CLINICAL AND EXPERIMENTAL VACCINE RESEARCH

COVID-19 vaccine hesitancy among medical students, health professionals, and health care workers: an umbrella review

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Vaccination provides great protection against several infections, including coronavirus disease 2019 (COVID-19). However, the endeavor faces multiple context-specific problems that affect its uptake, leading to vaccine hesitancy. Vaccine hesitancy is a focal barrier to the success of COVID-19 vaccination programs. This umbrella review aimed to present a summary of global data regarding vaccine hesitancy and acceptance rates among medical students, health professionals, and health care workers. In this regard, two databases, PubMed and Scopus, were selected for data retrieval and analysis. A search term and an inclusion/exclusion criterion were applied to summarize the findings of existing systematic reviews. A pooled prevalence of vaccine acceptance and hesitancy with 95% confidence interval (CI) was taken as a prerequisite for this review. The results found a high percentage of COVID-19 vaccination ranging from 13.1% (95% CI, 6.9%–20.9%) to 46% (95% CI, 0.38%–0.54%), while the percentage of acceptance varied from 46% (95% CI, 37%–54%) to 83.0% (95% CI, 71%–96%) among medical students, health professionals, and health care workers. This umbrella review found a high percentage of COVID-19 vaccine hesitancy among medical students, health professionals, and health care workers. Further studies analyzing the determinants of vaccine hesitancy are important predictors for successful vaccination programs at the global level.

Keywords: COVID-19, Vaccine hesitancy, Vaccine acceptance, Health care workers, Medical professionals

Introduction

The coronavirus disease 2019 (COVID-19) pandemic showed the devastating effects on both the world economy and population health. Despite the effectiveness of hygienic and behavioral control measures in combating pandemics, vaccinations have been proved as the single most important way to offer disease protection and to decrease the infection outbreak [1]. Considering that, enormous efforts have been accompanied globally for vaccine development and initiation of vaccination programs to control the COVID-19 pandemic.

Disease prevention and protection through vaccination has been known from several decades. Initially, the introduction of the smallpox vaccine by Edward Jenner in 1798, has received significant attention in various academic fields, including vaccine research and vaccinology. Also, the nature of immunological memory has been extensively studied since last 100 years by global clinical and public health professionals [2]. From public health perspective, vaccination is considered as a wonderful tool for

health equity, deals with the objectives of innovation, improved immunization systems, and accelerated disease control [3]. Similarly, previous evidence showed the interruption of vaccination programs can cause severe future disease outbreaks [4]. However, the endeavor faces multiple context-specific problems that affect its uptake. The estimates from the World Health Organization showed that 2–3 million deaths worldwide, and an additional 1.5 million lives can be saved annually through universal and efficient vaccination programs [5]; however, vaccine hesitancy has been identified as a global health threat and a focal barrier against successful COVID-19 vaccination programs [6].

Vaccine hesitancy is a delay in accepting or refusing vaccines despite available vaccination services. Since COVID-19 vaccinations have been shown to be a safe and effective measure in disease prevention and in lowering the death rate. Numerous worldwide studies on the other hand have shown a decreasing trend of vaccine acceptance around the world [7-10]. This hesitant attitude towards vaccination is influenced by several factors including convenience, confidence, and complacency [11]. Among sociocultural, economic, and political factors, considerably affect this endeavor of COVID-19 immunization [4]. Also, certain religious and cultural beliefs, a lack of awareness and understanding of vaccinations and their importance, and concerns about the risks and benefits vaccine uptake are few other reasons for COVID-vaccine resistance in global population [9].

In line to general population, health care workers (HCWs) also appeared to show the significant reluctant behaviors against COVID-19 vaccination. Earlier studies conducted before vaccine availability revealed that 70% of residents intended to get a vaccination [12]; however, opposing behaviors have been reported particularly among HCWs and medical students during the initiation phase of COVID-19 vaccination programs [13,14].

Since vaccine hesitancy and low acceptance rates are the primary obstacle for massive efforts made by governments and different health organizations to achieve successful COVID-19 vaccination programs. Many systematic reviews and meta-analyses have previously analyzed COVID-19 vaccine hesitancy rates among HCWs and health care students (HCSs). However, there are still ambiguous results and comprehensive reports about vaccine hesitancy worldwide. HCWs and HCSs being a strong influencer must have a crucial role in the implementation of vaccine uptake for general population. This is the first umbrella review of cross-sectional studies therefore conducted to summarize a global data of vaccine hesitancy and acceptance rates in health care professionals. The study findings will help to identify the gaps in public health and current research to minimize the COVID-19 vaccine hesitancy the future outbreaks. The objective of this umbrella review is to summarize the existing data of available systematic reviews demonstrating the vaccine hesitancy among health professionals, HCWs, and HCSs.

Methodology

This umbrella review aimed to investigate the COVID-19 vaccine hesitancy among medical students, professionals, and HCWs. For this purpose, we used a systematic search protocol to summarize the existing studies. Two data bases "Scopus" and "PubMed" were selected to track the related data. Further, a search term composed of (vaccination or vaccine or immunization) AND (hesitancy OR acceptance OR intention OR rejection OR resistance) AND (sars-cov-2 OR covid-19 OR covid19 OR coronavirus) AND (systematic review or meta-analysis OR meta-analyses) was applied on January 11, 2024 without any temporal restrictions. Since a few titles conducted a sub-group analysis on HCWs, we used a generalized term for literature without adding terms for healthcare workers to extract maximum studies.

The available data was extracted and compiled through using Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (https://www.prisma-statement.org/). Two independent reviewers scanned the literature through entering the selected search term while a third author validated the scanned literature. Any disagreements were resolved by mutual consensus.

An inclusion/exclusion criterion was defined to evaluate the most suitable and reliable studies matching our study objectives, such as (1) quantitative studies on COVID-19 vaccination, including surveys, experimental designs, or mixed methods; (2) investigations of pooled prevalence of COVID-19 vaccine hesitancy/acceptance; (3) systematic reviews; (4) reports on pooled prevalence; (5) explanations of heterogeneity levels and assessments of study quality; (6) written in the English language; and (7) inclusion of populations or independent subgroup analyses among medical students, health professionals, and HCWs.

We primarily focused on the prevalence of COVID-19 vaccine hesitancy among medical students, professionals, and HCWs, therefore, any subgroup analysis not meeting the
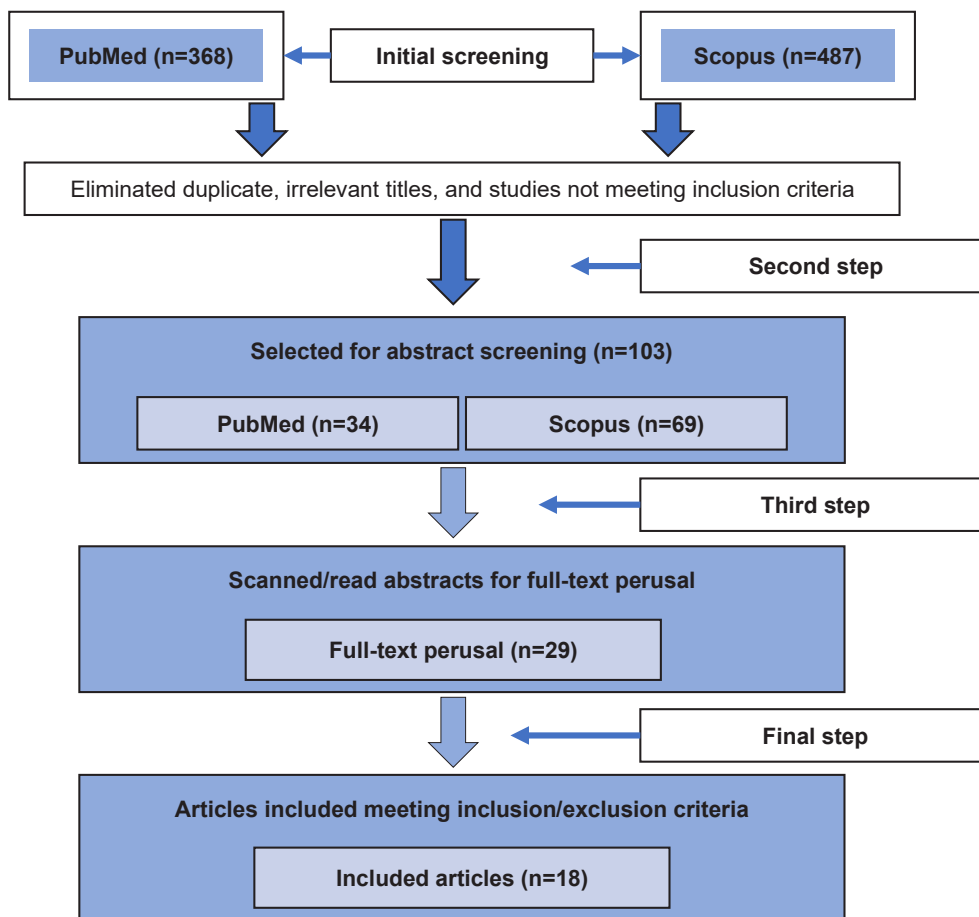
Fig. 1. Flow chart of screening process.

study objective was excluded. Similarly, studies other than English language, evaluating vaccine hesitancy in general population and sub-group population or conducted on people with any chronic disease/disorder was excluded. Furthermore, any scoping review, grey literature, newsletters or website news, opinions, and commentaries was excluded while focusing only on research studies published in a peer review reliable national and international journal.

After defining inclusion criteria, the above-mentioned search term was applied to scan the literature. A total of 487 articles from Scopus and 368 studies from PubMed emerged during the first level screening. After scanning the study titles, 34 studies from PubMed and 69 studies from Scopus were selected for the second step of abstract screening. Subsequently, a total of 29 articles were chosen for full-text review, and 18 studies were ultimately selected to be included in this umbrella review. The flowchart of the screening process is presented in Fig. 1. Additionally, study references, year, country, participants, characteristics of participants, pooled preva-

lence of vaccine hesitancy, heterogeneity, and conclusions were compiled into Table 1 to summarize the selected studies [15-23].

Results

A total of 18 articles were finally selected for this umbrella review of systematic reviews. In total, 527 studies, ranging from 3 to 93 studies per systematic review, were included. The sample sizes ranged from 46 to 196,235, with a total of 711,723 participants. Approximately nine studies collected data at the global level (Table 1), while the other studies were conducted in Africa and sub-Saharan Africa (n=4), the Gulf Cooperation Council countries (n=1), South Asia (n=1), Latin America and the Caribbean (n=1), Italy (n=1), and China (n=1) (Table 2) [24-29].

Almost all included studies used the random effect model (n=16). Since most of the studies did not mention the age group of the participants, a few studies included people rang-

Table 1. COVID-19 vaccine hesitancy among medical students, health professionals, and HCW: global data of cross-sectional studies

Reference	Country	No. of studies and participants	Characteristics of participants	Results pooled prevalence (95% CI)	Model used	Heterogeneity	Conclusion
[15]	Global data	41 studies 29,563 participants	Sample size (94–1,899), profession (healthcare students in nursing, medicine, and dentistry)	Pooled prevalence of vaccination intention: nursing students (63.85% [55.02–72.24]); medical students (72.30% [61.47–81.95]); dental students (56.71% [45.88–67.23])	Random effect model	Nursing students (I^2=98.52%), medical students (I^2=99.42%), dental students (I^2=96.91%)	COVID-19 vaccination acceptance was highest in the medical students, followed by nursing students and dental students.
[16]	Global data	31 articles 30,272 participants	Sample size (104–6,639), profession (health care students)	Pooled prevalence of the vaccine hesitancy rate: 25.8% (18.5–33.8)	Random-effects model	Vaccine hesitancy (I^2=99%)	Acceptance rates among healthcare students was low while having concerns about vaccine safety.
[17]	Global data	6 studies 4,118 participants	Sample size (not specified), profession (medical students)	Pooled prevalence of COVID-19 vaccination: 61.9% (39.7–80.1)	Both random and fixed effects model	I^2=99.1%	A moderate level of COVID-19 vaccination acceptance was found in medical students.
[18]	Global data	71 articles 12,585 participants	Sample size (250–6,639), profession (dental students and dental practitioners)	Acceptance rates of COVID19 vaccine: dental students (60.5% [56.1–65.0]); dental practitioners (81.1% [72.4–89.8])	Random effect model	Dental students (I^2=73.65%), dental practitioners (I^2=96.86%)	Dental students reported low acceptance rate of COVID-19 vaccination.
[19]	Global data	42 studies 77,466 participants	Sample size (166–3,677), profession (HCW)	HCW intention for mandatory COVID-19 vaccine: 64% (55–72)	Random-effects model	I^2=99.6%	About 36% of HCW opposed mandatory COVID-19 vaccination.
[20]	Global data	24 studies 50,940 participants	Sample size (208–12,034), profession (HCW)	Acceptance of COVID-19 vaccine: 63.5% (56.5–70.2)	Random-effects model.	I^2=99.59%	HCW reported vaccine hesitancy against COVID-19.
[21]	Global data	9 studies 24,952 participants	Sample size (461–8,243), profession (HCW)	Pooled effect value of COVID-19 vaccination: 51% (0.41–0.62)	Random-effects model	I^2=99.6%	Only 50% HCW showed acceptance level against COVID-19 vaccination.
[22]	Global data	71 studies 93,508 participants	Sample size (61–12,034), profession (HCW)	Willingness to undergo COVID-19 vaccination: 66% (0.61–0.67)	Random-effects model	I^2=99.7%	More than 30% health care professional reported hesitancy against COVID-19 vaccination.
[23]	Global data	93 studies 196,235 participants	Sample size (81–85,216), profession (HCW)	Acceptance rate: 68.56% (18.7–99.7)	Random-effects model	I^2=99.750%	The overall low acceptance rate of the COVID-19 vaccine in HCW was Reported.

COVID-19, coronavirus disease 2019; HCW, health care workers; CI, confidence interval.

ing from 18–60 years. Further, the heterogeneity level (I^2) of all included studies was reported between 41.9% to 99.75%.

In the results findings, a total of four studies reported the pooled prevalence of vaccine hesitancy among medical students, professionals, and HCWs. One study by Bianchi et al. [26] from Italy reported the lowest hesitancy rates among HCWs at 13.1% (95% CI, 6.9–20.9), while a study by Kigongo et al. [30] from Sub-Saharan Africa showed the highest prevalence of vaccine hesitancy among HCWs at 46% (95% CI, 38–54). In contrast, Islam et al. [31] found the pooled proportion

Table 2. COVID-19 vaccine hesitancy among HCW from Africa, Asia, America, Europe, and Gulf countries

Reference	Country	No. of studies and participants	Characteristics of participants	Results pooled prevalence (95% CI)	Model used	Heterogeneity I² (%)	Conclusion
[24]	East Africa (Ethiopia)	11 articles 5,981 participants	Study design (cross-sectional surveys), sample size (191–1,314)	Pooled prevalence of COVID-19 vaccine acceptance among LHW: 54.59% (42.49–66.69)	Random effect model	99.1	Low COVID-19 vaccine acceptance was reported among healthcare professionals in Ethiopia.
[25]	Africa	14 studies 23,739 participants	Study design (thirteen cross-sectional studies and one nationwide survey), sample size (234–15,087)	Pooled prevalence of LHW: acceptance of the COVID-19 vaccine: 56.59 (46.26–66.92)	Random-effects inverse-variance model	99.6	Low acceptance of the COVID-19 vaccine among African healthcare workers was reported.
[26]	Italy	14 studies 27,991 participants	Study design (cross-sectional), sample size (166–10,898)	Pooled prevalence of vaccine hesitancy: 13.1% (6.9–20.9)	Inverse-variance fixed-effects model.	99.6	Low levels of COVID vaccination hesitancy were reported among Italian LHW.
[27]	China	18 studies 45,760 participants	Study design (cross-sectional), sample size (416–11,951)	Pooled COVID-19 vaccine acceptance: 78% (73–83)	Random effect model	99.27	A high acceptance rate of COVID19 vaccines was found in China.
[28]	Africa	21 articles 14,132 participants	Study design (cross-sectional), sample size (182–2,133)	Pooled COVID-19 acceptance: 46% (37–54)	Random effect model	96	Low acceptance of the COVID-19 vaccine was reported in Africa.
[29]	Gulf Cooperation Council countries	39 articles 57,250 participants	Study design (cross-sectional), sample size (46–23,582)	Pooled acceptance rate of COVID-19 vaccine: 60.4% (53.8–66.6)	Random-effects model	41.9	A moderate acceptance rate of COVID-19 vaccines was reported among HCW in the Arab World.
[30]	Sub-Saharan Africa	15 articles 7,498 participants	Study design (cross-sectional), sample size (108–811)	Pooled prevalence of COVID-19 vaccination hesitancy rate: 46% (0.38–0.54)	Random-effects model	91.96	A high hesitancy of COVID-19 vaccine was seen in Sub-Saharan Africa.
[31]	South Asia	6 studies 7,545 participants	Study design (cross-sectional), sample size (266–5,237)	Pooled proportion of COVID-19 vaccine hesitancy: 19% (6.8–31.2)	Random-effects model	99.53	Vaccine hesitancy was lower among HCW as compared to general population.
[32]	Latin America and the Caribbean	3 studies 2,188 participants	Study design (cross-sectional), sample size (543–1,066)	Pooled prevalence of COVID vaccination acceptance: 83.0% (71.0–96.0)	Random effect model	98.9	Prevalence of vaccination intention in HCW is greater than vaccination intention of non-health professionals.

COVID-19, coronavirus disease 2019; HCW, health care worker; CI, confidence interval; LHW, local health workers.

of COVID-19 vaccine hesitancy among HCWs in South Asia to be 19% (95% CI, 6.8–31.2), while Patwary et al. [16] collected global data and included studies on HCWs, showing vaccine hesitancy rates of 25.8% (95% CI, 18.5–33.8; I²=99%).

Furthermore, 14 studies reported the acceptance rate of COVID-19 vaccination among medical students, professionals, and HCWs. In this regard, most of the studies reported low acceptance rates of COVID-19 vaccination. The overall percentage of acceptance varied from 46% (95% CI, 37–54) to 83.0% (95% CI, 71–96). Ackah et al. [28] reported the lowest at 46%, while Figa et al. [25] reported 56.59 (95% CI, 46.26–

66.92) in Africa. Furthermore, Moltot et al. [24] observed 54.59% (95% CI, 42.49–66.69), and Figa et al. [25] reported 56.59% (95% CI, 46.26–66.92).

Regarding studies conducted at the global level, Sahebi et al. [23] summarized 93 studies and data from 196,235 HCWs and found the highest acceptance rate of 68.56% (95% CI, 18.7–99.7) around the world. Similarly, Wang et al. [22] demonstrated the results at the rate of 66%, Politis et al. [19] with 64%, Galanis et al. [20] at 63.5%, Ulbrichtova et al. [17] at 61.9%, and Lin et al. [18] observed 60.5% acceptance rates when summarizing the global data. However, Luo et al. [21]

reported the lowest rates of 51% when summarize the data of 24,952 HCWs. Moreover, a study conducted on Gulf Cooperation Council countries included 57,250 HCWs and showed an acceptance rate of 60.4% (95% CI, 53.8–66.6) [29]. A high acceptance rates were seen in China 78% (95% CI, 73–83) and Latin America and Caribbeans (83.0%, 95% CI, 71.0–96.0), respectively [27,32].

Discussion

This umbrella review found a high COVID-19 vaccination resistance and low acceptance rates among HCWs around the world. The current COVID-19 pandemic has exhorted the global scientific community to find the solution in terms of therapeutics measures and vaccines to control the devastating global pandemic. Therefore, COVID-19 vaccination has been started in the pursuit of hope to end this pandemic. In this regard, medical workers treating high-risk populations, personnel in intensive care units and emergency services, the older population, as well as residents and staff of care homes, were taken as priority. However, many health professionals are still reluctant to taking COVID-19 vaccine. Previous studies from France, Belgium, and Canada investigated HCWs' attitudes toward COVID-19 vaccination and reported rates of high acceptance (48.6%), moderate acceptance (23%), and complete reluctance to receive the vaccine (28.4%) [14]. Equally, 25% of medical students in the United States were found unwilling to get vaccinated against COVID-19 [33]. Less than half of nursing students in the Czech Republic, Greece, Albania, Cyprus, Spain, Italy, and Kosovo were found to be willing for COVID-19 vaccination [34].

The COVID-19 vaccine hesitancy is attributed to a number of factors such as limited COVID-19 vaccine clinical trials or data, and concerns about the safety, cost, and efficacy of vaccines. Many studies previously studied the economic, geopolitical, and socio-cultural factors affecting the vaccine acceptance rates [35]. Such as a systematic review from China demonstrated that age, health status, vaccination uptake, and suggestions from family and friends were significantly associated with higher rates of vaccine acceptance [36]. Similarly, another systematic review from Canada showed that gender, education level, and racial disparities play a major role in COVID-19 vaccine resistance [37]. Vaccine safety, efficacy, and potential side effects were believed to be the major reason for COVID-19 vaccine hesitancy among HCWs, while males, aged people, and physicians tend to receive COVID-19

vaccines during the pandemic [38]. Similarly, conspiracies about vaccine side effects, vaccine cost and efficiency, mistrust, and insufficient information appeared to increase vaccine hesitancy among medical students [39].

To avoid an overwhelming situation, different countries have decided to include HCSs as volunteers to support and treat coronavirus patients while they complete their studies and training. HCSs are more likely to encounter COVID-19-infected patients during their training sessions and clinical practice. Also, health professionals are more vulnerable to infectious diseases due to their extensive exposure to infected populations and their continued work with patients. Therefore, these professionals have an urgent need for timely vaccination during their professional obligations. Health professionals can serve as role models for the general population in terms of increasing vaccination uptake to minimize the disease burden [40,41]. Furthermore, healthcare students must be educated about the benefits of vaccines as part of their training to prevent further infections and increase vaccine acceptance rates [42]. HCWs are among the first responders to COVID-19 infections, so it is essential that they receive the vaccine and encourage others to do the same. Failure to do so puts them at risk of contracting the virus and increases the risk for the general population due to their frequent encounters with COVID-19 patients, visitors, and other healthcare workers [43]. Additionally, both HCSs and HCWs are perceived as trustworthy and dependable sources of information by the public and their patients. Therefore, their acceptance or rejection of the COVID-19 vaccine appears to have an impact on how their patients and the broader public feel about getting vaccinated [44].

This is the first umbrella review emphasizing cross-sectional studies and the pooled prevalence of vaccine hesitancy among health professionals, HCWs, and HCSs. The study findings will provide a comprehensive summary of the scientific evidence regarding health professionals, HCWs, and HCSs. Additionally, it will explore the primary factors influencing HCWs' and HCSs' attitudes toward COVID-19 vaccinations. Furthermore, it will support public health experts, governments, and policymakers in making future policies and decisions to increase vaccine acceptance among health professionals. The results can also provide a framework for responding to COVID-19 booster doses, the release of new lifesaving vaccines, and proactive measures to combat other potential pandemics.

Conclusion

This umbrella review found high rates of vaccine hesitancy and low levels of vaccine acceptance among health professionals, HCWs, and HCSs globally. Further studies analyzing the determinants of vaccine hesitancy are important for increasing vaccine uptake and for successful vaccination programs at the global level. Additionally, it is essential to pursue comprehensive vaccination strategies in parallel to minimize reluctance, hesitancy, and refusal at both global and regional levels.

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