

Original Article

Factors Affecting the Intention of Healthcare Workers and Students to Receive COVID-19 Booster Dose Vaccination: A Systematic Review

Stavroula Zioga, RN, MPH,

National and Kapodistrian University of Athens, Athens, Greece

Aglaia Katsiroumpa, RN, MSc, PhD (c)

Clinical Epidemiology Laboratory, Faculty of Nursing, National and Kapodistrian University of Athens, Greece

Maria Kitsaki, RN, MSc

National and Kapodistrian University of Athens

Ioannis Moisoglou, RN, MSc, PhD

Faculty of Nursing, University of Thessaly, Larissa, Greece

Parisis Gallos, RN, MSc, PhD

Clinical Epidemiology Laboratory, Faculty of Nursing, National and Kapodistrian University of Athens, Greece

Antigoni Kolisiati, MD, MSc

Department of Endocrinology and Diabetes Center, General Hospital "G. Gennimatas", Athens, Greece

Petros Galanis, PhD

Assistant Professor, Clinical Epidemiology Laboratory, Faculty of Nursing, National and Kapodistrian University of Athens, Athens, Greece

Correspondence: Petros Galanis, Assistant Professor, Clinical Epidemiology Laboratory, Faculty of Nursing, National and Kapodistrian University of Athens, 123 Papadiamantopoulou street, GR-11527, Athens, Greece, e-mail: pegalan@nurs.uoa.gr

Abstract

Background: The COVID-19 pandemic has caused an unprecedented health, social and economic crisis worldwide, as the SARS-CoV-2 virus has managed to cause a major threat with significant morbidity and mortality in certain population groups. The risk of the virus is exacerbated by its easy transmission and continued spread, despite multilevel interventions, extensive containment measures and vaccination. Vaccine hesitancy refers to a person's reluctance, delay in accepting or even refusing to be vaccinated despite available vaccination services. **Objective:** To investigate the factors that influence health professionals and students of health sciences to accept, or not, a booster dose of a COVID-19 vaccine. Sub-objectives were to assess vaccine hesitancy, and specifically those of booster doses, and the presentation of views and attitudes in the above population groups. **Methods:** The relevant bibliography was searched electronically in scientific databases such as PubMed, Embase, Cochrane Library and Scopus until August 2023. The main selection criteria were mainly descriptive studies, published in English and Greek. The subjects were human over 18 years old. The time frame of this search was the last four years. **Results:** From the results of the systematic review, it was shown that many different factors influence the intention of both healthcare workers and students, as well as those in the general population, to accept a COVID-19 booster dose vaccine. At the same time, the health professionals and students of different countries and continents -that were studied- present diverse socio-demographic characteristics that influence their willingness, or not, to be vaccinated. **Conclusions:** COVID-19 booster doses offer further immunity and reduce severe impacts of the disease, such as hospitalization and death. Since health professionals play a critical role in shaping local communities' attitudes towards vaccines, their beliefs and attitudes play a crucial role. For this reason, it is recommended both training students and healthcare workers via competent institutions, as well as to mobilize and sensitize them, in order to base their attitudes on evidence-based practice. As new technologies and policies are built around

COVID-19 vaccines, ongoing testing of their effectiveness, and updated guidelines according to the population group are proven vital to the impact of the disease. Further future studies are necessary.

Keywords: COVID-19, booster dose, vaccine, vaccination, healthcare workers

Introduction

According to the World Health Organization (WHO), viral diseases and epidemics are proven as serious public health issue. The last 20 years have been seen viral epidemics, such as the SARS epidemic from 2002 to 2003, H1N1 influenza in 2009, Middle East respiratory syndrome (MERS-CoV) in 2012 in Saudi Arabia. Finally, on December 31st, 2019, an outbreak of lower respiratory infections was reported for the first time by China's health services. The etiology of this disease has been identified and has been attributed to a new virus belonging to the family of coronaviruses (Coronaviruses-CoV). The SARS-CoV-2 virus has managed to cause a major threat, as it causes significant morbidity and mortality in certain groups of population. Despite multi-level interventions and extensive containment measures, the risk of COVID-19 is exacerbated by its easy transmission and continued spread (WHO, 2023).

In March 2020, WHO declared COVID-19 as a pandemic. The governments worldwide, in order to combat the spread of the infection, initially adopted various non-pharmaceutical measures such as social distancing, movement restrictions and mandatory mask-wearing. Additionally, new therapeutic protocols were used for treating or preventing the disease (WHO, 2023). However, the SARS-CoV-2 with its continuous mutations prolong the ordeal for citizens, healthcare system and the economy.

Nevertheless, none of the aforementioned measures proved effective and the urgent need for the vaccine was quickly recognized. Rapid progress in vaccine development against the virus raised hopes for limiting the ordeal. The necessity of pandemic containment, as well as the lack of targeted antiviral therapeutics, underscores the importance of developing safe and effective vaccines (Fotiadis *et al.*, 2021). It is clear that vaccines are extremely

effective tools for controlling and eliminating diseases that can be prevented by them (Fotiadis *et al.*, 2021). Many European countries, such as Greece, France and Italy, have enacted laws mandating vaccination (Politis *et al.*, 2023). Moreover,

Vaccination hesitancy refers to the reluctance, delay in acceptance, or refusal of an individual to be vaccinated despite the availability of vaccination services. It involves a complex, but dynamic, interaction of factors that vary depending on individuals, time, place, vaccinations, and its greatly influenced by complacency, ease of access to vaccinations, and trust in government authorities (Asumah *et al.*, 2022). According to Abdelmoneim *et al.*, the acceptance rate of booster doses for COVID-19 vaccines among healthcare professionals was 66% (Abdelmoneim *et al.*, 2022). Moreover, several studies identified that vaccination is important not only among healthcare workers but among other groups such as high risk groups, pregnant women and teachers (Galanis *et al.* 2023, Galanis *et al.* 2022, Katsiroumpa *et al.* 2023, Moisoglou *et al.* 2023, Patelarou *et al.* 2022). As of March 01, 2024, 7.003.379 people have died so far from coronavirus COVID-19 outbreak (WHO Health Emergency Dashboard, 2023).

In this context, the aim our systematic review was to summarize the evidence regarding the factors that influence the intention of healthcare workers and students to receive COVID-19 booster dose vaccination.

Methods

We searched PubMed, Embase, Cochrane Library and Scopus until August 2023. In all fields was used the following search strategy (Keywords): (COVID-19 OR SARS-CoV-2 OR severe acute respiratory syndrome coronavirus 2 OR corona virus disease 2019) AND (booster dose vaccine OR booster dose vaccination) AND (healthcare workers OR

healthcare professionals) AND students. References to selected studies and other relevant sources were also checked for further identification. We performed the systematic review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher *et al.*, 2009). The main research focused on the population of healthcare professionals and students of health sciences. Only studies comparing healthcare professionals and the general population were included, not those evaluating only the general population. We used the following inclusion criteria in our systematic review: (a) quantitative studies and mainly descriptive, (b) studies published in English and Greek, (c) the subjects were humans over 18 years old, (d) the time frame of this search was the last four years. Exclusion criteria included studies published before 2019 and those published in other languages. Studies with access only to abstracts, conference proceedings, study protocols, editorial responses from scientific journals, reviews, case reports, and duplicate files were also excluded. Additionally, there were no restrictions on the type of vaccine and on healthcare workers and students from specific countries and continents. We collected the following data for each study included in the review: first author and year of publication, country, data collection time, sample size, study design, sampling method, and the main finding about the factors affecting the intention of healthcare workers and students to receive COVID-19 booster dose vaccination.

Results

The flow diagram of the systematic review according to PRISMA guidelines is shown in **Figure 1**. After the first search in the databases and the removal of the duplicate records we found 233 records. Applying the inclusion criteria, the total number of studies that were included in the review was twenty-nine. The main characteristics of the twenty-nine studies included in the systematic review are shown in **Table 1**.

The total number of studies consists of 26 cross-sectional studies, 2 prospective cohort

studies, and 1 longitudinal study. These studies were published between 2021 and 2023. Among them, 18 investigate hesitancy or acceptance regarding the administration of a booster dose of the COVID-19 vaccine. The remaining 11 are related to hesitancy or acceptance of COVID-19 vaccination more broadly. All of them identify and explore factors that favor the administration of either the vaccine or booster doses and influence the attitudes and beliefs of healthcare professionals or students and the general population, regarding these two population groups. Specifically, out of the total of 29 studies, 15 involved healthcare workers, and 8 involved students of health sciences schools. Additionally, 3 studied the factors influencing the intention of both healthcare professionals and students of related fields, 1 referred to healthcare workers and the general population, and 2 were related to the latter two groups and students.

The majority of studies were conducted in Europe (n=12) and Asia (n=9), followed by North America (n=3), Africa (n=3), and Australia (n=1). More specifically, 3 studies were conducted in Greece, 3 in Italy, 2 in Poland, 1 in Belgium, 1 in the Czech Republic, 1 in Wales, 1 in Albania, 2 in Saudi Arabia, 1 each in Saudi Arabia and India, 1 in Jordan, 1 in the United Arab Emirates, 1 in Vietnam, 1 in Thailand, 1 in Singapore, and 1 in Iraq. Additionally, there was 1 study conducted in Sudan, 1 in Ghana, and 1 in Nigeria, as well as 2 in Texas, 1 in New York, and 1 in Australia. It should be noted that from this continent and country distinction, one study (out of the 29) that examined healthcare professionals from a total of 91 countries was excluded.

This review investigated the factors influencing the intention of healthcare professionals and students to accept a booster dose of the COVID-19 vaccine.

Additionally, it highlighted the beliefs and attitudes of these two population groups, as well as partially the general population, regarding the broader vaccination coverage of the coronavirus.

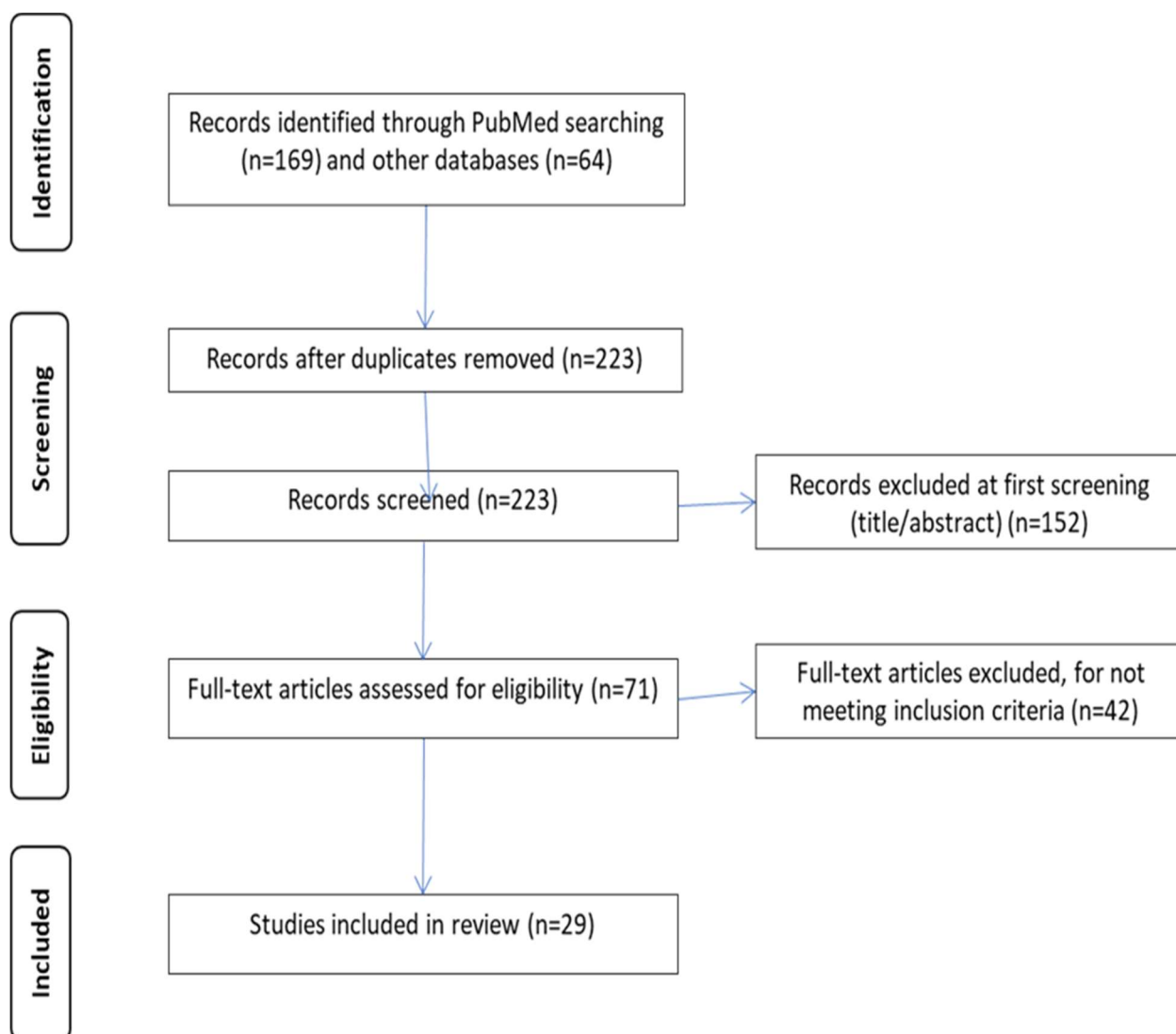


Figure 1. The flow diagram of the systematic review according to PRISMA guidelines (Moher *et al.*, 2009).

Results cont.

Key findings of the review and main deterrent factors identified in several of the above studies include long-term adverse effects (Vellappally *et al.*, 2022, Della Polla *et al.*, 2022, Elbadawi *et al.*, 2022, Le, Nguyen and Do, 2022, Al-Metwali *et al.*, 2021, Askarian *et al.*, 2022), and low confidence in the effectiveness (Vellappally *et al.*, 2022, Ryalat *et al.*, 2022, Della Polla *et al.*, 2022, Le, Nguyen and Do, 2022, Al-Metwali *et al.*, 2021, Ford *et al.*, 2023) and safety of the vaccine and booster doses (Asumah *et al.*, 2022, Alobaidi and Hashim, 2022, Le, Nguyen and Do, 2022).

Furthermore, the lack of information about vaccination (Vellappally *et al.*, 2022), uncertainty about protection against new virus mutations (Della Polla *et al.*, 2022), the serious complications of COVID-19 (Hosek *et al.*, 2022), the sense of fear (Della Polla *et al.*, 2022, Galanis *et al.*, 2023, Jairoun *et al.*, 2022, Kałucka, Kusideł and Grzegorzczak-Karolak, 2022, Lo Moro *et al.*, 2022), and previous COVID-19 illness (Jorgensen *et al.*, 2023, Paridans *et al.*, 2022), (Kałucka, Kusideł and Grzegorzczak-Karolak, 2022, Kunno *et al.*, 2022) are additional findings of the review.

In some, but only a considerable percentage of studies, concerns about other reactions and clinical consequences (such as thromboses)

(Njoga *et al.*, 2022, Peterson *et al.*, 2021) are observed. Doubts about the proper and adequate storage of vaccines (Al-Metwali *et al.*, 2021) and low trust at the government and relevant public health authorities reduced collective responsibility (Alhasan *et al.*, 2021, Bedston *et al.*, 2023, Njoga *et al.*, 2022, Ford *et al.*, 2023).

Negative reports, rumors, and misinformation were noted on social media, with characteristic short-term adverse effects such as pain at the injection site, fatigue, fever, chills, and musculoskeletal pain (Jairoun *et al.*, 2022, Bedston *et al.*, 2023, Elbadawi *et al.*, 2022, Njoga *et al.*, 2022, Ford *et al.*, 2023). Finally, in a study conducted in Africa (Njoga *et al.*, 2022), researchers also highlighted the difficulty of access to receive the COVID-19 vaccine, a phenomenon not observed in studies in developed countries. The social and demographic characteristics of the studies included in this review, relating to the willingness to vaccinate against COVID-19 booster doses, vary. Initially, the educational level of healthcare professionals, such as postgraduate students in health science schools (Vellappally *et al.*, 2022, Jairoun *et al.*, 2022, Le, Nguyen and Do, 2022), profession (Kałucka, Kusideł and Grzegorzczak-Karolak, 2022, Koh *et al.*, 2022), and income, which implies leadership positions and responsibility, appear to be highly encouraging factors (Alobaidi and Hashim, 2022). It is noted that a higher and more satisfactory vaccination rate, both for primary vaccinations and booster shots, is observed among doctors, dentists, pharmacists, and medical students, in contrast to nurses and midwives (Jorgensen *et al.*, 2023, Della Polla *et al.*, 2022, Klugar *et al.*, 2021, Fotiadis *et al.*, 2021, Ford *et al.*, 2023). Comorbidities of participants in a specific study (Alobaidi and Hashim, 2022), meaning their serious and chronic illnesses, encouraged them to get vaccinated against COVID-19. The gender of participants in the above studies (Vellappally *et al.*, 2022, Jorgensen *et al.*, 2023, Alobaidi and Hashim, 2022, Klugar *et al.*, 2021, Hosek *et al.*, 2022, Lo Moro *et al.*, 2022) is a characteristic variable, with the female population being more hesitant to receive updated vaccines.

Additionally, family status (Alobaidi and Hashim, 2022, Kunno *et al.*, 2022) appears to play a role in the intention for vaccination coverage, as according to Alobaidi and Hashim, widows/widowers, divorced individuals, and single/unmarried individuals are more willing to be vaccinated than married individuals. Other characteristics are described below. Age is a significant variable, as most studies agree that younger students are more reluctant to get vaccinated (Della Polla *et al.*, 2022, Al-Metwali *et al.*, 2021, Hosek *et al.*, 2022, Peterson *et al.*, 2021). The above fact is disapproved by a study (Tomietto *et al.*, 2022), which reveals that Generation X (individuals born between 1965 and 1980) has the highest hesitancy compared to the other generations of Baby Boomers (born between 1946 and 1964), Generation Y (born between 1981 and 1996), and Generation Z (born after 1997).

Additionally, geographical residence seems to influence the decision-making process, as urban residents are more positive about receiving vaccination doses compared to those in rural areas (Vellappally *et al.*, 2022, Bedston *et al.*, 2023, Njoga *et al.*, 2022). Finally, in one study (Njoga *et al.*, 2022), it was noted that personal ideology and religious beliefs may contribute to the willingness, or usually unwillingness, of some individuals to get vaccinated against COVID-19.

The Health Belief Model can serve as a useful theoretical framework not only to explore the motives of individuals willing to vaccinate, but even more importantly to investigate the reasons behind refusing vaccination. It is utilized by studies (Alobaidi and Hashim, 2022, Ford *et al.*, 2023, Le, Nguyen and Do, 2022, Al-Metwali *et al.*, 2021) in the results of the present review.

The major premise of this model is that existing beliefs can predict future behaviors. Specifically, it includes five major constructs, namely: perceived susceptibility, perceived severity, perceived barriers, perceived benefits, and cues to action (refer to the cues that stimulate a specific behavior) (Al-Metwali *et al.*, 2021).

Table 1. Summary of studies included in the systematic review.

Reference	Country	Study design	Sample	Sampling method	Results
Dziedzic et al., 2022	Poland	Cross-sectional study	443 HCWs and medicine students	Convenience sample	There is no significant difference between healthcare professionals and students regarding COVID-19 booster doses. Non-significant association between COVID-19 booster doses and demographic characteristics, in contrast to the association between COVID-19 booster doses and early SARS-CoV-2 disease.
Vellapally et al., 2022	India and Saudi Arabia	Cross-sectional study	530 HCWs	Convenience sample	Positive is the perception of COVID-19 booster vaccine, as also the hesitation for COVID-19 booster dose.
Jorgensen et al., 2023	Albania	Prospective cohort study	1504 HCWs	Convenience sample	In a large cohort of Albanian HCWs, COVID-19 vaccine booster dose uptake was very low, particularly among younger, female, and non-physician HCWs, despite evidence demonstrating the added benefit of boosters in preventing infection and severe disease. Exception is the group of Albanian doctors.
Ryalat et al., 2022	Jordan	Cross-sectional study	417 medical students	Convenience sample	The choice of the Pfizer vaccine versus others is significant among medical school students in Jordan. Opinions differ regarding other vaccination issues (such as immunity from vaccination, vaccination of children and COVID-19 booster dose vaccination).
Alobaidi and Hashim, 2022	Saudi Arabia	Cross-sectional study	2059 HCWs	Convenience sample	There is highly satisfactory intention (71.1%) for receiving a third dose vaccine. There is a significant correlation between the intention for a booster dose and Nationality, family status, gender, income, and coexisting illness were some significant factors that affected the intention to vaccination.
Paridans et al., 2022	Belgium	Prospective cohort study	3576 staff members and 25,378 students	Convenience sample	84.2% had the intention to receive a COVID-19 booster dose. Among them, 88.8% maintained their intention and got vaccinated. A significant percentage of the study population

					potentially changed their mind between intention and final decision.
Janabi and Pino, 2022	New York	Cross-sectional study	319 students	Convenience sample	70.2% seem to have received a booster dose of the vaccine, while the remaining 29.5% did not. Vaccine hesitancy, long-term immunity, and adverse effects of the vaccine were reasons for the reluctance to receive the booster dose.
Polla et al., 2022	Southern Italy	Cross-sectional study	496 HCWs	Convenience sample	Significant is the change in beliefs and attitudes of healthcare workers themselves.
Klugar et al., 2021	Czech	Cross-sectional study	3454 HCWs	Convenience sample	High acceptance (71.3%) of COVID-19 booster doses was found among healthcare workers in Czech Republic, while 12.2% were hesitant and 16,6% were against available vaccines.
Kalucka et al., 2022	Poland	Cross-sectional study	1200 HCWs	Convenience sample	The findings do not confirm that the government campaign was effective for healthcare professionals. Therefore, in this group, other forms of vaccination incentives should be sought.
Jairoun et al., 2022	United Arab Emirates	Cross-sectional study	614 students	Convenience sample	The average knowledge score was 44.6%. Better knowledge scores were observed in postgraduates, employees in the healthcare sector, participants who had relatives infected with the Covid-19, participants who had infected with Covid-19 and participants who had received first two doses of the COVID-19 vaccine.
Bedston et al., 2023	Wales	Prospective cohort study	73,030 HCWs	Convenience sample	Vaccination uptake was consistently lower among black HCWs, as well as those from deprived areas. Whilst breakthrough infections were highest in households with children.
Elbadawi et al., 2022	Sudan	Cross-sectional study	930 HCWs	Convenience sample	Majority of Sudanese HCWs believed that vaccination should be mandatory. A high reliance on social media was observed among healthcare workers in Sudan for information on the pandemic.

Njoga et al., 2022	Nigeria	Cross-sectional study	1525 HCWs and students	Convenience sample	There is a need for targeted awareness creation to increase COVID-19 vaccination coverage in Nigeria and elsewhere. Besides professionals, similar studies are recommended in the general population to develop appropriate public health interventions to improve vaccine uptake.
Asumah et al., 2022	Ghana	Cross-sectional study	215 HCWs	Convenience sample	High COVID-19 vaccination acceptability among HCPs. However, some HCPs are hesitant to take COVID-19 vaccinations immediately. Increased adoption of COVID-19 vaccinations among HCWs and the broader Ghanaian population requires concerted efforts, including strengthening public health education on the perceived risks and safety of COVID-19 vaccines.
Hosek et al., 2022	USA	Cross-sectional study	3439 students	Convenience sample	Fewer students reported COVID-19 vaccine hesitancy than expected from surveys on the general public and on HCWs.
Le et al., 2022	Vietnam	Cross-sectional study	911 students	Convenience sample	Health professions students' acceptability of COVID-19 vaccination might be based on the perceived susceptibility to and severity of COVID-19, concerns about vaccine efficacy and safety, and the influence levels of information from various sources. Health education and measures to prevent the harmful effects of COVID-19 vaccine misinformation could potentially improve the acceptance rate of the COVID-19 vaccine.
Kunno et al., 2022	Thailand	Cross-sectional study	780 HCWs	Convenience sample	HCWs were more satisfied with the type and efficacy of inactivated, viral vector, and mRNA vaccines than GP participants, and the former were also more satisfied with the cost of vaccine boosters. Our results indicate that satisfaction with the COVID-19 vaccine is based on academic knowledge sharing and the government's promotion efforts. Future research will explore strategies to raise awareness about the importance of vaccination.
Koh et al., 2022	Singapore	Cross-sectional study	528 HCWs	Convenience sample	COVID-19 vaccine hesitancy is a minute issue among Singapore primary HCWs. COVID-19 exposure risk influences vaccine acceptance; time is required for HCWs to

					weigh benefits against the risks. Future studies can focus on settings with higher hesitancy rates, and acceptance of booster vaccinations with the emergence of delta and omicron variants.
Moro et al., 2022	Italy	Cross-sectional study	929 medical students	Convenience sample	Hesitancy was remarkably lower than in similar studies. However, there is room for improvement in university activities that could deepen the competence in vaccines.
Al-Metwali et al., 2021	Iraq	Cross-sectional study	1680 students	Convenience sample	HCWs perceived significantly higher susceptibility and severity of the COVID-19 infection compared to the general population. HCWs were significantly more likely than the general population to receive vaccine. Factors that were significantly associated with the willingness to receive vaccine: Preventive measures, perceived benefit, perceived barriers, cue to action, subjective norm, supportive of vaccination in general and having received a flu vaccine
Peterson et al., 2021	USA	Cross-sectional study	234 medical students	Convenience sample	Medical students consider vaccination important and suggest that students can provide an important resource for patients and public education. Factors that were significantly associated with the unwillingness to receive COVID-19 vaccine: waiting for more data and negative side-effects.
Alhasan et al., 2021	Saudi Arabia	Cross-sectional study	1279 HCWs	Convenience sample	A high percentage of HCWs were aware of the Delta variant, but only a small fraction had decent quality of knowledge about it. The participants exhibited high worry levels and showed a modest acceptance of receiving a vaccine booster dose. Educational efforts recommendations about receiving a vaccine booster were proven vital.
Fotiadis et al., 2021	Greece	Cross-sectional study	1456 HCWs	Convenience sample	Acceptance of COVID-19 vaccines among HCWs in Greece could be considered satisfactory, especially among physicians. Areas for improvement exist among nurses and other healthcare professions/staff.
Askarian et al., 2022	worldwide	Cross-sectional	4630 HCWs	Convenience sample	Vaccination hesitancy rate was 37%. Increasing awareness regarding benefits of the vaccination, confronting the misinformation, and strengthening the prosocial norms

		multi-center survey			would be the primary domains for maximizing the vaccination coverage. The Human Development Index is strongly associated with the vaccination acceptance, in a way that those living in low HDI contexts are more hesitant to receive the vaccine
Tomietto et al., 2022	Italy	Cross-sectional study	1224 HCWs and students	Convenience sample	More positive attitudes towards COVID-19 vaccination were expressed by members of generation Z than by members of generation Y and baby boomers. Members of generation X had the highest vaccination hesitancy scores in the overall scale.
Ford et al., 2023	Australia	Cross-sectional study	556 HCWs	Convenience sample	Many nursing and midwifery students have shown reluctance towards getting vaccinated. The mandate to be vaccinated to attend clinical placement has led to the inability of some students to complete their course. Education and communication were identified as two major factors that facilitate vaccine acceptance.
Galanis et al., 2022	Greece	Cross-sectional study	963 HCWs	Convenience sample	Among nurses, 37.1% reported being very likely to be vaccinated, 34.4% reported being uncertain about their likelihood of vaccination, and 28.6% reported being very unlikely to be vaccinated with a booster dose. The COVID-19-related burnout reduced vaccination willingness, while social support functioned as a partial mediator of this relationship. Nurses who experienced burnout were less likely to accept a booster dose.
Galanis et al., 2022,	Greece	Cross-sectional study	795 HCWs	Convenience sample	30.9% were hesitant toward a second booster dose or a new vaccine. Significant is the percentage of hesitant nurses toward a second booster dose/new vaccine. This initial hesitancy could be a barrier to efforts to control the pandemic.

HCWs: Health Care Workers, HBM: Health Belief Model, PHC: Primary Health Care

Discussion

We conducted a systematic review to find the factors affecting the intention of healthcare workers and students to receive COVID-19 booster dose vaccination. We identified 29 studies that were conducted in all over the world, such as Europe (n=12) and Asia (n=9), followed by North America (n=3), Africa (n=3), and Australia (n=1). More specifically, 3 studies were conducted in Greece, 3 in Italy, 2 in Poland, 1 in Belgium, 1 in Czechia, 1 in Wales, 1 in Albania, 1 in Saudi Arabia, 1 both in Saudi Arabia and India, 1 in Jordan, 1 in the United Arab Emirates, 1 in Vietnam, 1 in Thailand, 1 in Singapore, and 1 in Iraq. Additionally, there was 1 study conducted in Sudan, 1 in Ghana, and 1 in Nigeria, as well as 2 in Texas, 1 in New York, and 1 in Australia. It should be noted that from this continent and country distinction, one study (from 29) that examined healthcare professionals from a total of 91 countries was excluded. Almost all studies found a positive relationship between healthcare workers, students and COVID-19 booster dose vaccination.

Education and the level of practical experience in each profession appeared to be related to the hesitancy of healthcare workers, as was evident from current review. Other factors that were regarded with vaccination hesitancy were race and ethnicity. Black and Latino healthcare professionals showed higher rates of vaccine hesitancy than white ones, with some exceptions (Florence M. Momplaisir *et al.*, 2021). No racial difference among physicians founded at a study (Green-McKenzie *et al.*, 2021) regarding the COVID-19 vaccine. This clearly demonstrates that physicians from various minorities could serve as role models among healthcare professionals.

Other adverse events, noted in the literature, included the appearance of thrombosis in combinations with thrombocytopenia and sometimes with bleeding. Initially, this complication was termed as Vaccine-Induced Immune Prothrombotic Thrombocytopenia (VITT), then renamed to Vaccine-Induced Immune Thrombotic Thrombocytopenia (VITT), and in some more recent publications, these conditions, this condition is described as Thrombosis with

Thrombocytopenia Syndrome (TTS). Vaccine-induced thrombotic thrombocytopenia (VITT) is a rare complication of ChAdOx1 nCov-19 and Ad26.COVS2 COVID-19 vaccines. Thus, taking the above into account, in March 2022, various European countries suspended the AstraZeneca vaccine mainly due to concerns about thrombosis.

According to Diaz-Arocutipa *et al.*, cases of myopericarditis are observed in 62% of patients who have had coronavirus. Thus, taking the above into account, in March 2021, various European suspended the AstraZeneca vaccine mainly due to concerns about thrombotic events. On the other hand, regarding the Johnson & Johnson vaccine, studies revealed concerns about thrombotic events. On the other hand, regarding the Johnson & Johnson vaccine, studies revealed concerns about fertility in young women (Peterson, Lee and Nugent, 2022).

There were also several cases of myocarditis that were associated with the Pfizer and Moderna mRNA vaccines, especially in young men. It is remarkable that the second dose of Moderna vaccine appears to increase the risk by 6,1 times, compared to the incidence of the condition in the general population (Daugherty *et al.*, 2021).

It is a fact that vaccination with COVID-19 booster dose has been proven safe, inducing immunity against significant variants of the disease. However, an Israeli study noted, that despite the fact that COVID-19 antibodies increased with the fourth booster dose of BNT162b2 mRNA vaccine, antibodies were not sufficient against Omicron variant (Chenchula *et al.*, 2022). The COVID-19 pandemic is the first public health crisis greatly influenced by social media. It appeared that 75-80% of Americans informed about health issues during the quarantine through these platforms (Shah and Coiado, 2023).

Additionally, Betsch *et al.* found that even a 5-10 minute exposure to vaccination-related topics increases the perceived risk and thus, reduces the intention to vaccinate (Betsch *et al.*, 2010). The sharing of personal experiences, especially negative ones (such as side effects, long-term impacts, rare diseases,

long waiting times, and others) regarding the first COVID-19 vaccination, was more common on social media than positive vaccination experiences. Many posts lacked of scientific accuracy and highlighted specific points from studies without presenting their final conclusions (Muric, Wu and Ferrara, 2021).

In developing countries, the factors, affecting the intention to receive a COVID-19 booster dose vaccination, differ from those in developed nations and continents. A study revealed that in 16 Sub-Saharan African countries, only 33.5% of urban dwellers had access to soap and water in order to support handwashing practices, as a primary prevention measure for the spread of COVID-19 (Jiwani and Antiporta, 2020).

Vaccine hesitancy among healthcare workers and students, as well as the unvaccinated healthcare professionals, contributed to the devaluation of their role among the general population. Demand for vaccines sharply declined in 2023 due to increased immunity from booster vaccines, previous infections and constant mutations. It is remarkable that government decisions in various countries regarding the mandatory vaccination have caused political polarization and further skepticism towards booster doses (Pandher and Bilszta, 2023).

Many concerns arise regarding the future of COVID-19 vaccines. The free provision of vaccination by the state, as well as the ensuring access, could be a significant factor in determining whether citizens will continue to vaccinate in the future. Additionally, regarding influenza, annual preventive vaccination (at specific population groups) is carried out in specific population groups. Evaluating the effectiveness of the influenza vaccine during the flu season in the Southern Hemisphere, from March to September, provides valuable information for countries in Northern Hemisphere. May the flu pattern be followed by COVID-19 booster doses vaccination?

The results of the present review proved satisfactory for the purpose of the study. Our systematic review had several limitations. First, a significant limitation is the search for articles in English and Greek. The limited

number of studies highlighted in this review does not manage to support the accuracy of the data with sufficient certainty. Second, it focuses on specific professional groups, such as healthcare workers and students, rather than the general population. Thus, it is proven the inability to generalize the results. Third, the described studies come from different continents (Europe, Asia, North America, Australia and Africa) with different cultures and economies. Fourth, most of the included studies were cross-sectional and therefore do not provide information regarding changes in attitudes and perceptions about vaccination and booster doses against COVID-19. Fifth, regarding healthcare professionals, there is no classification of studies based on their level of education (university studies or not), and some of them, due to selection of participants through convenience sampling, their workplace (Primary, Secondary or Tertiary Health Care) is not revealed. Specifically, five studies (Fotiadis *et al.*, 2021, Elbadawi *et al.*, 2022, Jorgensen *et al.*, 2023, Della Polla *et al.*, 2022, Kałucka, Kusideł and Grzegorzyc-Karolak, 2022) refer to healthcare professionals identifies in hospitals in various countries and only one (Koh *et al.*, 2022) is related to primary health care.

In conclusion, it is remarkable that the World Wide Web and the scientific community present a plenty of information about the coronavirus. However, due to the nature of the disease, the constant mutations of the SARS-CoV-2 change the aspects over the years. Therefore, future studies, reviews and analyses will certainly be beneficial.

It is undeniable that COVID-19 booster doses provide further immunity and reduce the severity of the disease's consequences, such as hospitalization and death. Since healthcare professionals play a critical role in shaping local communities' attitudes towards vaccines, their beliefs and attitudes play a crucial role (Dziedzic *et al.*, 2022). For this reason, it is recommended both training students and healthcare workers via competent institutions, as well as to mobilize and sensitize them, in order to base their attitudes on evidence-based practice. As new technologies and policies are built around COVID-19 vaccines, ongoing testing of their effectiveness, and updated guidelines

according to the population group, is proven vital to the impact of the disease.

References

- Abdelmoneim, S. A., Sallam M, Hafez DM, Elrewany E, Mousli HM, Hammad EM, Elkhadry SW, Adam MF, Ghobashy AA, Naguib M, Nour El-Deen AE, Aji N, Ghazy RM. (2022) COVID-19 Vaccine Booster Dose Acceptance: Systematic Review and Meta-Analysis, *Tropical Medicine and Infectious Disease*, 7(10): 46–71. doi: 10.3390/tropicalmed7100298.
- Al-Metwali, B. Z. Al-Jumaili AA, Al-Alag ZA, Sorofman B. (2021) Exploring the acceptance of COVID-19 vaccine among healthcare workers and general population using health belief model, *Journal of Evaluation in Clinical Practice*, 27(5): 1112–1122. doi: 10.1111/jep.13581.
- Alhasan, K. Aljamaan F, Temsah MH, Alshahrani F, Bassrawi R, Alhaboob A, Assiri R, Alenezi S, Alaraj A, Alhomoudi RI, Batais MA, Al-Eyadhy L, Halwani R, AbdulMajeed N, Al-Jedai A, Senjab A, Memish ZA, Al-Subaie S, Barry M, Al-Tawfiq JA. (2021) Covid-19 delta variant: Perceptions, worries, and vaccine-booster acceptability among healthcare workers, *Healthcare (Switzerland)*, 9(11): 1–19. doi: 10.3390/healthcare9111566.
- Alobaidi, S. and Hashim, A. (2022) Predictors of the Third (Booster) Dose of COVID-19 Vaccine Intention among the Healthcare Workers in Saudi Arabia: An Online Cross-Sectional Survey, *Vaccines*, 10(7): 1–15. doi: 10.3390/vaccines10070987.
- Askarian, M. *et al.* (2022) The COVID-19 vaccination acceptance / hesitancy rate and its determinants among healthcare workers of 91 countries : a multicenter cross-sectional study, *EXCLI J*, 21:93–103.
- Asumah, M. N. Abubakari A, Fosu B, Dzantor EK, Agyapong PD, Harrison SB, Apio G, Abukari AK. (2022) Determinants of COVID-19 vaccine acceptance and hesitancy among healthcare professionals in the Kintampo North Municipality, Bono East Region, Ghana, *Ghana Medical Journal*, 56(3), pp. 152–159. doi: 10.4314/gmj.v56i3.4.
- Bedston, S. Lowthian E, Jarvis CI, Akbari A, Beggs J, Bradley D *et al.* (2023) COVID-19 booster vaccination uptake and infection breakthrough amongst health care workers in Wales: A national prospective cohort study, *Vaccine*, 41(7): 1378–1389. doi: 10.1016/j.vaccine.2023.01.023.
- Betsch, C. Renkewitz F, Betsch T, Ulshöfer C. (2010) The influence of vaccine-critical websites on perceiving vaccination risks, *J Health Psychol*. doi: 10.1177/1359105309353647.
- Chenchula, S. Karunakaran P, Sharma S, Chavan M. (2022) Current evidence on efficacy of COVID-19 booster dose vaccination against the Omicron variant: A systematic review, *Journal of Medical Virology*, 94(7): 2969–2976. doi: 10.1002/jmv.27697.
- Daugherty, S. E. Guo Y, Heath K, Dasmariñas MC, Jubilo KG, Samranvedhya J, Lipsitch M, Cohen K. (2021) Risk of clinical sequelae after the acute phase of SARS-CoV-2 infection: Retrospective cohort study, *The BMJ*, 373. doi: 10.1136/bmj.n1098.
- Dziedzic, A. Issa J, Hussain S, Tanasiewicz M, Wojtyczka R, Kubina R, Konwinska MD, Riad A. (2022) COVID-19 vaccine booster hesitancy (VBH) of healthcare professionals and students in Poland: Cross-sectional survey-based study, *Frontiers in Public Health*, 10. doi: 10.3389/fpubh.2022.938067.
- Elbadawi, M. H. Altayib LS, Birier ABG, Ali LE, Hasabo EA, Esmaeel MAM, Elmahi OK (2022) Beliefs and barriers of COVID-19 vaccination hesitancy among Sudanese healthcare workers in Sudan: A cross sectional study, *Human Vaccines and Immunotherapeutics*, 18(6). doi: 10.1080/21645515.2022.2132082.
- Ford, A. Heidke P, Kurup C, Wirihana L, Kroll J, Calleja P. (2023) Factors influencing Australian nursing and midwifery students COVID-19 vaccination intentions', *Vaccine: X*, 14: 100352. doi: 10.1016/j.jvacx.2023.100352.
- Fotiadis, K. Dadouli K, Avakian I, Bogogiannidou Z, Mouchtouri VA, Gogosis K, Speletas M, Koureas M, Lagoudaki E, Kokkini S, Bolikas E, Diamantopoulos V, Tzimitreas A, Papadopoulos C, Farmaki E, Sofos A, Chini M, Tsolia M, Papaevangelou V, Ntzani EE, Gikas A, Prezerakos P, Hadjichristodoulou C. (2021) Factors associated with healthcare workers' (HCWs) acceptance of COVID-19 vaccinations and indications of a role model towards population vaccinations from a cross-sectional survey in Greece, may 2021, *International Journal of Environmental Research and Public Health*, 18(19). doi: 10.3390/ijerph181910558.
- Galanis, P. Vraka I, Katsiroumpa A, Siskou O, Konstantakopoulou O, Katsoulas T, Mariolis-Sapsakos T, Kaitelidou D. (2023) Predictors of second COVID-19 booster dose or new COVID-19 vaccine hesitancy among nurses: A cross-sectional study, *Journal of Clinical Nursing*, 32(13–14): 3943–3953. doi: https://doi.org/10.1111/jocn.16576.
- Galanis, P, Katsiroumpa, A.; Vraka, I.; Siskou O;

- Konstantakopoulou O; Katsoulas T; Kaitelidou D; (2023). Seasonal Influenza Vaccine Intention among Nurses Who Have Been Fully Vaccinated against COVID-19: Evidence from Greece. *Vaccines*, *11*, 159. <https://doi.org/10.3390/vaccines11010159>
- Galanis, P.; Katsiroumpa, A.; Sourtzi, P.; et al. (2023). COVID-19-Related Burnout and Intention of Fully Vaccinated Individuals to Get a Booster Dose: The Mediating Role of Resilience. *Vaccines*, *11*, 62. <https://doi.org/10.3390/vaccines11010062>
- Galanis, P.; Katsiroumpa, A.; Sourtzi, P.; Siskou, O.; Konstantakopoulou, O.; Katsoulas, T.; Kaitelidou, D. (2023). Social Support Mediates the Relationship between COVID-19-Related Burnout and Booster Vaccination Willingness among Fully Vaccinated Nurses. *Vaccines*, *11*, 46. <https://doi.org/10.3390/vaccines11010046>
- Galanis, P.; Vraka, I.; Katsiroumpa, A et al (2023). Psychosocial Predictors of COVID-19 Vaccine Uptake among Pregnant Women: A Cross-Sectional Study in Greece. *Vaccines*, *11*, 269. <https://doi.org/10.3390/vaccines11020269>
- Galanis, P.; Vraka, I.; Katsiroumpa, A.; et al. (2022). COVID-19 Vaccine Uptake among Healthcare Workers: A Systematic Review and Meta-Analysis. *Vaccines*, *10*, 1637. <https://doi.org/10.3390/vaccines10101637>
- Galanis, P., Vraka, I., Siskou, O., et al. (2022). Cross-sectional assessment of predictors for COVID-19 vaccine uptake: an online survey in Greece. *Vacunas*, *23*, S60–S66. <https://doi.org/10.1016/j.vacun.2022.03.003>
- Galanis, P.; Vraka, I.; Siskou, O.; et al. (2022). Uptake of COVID-19 Vaccines among Pregnant Women: A Systematic Review and Meta-Analysis. *Vaccines* **2022**, *10*, 766. <https://doi.org/10.3390/vaccines10050766>
- Katsiroumpa, A.; Sourtzi, P.; Kaitelidou, D.; et al (2023) Predictors of Seasonal Influenza Vaccination Willingness among High-Risk Populations Three Years after the Onset of the COVID-19 Pandemic. *Vaccines*, *11*, 331. <https://doi.org/10.3390/vaccines11020331>
- Green-McKenzie, J. . et al. (2021) Factors Associated With COVID-19 Vaccine Receipt by Health Care Personnel at a Major Academic Hospital During the First Months of Vaccine Availability, *JAMA Network Open*. doi: 4(12):e2136582.
- Hosek, M. G. et al. (2022) Low Prevalence of COVID-19 Vaccine Hesitancy in Students Across Health Science Disciplines in Texas, *Vaccine*, *10*:100154. doi: 10.1016/j.jvacx.2022.100154.
- Jairoun, A. A. et al. (2022) Assessing public knowledge, attitudes and determinants of third COVID-19 vaccine booster dose acceptance: current scenario and future perspectives, *Journal of Pharmaceutical Policy and Practice*, *15*(1): 1–13. doi: 10.1186/s40545-022-00422-2.
- Jiwani, S. S. and Antiporta, D. A. (2020) Inequalities in access to water and soap matter for the COVID-19 response in sub-Saharan Africa, *International Journal for Equity in Health*, *19*(1): 10–12. doi: 10.1186/s12939-020-01199-z.
- Jorgensen, P. et al. (2023) Factors associated with receipt of COVID-19 vaccination and SARS-CoV-2 seropositivity among healthcare workers in Albania (February 2021–June 2022): secondary analysis of a prospective cohort study, *The Lancet Regional Health - Europe*, *27*: 100584. doi: 10.1016/j.lanepe.2023.100584.
- Kałużka, S., Kusideł, E. and Grzegorzyc-Karolak, I. (2022) A Retrospective Cross-Sectional Study on the Risk of Getting Sick with COVID-19, the Course of the Disease, and the Impact of the National Vaccination Program against SARS-CoV-2 on Vaccination among Health Professionals in Poland, *International Journal of Environmental Research and Public Health*, *19*(12): 1–17. doi: 10.3390/ijerph19127231.
- Klugar, M. et al. (2021) COVID-19 vaccine booster hesitancy (VBH) of healthcare workers in czechia: National cross-sectional study, *Vaccines*, *9*(12): 1–29. doi: 10.3390/vaccines9121437.
- Koh, S. W. C. et al. (2022) COVID-19 vaccine acceptance and hesitancy among primary healthcare workers in Singapore, *BMC Primary Care*, *23*(1): 1–9. doi: 10.1186/s12875-022-01693-z.
- Kunno, J. et al. (2022) Satisfaction with COVID-19 Vaccines in Health Care Workers and the General Population: A Cross-Sectional Study in Urban Bangkok, Thailand, *Vaccines*, *10*(8): 1–13. doi: 10.3390/vaccines10081345.
- Le, C. N., Nguyen, U. T. T. and Do, D. T. H. (2022) Predictors of COVID-19 vaccine acceptability among health professions students in Vietnam, *BMC Public Health*, *22*(1): 1–12. doi: 10.1186/s12889-022-13236-3.
- Moher, D. et al. (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. doi: <https://doi.org/10.1371/journal.pmed.1000097>
- Moisoglou, I., Passali, C., Tsiachri, M., & Galanis, P. (2023). Predictors of COVID-19 Vaccine Uptake in Teachers: An On-line Survey in Greece. *Journal of community health*, *48*(1), 59–66. <https://doi.org/10.1007/s10900-022-01144-x>
- Momplaisir, F.M. Kuter BJ, Ghadimi F, Browne S, Nkwihoreze H, Feemster KA, Frank I, Faig W,

- Shen AK, Offit PA, Green-McKenzie J. (2021) Racial/Ethnic Differences in COVID-19 Vaccine Hesitancy Among Health Care Workers in 2 Large Academic Hospitals, *JAMA Network Open - Infectious Diseases*, 388: 1–14.
- Lo Moro, G. *et al.* (2022) Vaccine Hesitancy and Fear of COVID-19 Among Italian Medical Students: A Cross-Sectional Study', *Journal of Community Health*, 47(3): 475–483. doi: 10.1007/s10900-022-01074-8.
- Muric, G., Wu, Y. and Ferrara, E. (2021) COVID-19 Vaccine Hesitancy on Social Media: Building a Public Twitter Data Set of Antivaccine Content, Vaccine Misinformation, and Conspiracies, *JMIR Public Health Surveill.*, 17(7): 11. doi: 10.2196/30642.
- Njoga, E. O. *et al.* (2022) COVID-19 Vaccine Hesitancy and Determinants of Acceptance among Healthcare Workers, Academics and Tertiary Students in Nigeria, *Vaccines*, 10(4). doi: 10.3390/vaccines10040626.
- Pandher, R. and Bilszta, J. L. C. (2023) Novel COVID-19 vaccine hesitancy and acceptance, and associated factors, amongst medical students: a scoping review, *Medical Education Online*, 28(1). doi: 10.1080/10872981.2023.2175620.
- Paridans, M. *et al.* (2022) The Dynamic Relationship between the Intention and Final Decision for the COVID-19 Booster: A Study among Students and Staff at the University of Liège, Belgium, *Vaccines*, 10(9), pp. 1–19. doi: 10.3390/vaccines10091485.
- Patelarou, A., Saliadj, A., Galanis, P., *et al.* (2022). Predictors of nurses' intention to accept COVID-19 vaccination: A cross-sectional study in five European countries. *Journal of clinical nursing*, 31(9-10), 1258–1266. <https://doi.org/10.1111/jocn.15980>
- Peterson, C. J. *et al.* (2021) 2019 Novel Coronavirus Vaccination Among Medical Students, *Journal of Primary Care and Community Health*, 12. doi: 10.1177/21501327211058316.
- Peterson, C. J., Lee, B. and Nugent, K. (2022) COVID-19 Vaccination Hesitancy among Healthcare Workers—A Review, *Vaccines*, 10(6): 1–30. doi: 10.3390/vaccines10060948.
- Politis, M. *et al.* (2023) Healthcare Workers' Attitudes towards Mandatory COVID-19 Vaccination: A Systematic Review and Meta-Analysis, *Vaccines*, 11(4): 1–28. doi: 10.3390/vaccines11040880.
- Della Polla, G. *et al.* (2022) Willingness to accept a second COVID-19 vaccination booster dose among healthcare workers in Italy, *Frontiers in Public Health*, 10. doi: 10.3389/fpubh.2022.1051035.
- Ryalat, S. *et al.* (2022) Attitudes towards COVID-19 Booster Vaccines, Vaccine Preferences, Child Immunization, and Recent Issues in Vaccination among University Students in Jordan, *Vaccines*, 10(8). doi: 10.3390/vaccines10081258.
- Shah, A. and Coiado, O. C. (2023) COVID-19 vaccine and booster hesitation around the world: A literature review, *Frontiers in Medicine*, 9. doi: 10.3389/fmed.2022.1054557.
- Tomietto, M. *et al.* (2022) A large cross-sectional survey of COVID-19 vaccination willingness amongst healthcare students and professionals: Reveals generational patterns, *Journal of Advanced Nursing*, 78(9), 2894–2903. doi: 10.1111/jan.15222.
- Vellappally, S. *et al.* (2022) Perception of COVID-19 Booster Dose Vaccine among Healthcare Workers in India and Saudi Arabia' *International journal of environmental research and public health*, 19(15): 1–11. doi: 10.3390/ijerph19158942.