and reports of reinfection in the US have been relatively rare [14].

However, there was a decline in vaccine efficacy over time. [17] Breakthrough infections of COVID-19 have been documented despite widespread vaccination efforts. Cases have occurred with various vaccines, indicating that while vaccination reduces severe illness, it doesn't guarantee immunity. Studies from different countries, including Germany [18], Italy [19], the US [20], Israel [21], and Qatar [22] have reported instances of breakthrough infections among vaccinated individuals. This confirms that vaccines do not offer 100% protection and emphasises the importance of ongoing monitoring and further research to understand vaccine effectiveness over time and the need for booster shots.

Among previous work that investigated the COVID-19 vaccine acceptance rate [23–25], a systematic review reported that the highest COVID-19 vaccine acceptance rate was found in Ecuador (97.0%), Malaysia (94.3%), Indonesia (93.3%), and China (91.3%), whereas the lowest acceptance rate was found in Kuwait (23.6%), Jordan (28.4%), Italy (53.7%), Russia (54.9%), Poland (56.3%), US (56.9%), and France (58.9%). [25] The vaccine acceptance rate differs across the globe, and it may be associated with the availability of the vaccines in different countries, individuals' perceived vulnerability to COVID-19, perceived safety of the vaccines, the severity of COVID-19 as well as a variety of sociodemographic factors including age, gender, education, income, and occupation [24–26].

Vaccine hesitancy has been described as one of the top ten global health threats in 2019 by WHO. [27] Concerns about any vaccine's safety may jeopardise vaccination programmes since the effectiveness of vaccine programmes depends on the number of people willing to be vaccinated. [28] People with legitimate concerns about vaccination should not be dismissed as "anti-vaxxers" but their voices need to be heard and responded to respectfully. [29] Previous studies have focused on attitudes towards the COVID-19 vaccines [23,30], however, no systematic review exists in this area. Therefore, our primary aim was to conduct a systematic review to collate information about individuals' cultural and social attitudes towards COVID-19 vaccination and generate robust evidence towards solutions to key global health challenges – increasing the uptake of COVID-19 vaccines. In addition, this systematic review aimed to explore the associated factors influencing COVID-19 vaccine uptake, which could inform the development and delivery of interventional measures to build and maintain responses to address this public health threat.

2. Methods

This systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and statement [31] and Joanna Briggs Institute (JBI) Manual for Evidence Synthesis. [32] A protocol for this review was registered in the International Prospective Register of Systematic Reviews (PROSPERO registration number: CRD42021248016).

2.1. Search strategy

The SPIDER framework (sample, phenomenon of interest, design, evaluation, and research type) was adopted to inform the search strategy (Table 1) [33].

The search terms were identified based on a consultation with an Information Specialist and formed from a combination of keywords and Medical Subject Heading (MeSH) terms shown in three categories (Table 2). [34] The search terms were combined using the Boolean operators 'OR' and 'AND' for a comprehensive search. Firstly, 'OR' was used to combine all the search terms in each category separately, and then 'AND' was applied to combine the search terms across the three categories.

To maximise the search result, wildcard characters including an asterisk (*) were added to the end of the search terms to search variable endings of a word, as well as a truncation symbol ($) within one search term to ensure the inclusion of spellings that differ between British and American English.

2.2. Data sources

Six electronic databases were searched including CINAHL, Coronavirus Research Database, Embase, MEDLINE, Nursing and Allied Health Database, and Web of Science Core Collection. Additional studies were identified through Google Scholar and hand searching the reference lists of all studies included in the review. The initial searches were limited to studies published in English, from December 2019 when the first case of coronavirus was discovered to February 2021. A further search in Google Scholar was undertaken to identify all relevant papers published from February to December 2021.

2.3. Eligibility criteria

Any primary research with quantitative, qualitative, or mixed methods study design investigating the attitudes towards COVID-19 vaccination and associated factors in the adult population (16 years old and above, not limited to gender, race, and religion) were included. Studies with different focuses such as attitudes towards preventative measures (e.g., social distancing, face masks, and isolation), or attitudes towards the vaccines of other diseases were excluded. Any reviews, commentary/opinion papers, editorials, and grey literature including third sector and government reports and briefings, educational theses,

Table 1
SPIDER framework.

Sample	Phenomenon of Interest	Design	Evaluation	Research type
Adults (16 years old and above)	COVID-19 vaccination	Any study design (e.g., surveys, interviews, focus groups)	Cultural and social attitudes towards the vaccine and factors influencing vaccine uptake	Peer-reviewed studies including qualitative, quantitative, and mixed methods studies

Table 2
Search terms.

Category 1	Category 2	Category 3
Pandemic*	Vaccine*	Attitude* (MeSH)
Coronavirus*	Vaccination (MeSH)	Intention* (MeSH)
"Coronavirus infection" (MeSH)	Immunity* (MeSH)	Acceptance*
Covid-19*	"Viral vaccines" (MeSH)	Willingness*
2019-nCoV*	Immuni$ation	Perception* (MeSH)
SARS-cov-2*		Hesitancy*
		"Vaccination refusal" (MeSH)

and conference proceedings were excluded. In addition, studies not available in full texts were excluded as key information was not accessible.

2.4. Study selection

Once all the papers were accumulated from database searching and hand searching, duplicates were removed. Titles and abstracts were initially screened by two independent reviewers (PG and TB) to exclude irrelevant papers. Then the full texts of the remaining papers were retrieved and assessed against eligibility criteria. If there was any disagreement, a third reviewer (NE or CB) was consulted before a final decision was made. Reasons for exclusion at this stage were recorded.

2.5. Critical appraisal

The studies with cross-sectional survey design were critically appraised using the Appraisal tool for Cross-Sectional Studies (AXIS tool). This tool contains 20 components and was developed to address the issues that usually occur in cross-sectional studies (e.g., study design, quality, and risk of bias), allowing researchers to critically assess the quality of the cross-sectional studies to ensure findings are trustworthy in clinical decision-making [35].

The studies with qualitative design were critically appraised using the Critical Appraisal Skills Programme (CASP). It consists of 10 questions that allow researchers to address the issues and quality of qualitative studies in health care. [36] Two reviewers (TB and PG) independently reviewed and assessed the methodological quality of the included studies, increasing the credibility of this review. To reduce the risk of bias and subjectivity, a third reviewer (NE or CB) was involved if disagreement occurred. No studies were excluded based on their quality.

2.6. Data extraction and synthesis

Data were extracted by one reviewer (TB) using a predesigned data extraction table, including the study details (authors, year of publication, and country where the study was conducted), methods (design; aim/objectives; participant details including age and gender, setting and sample size; recruitment process; data collection and analysis methods), and main findings. Extracted data were checked for accuracy by another reviewer (PG). Disagreements were resolved by a third reviewer (NE or CB).

For this review, a narrative synthesis of the data was undertaken [37]. This process included the summary of similar outcomes and the development of narrative reports to synthesise key points. After reviewing the included papers and extracting their outcomes, overarching themes were identified. Similar and contrasting findings under these themes were explored and connections or relationships were formulated between the overarching themes [38].

2.7. Patient and public involvement

This is a review of published evidence; therefore, no patient and public were involved.

3. Results

From the initial database searches completed in February 2021, 1,153 papers were identified. Additionally, 107 papers were retrieved from Google Scholar and manual searching. All papers were then exported to Refworks 2.0 (reference management software package, produced by a ProQuest company) from which 241 duplicates and one non-English paper were removed. After screening titles and abstracts, 961 irrelevant papers were excluded and then full texts of the remaining 57 papers were retrieved and reviewed. Twentynine papers met the eligibility criteria and were included in the review. From a further search from February to December 2021 on Google Scholar, we were able to retrieve nine more papers that also met the eligibility criteria. Finally, a total of 38 papers were included in the review (Fig. 1).

3.1. Quality appraisal

Thirty-seven studies included in the review used a cross-sectional design to identify population characteristics and comprehend health determinants that influence COVID-19 vaccine uptake. These studies were critically appraised using the AXIS tool. One study [39] used a mixed-method design for which we used the AXIS to assess the quality of its quantitative component and CASP to assess its qualitative component. Sample sizes ranged from 168 in one school of the US [40] to 32,361 participants in the UK. [41] Among these 38 studies, 19 (50%) mentioned non-response bias; however, the characteristics of these non-participants were not described.

All the studies used non-probability sampling methods such as convenience, voluntary, snowball, and quota sampling to accumulate their participants. As the studies were conducted during the COVID-19 pandemic, all the studies included in this review were conducted through the Internet. One of the disadvantages would be that it may have increased selection bias, which could potentially affect how representative the sample was drawn from the population, for example, only people with access to a smartphone, tablet, computer, or laptop and those with an internet connection could participate in the studies.

A total of 27 studies mentioned that informed consent was obtained from their participants and the remaining studies did not explicitly state this. As data were collected through online surveys, the study objectives and procedures may not have been clearly explained to the participants which could have resulted in the misinterpretation of the questions and influenced the accuracy and quality of the data. In addition, 27 studies reported the validity and reliability of the questionnaires they used, of

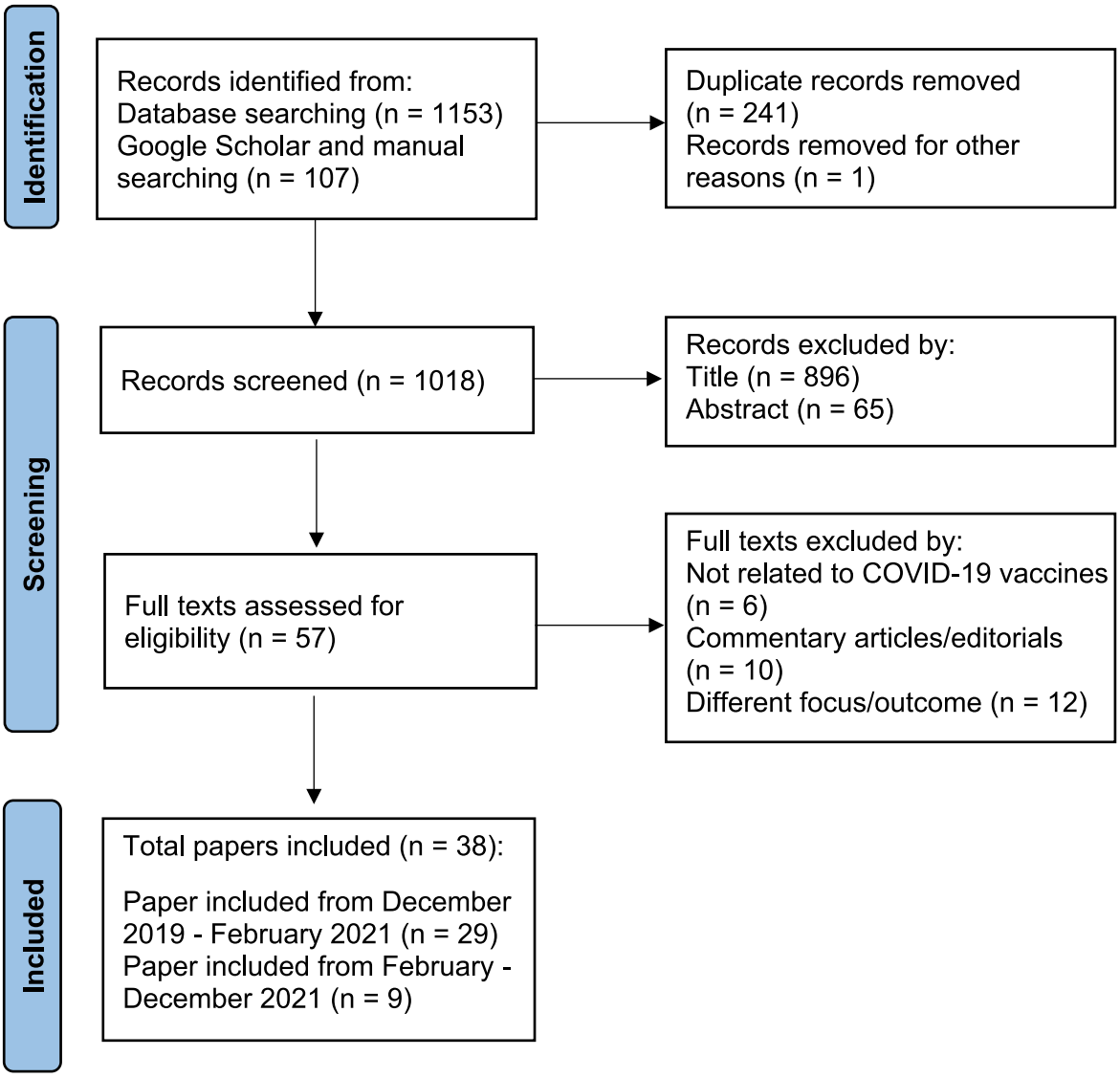

Fig. 1. PRISMA flow diagram.

which 10 studies developed and piloted new questionnaires and 17 studies used existing questionnaires to assess vaccine hesitancy, beliefs, knowledge, and concerns about the COVID-19 vaccine with or without further refinement. The remaining 11 studies lacked information about it.

Studies took place between March 2020 and January 2021, before the COVID-19 vaccine was available; thus, vaccine uptake was measured using a hypothetic vaccine. It is challenging to determine whether the factors identified to influence vaccine uptake of a hypothetic COVID-19 vaccine would be similar to the influencing factors after actual vaccines became available. [42] in addition, the nature of a cross-sectional study design meant that individual attitudes towards vaccination were only captured at one time point when vaccines were still under development and testing. As more evidence on the safety and effectiveness of COVID-19 vaccines became available, individuals might change their stance regarding vaccination, which was not evaluated in these studies. The remaining three studies took place from February to March 2021, when a vaccine was available. [43–45] However, Shibani et al.'s study was conducted in Syria before any vaccination programmes were launched for healthcare workers (HCWs). [44] In addition, Syria is a country experiencing major healthcare crises, that may limit the generalisability of the results to other countries or contexts [44].

3.2. Study characteristics

The studies included in this review were conducted across the globe, including the US (n = 7), UK (n = 4), China (n = 3), Egypt (n = 2), Italy (n = 2), Saudi Arabia (n = 2), Turkey (n = 2), and Australia, Congo, Germany, Indonesia, Japan, Jordan, Kuwait, Poland, Russia, South Africa, Syria (n = 1 in each country). In addition, five studies took place in multiple countries: Lazarus et al.'s study was conducted in 19 countries (Brazil, Canada, China, Ecuador, France, Germany, India, Italy, Mexico, Nigeria, Poland, Russia, Singapore, South Africa, South Korea, Spain, Sweden, US, and the UK) [24], Sallam et al.'s in three countries (Jordan, Kuwait, and Saudi Arabia) [46], Velikonja et al.'s in three countries (Poland, Serbia, and Slovenia) [45], Verger et al.'s in three countries (Belgium, Canada, and France) [47], and Murphy et al.'s in two countries (Ireland and UK) [48].

The participants in most studies were public (n = 23), followed by healthcare professionals (n = 9), medical and non-medical students (n = 5), and parents and guardians (n = 1). All the studies collected data on adults' willingness to vaccinate and attitudes and beliefs regarding the COVID-19 vaccine. Five-point Likert scales were commonly used in these studies where respondents specified their level of agreement on the likelihood of being vaccinated. Five studies used different tools such

as the vaccination hesitancy scale, vaccination knowledge scale, coronavirus conspiracy scale, vaccination attitude examination scale, and the standardised depression, anxiety, and stress scale. [41,46,49–51] Table 3 summarises the characteristics of these 38 studies reviewed.

3.3. Intent to uptake COVID-19 vaccination and associated factors

The acceptance rates of COVID-19 vaccination (Table 4) and factors influencing its uptake vary across the globe. The results are presented in three categories: (1) general adult populations, (2) healthcare workers, and (3) medical and non-medical students.

3.3.1. General adult population (n = 24 studies)

Out of the 24 studies conducted among the public, 16 studies reported an acceptance rate of above 60%. Most countries where the acceptance rate exceeded 80% among the adult population were in the Eastern, Southern, and South-Eastern parts of Asia (e.g., Indonesia 93.3% [52], China 91.3% [53]), along with South Africa 81.6% [24] and Australia 80%. [54] Most participants (ranging from 94.7% [49], 89.5% [53] to 83% [54]) viewed the vaccine as an effective preventive measure in controlling the spread of COVID-19. In addition, more than 70% of participants (ranging from 84% [54], 80.6% [53] to 70.1% [49]) were more willing to vaccinate upon healthcare professionals' recommendations as they were viewed as a trusted source of information. Adherence to government guidelines contributed towards a high acceptance rate as the government was also seen as a trusted source of information to protect the health of the community. [24,49,54] Some participants were unwilling to vaccinate until more information about the vaccine was released that would confirm the safety of the vaccine and clear doubts about side effects. [49,53]

Countries with an acceptance rate between 60% and 79% were mostly European countries (e.g., Italy 75.8% [55], UK 64% [56]). Some countries with a relatively high acceptance rate were in different regions of America (e.g., Ecuador 72% [24], Canada 68.7% [24], and US 67% [57]), along with countries in Asia, the Middle East, and Africa (e.g., Singapore 68% [24], Japan 65.7% [58], Nigeria 65.2% [24], and Saudi Arabia 64.7% [59]). In these studies, most participants (ranging from 86.4% [58], 81% [60], to 78.1% [61]) were willing to vaccinate as they viewed the vaccine as an effective preventive measure against COVID-19. However, 86% of participants in Murphy et al.'s and 74% in Pogue et al.'s study reported vaccine hesitancy due to the rapid development of the vaccine that led to doubts about the vaccine's efficacy and safety. [48,61] 73–75% participants were willing to vaccinate as they had a higher confidence in healthcare professionals' recommendations [57,60], whereas 32% participants in Freeman et al.'s study held negative views of healthcare professionals' advice and 21% participants in Malik et al.'s study viewed social media platforms as a reliable source of information.[50,57] Most participants were willing to vaccinate as they were chronically ill [58], and people concerned about the side effects of COVID-19 were 2.13 times more likely to vaccinate than those who were not. [59] On the other hand, less than 1% of participants believed the vaccine was a way of tracking individuals through microchips. [61] However, about 32% of participants also believed in similar conspiracy theories that led to paranoia around the vaccine resulting in vaccine hesitancy. [48,50]

The eight studies conducted among the general adult population had an acceptance rate of below 60%. The majority of these studies were conducted in the Middle East (e.g., Kuwait 53.1% [62], Turkey 49.7% [63], Saudi Arabia 44.7% [64], Jordan 37.4% [65], Syria 37% [44]), along with two countries in Europe including France 58.9% and Poland 56.3% [24] and Russia 54.9% in Lazarus et al.'s study and Russia 41.7% in Trans et al.'s study. [24,66] Among these studies, some participants (27.6–66.5%) believed that the vaccine would help control the spread of COVID-19, reduce its complications, and provide long-term immunity against COVID-19. [65,66] The percentage of participants who would vaccinate upon healthcare professionals' recommendations ranged from 36.4% to 50.9% [44,46], which is much less compared to the countries mentioned above who had higher levels of trust in them. Around 27.7% – 62.4% of participants were reluctant to vaccinate due to unknown side effects. [44,62,63,65,66] They doubted the safety and efficacy of the vaccine and would only accept the vaccine if more studies confirmed the vaccine safety. [62–64,66] 46% of participants believed the vaccine was developed too fast, hence 58.8% do not trust the vaccine's formula. [44] Majority of the studies reported participants having a higher belief in conspiracy theories. They believed the vaccine itself could cause COVID-19 (7.2%) and infertility (23.5%) [63], be a method of implanting microchips into the body to track individuals (27.7%) [46], and a way for manufacturing companies to make money (36.8%) [44].

Nine studies among the general adult population identified participants over 45 years old were more willing to vaccinate with an acceptance rate between 45% – 95%. [24,48,50,52,54,56–59] Older people were more willing to vaccinate as they perceive themselves as vulnerable individuals who are more at risk of contracting COVID-19 as compared to younger individuals. This leads to older-aged groups wanting to vaccinate as they fear their immune system would not be able to protect them from COVID-19 as effectively as a vaccine would. [59,67] Evidence revealed those who were younger were more hesitant to receive the vaccine as they were concerned about the unknown side effects related to a new vaccine and the spread of false information across social media platforms. [58,68] However, four studies identified an acceptance rate between 70%-95% among younger individuals as they were concerned about the safety of their family members and fear of infecting elderly relatives who are at a higher risk of contracting COVID-19 as well as their health deterioration [48,51,62,69].

Fifteen studies identified females were more hesitant to receive the COVID-19 vaccine and males had a higher acceptance rate between 35.3% and 74.8%. [41,46,48,50,57–59,62,63,65,67–71] Males were also observed to be more likely to rely on healthcare professionals as opposed to females who gained their knowledge from social media platforms which may have influenced their intention to vaccinate and belief in conspiracy theories [46]. However, females may also be hesitant to receive the COVID-19 vaccine as they are more concerned about unforeseen side effects [41],which not only affected them but their family as females make approximately 80% of healthcare decisions for their children, and are the primary caregivers for their family. [67] On the contrary, only one study found females to have a higher acceptance rate compared to males (females 83% vs males 78%) [54].

3.3.2. Healthcare workers (n = 9)

There was a difference in acceptance rate across the nine studies conducted among HCWs. Three studies had an acceptance rate of over 50%, including 72.4% as the highest in France, Belgium, and Canada [47], followed by 68.6% in Izmir [69], and 57.5% in the US. [67] A low acceptance rate of 36% was also found in the US [71], followed by 27.7% in Congo. [68] Intention to vaccinate among healthcare professionals influenced vaccine uptake among the general public as most would accept the vaccine if recommended by HCWs. [68] However, concerns regarding the safety and effectiveness of the vaccine developed during an emergency [47,67], and misinformation spread through social media were the main factors that resulted in vaccine hesitancy among some HCWs. [68] 46% of HCWs do not trust the government and 34% do not trust the regulatory authorities for overseeing the vaccine's safety and development. [71] Our updated search found an acceptance rate of 91.7% in Germany, in a study conducted in February 2021, when 49.1% of the HCWs had already received their first dose of the vaccine and 80% of them believed the vaccine was safe and effective in controlling the spread of COVID-19. [43] But two studies conducted at a similar time by Fares et al. [72] and Hussein et al. [73] found a low acceptance rate of 21% and 13.5% in Egypt and highlighted that HCWs still had doubts in the safety and effectiveness of the vaccine and more beliefs in conspiracy theories. 92.4% refused vaccination as they believed there were still not enough clinical trials and a lack of information [72,73].

Table 3
Data extraction (n = 38 studies).

Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
Adeniyi et al., 2021 South Africa Cross-sectional survey	To assess the perceptions and acceptance of COVID-19 vaccination and examine its influencing factors among HCWs.	1308 HCWs from two large academic hospitals in the Eastern Cape: 45.2% of nursing staff, 28.7% supporting staff, 4.7% pharmacy staff. Multi-stage cluster sampling to obtain a representative sample.	Data collected November – December 2020 on acceptance of the COVID-19 vaccine, and general attitudes towards the vaccine. Logistic regression to identify the determinants of vaccine hesitancy.	90.1% were willing to accept the vaccine as it is needed to end the pandemic. 86.9% believe the vaccine is safe and 86.5% have not refused a vaccine in the past. 90.2% have not experienced adverse effects from previous vaccines. Individuals with lower levels of education and who refuse annual vaccines were more hesitant to accept the vaccine.	The high level of acceptance of the vaccine is reassuring, however those with lower levels of education and who refuse annual vaccines need to be targeted for further engagement to address their concerns and fears.	Two large academic hospitals were studied. The yes/no nature of the study did not allow for a better understanding of the timing of vaccine acceptance.
Akarsu et al., 2021 Turkey Cross-sectional survey	To investigate the thoughts and attitudes of individuals towards the future COVID-19 vaccine.	759 participants from Turkey: 62% females, 63.6% studying at university, 46.6% married, 40.6% health employees. the snowball method.	Data collected from 10th June – 10th July 2020 on sociodemographic characteristics, health conditions, COVID-19 infection, and opinions about future COVID-19 vaccine.	49.7% stated to be vaccinated. 38.4% stated to vaccinate their children.5.8% would vaccinate if free. Students, HCWs, those with health insurance, and had flu vaccines were more willing to get vaccinated. Females and the unemployed were less willing to get vaccinated. 6.2% of 232 participants rejected any vaccines for their children. 27.7% afraid of side-effects. 27.4% assume it is not reliable. 8.2% doubt its effectiveness. 1.4% believe COVID-19 is not serious, hence no vaccine needed, and 7.2% believe a vaccine can cause COVID-19.	Rejection and uncertainty towards the vaccine due to fear of side effects and it is not reliable due to its newness. , and HCWs should closely follow the vaccination process and inform the public to address their concerns.	Big sample size. Participants include male/female, students/ employed, and HCWs. The sample consisted of participants with higher education attainment, and high rates of HCWs, so it cannot be generalised to the general population. Web-based survey.
Al-Mohaithef & Padhi, 2020 Saudi Arabia Web-based cross-sectional survey	To assess the prevalence of the acceptance of the COVID-19 vaccine and its determinants.	992 participants from Riyadh, Dammam, Jeddah, and Abha. 43.9% were between 26–35 years old, 26.6% ages 18–25, 24% aged 36–45 and 5% aged 45 + . 65.8% were female, 51.6% married, 82% were Saudi nationality, 50.1% had graduated, and 43.1% worked in the government sector. Snowball sampling through online surveys on social media platforms and email.	Data were collected on demographics, knowledge, perception towards COVID-19, trust in the health system, and willingness to accept the vaccine. Key determinants that predict vaccine acceptance were modelled using logistic regression analysis, and cross-tabulation analysis to examine the distribution of intent to uptake the COVID-19 vaccine with sociodemographic characteristics using chi-squared tests.	64.7% showed interest in taking the COVID-19 vaccine when available. 28.2% were not sure and 7% reported hesitancy. 42/53 (79.2%) of those aged 45 + showed interest and 355/512 (69.3%) married participants showed willingness. Those with a higher perceived risk of being infected were 2.13 times more likely to be vaccinated. Having greater trust in the health system were 3.05 times more likely to be vaccinated.	Acceptance rate was high among other countries, compared to the influenza A pandemic. Older-aged participants were more likely to accept the vaccine. Addressing sociodemographic determinants relating to COVID-19 vaccination may help increase the uptake of the global vaccination program to tackle future pandemics.	The study explores the intention to uptake the COVID-19 vaccine. Representative sample size across the country. It was conducted for a hypothetical vaccine; responses may change when one is available. The study was online which could lead to potential bias. Snowball sampling may not represent the true picture of the study participants.

(*continued on next page*)

Table 3 (*continued*)

Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
				Females (7.5%), graduates (8.45%), and unemployed (7.36%) were not willing to accept the vaccine.		
Alqudeimat et al., 2021 Kuwait Web-based cross-sectional survey	To determine the acceptance of a coronavirus disease 2019 vaccine among the general adult population and assess its determinants.	2368 adult participants from Kuwait: 1597 females, 4.9% self-reported they had COVID-19, 25.6% aged between 25–34 years, 90.6% Kuwait nationality, 62% with bachelor's degree, 49% non-HCWs, 8.7% were physicians. Snowball sampling to yield a convenient sample.	Data were collected from 26th August − 1st September 2020 on demographic data, lifestyle factors and anthropometric measurements, general acceptance of a COVID-19 vaccine, willingness to vaccinate with a 50%/75%/95% effective vaccine, and self-perceived likelihood of contracting COVID-19. Descriptive analysis, chi-squared tests, and a modified Poisson regression.	53.1% were willing to be vaccinated. Acceptance: 95% effective vaccine (32.4%), 75% effectiveness (16.2%), and 50% effectiveness (9.5%). were concerned about side effects, lack of information (82.3%), safety (71.8%), and doubtful efficacy (69.6%).	Participants who viewed vaccines in general to have health-related risks were less willing. The vaccine appears to be an essential preventive measure that can stop the spread of COVID-19.	Large sample size, the study assessed a wide range of factors affecting the acceptability of COVID-19 vaccination. Non-random sampling affects the representativeness of results. Internet-based study.
Barello et al., 2020 Italy Cross-sectional survey	To explore Italian students' attitudes towards a future vaccine to prevent COVID-19 and evaluate the impact of the university curricula (healthcare vs non-healthcare) on the intention to vaccinate.	934 student participants from Italy: 58.9% attended healthcare curricula e.g., nursing/medicine. 41.1% attended non-healthcare e.g., engineering, law, etc. 79.6% females, mean age 23.6 years. Convenience sample.	Data collected on demographic characteristics, and intention to vaccinate. Descriptive and comparison analysis. Healthcare students were expected to have a higher intention to vaccinate due to more knowledge of health-related issues.	86.1% would accept the vaccine, whilst 13.9% would not/unsure. Responders who chose not to disclose their intention to vaccinate did not significantly differ from the others on demographic and social characteristics. No significant difference was seen in responses' percentage distribution ($p = 0.097$), between medical and non-medical students despite their curriculum. Vaccination attitude is not only influenced by student knowledge but also by motivational and psychological factors. Acceptance is because of individual responsibility for population health and a sense of value in civic life and social solidarity.	Understanding students' perspectives on future vaccines and supporting health engagement and consciousness may help in producing strategies that address psychological perspectives on vaccine hesitancy underlying factors. Public health services should implement target and cultural-specific action for university students – influencing attitudes earlier can be more advantageous.	High response rate, big sample size to represent students. A mixture of healthcare and non-healthcare students. The study does not mention how many universities students were recruited from to generalise findings.
Bell et al., 2020 UK Mixed methods – cross-sectional online survey and semi-structured interviews	To gain a more complete insight into the acceptability of a future COVID-19 vaccine.	1242 parents and guardians (16 +) from England: 95% female, 97% raising a child with a partner. 94% identified as White British, Irish, or White Other.Mean age 32 (18–48 years). Median income £55,000-£64.999. 19 survey participants were interviewed. , and above 16).	"*If a new coronavirus (COVID-19) vaccine became available, would you accept the vaccine for yourself?*" and "*If a new coronavirus (COVID-19) vaccine became available, would you accept the vaccine for your child/ children?*" measured with a 4-point Likert scale Semi-structured interviews to explore the reason for those accepting/refusing the COVID-19 vaccine.	55.8% definitely and 34.3% likely to accept for themselves; 48.2% definitely and 40.9% likely to accept vaccine for their child. Protect someone known to them in a risk group (8.2% for self, 3.1% for child). Other reasons for acceptance: 5% of participants wanted to stay healthy to look after their child. 6.7% of participants as	The main concerns raised by parents were around the safety and effectiveness of a rushed vaccine. Information on COVID-19 must be communicated clearly and factors need to be addressed to reduce inequalities in ethnic minority and low-income groups.	Use of multi-methods approach, open text responses. Study conducted at the peak of the pandemic. A large representative sample, however, lack representability in household incomes and ethnicity.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
			Paired samples *t*-test, logistic regressions, and thematic analysis.	key workers – protect themselves and patients. 3.7% would accept to end social-distancing and return to normal life. 5.1% participants (self) and 7% (for child) if recommended by the government. 3.2% reported less risk to vaccinate adults than children as vaccine trials were conducted in adults. Common concerns for hesitancy: Safety (self, 49%, for child 62.1%) and effectiveness (self 50%, child 67.7%). Prompted by the newness and rapid development of the vaccine (self 53, child 89) – not enough time to confirm short/long-term side effects. 19.4% viewed children as less at risk of infection and transmitting, hence would not benefit from vaccinating. Lack of information about the vaccine (self 1%, child 4.8%) Lack of trust in vaccinations, science, and medical professionals (self 4%, child 1.6%) Low-income groups, Black, Asian, Chinese, and Mixed 2 times more likely to reject the vaccine for themselves and almost 3 times more likely to reject it for their child.		
Chen et al., 2021 China Cross-sectional survey	To understand the willingness and determinants for the acceptance of an COVID-19 vaccine among Chinese adults.	3195 adult participants from China: 86.5% aged between 18–44 years. Male proportion to female: 36.4:63.6. 56.7% had a university/college degree. 10.4% suffered from chronic diseases. Recruited through snowball sampling using social software.	Data collection from all 34 provincial administrative regions in China May – June 2020 on demographic and health information, knowledge, and attitudes regarding COVID-19 and vaccine, using the vaccination hesitancy scale and 5-point Likert scale. Chi-square tests, T-tests, multivariable logistic regression.	83.8% were willing to vaccinate. 94.7% believed the future COVID-19 vaccine would effectively control spread. 76.6% believed vaccine will benefit their health. 80% believed it was beneficial if recommended by the government and 70.1% by HCWs. 18.9% hoped to receive the vaccine free and less than 50% would pay out of pocket. 74.9% expressed concerns/neutral attitudes regarding	Participants had a high willingness to vaccinate compared to other vaccines in China. However, lack of confidence, complacency concerning health, risk of the vaccine, and potential adverse effects were the main factors for vaccine hesitancy. Vaccine efficacy and safety of an upcoming COVID-19 vaccine should be disseminated to ensure acceptance and coverage.	Access to large and diverse samples. Bias by providing directed invitations, participants were relatively young and highly educated compared to the whole society – less representative of the whole population.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
				potential side effects. 20.5% doubted the safety of the vaccine. rather than imported vaccines. Males, high-income participants, and those with lower education levels showed greater vaccination acceptance.		
El-Elimat et al., 2020 Jordan Cross-sectional survey	To investigate the acceptability of COVID-19 vaccines and its predictors in addition to the attitudes towards these vaccines among public in Jordan.	3100 adult participants: The median age was 29 years. 67.4% were females. 49.8% were married and had kids (46.1%). 70% with an undergraduate degree. 53.8% with health-related educational backgrounds. 46.4% were employed and 13.4% had chronic conditions. Less than 10% received influenza vaccine the previous year. Convenient sample approach where people from different Jordanian regions were invited.	Data collected in November 2020 on sociodemographic characteristics, medical history, whether they took seasonal flu vaccine the previous year, if they or anyone known were infected with COVID-19, most trusted sources when seeking knowledge about COVID-19 vaccines, and hesitancy and concerns regarding the vaccine. Independent Mann-Whitney *U* test, Chi-square test, and logistic regression.	37.4% were willing to vaccinate. 45.4% trusted HCWs as information sources and 16% as social media. 66.5% believed it was important to vaccinate to protect people. 59% believed pharmaceutical companies would develop safe/effective vaccines. 36.2% believed the government would be able to provide free vaccines, this affected the acceptance rate. 36.3% unwilling to vaccinate. 17.5% were concerned about the unavailability of vaccines. 49.6% reported side-effects influencing decision and 49.3% will refuse once licensed. vaccinate, those who believe vaccines are generally safe and those willing to pay are more likely to accept the vaccine. 30 + years, employed, those who believe conspiracy theories and do not trust any source of information were less likely to accept.	Vaccine acceptance was fairly low – alarming to Jordanian health authorities. a trusted source of information rather than social media. transparent information about the safety and efficacy of vaccines.	Large sample size. Limitations with the design of a cross-sectional study.
Fares et al., 2021 Egypt Cross-sectional survey	To assess the perception and attitudes of HCWs in Egypt toward COVID-19 vaccines, acknowledge the determinants of their attitude, and the factors that could increase the acceptance of the vaccine.	385 Egyptian HCWs: 81.3% females, 70.3% were aged 17–35 years old, 23.1% nursing staff, 3.38% dentists, and 22.6% pharmacists. 41.% were working in the COVID-19 isolation hospitals and directly with COVID-19 patients. Participants were collected from social media platforms to be a representative sample.	Data collected from December 2020 – January 2021 on sociodemographic, whether participants are working in COVID-19 isolation hospitals and if they are directly dealing with COVID-19 patients, perception and attitudes towards the vaccine, reasons behind their vaccination decision and factors that could increase vaccination acceptance. Chi-square test.	51% were undecided, 28% refused, and 21% accepted vaccination. 93% of those who would accept is due to the risks of COVID-19, 57.5% of these believe it is safe and 56.3% believe the vaccine is effective. 43.7% would accept due to travelling facilitation. 92.4% of those who refused the vaccine is due to the absence of enough clinical trials. 91.4% fear side-effects.	Since only 21% of HCWs would accept the vaccine, this represents a major barrier to implementing vaccination programs.	The sample was representative of the target population. Limitations of an online survey, and females and younger age groups were over-represented.
Fisher et al., 2020.	To assess intent to be vaccinated against COVID-19 among a	991 adult participants: 63.3% white, 30% 60 years or older, 51.5%	Data collected 16th – 20th April 2020.on demographic	57.6% of participants intended to be vaccinated against	Approximately 3/10 were not sure they would vaccinate and 1/	The study was conducted during the peak of the pandemic. A

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
US Cross-sectional survey	representative sample of adults in the United States and identify predictors of and reasons for vaccine hesitancy.	female, 37.8% with a high school diploma or less. 64.1% perceived their risk for coronavirus to be low. 27.1% predicted they would get a mild case in the next 6 months. 6% predicted they would get seriously ill. 52.8% reported having received the influenza vaccine. Recruitment via the National Opinion Research Center AmeriSpeak Omnibus Survey.	characteristics, and intent to receive the COVID-19 vaccination which was measured with "When a vaccine becomes available, will you get vaccinated". Those who responded with no/not sure were asked further questions regarding the reason for not wanting to be vaccinated and whether they believed they would be infected within the next 6 months. Cross-tabulations, chi-square tests, and thematic analysis.	COVID-19 which is slightly higher than the percentage of those who received the influenza vaccination (45%) during the 2018–2019 influenza season. 31.6% were not sure; reasons for this were specific concerns regarding the safety/ effectiveness or the need for more information. 10.8% did not intend to be vaccinated; the reasons for this were a lack of trust and antivaccine attitudes/ beliefs. Females, Black or Hispanic, with lower education, and lower income were less likely to accept.	10 did not intend to be vaccinated against COVID-19. Vaccine hesitancy: younger age (below 60) Black race, lower education attainment and not had the influenza vaccine the previous year. Recommended for development of vaccine implementation strategies that anticipate racial gaps in COVID-19 vaccination.	large, nationally representative sample allows generalisation of the findings. Participants were approached about their intent to be vaccinated when one was not yet available as their responses could be different. Further research is also needed to develop effective strategies to combat conspiracy theories and misinformation.
Freeman et al., 2020 UK Cross-sectional online survey	To estimate provisional willingness to receive a COVID-19 vaccine, identify predictive socio-demographic factors, and, principally, determine potential causes to guide information provision.	5114 adult participants: 2574 males, 18 – 99 years, Different ethnic backgrounds, household income, education attainment, relationship, and employment. Recruited using quota sampling which was based on the UK Office for National Statistics population estimate data for gender, age, ethnicity, income, and region.	Data collected 24th September – 17th October 2020 on a vaccine hesitancy scale, attitudes around vaccine complacency and confidence, vaccination knowledge scale, general and specific coronavirus conspiracy scale, a 5-point scale to rate how often they followed key aspects of government guidance and parents' views of childhood vaccines. Structural equation modelling.	71.7% were willing to be vaccinated, 16.6% very unsure, and 11.7% strongly hesitant. 86% of the variance in hesitancy was provided by beliefs about the collective importance, efficacy, side effects and how quickly the vaccine was developed. 32% of the variance was provided by excessive mistrust: conspiracy beliefs, negative views of doctors, need for chaos. Hesitancy was associated with younger age, females, low income, and ethnicity.	Willingness to uptake the vaccine is closely bound to recognition of the collective importance. Vaccine hesitancy is evenly spread across the population. Factors such as conspiracy beliefs and mistrust lower vaccine uptake.	The survey findings indicate materials may benefit from highlighting the positive contribution the NHS staff make. Non-probability online quota sampling method. Not aware of the extent to which expressed intent to uptake vaccine is associated with behaviour. It is cross-sectional. Do not know whether beliefs, attitudes, and experiences cause willingness to take the COVID-19 vaccine.
Harapan et al., 2020 Indonesia Cross-sectional online survey	To assess the acceptance of a hypothetical COVID-19 vaccine among the general population in Indonesia.	1359 adult participants from Aceh, West Sumatra, Jambi, DKI Jakarta, Yogyakarta and Bali: 65.7% females, 51.4% aged 21–30 years old, 66.1% have graduated, 27.6% worked in the private sector. 39.2% believed they had a 0% risk of being infected. Snowball sampling by sending invitations through WhatsApp.	Data collected 25th March – April 2020 on demographic data, access to COVID-19 information, perceived risk of being infected with COVID-19, and acceptance of the vaccine through responses from 2 given scenarios with different vaccine efficacies (95% or 50%). Logistic regression model.	93.3% were willing to get a 95% effective vaccine if provided freely. Being an HCW and more at risk was associated with higher acceptance for the 95% effective vaccine. Retired individuals were less likely to accept vaccines due to lower perceived risk. Being an HCW was the only trait associated with accepting the 50% effective vaccine.	Acceptance was highly influenced by the baseline's effectiveness of the vaccine. Acceptance rate was calculated assuming the vaccine was given freely. Further studies need to be done in other Southeast Asian countries measuring the acceptance rate of vaccines if they are willing to pay.	A large sample size of the adult population from different provinces. Generalisability may be impacted due to questionnaire distribution, and selection bias due to some regions having better internet access. The acceptance rate was based on a hypothetical vaccine; this may change when a real vaccine is introduced.
Holzmann-Littig et al., 2021 Germany Cross-	To investigate COVID-19 vaccination acceptance and hesitancy among HCWs in Germany.	4500 participants from Southern, northern, western, and eastern Germany: 58% females, 29.5% physicians with specialised	Data were collected using the SoSci Survey in February 2021 on demographic data, trust in vaccines, health politics, and the pharmaceutical	91.7% would accept the vaccine. 49.1% had received the first dose. 80.9% trust the vaccine and 88% believe the vaccine is effective.	A high acceptance rate was found among German HCWs. Factors associated with vaccination hesitancy should be targeted in	One of the largest and most comprehensive studies on COVID-19 vaccination acceptance in HCWs in all fields. Due to the speed of

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
sectional survey		responsibilities, 10.4% nurses, and 29.2% medical students.	industry, fear of adverse effects, knowledge of the vaccine, and assumptions regarding the consequences of COVID-19. Data extraction through Microsoft Excel.	92.2% claimed to keep their vaccinations up to date. Those younger than 20 showed the lowest acceptance rate as well as dentistry personnel (16.3%). 35% of those hesitant feared long-term side effects. Lack of trust in authorities and pharmaceutical industries were reasons for hesitation.	HCW vaccination campaigns.	development during the pandemic, validity and reliability testing of the question set was impossible.
Hussein et al., 2021 Egypt Cross-sectional survey	To describe the existing COVID-19 vaccine approval landscape among HCWs; identify the most probable cause of agreement or disagreement of COVID-19 vaccine.	496 healthcare providers: 34.9% males, 55% 18–45 years old, 40.4% with a history of chronic disease. Snowball technique through social media platforms.	Data were collected from 1st December 2020 − 1st January 2021 on intention to vaccinate using a 5-point Likert scale, query about the desirable type of vaccine, and source of information about the COVID-19 vaccine. Bivariate analysis.	Only 13.5% would definitely agree, 32.4% somewhat agree, and 40.9% disagreed to receive the vaccine. 46.2% would prefer Pfizer. Reasons for refusal were safety (57%), fear of genetic mutation (20.2%), doubts about effectiveness (16.6%), and doubts about recent techniques (17.7%).	The age and presence of comorbidities or chronic diseases were the main factors related to COVID-19 acceptance. An urgent need to start campaigns is required to increase the awareness of the vaccine importance.	The study aimed to describe the existing COVID-19 vaccine approval. Cross-sectional survey and participants were recruited through social media platforms.
Kose et al., 2020 Turkey Cross-sectional survey	To determine the acceptance status of COVID-19 vaccine amongst healthcare professionals.	1138 HCWs from Izmir: 27.5% male, 89.6% aged 15–24, 9.8% aged 25–45 + . 4.7% physicians, 26.9% nurse/midwife, 61% students (medicine/nurse), and 7% other.	Data were collected from 17th − 20th September 2020 on demographic characteristics, desire, hesitation, and reasons for getting the COVID-19 vaccine through Google Forms. Chi-square test.	68.6% stated they could be vaccinated. Men (74.8%), students (72.3%), younger age (70.5%), and previous flu shots (influenza 75.3%) were willing to get vaccinated. it's new, do not believe it works, trust their immune system, they are protected from the disease and not afraid of getting sick.	Efforts to increase the knowledge of HCWs regarding the vaccine and to reduce doubts and concerns are important. , and economic characteristics.	Large sample size including medical students. First in the country to provide an insight into the issue. Reaching and responding to participants through social media, and the design of a cross-sectional study.
Lazarus et al., 2021 19 countries Cross-sectional survey	To determine the potential acceptance of COVID-19 vaccine in a global survey.	13, 426 participants from 19 countries: 53.5% females, 62.4% 25–54 years old, and 36.3% with a university degree.	Data collected in June 2020 in Brazil, Canada, China, Ecuador, France, Germany, India, Italy, Mexico, Nigeria, Poland, Russia, Singapore, South Africa, South Korea, Spain, Sweden, the UK, US on vaccine uptake, trust in pandemic information sources and standard demographic information. Logistic regression.	71.5% would be very or somewhat likely to accept the vaccine. 46.8% would accept the vaccine if available. 61.4% would accept their employer's recommendation. 27.3% of participants from Poland reported the highest proportion of negative responses. Higher levels of education, those who trust the government, and older people were more likely to accept the vaccine, whereas younger participants were likely to accept an employer's vaccine recommendation. Acceptance rate: China (88.6%), Brazil (85.4),	Acceptance rates ranged from 88.6% (China) to 54.9% (Russia). Countries where acceptance exceeded 80% were Asian nations (China, South Korea, and Singapore). Those who have a higher trust in information from government sources and their employers are more likely to accept the vaccine.	Global survey of 19 countries which provides a good overview of vaccine acceptance. Limitations of a cross-sectional survey.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
				South Africa (81.6%), South Korea (80%), Mexico (76.2%), US (75.4%), India (74.5%), Spain (74.3%), Ecuador (72%), UK (72%), Italy (70.8%), Canada (68.7%), Germany (68.4%), Singapore (68%), Sweden (65.2%), Nigeria (65.2%), France (58.9%), Poland (56.3%) and Russia (54.9%).		
Lucia et al., 2020 US Cross-sectional survey	To assess vaccine hesitancy and acceptance of medical student to a novel COVID-19 vaccine.	168 medical students from a single allopathic medical school in Southeast Michigan: 51% preclinical students, 49% clinical students, and 57% female.	Data were collected on previous immunisation behaviour, general attitudes and perception of vaccines, current knowledge about the COVID-19 vaccine, the likelihood of COVID-19 infection, and personal experience with COVID-19. Chi-square test.	More than 98% showed positive attitudes towards the vaccine to prevent disease spread. 98% agreed they would more likely be exposed to COVID-19. to accept: Trust public health experts, have few concerns about side effects, and agree with vaccine mandates. were unwilling to take the vaccine immediately upon FDA approval.	Findings highlight the need for an educational curriculum about the safety/effectiveness of COVID-19 vaccine to promote uptake.	First study to evaluate COVID-19 vaccine hesitancy among US medical students. impacts generalisability.
Magadmi & Kamel, 2021 Saudi Arabia Cross-sectional survey	To identify beliefs and barriers associated with COVID-19 vaccination among the general adult population in Saudi Arabia.	3101 participants from five regions of Saudi Arabia: 53.4% between 40–59 years, 58.3% female, 63.9% with a university degree, 13.3% HCWs. 40% receive seasonal influenza vaccine. Recruited through purposive sampling strategy.	Data collected in May 2020 on demographic data, beliefs towards COVID-19 vaccination, and the vaccine's safety. Descriptive statistics, and Chi-square test.	44.7% would accept the vaccine if available. 63.9% will agree if further studies confirm the vaccine's safety and effectiveness. 55.3% would hesitate. 55.4% were uncertain about vaccine safety and 56.1% about vaccine effectiveness. 80% were concerned about side effects. 23.4% lack confidence in the vaccine's effectiveness. One-fifth support conspiracy theories and don't see themselves at risk. Younger, males and those who already receive seasonal flu vaccine would accept the vaccine.	Concerns about side-effects were a key barrier to vaccine acceptance. The majority would accept if additional studies confirmed vaccine safety and effectiveness. Results can be used in planning vaccination campaigns while waiting for vaccine development.	High response rate. Online survey and cross-sectional nature of the study.
Malik et al., 2020 US Cross-sectional survey	To predict COVID-19 vaccine acceptance and identify most vulnerable population and provide information for public health officials to develop messaging, whilst targeting communities most in need.	672 participants from the US: 57% females, 38% ages 55+, 65% non-Hispanic white, and 52% college/ graduate. , and had a CloudResearch account.	Data were collected in May 2020 on demographic data, how likely they were to accept the COVID-19 vaccine, perceived risk, confidence in media sources, and reliability of these regarding the COVID-19 pandemic. Descriptive statistics, and logistic regression analysis.	67% would accept the vaccine. Males (72%), older age (>55; 78%), Asian (81%), and graduates (75%) were likely to accept the vaccine. the most reliable source for COVID-19 information. 21% reported social media as a reliable source.	Although 67% would accept, there are still demographic/ geographical barriers to vaccine acceptance. Authorities and policymakers must prioritise COVID-19 vaccine-acceptance messaging for all Americans, especially the vulnerable.	72% response rate, data representative of the US population. Selection bias due to the eligibility criteria, reduces generalisability of the sample. Limitations of the online-based study design.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
Mo et al., 2021 China Cross-sectional online survey	To investigate the association between perceived personal benefits, variables reflecting external motives (i.e., perceived social benefits, collectivism, and national pride) and intention to receive COVID-19 vaccination among university students in China.	6922 students from 5 Universities in 5 provinces (Zhejiang, Yunnan, Guangdong, Inner Mongolia, and Henan) of mainland China: 63.6% female, mean age 19.4 years. Majority of Han ethnicity. 50.9% in medicine-related disciplines, and 43.2% in freshman. Recruited through invitation messages for the questionnaire.	Data were collected 1st − 28th November 2020 on the perceived efficacy of the vaccine, descriptive norm, their likelihood of receiving the COVID-19 vaccination if it was recommended by the government and offered free or self-paid using 5-point scales. Path analysis.	Intention to receive free and self-paid COVID-19 vaccination is 78.9% and 60.2%. Perceived efficacy of the vaccination, social media use for COVID-19 vaccine-related information, and descriptive norms all had a significant positive correlation with the intention to receive the COVID-19 vaccination (free and self-paid).	Findings accentuate the importance of increasing public education on vaccine efficacy and necessity as a means to reduce vaccine hesitancy and increase acceptance. Those who use social media for COVID-19-related vaccination might have an increased understanding of the benefits and necessity of the COVID-19 vaccination, therefore promoting willingness to receive vaccination.	Large sample size from different provinces. The usefulness of Diffusion of Innovations Theory and the moderating role of openness of experience. Cross-sectional, no causality between the variables can be assumed. Data from only 5 provinces and more medical students so cannot be representative of university students.
Murphy et al., 2021 Ireland & UK Cross-sectional survey	To examine the association between psychological characteristics and COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom as part of the COVID-19 Psychological Research Consortium (C19PRC) to track the mental health and societal impact of the pandemic.	1041 adults from Ireland and 2025 from the UK: Ireland: 51.5% female, 50.9% aged 18–44, 49.1% 45–65+, 75.1% Irish, 17.3% other white background, 7.6% other ethnic background. UK: 51.7% female, 48.3% aged 18–44, 51.6% 45–65+, 85.5% White British, 5.7% White, and 7% from other ethnic backgrounds. Recruited using quota sampling.	Data were collected on 23rd-28th March 2020 in the UK and 31st March-5th April 2020 in Ireland on medical history, psychological indicators, locus of control, conspiracy beliefs, paranoia, religious beliefs, trust in institutions, and authorisation. Participants were asked, 'If a new vaccine were to be developed that could prevent COVID-19, would you accept it for yourself?' Multinomial logistic regression analyses, and ANOVA tests with Bonferroni post-hoc test.	65% of Irish respondents were accepting COVID-19 vaccine. 26% hesitant (female, aged 35–44 years and less likely to have received treatment for mental health problems). 9% resistant (35–44 years, residing in the city, non-Irish, have an underlying health condition and low income). 69% of UK respondents accept. 25% hesitant (female and under 65) Reasons: Lower level of trust in scientists, HCWs, state, high levels of paranoia, and religious beliefs.	Main concerns – distrust in experts and authority figures, HCWs and hold stronger religious and paranoid beliefs. Knowledge regarding the vaccine was found within social media platforms, consistent with global trends. More effective communication is required to disseminate information.	Large sample size in two countries. The sample is representative of the general adult population. Quota sampling to recruit non-probability-based samples through the Internet. Data were collected during the first week of lockdown, responses could change over time.
Nzaji et al., 2020 Congo Cross-sectional survey	To estimate the acceptability of a future vaccine against COVID-19 and associated factors if offered in Congolese health-care workers, since they have the highest direct exposure to the disease.	613 HCWs from Mbuji-Mayi (Kasai Oriental province) and Kamina (Haut-Lomami province): 50.9% males, 95.3% 25 + years, 72.8% HCWs, and 66.6% married. 53.5% had 10 years of experience within healthcare. 99.3% agreed they heard about COVID-19. s and 3 university hospitals.	Data collected from 20th March − 30th April 2020 on demographic data, knowledge of COVID-19 and attitudes towards COVID-19 (confidence overcoming the pandemic, willingness to vaccinate), and practices towards COVID-19 prevention. *t*-test, Chi-square test, and stepwise logistic regressions.	Only 27.7% would accept COVID-19 vaccine. 35.3% of males, 31% of those under 25 years, 29.4% of married participants, and 37.7% of doctors would accept. Those having a positive attitude towards the vaccine (38.7%) were willing to be vaccinated. Low acceptance due to misinformation spread via social media. Older people wanting to be vaccinated – were vulnerable to worse outcomes, which created fear.	Acceptance of COVID-19 vaccine among HCWs is very low compared to other studies. Acceptability among others requires HCWs to be educated as their attitudes towards the vaccine are an important determinant of their vaccine uptake and the likelihood of recommending it to their patients.	The sample was recruited from different provinces with good representativeness. Limitations of a cross-sectional and internet-based survey.
Paul et al., 2021 UK Cross-	To estimate predictors of four domains of negative attitudes towards vaccine and identify groups most at risk of	32,361 adult participants in the UCL COVID-19 Social Study from the UK: 49.4% males, 79% aged 18–64	Data collected on 21st March 2020 on negative general attitudes towards vaccines measured using the 12-item Vaccination	14% reported unwillingness to vaccinate and 23% were unsure. 24.4% expressed high/ uncertain levels of	High levels of mistrust of vaccine benefits and concerns of unforeseen side-effects were the most important determinants of	The first study to comprehensively describe predictors of negative vaccine attitudes and factors influencing uncertainty

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
sectional survey	uncertainty and unwillingness to receive COVID-19 vaccine in a large sample of UK adults.	years, 87.2% white, and 12.8% from ethnic minority groups. Convenience sampling and then targeted recruitment.	Attitudes Examination (VAX) Scale (mistrust of vaccine benefit, worries about unforeseen future effects, concerns about commercial profiteering, and preference for natural immunity), confidence in government, and the health service to handle the pandemic. Multinomial regression.	mistrust of vaccine safety. 69.2% expressed strong/moderate worries about unforeseen side effects. 36.9% expressed concerns about commercial profiteering. 44.7% expressed natural immunity might be better than a vaccine. Low-income groups (<£16000), those without previous influenza vaccine, females, and living with children were the largest predictors of vaccine uncertainty and refusal. groups with low education attainment, low income, poor knowledge, and poor compliance with government guidelines.	unwillingness to vaccinate. especially to women, low-income groups, less educated, and ethnic minorities.	and unwillingness. Large sample size. Not nationally representative. Multiple approaches for recruitment, possibly some individuals from the same household participated which influenced one another.
Pogue et al., 2020 US Cross-sectional survey	To understand the attitudes towards and obstacles facing vaccination with a potential COVID-19 vaccine.	316 participants: 49.38% female, 64.2% aged 18–45 years, 35.8% over 46. Participants were selected by age, race, and gender to reflect national census data.	Data collected on demographics, opinions/knowledge of COVID-19, intention/ behaviour regarding a potential COVID-19 vaccine and other vaccines in general, how efficacy affects the likelihood to vaccinate and how the location of vaccine development affects comfort with the vaccine, history of vaccination, underlying knowledge of vaccine immunity, and attitudes/intentions towards a COVID-19 vaccine. Structural equation modelling and factor analysis.	68.57% strongly/ somewhat agree, 15.57% strongly/ somewhat disagree with 'I am likely to be vaccinated for COVID-19 when a vaccine becomes available'. 78.19% strongly/ somewhat agree with "A vaccine is important to stop the COVID-19 pandemic." 7.41% felt COVID-19 was "Not a problem at all." 63.47% strongly/ somewhat agree with "I am worried about the side effects of the vaccine for myself". About 40% strongly/ somewhat agree with "The side effects of the vaccine are likely to be worse than COVID-19 itself." 66.05% would vaccinate if available in 30 days and 74.38% would if one was available in the next 6 months. 74% strongly agree/ agree with "I worry that the rushed pace of testing for a new COVID-19 vaccine will fail to detect potential side effects or dangers."	The majority are supportive of being vaccinated. However, side effects, efficacy, and length of testing remained concerns. The greater the perceived impact of the virus on America, the more receptive participants are to receiving a potential COVID-19 vaccine. Understanding of vaccines and immunity did not impact their attitudes as well as people they knew who had the virus. Household income and political ideology showed no relationship with attitudes towards the vaccine. , and development were significantly associated with increased vaccine acceptance. Messages promoting vaccine uptake should address the concerns of those who are hesitant.	Robust model fit statistics. Fewer participants in the study. There was an acceleration in vaccine distribution and major vaccine were paused due to safety concerns. The survey does not reflect these significant occurrences.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
				51.85% expressed concerns about safety or side effects. 10.65% expressed that effectiveness was the second most concern. Not enough testing was third, with 10.18%. Whereas 2.31% were most concerned that the vaccine would not arrive in time, and 2.13% were afraid there would not be enough vaccine to go around or that there would be problems with distribution. Less than 1% were most worried about being tracked by microchips, the vaccine being made in China, or other people being unwilling to be vaccinated.		
Prati, 2020 Italy Cross-sectional survey	To determine the extent to which Italian people intend to receive a vaccine against SARS-CoV-2 and to investigate its associations with worry, institutional trust, and beliefs about the non-natural origin of the virus.	624 participants: 54% female, age range 18–72 years, 52.4% employed, household income in the last 12 months: excellent (13.8%), adequate (72%), scarce (13.7%), or absolutely insufficient (0.5%). 4% belonged to an ethnic minority group. Snowball sampling via email, websites, blogs, and social media.	Data were collected in April 2020 on demographic characteristics, intention to receive the vaccine, worry about COVID-19 and the epidemic using a 10-point scale, institutional trust, trustworthiness of the Italian government and Ministry of Health, and beliefs about the non-origin of the virus. Multinomial logistic regression.	75.8% intend to receive the vaccine. 10.1% responded with 'Do not know' and 5.1% responded with 'no'. Participants who did not intend to be vaccinated reported lower levels of worry and institutional trust. Belief about the origin of the virus was not associated with no intention to receive the vaccine. Participants who were unsure, of age, gender, employment, and the minority did not influence their intention to receive the vaccine.	Findings confirm the role of institutional trust in determining vaccination intent rather than beliefs in the non-natural origin of the virus. Public information campaigns to increase vaccine acceptance should consider risk communication strategies that appeal to emotions without exaggerating the risks.	One of the first studies to examine intention to receive the vaccine. A diverse population and high response rate. Results may be affected by social desirability and selection bias due to online surveys. Only 4% are from ethnic minority groups, difficult to generalise.
Reiter et al., 2020 US Cross-sectional survey	To examine the acceptability of a COVID-19 vaccine among a national sample of adults in the US.	2006 adults from all 50 states (including the District of Columbia): 56% female, 16% aged 18–29, 33% aged 30–49, 27% aged 50–64, and 25% over 65. 51% married/ relationship, 65% with a college education, 67% non-Latinx white, 86% living in urban counties, and 53% income less than $50,000. 87% had health insurance. Recruited through an online survey panel (national opt-in panel)	Data collected in May 2020 on acceptance of a COVID-19 vaccine, 11 factors that would affect decisions, knowledge, attitudes, and beliefs about COVID-19 infection, perceived likelihood of infection, perceived severity of COVID-19, perceived potential harm of COVID-19 vaccine and perceived effectiveness of COVID-19 vaccine. Multivariable regression model and Chi-square test with Bonferroni adjustment.	69% were willing to get the vaccine (48% definitely, 21% probably). 31% not willing (17% unsure, 5% probably not & 9% not). 70% willing to pay, 30% would not. 35% would pay more than $50. Influential factors: effectiveness (81%), doctors' recommendation (73%), health history (72%), duration of protection (68%), health insurance coverage (62%), age (60%), side-effects (58%), family beliefs (38%) and ethnicity/	Many adults in the US are willing to get vaccinated if one becomes available. However, decisions may differ by demographic characteristics, the role of healthcare providers, and health beliefs. A strong correlation of vaccine acceptability was healthcare providers' recommendations, therefore if a vaccine becomes available, healthcare recommendation will be critical to promote vaccine uptake.	Large sample size from the entire US, examining a wide range of possible correlates. Convenience sample. Data collection during early stages of vaccine development. Vaccine acceptability was measured under the presumption that the vaccine was free or covered by health insurance.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
		accessed through SSRS.		race (21%). Vaccine acceptance was lower among non-Latinx black, low-income, no health insurance groups. Latinx participants were most willing as they experienced the high burden of COVID-19.		
Sallam et al., 2021 Jordan, Kuwait & Saudi Arabia Online cross-sectional survey	To assess the attitudes towards the prospective COVID-19 vaccine among the general public in Jordan, Kuwait, and other Arab countries.	3414 participants from Jordan (2173), Kuwait (771) and Saudi Arabia (154): Jordan: 69.4% females, 34.7% aged 16–21 years. 23.9% >40 years. 75.7% undergraduates and 9.4% with a history of chronic disease. Kuwait: 63.9% females. 20.2% aged 16–21 years. 25.7% >40 years. 72.6% of undergraduates and 13.5% with chronic disease. Saudi Arabia: 76.6% females. 6.5% aged 16–21 years. 48.1% > 40 years. 72.1% of undergraduates and 13.6% with chronic disease. Recruited through social media advertisement and messaging services.	Data collected 14th – 18th December 2020 on previous experience with COVID-19, history of chronic diseases, and previous COVID-19 diagnosis, Vaccine Conspiracy Belief Scale (VCBS), the main source of knowledge about COVID-19. Chi-squared test, and multinomial logistic regression.	Overall acceptance was 29.4%: Saudi Arabia (31.8%), Jordan (28.4%) and Kuwait (23.6%). Males (38.6%), with higher education attainment and chronic disease history had a higher rate of vaccine acceptance. 59.5% believed COVID-19 is manmade, with more than 40% believing it was to force everyone to get vaccinated. 27.7% believed in the implantation of microchips to control the body and 23.5% believed it would cause infertility. Higher belief in conspiracy theories among females and undergraduate level or less was found. Lower beliefs among those who relied on HCWs and scientists (36.4%) as a common source of information about COVID-19 vaccines compared to those who relied on the news (31.7%) and social media platforms (30.1%). Conspiracy regarding origin was higher among those who rely on social media platforms (65.8%) compared to 49.8% who rely on HCWs.	Vaccine hesitancy is extremely high, lowest acceptance rate globally due to social media. Males were more willing as they relied on HCWSs, and scientists compared to females who rely on social media. Educated participants were likely to accept the vaccine due to not believing conspiracies. Those with chronic disease were also more likely due to vulnerability. A lack of trust in governments and vaccine manufacturers can lead to conspiracy beliefs. Governments and the general public should be alerted about the importance of vigilant fact-checking and evidence-based scientific information.	The use of VCBS to achieve the aim increases the confidence in the results. The unequal distribution of respondents in different Arab countries affects generalisability. A high response rate was seen in Jordan and Kuwait which could be due to the authors' contacts living in both countries.
Seale et al., 2021 Australia Cross-sectional online survey	To understand the public perceptions regarding a future COVID-19 vaccine in Australia.	1420 adults: 48% males, 58% in employment. 25% had chronic health conditions and 58% had private health insurance. Recruited using proportional quota sampling to ensure participants demographically	Data collected 18th – 24th March 2020 on demographic data, perceptions of vaccine effectiveness, priorities for COVID-19 rollout and social influences, vaccine acceptance, and risk perception of COVID-19. Univariate and multivariable logistic regression model,	80% of participants agreed that 'getting myself vaccinated for COVID-19 would be a good way to protect myself'. 91% of those aged 70 + agreed with the statement than the 18–29-year-olds. 83% of females agreed with the statement. Those who reported chronic disease also agreed with the statement.	The same psychological factors that influence acceptance of national immunisation program vaccines apply during pandemics – perceived risk of personal infection and severity of infection. Recommendation from HCWs is a key driver for routine immunisation, hence HCWs need more	Large, representative adult population in Australia. Convenience sample. Those who couldn't communicate in English were excluded which can affect the representation of ethnic minorities. The study was on a voluntary basis, leading to self-selection bias. Online

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
		represent the Australian public.	independent samples *t*-test, and ANOVA with Bonferroni correction.	14% were uncertain about the statement and 5.8% disagreed. 84% believed HCWs should be first to get the vaccine and 85% believed patients with risk factors should be first. 83% agreed that 'vaccines are effective at preventing diseases.' 21% indicated 'diseases provide better immunity than vaccines do'. 84% agree with 'to protect the health of the community, we should follow government guidelines about the vaccine''. 84% agreed they do what the HCWs recommend. 74% ranked their risk of getting COVID-19 intermediate low.	understanding about COVID-19. To support the effective launch of the new vaccines, the governments need to understand the concerns and then develop strategies to support engagement.	access is needed, limiting participants from the community.
Shaw et al., 2021 US Cross-sectional survey	To provide a snapshot of vaccination attitudes to identify areas of concern that would impinge on COVID-19 vaccination program planning and implementation.	5287 HCWs: Nurses (22.7%), physicians (22.7%), administration (19.2%), ancillary services (17.8%), technical support (8.4%), and allied health professionals (6.2%). Masters-level clinicians (5.65%), public safety and spiritual care (0.5%), and pharmacists (2.4%). Female (72.8%), mean age of 42.5 years, White (85.1%), Black/African American (5%), Asian (6%). 58.5% provide direct patient care. 32.2% provided care for COVID-19 patients.	Data were collected from 23rd November – 5th December 2020 on demographic data, perceived risk, and severity of COVID-19, whether they had prior influenza vaccine and intent to get vaccinated, beliefs, attitudes, and willingness to get vaccinated. Descriptive statistics, Chi-square, and ANOVA.	57.5% expressed intent to receive the vaccine. Mean age: 43.83 years, strongly/agree they would accept, 41.62 years unsure, and 38.67 years disagreed. Males (72.5%) agreed. 80.4% physicians and scientists, direct care (54%) vs non-care providers (62.4%) and cared for COVID-19 patients (52%) vs those who did not (60.6%) would accept. Nurses (33.6%), allied health professionals (31.6%), and master's level clinicians (32%) were unsure. Older age agreed as concerned about contracting COVID-19. Younger participants were more concerned for families getting COVID-19. White (28.4%) were less concerned about their safety from COVID-19 than Black/African American (41.1%) or Asian (43.5%). Concerns: Potential long-term side-effects (47%), effectiveness (14.7%), speed of vaccine development (10.8%). Safety (10.9%) and newness (6.60%).	Females were less likely to accept due to being more research-orientated or family caregivers. Black/African American less likely to accept which is concerning as they are more affected by COVID-19. Those providing direct care to COVID-19 patients would be less likely to accept – counterintuitive observation should be explored further to provide insight into the decision. Tailored communication strategies are needed.	Large sample size, including those who provide direct and non-direct patient care. High response rate. A cross-sectional study was conducted in a single healthcare system in northeastern US. Generalisability to other regions may be limited. A voluntary approach may increase selection bias.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
Shekhar et al., 2021 US Cross-sectional online survey	To assess the attitude of HCWs towards COVID-19 vaccination.	3479 HCWs from hospitals in New Mexico, Texas, Missouri & Ohio: 75% female, 54% under 40 years old, 80% graduated, 81% white, 59% without chronic medical conditions. 64% work in urban areas. 54% work in primary medical and medical subspecialties. 79% provide direct patient care. 45% of HCWs care for COVID-19 patients. 87% view themselves at risk of getting COVID-19. 21% think they will acquire serious disease requiring hospital admission. 8% confident they would not get COVID-19. Recruited using snowball sampling through links sent on social media to different hospitals.	Data collected from 7th October – 9th November 2020 on demographic data, self-perceived risk of COVID-19, exposure to COVID-19, acceptance of COVID-19 vaccine, and attitudes towards the vaccination measured on a Likert scale. Multinomial logistic regression and likelihood-ratio test leading to derived chi-square and p-values.	36% were willing to vaccinate when available and 56% would wait to review more data. 34% of 18–30 age group was willing, and 47% in > 70 age group. Similar trends in education and income level. Only 31% were female, 19% Black, 30% Latinx, and 26% rural HCWs willing. Direct medical care providers had higher vaccine acceptance (49%). 90% of HCWs believe the vaccine works, is safe (86%), no personal (87%) or religious beliefs (95%) influencing vaccine uptake. 8% do not plan to vaccinate. The majority of these would not recommend it to friends and family and believe the vaccine should be voluntary. Concerns: safety (69%), effectiveness (69%), speed of development (74%). 73% trust doctors' recommendations, 46% do not trust governments and 34% do not trust regulatory authorities for overseeing vaccine development and safety.	Acceptance for COVID-19 vaccination is low when one becomes available as the majority of HCWs want to wait to review more data before deciding. Vaccine acceptance increased with older age due to vulnerability. The black race had a low acceptance rate whilst Asians had higher. A small percentage refuse due to concerns regarding the vaccine. It is important to address the barriers to vaccinating to avoid exacerbating health inequalities formed by the pandemic. Targeted messaging and outreach will be required to achieve a higher vaccination rate.	Large sample size, representation from different genders, ethnicities, racial backgrounds, age groups, and roles in healthcare. Snowball sampling introduced selection bias which limits the generalisability of findings. The survey was in English and distributed online which favours English-literate HCWS and those who have internet access.
Sherman et al., 2020 UK Online cross-sectional survey	To investigate factors associated with intention to be vaccinated against COVID-19.	1500 adult participants: 51% females, mean age 46 years, 85% white, 52.6%-degree level, 36.6% keyworkers, 32.3% had influenza vaccine last year, and 29.7% were vulnerable. Recruited from an existing online research panel using quota sampling based on age, gender, and ethnicity.	Data collected 14th – 17th July 2020 on demographic data, likelihood to be vaccinated, perceived susceptibility and severity of COVID-19, benefits of/ barriers to being vaccinated, trust in the Government and NHS, concerns about commercial profiteering, and their beliefs about vaccination allowing life to get back to 'normal'. Linear regression.	64% likely to be vaccinated, 27% unsure, and 9% unlikely. Intention to vaccinate: older age, prior influenza vaccination, perceiving greater risk, positive attitudes, and weaker beliefs of causing side-effects/ unsafe.	Most participants are willing despite uncertainty. Messages and campaigns should emphasise the risk of COVID-19 to others.	Large sample size. High response rate (98%). Unsure about a representative sample of the general population. Actual uptake might be lower when the vaccine is available.
Shibani et al., 2021 Syria Cross-sectional survey	To investigate COVID-19 vaccination acceptance among Syrian population.	7531 participants from all major cities in Syria: 46.5% males, 41.5% 18–24 years old, and 38.6% university students. 34.5% worked in a healthcare-related	Data collected from 3rd January – 17th March 2021 on demographic data, beliefs and opinions about COVID-19 and a COVID-19 vaccination, and willingness to vaccinate.	37% were likely to get the vaccine, 32% unlikely, and 31% unsure. 66.2% believe there is not enough information available about the vaccine. 62.4% were hesitant due to possible	Vaccination intention was significantly associated with gender, financial status, educational level, and geographic origin. More effort is required to correct	Fairly representative data of Syrian society. Limitations of a cross-sectional study and online distribution method.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
		field. Chain-referral sampling in the online distribution phase and convenience sampling in the hard copy distribution phase.	Chi-square test and logistic regression.	side effects. 36.8% of participants agreed the vaccine is just a way for manufacturing companies to make money. 58.8% did not trust the vaccine formula. 29.5% think COVID-19 poses a major risk to them personally. 46% do not trust the rapid development of the vaccine. 37.3% believe other motives are not yet known for the vaccine. HCWs as the main source of information (50.9%), followed by social media (46.3%).	misinformation about the vaccine and answer all questions.	
Szymd et al., 2021 Poland Cross-sectional online survey	To identify any relationship between associate factors and the current state of knowledge regarding vaccination among student and their readiness to become vaccinated against SARS-CoV-2.	1971 medical students and non-medical students Medical: 687 students, 35.23% males, median age 21 (20–24). Non-medical: 1284 students, 56.70% males, median age 20 (19–22). Most grew up in the countryside and small cities (<50,000 residents). Recruited through institutional emails, university-affiliated websites, and social media.	Data were collected 22nd – 25th December 2020 on demographic data, previous SARS-CoV-2 infection in themselves and relatives, fear of getting COVID-19, willingness to get vaccinated and past medical history of mandatory and recommended vaccinations, and standardised Depression, Anxiety and Stress Scale. Student's *t*-test or the Mann-Whitney *U* test, Chi-square test, Yates-corrected chi-square, and binary logistic regression	91.99% of medical students and 59.42% of non-medical students indicated a desire to get vaccinated. Common concerns: Infecting elderly, post-COVID syndrome, and family/ own health deterioration. Medical students were less worried about side effects and would like to get vaccinated immediately rather than non-medical students. However, most wanted to get vaccinated in year 3, those studying in microbiology, paediatrics and infectious disease do not mind when. Medical students' greatest concern: Fever and malaise. Non-medical students' greatest concern: conspiracy theories (microchip implantation and government attempt to control birth count). Medical students showed a lower intensity of depression syndrome but a higher intensity of anxiety and stress – willingness to vaccinate was significantly amplified by the stress level.	Both groups willing to be vaccinated as their common concern was passing on the disease to elderly relatives. Medical students more willing due to greater health awareness obtained from clinical experience. Conspiracy theories are less popular among medical students due to greater knowledge and realisation. Both groups indicated concerns that vaccines may cause long-term effects e.g., autism.	One of first studies in Poland and worldwide exploring attitudes and behaviour towards COVID-19 among students. Sample size calculations was performed. Limitations of an online survey – not able to calculate response rate. Students who want to be vaccinated may be overrepresented in the study affecting results.
Tran et al., 2021 Russia	To identify determinants of COVID-19 vaccine acceptance in a high	876 participants: 74.3% females, 40% 18–25 years old, 7.3% over 60, and 63.6% university students.	Data were collected 26th September – 9th November 2020 on sociodemographic/ health-related	41.7% were willing to receive the vaccine if available. 27.6% believe the vaccine would help reduce the risk of virus	The study showed the usefulness of the health belief model constructs in understanding the COVID-19 vaccination	It provides a snapshot of the intention to vaccinate in a hypothetical situation.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
Cross-sectional survey	infection-rate country.	87.2% lived in urban areas. 69.5% did not have any chronic diseases. Snowball sampling method.	characteristics, willingness to vaccinate, and health beliefs related to vaccination. Logistic regression.	infection, and 28.8% believed it would reduce complications from the disease. 37.9% believed it would provide long-term immunity. 63.2% would be willing with verified the safety and effectiveness of the vaccine. 61.5% were worried about vaccine safety and effectiveness and 59.8% were worried about side effects. Males, people with lower incomes, and those who trust the healthcare system were most willing to accept the vaccine.	acceptance rate. The rate was influenced by sociodemographic and health-related characteristics. These findings might help guide future efforts for policymakers and stakeholders to improve vaccination rates by enhancing trust in the healthcare system.	Limitations of the snowball sampling method and online survey, which means only those with internet access can participate.
Velikonja et al., 2021 Slovenia, Poland & Serbia Cross-sectional survey	To investigate adherence to preventive measures and vaccination intentions among nursing students in three European countries and the factors associated with vaccination intention and advising vaccination.	872 nursing students – 252 from Slovenia, 353 from Poland, and 267 from Serbia: 89% female. 30.4% were already employed in the health sector. 8.9% worked occasionally. 60.7% were involved in clinical work only during clinical training. Recruited using convenience/snowball sampling.	Data collected from 12th February – 5th March 2021 on vaccination intention, acceptance, and attitudes. Descriptive analyses.	35% would vaccinate in Slovenia, 57% in Poland and 13% in Serbia. Reasons for acceptance were belief in the benefits of the vaccine, trust in institutions, and influence of the social environment. 22% would refuse in Slovenia, 7% in Poland, and 39% in Serbia. Reasons for refusal were fear of side effects and general refusion of vaccines.	Higher education institutions can support the development of appropriate professional attitudes and behaviours among nursing students.	A cross-national study in the Central and Eastern Europe. Student cohorts and vaccination strategies in the three countries differed significantly.
Verger et al., 2020 France, Belgium & Canada Cross-sectional survey	To measure the willingness of HCWs to accept the future COVID-19 vaccine and explore determinants of acceptance.	2678 HCWs: 1209 (43%) GPs in France, 414 (5%) GPs in French-speaking Belgium, and 1055 (27%) nurses in Quebec, Canada. France: 60.87% males. 51.27% aged 40–59 years, 36.57% >60 years. Recruited from a survey. Belgium: 52.78% males. 31.05% aged 40–59 years, 48.97% >60 years. Recruited via databases. Canada: 11.50% males. 48.05% aged 18–39 years, 45.68% aged between 40–59 years, 6.27% >60 years. Recruited randomly.	Data collected October –November 2020 on willingness to vaccinate and whether they would recommend vaccines to their patients using a 5-point scale, COVID-19 vaccine acceptance, the safety of the vaccine developed in an emergency, trust in science to develop safe and effective new vaccines, and whether they trust the ministry of health to ensure the vaccines are safe.	79.6% would certainly or probably recommend future COVID-19 vaccines to their patients. 72.4% would certainly or probably agree to be vaccinated. 40.9% reported safety of vaccines developed in an emergency during an epidemic cannot be guaranteed. Distrust in the Ministry of Health to ensure vaccine is safe also played a role in low COVID-19 vaccine acceptance.	HCWs should be among the first to receive the COVID-19 vaccine as a priority group because of being directly involved in patient care. Factors identified to influence their decision of intent to be vaccinated should be addressed as early as possible. Monitoring the side effects of authorised vaccines and regular feedback to HCWs is essential to ensure trust in the COVID-19 vaccines. Guidelines are needed to prove the effectiveness of the vaccine.	The model averaging approach enabled the obtaining of robust estimates and rank of explicative factors. Although a large sample size was obtained in France and Canada, the generalisation may not be confirmed.
Wang et al., 2020	To evaluate the acceptance of COVID-19 vaccination in China and give	2058 adult participants: 54.2% females. 50.2% aged 31–50	Data collected in March 2020 on sociodemographic data, self-risk perception of	91.3% would accept when one is available and 52.2% want to get vaccinated asap. 89.5%	Strong demand for and high acceptance of COVID-19 vaccination among the Chinese	The first study to investigate the acceptance of COVID-19 among a large

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
China Cross-sectional survey	suggestions for vaccination strategies and immunisation programmes accordingly.	years, 7.3% 51 + years. 67.3% married, 80.2% employed, 38.2% high school or below, and 55.4% with a degree. 79.6% living in urban areas. 74.2% thought their health status was good/very good. 51.2% of family income in 2019 CNY 50,000–150,000. Stratified random sampling to match by age and location.	COVID-19, impact of COVID-19 on work/study, income, and daily life, attitudes, acceptance for future COVID-19 vaccines, the importance of identified factors on vaccination decision-making (price, convenience, and doctor recommendations) using 5-point Likert scale. Multivariate logistic regression.	believe vaccination is effective. Factors in decision-making: Doctor's recommendation (80.6%), and convenience (75.7%). 59.5% considered price could reduce willingness to vaccinate – should be affordable for the public. 47.8% would wait until the safety of the vaccine is confirmed – unknown side effects. 49.4% preferred routine immunisation than an emergency (9%). 64.2% showed no preference for domestic or imported vaccines. Males, married, those perceiving a high risk of infection, previously vaccinated for Influenza, believing the efficiency of the COVID-19 vaccine and valuing doctor recommendations could increase acceptance. However, vaccine price and safety may hinder vaccine uptake.	population were shown. Health education and communication from authoritative sources are required to alleviate safety concerns.	population in China, providing baseline information for the ongoing monitoring of the acceptance of COVID-19 by the public. An offline survey is not feasible.
Yoda & Katsuyama, 2021 Japan Cross-sectional survey	To explore the willingness of people in Japan to be vaccinated or not to be vaccinated and the reasons for either decision.	1100 participants: 53.1% males, average age 44.8 years. 58.6% live in central area. 25.7% presently ill. Recruited through an internet research panel.	Data collected in September 2020 on demographic data, underlying health condition/history, willingness to be vaccinated or not, and reasons. Descriptive statistics, chi-squared test, and logistic regression.	65.7% were willing to be vaccinated. Males were more willing (68%) than females (63.2%). 70 + years more willing (77.2%). People with chronic disease were more willing (78.4%) than those who did not have (61.3%). People from rural areas were more willing (70.3%) than those in central areas (62.5%). Reasons: Assume the vaccine is an effective and preventable tool for them (86.4%), and for others (60.4%). Would accept as they would not need to continue with preventative measures (21.3%). 22% unsure and 12.3% refused. Reasons: Two-thirds were concerned about side effects (more common among women). One-fifth did not trust efficiency. They believed COVID-19 was not dangerous to	Vaccine hesitancy and refusal ratio were higher in Japan compared to other countries. Females, younger aged people, those unburdened by chronic disease, and central areas people felt more concerned about side effects. Policy efforts are required to make the country's vaccination programme viable.	The first study to examine the willingness of Japanese people to be vaccinated. Internet-based surveys may cause selection bias. Limitations of a cross-sectional survey design and use of a simple questionnaire that could not evaluate other factors.

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Author Year Country Design	Aim	Participants	Methods	Results	Conclusions	Strengths & Limitations
				their health (male 12.6%).		

3.3.3. Medical and non-medical students (n = 5)

Among the four studies conducted between medical and non-medical students [40,51,74,75], the highest acceptance rate was found among medical students with > 98% in the United States [40], followed by 91.99% from Poland [51], whilst the lowest acceptance rate was 59.42% among non-medical students from Poland. [51] Medical students were more willing to vaccinate and showed significantly lower fears of vaccination as they were more likely to trust public health experts and had greater awareness and understanding of this field because of their educational experience. [40,51] On the other hand, non-medical students were less willing to vaccinate due to the wide reach of conspiracy theories on social media that lead to beliefs such as restrictions on personal liberties, the possibility of microchip implantation, and the government's attempt to monitor birth rate. [51] Their willingness to vaccinate was significantly increased due to the fear of passing COVID-19 to their relatives. [51] This was supported by Barello et al.'s study, in which 86.1% were willing to vaccinate with no significant difference between medical and non-medical students and willingness to vaccinate was not due to knowledge but due to psychological factors such as the personal responsibility for the population health and social solidarity. [74] Mo et al.'s study in China also showed similar findings that the acceptance rate was not driven by student knowledge but by the cost of the vaccine as 78.9% would accept the vaccine if it was free and 60.2% would accept if it was self-paid. [75] Our updated search found one more study among nursing students in Europe, in which an acceptance rate of 35% was found when the COVID-19 vaccine was being administered in Europe at that time and the main reason for hesitation was the fear of possible side effects [45].

4. Discussion

Approximately 2.4 billion doses of vaccine have been administered globally as of June 2021. This contributes to only 20.8% of the world's population having received their first dose of the COVID-19 vaccine [76], whereas the latest estimate on COVID-19 herd immunity requires 60–75% of immunised individuals to contain the virus and stop the spread. [77,78] Therefore, the aim of this systematic review was not only to identify and synthesise evidence on cultural and social attitudes towards COVID-19 vaccination but also to explore the factors associated with vaccine acceptance in the adult population, which could inform possible solutions to increasing the uptake of the COVID-19 vaccines.

This review confirmed that people in East and Southeast Asian countries had a higher acceptance rate of COVID-19 vaccine > 80%. This is consistent with a recent study measuring vaccine acceptance and hesitancy which also reported the highest acceptance rate (>90%) among East and Southeast Asian countries that were attributable to the high level of trust in the government and strong confidence in vaccine safety. [46] The acceptance rate in European countries was about 60% due to concerns about vaccine safety coupled with low levels of trust among doctors and nurses. This issue has been shown in the Global Survey in 2016 reporting that the European region had the least confidence in vaccine safety. The lowest acceptance rate was found in the adult population of countries in the Middle East. A systematic review also confirmed the low acceptance rate in these countries, which is attributed to misconception and conspiracy theories, ultimately distorting public opinion and affecting vaccine uptake. [25]

In December 2020, Universal Mass Vaccination for COVID-19 was initiated in Europe, Israel, United Arab Emirates (UAE), and the US. [79] At the outset of the vaccination strategy, the primary concern revolved around determining the priority groups, given the limited vaccine supply. The goal was to minimise hospitalisation and deaths caused by COVID-19 by focusing on vulnerable populations, including the elderly, individuals with pre-existing health conditions, healthcare professionals, and essential workers who faced higher exposure risks due to their occupations. It was hoped that by vaccinating these groups first could alleviate strain on healthcare systems and reduce the severity of cases and mortality rates. As vaccine production increased, distribution efforts could then extend to encompass a wider demographic range [79,80].

This review found individuals over the age of 45-years-old were more willing to accept the COVID-19 vaccine as opposed to the younger age groups. This may be due to older people identifying themselves as a vulnerable group who are more at risk of contracting COVID-19 compared to younger individuals. A study by Larson et al. reported that those most susceptible to infection are more likely to accept vaccines [81], as a result, older people fear their immune system will not protect them from COVID-19 as effectively as the vaccine would. [59,67] In many countries, the distribution of the COVID-19 vaccine was stratified by age, and according to WHO recommendations in 2021, the elderly should be vaccinated first and lastly 18-year-olds. [11] However, this has implications for practice as it disregards young people as a priority for vaccination.

Although younger individuals may be less affected by the physical health consequences of COVID-19, they have become more socially and mentally vulnerable to the disruption caused by COVID-19 on their education and future, and see the vaccine as a way to normalise their lives. [82] The distribution of vaccines should not only prioritise age groups based on their physical vulnerability to COVID-19 but also consider one's mental and social vulnerability to the pandemic to meet the holistic needs of an individual. It is recognised that children tend to become infected more frequently and for a longer time during the annual flu, thus becoming a vector of disease transmission among older people who are insufficiently protected by the vaccine in the same household. [83] The willingness to vaccinate was found significantly higher for those under the age of 24 as they are concerned for the safety of their family members and fear infecting old relatives. [51] Therefore, further research is needed to understand young people's attitudes towards the COVID-19 vaccine, particularly on vaccination strategies in the paediatric population because it is unclear how infectious COVID-19 is in this group and how this affects the health of the old people in the same family. An effective vaccination strategy should also consider vaccinating children with old people in the same household to achieve herd immunity, which will potentially alleviate the burden on the healthcare systems [82,84].

A modelling study in Norway found that although rolling out vaccines in an age-descending order may reduce around one-third of infections, distributing the vaccines according to core-sociable groups may result in a further 10% fewer infections. [85] To tackle this, the European Union Digital COVID Certificate (EUDCC), or 'Green Pass' was introduced through Regulation (EU) 2021/953 of the European Parliament and of the Council allowing holders to freely move during the pandemic. By 23rd July 2021, the Green Pass allowed access to restaurants, gyms, public events, and parks to individuals aged 11 and above. By 6th August 2021, the Green Pass became mandatory for

Table 4
The intent to uptake vaccination (n = 38 studies).

Author/Year	Country	Participants	Vaccine acceptance rate
Studies with the general adult population (n = 24)			
Akarsu et al., 2021	Turkey	N = 759	49.7%
Al-Mohaithef and Padhi 2020	Saudi Arabia	N = 992	64.7%
Alqudeimat et al., 2021	Kuwait	N = 2368	53.1%
Bell et al., 2020	UK	N = 1242	90.1%
Chen et al., 2021	China	N = 3195	83.8%
El-Elimat et al., 2020	Jordan	N = 3100	37.5%
Fisher et al., 2020	United States	N = 991	57.6%
Freeman et al., 2020	United Kingdom	N = 5114	71.7%
Harapan et al., 2020	Indonesia	N = 1359	93.3%
Lazarus et al., 2021	China	N = 13,426	88.6%
	Brazil		85.4%81.6%
	South Africa		80%
	South Korea		76.2%
	Mexico		75.4%
	United States		74.5%74.3%
	India		72%
	Spain		72%
	Ecuador		70.8%
	United Kingdom		68.7%
	Italy		68.4%
	Canada		68%
	Germany		65.2%
	Singapore		65.2%
	Sweden		58.9%
	Nigeria		56.3%
	France		54.9%
	PolandRussia		
Magadmi and Kamel., 2021	Saudia Arabia	N = 3101	44.7%
Malik et al., 2020	United States	N = 672	67%
Murphy et al., 2021	IrelandUnited Kingdom	N = 1041 N = 2025	65%69%
Paul et al., 2021	United Kingdom	N = 32,361	63%
Pogue et al., 2020	United States	N = 316	68.6%
Prati, 2020	Italy	N = 624	75.8%
Reiter et al., 2020	United States	N = 2006	69%
Sallam et al., 2021	Saudi Arabia	N = 3414	31.8%28.4%
	JordanKuwait		23.6%
Seale et al., 2021	Australia	N = 1420	80%
Sherman et al., 2020	United Kingdom	N = 1500	64%
Shibani et al., 2021	Syria	N = 7531	37%
Tran et al., 2021	Russia	N = 876	41.7%
Wang et al., 2020	China	N = 2058	91.3%
Yoda and Katsuyama., 2021	Japan	N = 1100	65.7%
Studies with healthcare workers (n = 9)			
Adeniyi et al., 2021	South Africa	N = 1308	90.1%
Fares et al., 2021	Egypt	N = 385	21%
Holzmann-Littig et al., 2021	Germany	N = 4500	91.7%
Hussein et al., 2021	Egypt	N = 496	13.5%
Kose et al., 2020	Turkey – Izmir	N = 1138	68.6%
Nzaii et al., 2020	Congo	N = 613	27.7%
Shaw et al., 2021	United States	N = 5287	57.5%
Shekhar et al., 2021	United States	N = 3479	36%
Verger et al., 2020	France	N = 1209	
	Belgium Canada	N = 414 N = 1055	
Studies with medical and non-medical students (n = 5)			
Barello et al., 2020	Italy	N = 551 medical N = 383 non-medical	86.1% overall
Lucia et al., 2020	United States	N = 168 medical	>98%
Mo et al., 2021	China	N = 6922 medical and non-medical	78.9%
Szymd et al., 2021	Poland	N = 687 medicalN = 1284 non-medical	91.99%59.42%
Velikonja et al., 2021	Poland	N = 353 medical	57%
	SloveniaSerbia	N = 252 medicalN = 267 medical	35%13%

schools and universities, and by 10th September 2021, access to the workplace also necessitated the use of the Green Pass [86].

Our review also showed that men were more willing to accept the COVID-19 vaccine than women. An earlier study discovered that males who tested positive for COVID-19 had fewer antibodies in their plasma than females, resulting in a weaker immune response to COVID-19. [87] In addition, women had a more responsible attitude towards COVID-19 and preventive measures such as wearing face masks, frequent hand-washing and social distancing [88], and were 50% more likely than men to practice these preventive measures. [89] Men acknowledging their risk of COVID-19 positively influenced their intention to vaccinate, as self-risk perception played an essential role in the decision-making process. [68] The outbreak of misinformation through social media has created a gender gap as men were more likely to trust healthcare professionals' recommendations, while women gained knowledge from social media platforms leading to beliefs in vaccine and virus origin conspiracies. [30].

Women's reluctance to get vaccinated also prompt other members of the family and communities to do so, which could hamper global efforts to control the pandemic. To eliminate misinformation, women need tailored communication and encouragement from trusted persons to obtain reliable information about vaccines. [90] Therefore, government sources should empower local Grassroot organisers by providing them with the resources they need to reach out to people who require more education about the vaccine. [90] Where appropriate, HCWs (doctors and nurses) can also work alongside them to promote consistency in information giving [91,92].

The implications of misinformation regarding vaccine safety have led to an observed decline in the willingness to vaccinate as people cannot comprehend the severity of COVID-19. [93,94] The low acceptance rates among doctors and nurses have major implications in practice, as the intention to vaccinate not only involves them, but also affects the acceptance rate in the general adult population. This is because most people will accept vaccines if recommended by HCWs as they are considered a reliable and trustworthy source of information for vaccine knowledge. [68] In the study by Verger et al., 72.4% of doctors and nurses would accept the vaccine, and 79.6% would recommend the COVID-19 vaccine to their patients. [47] Whereas, in another study by Shekar et al., only 36% would accept the vaccine and 54% would recommend the vaccine until more information about the vaccine was available. [71] The large number of cases not only exceeds the hospital's capacity [92], but also affects the sustainability of health services and the care quality provided by HCWs during the pandemic [95,96].

Between February to April 2021, mandatory COVID-19 vaccination for HCWs was implemented, driven by concerns over the low uptake of COVID-19 vaccines among unvaccinated HCWs and the staffing difficulties arising from HCWs being absent from work due to illness, infection, or isolation. [97,98] Italy was the first country in Europe to make vaccination mandatory for HCWs and took measures such as placing unvaccinated HCWs on unpaid leave or transferring their roles [99], whilst in British Columbia, Canada, approximately 2,452 unvaccinated HCWs faced termination of employment once the mandate deadline expired. [100] COVID-19 vaccine mandates for HCWs generally proved effective in increasing vaccine uptake across most settings as it likely helped maintain service continuity. The penalties for

unvaccinated HCWs did not cause significant disruptions in health services, however, areas with fewer resources may have experienced a greater impact as HCWs had to work longer hours and additional days following the departure of their unvaccinated colleagues [101].

To overcome this problem, a multi-faceted and non-stigmatising method is required to share information from trusted sources, including policymakers and traditional media channels. [102,103] The European Medicines Agency succeeded in alleviating growing national concerns about the possible thrombosis following the AstraZeneca vaccine by concluding that the benefits of vaccines outweighed the risks. [104] This highlights the need for measures to address public acceptance, confidence, and concerns about the safety and benefits of approved vaccines. [94] Strategies have been implemented such as listening to the public's concerns, respecting different religious and cultural beliefs, and being aware of historically rooted mistrust and other ethical considerations surrounding clinical interventions [92].

Healthcare professionals' concerns must be first addressed as they can influence the local vaccination rates at a population level. A recent systematic review on vaccine hesitancy among HCWs in Europe reveals the same factors influencing reluctance to vaccinate including concerns about vaccine safety, efficacy, misinformation, distrust in healthcare authorities, or religious/cultural beliefs. [105] Addressing vaccine hesitancy among HCWs is crucial not only for their protection but also for maintaining public trust in vaccination programmes and preventing the spread of vaccine-preventable diseases within healthcare settings. With better knowledge, healthcare professionals can use the ''elicit-share-elicit'' approach where they ask open-ended questions to identify individual concerns and then share appropriate support to address these concerns. [92] This gives people the opportunity to voice their concerns, which in turn can provide appropriate support to dispel their doubts about the vaccine. Therefore, a comprehensive multi-component approach tailored to the local population was recommended, combined with good communication at an individual level. [91]

A large cross-sectional survey on COVID-19 vaccination willingness among healthcare students and professionals has unveiled generational patterns that shed light on vaccine acceptance within this demographic. [106] The findings suggest variations in vaccination willingness across different age groups, with younger healthcare students and professionals exhibiting higher levels of hesitancy compared to their older counterparts. Possible factors contributing to this trend may include differences in risk perception, exposure to misinformation, and varying levels of trust in healthcare systems and authorities. Understanding these generational patterns is crucial for designing targeted education and training interventions on vaccine-related topics to increase knowledge among healthcare students and professionals that will then contribute to public health efforts in combating COVID-19.

4.1. Recommendations for future practice and research

The findings of this review endorse the need for better promotion of public health education initiatives aimed at young people, females, and non-medical students, who were identified to be the least willing to receive the COVID-19 vaccine. Due to misinformation accessed through social media platforms, doubts about the vaccine's safety and efficacy are the most common factors influencing vaccine acceptance. Therefore, increased positive messaging from government sources and healthcare professionals is essential to build public confidence in vaccination programmes. [93] This requires adequate education and communication to be delivered accordingly to raise public awareness and knowledge. Effective communication is essential for resolving issues, clearing myths, and building trust. Tailoring communication strategies to different demographics, considering cultural sensitivities, and utilising various channels (e.g., social media, conventional media, and community outreach) can enhance the reach and impact of the message. Future vaccine promotion strategies should provide more detailed information about the vaccine instead of only claiming that they are safe and effective. Explaining the vaccine development process from recruitment to regulatory approval based on safety, vaccine effectiveness, and the importance of vaccinating the population to achieve herd immunity may have a positive impact on the uptake of vaccines and ease some of the burden on the health system [24].

The majority of the studies included in this review were conducted in developed countries, which questions whether the identified factors may differ in less developed countries like India. Future research is needed in less developed countries to provide sufficient support to expand vaccination internationally to achieve herd immunity. More studies with longitudinal designs are needed to assess the trends of whether vaccine intake increases or decreases after the formulation of vaccine promotion strategies to examine the long-term efficacy of these strategies. In addition, qualitative research specifically conducted among the most vaccine-averse groups could be beneficial because it can provide a better understanding of their concerns and how to address them appropriately.

Understanding the importance of information, communication, and organisational strategies is crucial in determining the acceptability of numerous booster doses and coadministration in the present epidemiological landscape. A study found the third dose (booster) provided significant protection against severe outcomes (85–87%), with continued efficacy even after the fourth dose. This suggests that the booster doses considerably increased immunity, reducing the risk of severe illness following vaccination. Although there was a reduction in protection compared to the third dose, the fourth dose still provided a significant degree of effectiveness, ranging from 86% to 89%. [107] Stefanizzi et al. investigated the acceptance of co-administering the third dose of the COVID-19 vaccine along with the influenza vaccine among HCWs in Italy and a 60% acceptance rate was reported. The findings suggest that simultaneous administration of the COVID-19 and influenza vaccines among HCWs is feasible and well-received, potentially serving as a model for broader vaccination strategies in the general population.

Clear and accurate information about the necessity, safety, and efficacy of booster doses is essential. This information should be easily accessible to the public, healthcare professionals, policymakers, and stakeholders. Providing data on vaccine efficacy declining over time, the emergence of new variants, and the benefits of booster doses can all assist in increasing knowledge and acceptability. Additionally. engaging the public in decision-making processes promotes transparency and accountability. Soliciting feedback, addressing concerns, and including communities in vaccine rollout plans can enhance acceptance and uptake of booster doses [108].

Continuous monitoring of vaccine coverage, adverse events, and public attitudes allows for swift changes to strategies. Surveillance methods for vaccine safety and effectiveness are crucial for identifying issues and maintaining public trust. Regular evaluation of communication efforts assists in identifying areas for improvement and ensuring messages are comprehended by the intended audience. Prioritising these strategies allows for more successful navigation of booster doses and coadministration, which contributes to overall public health goals in fighting against infectious diseases [109].

4.2. Limitations

Any reviews, commentary/opinion papers, editorials, and grey literature including third sector and government reports and briefings, educational theses, and conference proceedings were excluded. We may have missed important evidence from this. Meta-analysis was not possible due to the diversity in the characteristics of the included studies. Only studies written in English were included, which may limit the cultural diversity and generalisability of the findings of this review. Offline surveys were not feasible due to the lockdown. The disadvantages of using an online survey, are that it increases selection bias which affects how representative the sample is to the overall population e.g., only those with internet can access the survey. Also, this review only

assessed adults' attitudes towards the vaccine and associated factors, and the perspectives of young people and children will need to be investigated in future studies. This review consisted of cross-sectional studies conducted at one-time point; therefore, it is difficult to know whether the acceptance rate and identified factors will change over time without further investigation.

5. Conclusion

Recommendations from healthcare professionals and government sources, and the perceived increased risk of contracting COVID-19 were identified to be the most common factors influencing vaccine acceptance, especially in East Asia and Southeast Asia. However, the acceptance rates varied globally due to unknown side effects, doubts about effectiveness and safety, and belief in conspiracy theories being the most influential factors for reluctance to vaccinate, especially in the countries of the Middle East. At a time when herd immunity is critical, the high acceptance rate of the COVID-19 vaccine may act as an important step in global efforts to control the pandemic. Therefore, this review informs future policies to address people's concerns and increase their understanding of vaccines to counteract misinformation and increase vaccine acceptance. Evidence-based training on vaccines and vaccination strategies should be provided for healthcare professionals. However, future research is needed to further explore the influential factors, so that education and communication can be tailored appropriately and targeted at those least willing to receive the vaccine.

Contributors

PG and TB conceptualised and designed the research, with input from NE and CB. TB developed search terms and performed the searches and study selection, extracted, and analysed data, and drafted the first version of the manuscript with the guidance of PG. NE, CB, and PG contributed to editing for intellectual content and interpretation of data. All authors extensively revised the manuscript and approved the final version.

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Patient consent for publication

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Ethics approval

As this is a systematic review of published literature, ethics approval was not required.

Provenance and peer review

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Data availability statement

All data relevant to the study are included in the article or uploaded as online supplemental information.

Records identified from: Database searching (n = 1153) and Google Scholar and manual searching (n = 107).

CRediT authorship contribution statement

Tasniah Begum: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Nikolaos Efstathiou:** Writing – review & editing, Validation. **Cara Bailey:** Writing – review & editing, Validation. **Ping Guo:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization.

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

No data was used for the research described in the article.

References

[1] Liu YC, Kuo RL, Shih SR. COVID-19: The first documented coronavirus pandemic in history. Biomed J 2020;43(328–333):20200505. https://doi.org/10.1016/j.bj.2020.04.007.
[2] World Health Organization. WHO Director - General's opening remarks at the media briefing on COVID-1 - 11 March 2020, https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020 (2020, accessed 07/06/2021).
[3] Bhattacharya S, Basu P and Poddar S. Changing epidemiology of SARS-CoV in the context of COVID-19 pandemic. *J Prev Med Hyg* 2020; 61: E130-e136. 2020/08/18. DOI: 10.15167/2421-4248/jpmh2020.61.2.1541.
[4] World Health Organization. Rolling updates on coronavirus disease (COVID-19), https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen (2021, accessed 27/03/2021).
[5] WORLDOMETER. COVID-19 Coronavirus Pandemic, https://www.worldometers.info/coronavirus/ (2024, accessed 19/02/2024).
[6] Centers for Disease Control and Prevention. Protect Yourself, https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html (2021, accessed 07/06/2021).
[7] Girum T, Lentiro K, Geremew M, Migora B, Shwamare S. Global strategies and effectiveness for COVID-19 prevention through contact tracing, screening, quarantine, and islation: a systematic review. *Trop*. Med Health 2020;48. https://doi.org/10.1186/s41182-020-00285-w.
[8] Viner MR, Russel JS, Croker H, Packer J, Stansfield C, Mytton O, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. Lancet Child Adolesc Health 2020;4:397–404. https://doi.org/10.1016/S2352-4642(20)30095-X.
[9] Chiesa V, Antony G, Wismar M, et al. COVID-19 pandemic: health impact of staying at home, social distancing and 'lockdown' measures-a systematic review of systematic reviews. J Public Health (Oxf) 2021;43:e462–81. https://doi.org/10.1093/pubmed/fdab102.
[10] Nicola M, Alsafi Z, Sohrabi C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. Int J Surg 2020;78(185–193):20200417. https://doi.org/10.1016/j.ijsu.2020.04.018.
[11] World Health Organization. How do vaccines work?, https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work (2021, accessed 22/12/2021).
[12] Al-Qerem WA, Jarab AS. COVID-19 vaccination acceptance and its associated factors among a Middle Eastern population. Front Public Health 2021;9(632914):20210210. https://doi.org/10.3389/fpubh.2021.632914.
[13] Brown P, Waite F, Larkin M, et al. "It seems impossible that it's been made so quickly": a qualitative investigation of concerns about the speed of COVID-19 vaccine development and how these may be overcome. *Hum Vaccin Immunother* 2022; 18: 2004808. 2022/02/18. DOI: 10.1080/21645515.2021.2004808.
[14] Lin L, Zhao Y, Chen B, et al. Multiple COVID-19 waves and vaccination effectiveness in the United States. Int J Environ Res Public Health. 2022;19. https://doi.org/10.3390/ijerph19042282.
[15] Doke PP, Mhaske ST, Oka G, et al. SARS-CoV-2 breakthrough infections during the second wave of COVID-19 at Pune. India. Front Public Health 2023;10:1040012. https://doi.org/10.3389/fpubh.2022.1040012.
[16] Thompson MG, Burgess JL, Naleway AL, et al. Interim estimates of vaccine effectiveness of BNT162b2 and mRNA-1273 COVID-19 vaccines in preventing SARS-CoV-2 infection among health care personnel, first responders, and other essential and frontline workers - eight U.S. locations, December 2020-March 2021. *MMWR Morb Mortal Wkly Rep* 70 (2021) 495-500. DOI: 10.15585/mmwr.mm7013e3.
[17] Tartof SY, Slezak JM, Fischer H, et al. Effectiveness of mRNA BNT162b2 COVID-19 vaccine up to 6 months in a large integrated health system in the USA: a retrospective cohort study. *Lancet* 2021; 398: 1407-1416. 2021/10/08. DOI: 10.1016/s0140-6736(21)02183-8.
[18] Kroidl I, Mecklenburg I, Schneiderat P, et al. Vaccine breakthrough infection and onward transmission of SARS-CoV-2 Beta (B.1.351) variant, Bavaria, Germany, February to March 2021. *Euro Surveill* 2021; 26. DOI: 10.2807/1560-7917.Es.2021.26.30.2100673.
[19] Moscara L, Venerito V, Martinelli A, et al. Safety profile and SARS-CoV-2 breakthrough infections among HCWs receiving anti-SARS-CoV-2 and influenza

vaccines simultaneously: an Italian observational study. Vaccine 2023;41: 5655–61. https://doi.org/10.1016/j.vaccine.2023.07.043.
[20] Teran RA, Walblay KA, Shane EL, et al. Postvaccination SARS-CoV-2 infections among skilled nursing facility residents and staff members - Chicago, Illinois, December 2020-March 2021. Am J Transplant 2021;21:2290–7. https://doi.org/10.1111/ajt.16634.
[21] Bergwerk M, Gonen T, Lustig Y, et al. Covid-19 breakthrough infections in vaccinated health care workers. N Engl J Med 2021;385:1474–84. https://doi.org/10.1056/NEJMoa2109072.
[22] Alishaq M, Nafady-Hego H, Jeremijenko A, et al. Risk factors for breakthrough SARS-CoV-2 infection in vaccinated healthcare workers. *PLoS One* 2021; 16: e0258820. DOI: 10.1371/journal.pone.0258820.
[23] Biswas N, Mustapha T, Khubchandani J, et al. The nature and extent of COVID-19 vaccination hesitancy in healthcare workers. J Community Health 2021;46 (1244–1251):20210420. https://doi.org/10.1007/s10900-021-00984-3.
[24] Lazarus JV, Ratzan SC, Palayew A, et al. A global survey of potential acceptance of a COVID-19 vaccine. Nat Med 2021;27(225–228):20201020. https://doi.org/10.1038/s41591-020-1124-9.
[25] Sallam M. COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. Vaccines 2021;9:160. https://doi.org/10.3390/vaccines9020160.
[26] Karlsson LC, Soveri A, Lewandowsky S, et al. Fearing the disease or the vaccine: The case of COVID-19. Pers Individ Dif 2021;172(110590):20201214. https://doi.org/10.1016/j.paid.2020.110590.
[27] Scheres J, and Kuszewski, K. The Ten Threats to Global Health in 2018 and 2019. A welcome and informative communication of WHO to everybody. *Zdrowie Publiczne Zarzadnie* 2019; 17: 2-8. DOI: 10.4467/20842627OZ.19.001.11297.
[28] Mahase E. Covid-19: UK approves Pfizer and BioNTech vaccine with rollout due to start next week. BMJ 2020;371(m4714):20201202. https://doi.org/10.1136/bmj.m4714.
[29] Hanif W, Ali SN, Khunti K. Cultural competence in covid-19 vaccine rollout. BMJ 2020;371. https://doi.org/10.1136/bmj.m4845.
[30] Lin C, Tu P, Beitsch LM. Confidence and receptivity for COVID-19 vaccines: a rapid systematic review. Vaccines (Basel) 2020;9 20201230. https://doi.org/10.3390/vaccines9010016.
[31] Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS Med 2009;6(e1000100): 20090721. https://doi.org/10.1371/journal.pmed.1000100.
[32] Aromataris E and Munn Z. JBI Manual for Evidence Synthesis, https://synthesismanual.jbi.global (2020, accessed 19.02 2024).
[33] Cooke A, Smith D, Booth A. Beyond PICO: the SPIDER tool for qualitative evidence synthesis. Qual Health Res 2012;22(1435–1443):20120724. https://doi.org/10.1177/1049732312452938.
[34] Baumann N. How to use the medical subject headings (MeSH). Int J Clin Pract 2016;70(171–174):20160113. https://doi.org/10.1111/ijcp.12767.
[35] Downes MJ, Brennan ML, Williams HC, et al. Development of a critical appraisal tool to assess the quality of cross-sectional studies (AXIS). BMJ Open 2016;6 (e011458):20161208. https://doi.org/10.1136/bmjopen-2016-011458.
[36] Long HA, French DP, Brooks JM. Optimising the value of the critical appraisal skills programme (CASP) tool for quality appraisal in qualitative evidence synthesis. Research Methods in Medicine & Health Sciences 2020;1:31–42. https://doi.org/10.1177/2632084320947559.
[37] Popay J, Roberts H, Sowden A, et al. Guidance on the conduct of narrative synthesis in systematic reviews. A product from the ESRC methods programme Version 2006;1:b92.
[38] Lisy K, Porritt K. Narrative synthesis: considerations and challenges. JBI Evid Implement 2016;14.
[39] Bell S, Clarke R, Mounier-Jack S, et al. Parents' and guardians' views on the acceptability of a future COVID-19 vaccine: A multi-methods study in England. Vaccine 2020;38(7789–7798):20201019. https://doi.org/10.1016/j.vaccine.2020.10.027.
[40] Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. J Public Health (Oxf) 2021;43:445–9. https://doi.org/10.1093/pubmed/fdaa230.
[41] Paul E, Steptoe A, Fancourt D. Attitudes towards vaccines and intention to vaccinate against COVID-19: Implications for public health communications. Lancet Reg Health Eur 2021;1:100012. https://doi.org/10.1016/j.lanepe.2020.100012.
[42] Levin KA. Study design III: Cross-sectional studies. Evid Based Dent 2006;7:24–5. https://doi.org/10.1038/sj.ebd.6400375.
[43] Holzmann-Littig C, Braunisch MC, Kranke P, et al. COVID-19 vaccination acceptance and hesitancy among healthcare workers in Germany. Vaccines (Basel) 2021;9 20210712. https://doi.org/10.3390/vaccines9070777.
[44] Shibani M, Alzabibi MA, Mouhandes AE, et al. COVID-19 vaccination acceptance among Syrian population: a nationwide cross-sectional study. BMC Public Health 2021;21(2117):20211118. https://doi.org/10.1186/s12889-021-12186-6.
[45] Kregar Velikonja N, Dobrowolska B, Stanisavljević S, et al. Attitudes of nursing students towards vaccination and other preventive measures for limitation of COVID-19 pandemic: cross-sectional study in three European countries. Healthcare (Basel) 2021;9 20210622. https://doi.org/10.3390/healthcare9070781.
[46] Sallam M, Dababseh D, Eid H, et al. High rates of COVID-19 vaccine hesitancy and its association with conspiracy beliefs: a study in Jordan and Kuwait among other Arab countries. Vaccines (Basel) 2021;9 20210112. https://doi.org/10.3390/vaccines9010042.
[47] Verger P, Scronias D, Dauby N, et al. Attitudes of healthcare workers towards COVID-19 vaccination: a survey in France and French-speaking parts of Belgium and Canada, 2020. *Euro Surveill* 2021; 26. DOI: 10.2807/1560-7917.Es.2021.26.3.2002047.
[48] Murphy J, Vallières F, Bentall RP, et al. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. Nat Commun 2021;12(29):20210104. https://doi.org/10.1038/s41467-020-20226-9.
[49] Chen H, Li X, Gao J, et al. Health belief model perspective on the control of COVID-19 vaccine hesitancy and the promotion of vaccination in China: web-based cross-sectional study. J Med Internet Res 2021;23(e29329):20210906. https://doi.org/10.2196/29329.
[50] Freeman D, Loe BS, Chadwick A, et al. COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II. Psychol Med 2022;52(3127–3141):20201211. https://doi.org/10.1017/s0033291720005188.
[51] Szmyd B, Bartoszek A, Karuga FF, et al. Medical students and SARS-CoV-2 vaccination: attitude and behaviors. Vaccines (Basel) 2021;9 20210205. https://doi.org/10.3390/vaccines9020128.
[52] Harapan H, Wagner AL, Yufika A, et al. Acceptance of a COVID-19 vaccine in Southeast Asia: a cross-sectional study in Indonesia. Front Public Health 2020;8 (381):20200714. https://doi.org/10.3389/fpubh.2020.00381.
[53] Wang J, Jing R, Lai X, et al. Acceptance of COVID-19 vaccination during the COVID-19 pandemic in China. Vaccines (Basel) 2020;8 20200827. https://doi.org/10.3390/vaccines8030482.
[54] Seale H, Heywood AE, Leask J, et al. Examining Australian public perceptions and behaviours towards a future COVID-19 vaccine. BMC Infect Dis 2021;21. https://doi.org/10.1186/s12879-021-05833-1.
[55] Prati G. Intention to receive a vaccine against SARS-CoV-2 in Italy and its association with trust, worry and beliefs about the origin of the virus. Health Educ Res 2020;35:505–11. https://doi.org/10.1093/her/cyaa043.
[56] Sherman SM, Smith LE, Sim J, et al. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey. Hum Vaccin Immunother 2021; 17(1612–1621):20201126. https://doi.org/10.1080/21645515.2020.1846397.
[57] Malik AA, McFadden SM, Elharake J, et al. Determinants of COVID-19 vaccine acceptance in the US. EClinicalMedicine 2020;26(100495):20200812. https://doi.org/10.1016/j.eclinm.2020.100495.
[58] Yoda T, Katsuyama H. Willingness to receive COVID-19 vaccination in Japan. Vaccines (Basel) 2021;9 20210114. https://doi.org/10.3390/vaccines9010048.
[59] Al-Mohaithef M, Padhi BK. Determinants of COVID-19 vaccine acceptance in Saudi Arabia: a web-based national survey. J Multidiscip Healthc 2020;13 (1657–1663):20201120. https://doi.org/10.2147/jmdh.S276771.
[60] Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: How many people would get vaccinated? Vaccine 2020;38:6500–7. https://doi.org/10.1016/j.vaccine.2020.08.043.
[61] Pogue K, Jensen JL, Stancil CK, et al. Influences on attitudes regarding potential COVID-19 vaccination in the United States. Vaccines (Basel) 2020;8 20201003. https://doi.org/10.3390/vaccines8040582.
[62] Alqudeimat Y, Alenezi D, AlHajri B, et al. Acceptance of a COVID-19 vaccine and its related determinants among the general adult population in Kuwait. Med Princ Pract 2021;30(262–271):20210122. https://doi.org/10.1159/000514636.
[63] Akarsu B, Canbay Özdemir D, Ayhan Baser D, et al. While studies on COVID-19 vaccine is ongoing, the public's thoughts and attitudes to the future COVID-19 vaccine. Int J Clin Pract 2021;75(e13891):20201219. https://doi.org/10.1111/ijcp.13891.
[64] Magadmi RM, Kamel FO. Beliefs and barriers associated with COVID-19 vaccination among the general population in Saudi Arabia. BMC Public Health 2021;21(1438):20210721. https://doi.org/10.1186/s12889-021-11501-5.
[65] El-Elimat T, AbuAlSamen MM, Almomani BA, et al. Acceptance and attitudes toward COVID-19 vaccines: A cross-sectional study from Jordan. PLoS One 2021; 16(e0250555):20210423. https://doi.org/10.1371/journal.pone.0250555.
[66] Tran VD, Pak TV, Gribkova EI, et al. Determinants of COVID-19 vaccine acceptance in a high infection-rate country: a cross-sectional study in Russia. Pharm Pract (Granada) 2021;19(2276):20210322. https://doi.org/10.18549/PharmPract.2021.1.2276.
[67] Shaw J, Stewart T, Anderson KB, et al. Assessment of US healthcare personnel attitudes towards coronavirus disease 2019 (COVID-19) vaccination in a large university healthcare system. Clin Infect Dis 2021;73:1776–83. https://doi.org/10.1093/cid/ciab054.
[68] Kabamba Nzaji M, Kabamba Ngombe L, Ngoie Mwamba G, et al. Acceptability of vaccination against COVID-19 among healthcare workers in the democratic republic of the Congo. Pragmat Obs Res 2020;11(103–109):20201029. https://doi.org/10.2147/por.S271096.
[69] Kose SM, A; Sahin, S; Kaynar, T; Karbus, O; and Ozbel, Y. Vaccine hesitancy of the COVID-19 by health care personnel. *Int J Clin Pract* 2020; 75. DOI: 10.1111/ijcp.13917.
[70] Fisher KA, Bloomstone SJ, Walder J, et al. Attitudes toward a potential SARS-CoV-2 vaccine: a survey of U.S. adults. Ann Intern Med 2020;173(964–973): 20200904. https://doi.org/10.7326/m20-3569.
[71] Shekhar R, Sheikh AB, Upadhyay S, et al. COVID-19 vaccine acceptance among health care workers in the United States. Vaccines (Basel) 2021;9. https://doi.org/10.3390/vaccines9020119.
[72] Fares S, Elmnyer MM, Mohamed SS, et al. COVID-19 vaccination perception and attitude among healthcare workers in Egypt. J Prim Care Community Health 2021;12. https://doi.org/10.1177/21501327211013303.

[73] Hussein AAM, Galal I, Makhlouf NA, et al. A national survey of potential acceptance of COVID-19 vaccines in healthcare workers in Egypt. *medRxiv* 2021: 2021.2001.2011.21249324. DOI: 10.1101/2021.01.11.21249324.
[74] Barello S, Nania T, Dellafiore F, et al. 'Vaccine hesitancy' among university students in Italy during the COVID-19 pandemic. Eur J Epidemiol 2020;35 (781–783):20200806. https://doi.org/10.1007/s10654-020-00670-z.
[75] Mo PKH, Yu Y, Luo S, et al. Dualistic determinants of COVID-19 vaccination intention among university students in China: from perceived personal benefits to external reasons of perceived social benefits, collectivism, and national pride. Vaccines (Basel) 2021;9 20211115. https://doi.org/10.3390/vaccines9111323.
[76] Data OWi. Coronavirus (COVID-19) Vaccinations, https://ourworldindata.org/covid-vaccinations (2021, accessed 16/06/2021).
[77] Aschwanden C. Five reasons why COVID herd immunity is probably impossible, https://www.nature.com/articles/d41586-021-00728-2 (2021, accessed 19/06/2021).
[78] Britton T, Ball F, Trapman P. A mathematical model reveals the influence of population heterogeneity on herd immunity to SARS-CoV-2. Science 2020;369 (846–849):20200623. https://doi.org/10.1126/science.abc6810.
[79] Stefanizzi P, Bianchi FP, Brescia N, et al. Vaccination strategies between compulsion and incentives. The Italian Green Pass experience. Expert Rev Vaccines 2022;21:423–5. https://doi.org/10.1080/14760584.2022.2023012.
[80] Klimek P. Why we may need to rethink future SARS-CoV-2 vaccination strategies. *The Lancet Regional Health* –. Europe 2021;10. https://doi.org/10.1016/j.lanepe.2021.100214.
[81] Larson HJ, Jarrett C, Eckersberger E, et al. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. Vaccine 2014;32(2150–2159):20140302. https://doi.org/10.1016/j.vaccine.2014.01.081.
[82] Verger P, Peretti-Watel P. Understanding the determinants of acceptance of COVID-19 vaccines: a challenge in a fast-moving situation. *Lancet*. Public Health 2021;6. https://doi.org/10.1016/s2468-2667(21)00029-3.
[83] Glezen WP. Herd protection against influenza. J Clin Virol 2006;37(237–243): 20060926. https://doi.org/10.1016/j.jcv.2006.08.020.
[84] Giubilini A, Savulescu J, Wilkinson D. COVID-19 vaccine: vaccinate the young to protect the old? J Law Biosci 2020;7(lsaa050):20200626. https://doi.org/10.1093/jlb/lsaa050.
[85] Li R, Bjørnstad ON, Stenseth NC. Prioritizing vaccination by age and social activity to advance societal health benefits in Norway: a modelling study. *The Lancet Regional Health* –. Europe 2021;10. https://doi.org/10.1016/j.lanepe.2021.100200.
[86] Roncati L, Roncati M. COVID-19 "Green Pass": a lesson on the proportionality principle from Galicia. Eur J Health Law 2021;28:525–32. https://doi.org/10.1163/15718093-bja10055.
[87] Zeng F, Dai C, Cai P, et al. A comparison study of SARS-CoV-2 IgG antibody between male and female COVID-19 patients: A possible reason underlying different outcome between sex. J Med Virol 2020;92(2050–2054):20200522. https://doi.org/10.1002/jmv.25989.
[88] Bwire GM. Coronavirus: why men are more vulnerable to Covid-19 than women? SN Compr Clin Med 2020;2(874–876):20200604. https://doi.org/10.1007/s42399-020-00341-w.
[89] Moran KR, Del Valle SY. A meta-analysis of the association between gender and protective behaviors in response to respiratory epidemics and pandemics. PLoS One 2016;11(e0164541):20161021. https://doi.org/10.1371/journal.pone.0164541.
[90] Leader L and Robinson L. Why women are 'critical' to Covid-19 vaccine distribution and acceptance, https://www.msnbc.com/know-your-value/feature/why-women-are-critical-covid-19-vaccine-distribution-acceptance-ncna1263186 (2021, accessed 29/06/2021).
[91] Jarrett C, Wilson R, O'Leary M, et al. Strategies for addressing vaccine hesitancy - A systematic review. Vaccine 2015;33(4180–4190):20150418. https://doi.org/10.1016/j.vaccine.2015.04.040.
[92] Razai MS, Chaudhry UAR, Doerholt K, et al. Covid-19 vaccination hesitancy. BMJ 2021;373(1138):20210520. https://doi.org/10.1136/bmj.n1138.
[93] Loomba S, de Figueiredo A, Piatek SJ, et al. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. Nat Hum Behav 2021;5(337–348):20210205. https://doi.org/10.1038/s41562-021-01056-1.
[94] Robinson E, Jones A, Lesser I, et al. International estimates of intended uptake and refusal of COVID-19 vaccines: A rapid systematic review and meta-analysis of large nationally representative samples. Vaccine 2021;39(2024–2034): 20210206. https://doi.org/10.1016/j.vaccine.2021.02.005.
[95] Al-Thobaity AA, S.; Plummer, V. and Williams, B. Exploring the necessary disaster plan components in Saudi Arabian hospitals. *Int J Distaster Risk Reduct* 2019; 41. DOI: 10.1016/j.ijdrr.2019.101316.
[96] Al-Thobaity A, Alshammari F. Nurses on the frontline against the COVID-19 pandemic: an integrative review. Dubai Med J 2020;3:87–92. https://doi.org/10.1159/000509361.
[97] Dzieciolowska S, Hamel D, Gadio S, et al. Covid-19 vaccine acceptance, hesitancy, and refusal among Canadian healthcare workers: A multicenter survey. Am J Infect Control 2021;49:1152–7. https://doi.org/10.1016/j.ajic.2021.04.079.
[98] Gohar B, Larivière M, Nowrouzi-Kia B. Sickness absence in healthcare workers during the COVID-19 pandemic. Occup Med 2020;70:338–42. https://doi.org/10.1093/occmed/kqaa093.
[99] Marta P. Covid-19: Italy makes vaccination mandatory for healthcare workers. BMJ 2021;373:n905. https://doi.org/10.1136/bmj.n905.
[100] Kretzel L. 2,452 B.C. health-care workers fired for not getting COVID vaccination, https://vancouver.citynews.ca/2022/02/24/bc-health-care-workers-fired-covid-vaccination/ (2022, accessed 30/04/2024).
[101] Okpani AI, Adu P, Paetkau T, et al. Are COVID-19 vaccination mandates for healthcare workers effective? A systematic review of the impact of mandates on increasing vaccination, alleviating staff shortages and decreasing staff illness. Vaccine 2024;42:1022–33. https://doi.org/10.1016/j.vaccine.2024.01.041.
[102] Arede M, Bravo-Araya M, Bouchard É, et al. Combating vaccine hesitancy: teaching the next generation to navigate through the post truth era. Front Public Health 2018;6(381):20190114. https://doi.org/10.3389/fpubh.2018.00381.
[103] Tull K. *Vaccine hesitancy: guidance and interventions*. 2019. Brighton, UK: Institute of Development Studies.
[104] Hunter PR. Thrombosis after covid-19 vaccination. BMJ 2021;373(958): 20210414. https://doi.org/10.1136/bmj.n958.
[105] Kaur M, Coppeta L, Olesen OF. Vaccine hesitancy among healthcare workers in Europe: a systematic review. Vaccines 2023;11:1657.
[106] Tomietto M, Simonetti V, Comparcini D, et al. A large cross-sectional survey of COVID-19 vaccination willingness amongst healthcare students and professionals: Reveals generational patterns. J Adv Nurs 2022;78:2894–903. https://doi.org/10.1111/jan.15222.
[107] Grewal R, Nguyen L, Buchan SA, et al. Effectiveness of mRNA COVID-19 vaccine booster doses against Omicron severe outcomes. Nat Commun 2023;14:1273. https://doi.org/10.1038/s41467-023-36566-1.
[108] Wong MTJ, Dhaliwal SS, Balakrishnan V, et al. Effectiveness of booster vaccinations on the control of COVID-19 during the spread of Omicron variant in Malaysia. Int J Environ Res Public Health 2023; 20 2023/01/22.. https://doi.org/10.3390/ijerph20021647.
[109] Valley TS, Scherer AM, Knaus M, et al. Prior vaccination and effectiveness of communication strategies used to describe infectious diseases. *Emerg Infect Dis* 2019; 25: 821-823. 2019/03/19. DOI: 10.3201/eid2504.171408.