Attitudes of health care workers toward COVID-19 vaccination: A literature review

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ABSTRACT: One of the main goals of current COVID-19 vaccination programs is to achieve herd immunity, which would inhibit further spread of the virus. However, achieving this goal is impossible without widespread public acceptance of vaccination. As a result, concerns about the decision to accept vaccination have become a key public health challenge on a global scale in recent years. Healthcare workers' attitudes toward COVID-19 vaccination are mostly related to accepting vaccine preparations and recommending them to patients. This is of great importance for maintaining the continuity of health care, as it contributes to protecting medical workers from SARS-CoV-2 virus infection and thus counteracts their absenteeism. In turn, with an adequate number of employees in healthcare facilities, it is possible to provide proper care to patients in a life- or health-threatening condition. In addition, medics are often considered authorities on health issues. Therefore, their trust and submission to vaccination will positively influence the public and encourage them to undergo the COVID-19 vaccination.

KEYWORDS: vaccination; health care workers; vaccination acceptance; COVID-19 pandemic

1. Introduction

The development, dynamism, and scale of the COVID-19 pandemic, as well as the associated morbidity and mortality, have accelerated the development and testing of vaccines against COVID-19. Well, according to statistics from the World Health Organization (WHO), as of 25 October 2023, 771,549,718 confirmed cases of COVID-19 were reported worldwide, including 6,974,473 deaths, which only confirms the very high degree of prevalence, and therefore global coverage of the COVID-19 disease[1]. In Poland, according to data from the Ministry of Health website, as of 25 October 2023, the number of infections as of 4 March 2020 was 6,530,685, including 119,666 deaths[2]. These statistics are the best and, unfortunately, the most brutal evidence of what havoc the COVID-19 pandemic has wreaked, as it has led to the destabilization of society in many areas of life, from the economy, finance, tourism, education, and healthcare[3]. Importantly, despite the end of the pandemic period, the consequences of certain changes in many countries are still noticeable and present to this day.

To minimize the risk of transmission of the SARS-CoV-2 virus, the World Health Organization

announced official recommendations for people, resulting in the first restrictions in early 2020 in the form of mandatory wearing of protective masks or keeping a social distance[4,5]. Unfortunately, this did not make the morbidity or mortality rate drop completely, so the primary and most effective tool to be able to combat the pandemic and bring it to a state of relative normalcy turned out to be vaccination[6]. Although the beliefs of the community varied, the initial introduction and administration of the COVID-19 vaccination became an opportunity for many people to gain immunization against the infection, and thus to take control of the transmission of the virus and effectively counter the pandemic[7]. This did not mean, however, that the aforementioned non-pharmacological interventions ceased to be relevant, for despite the promotion of vaccination around the world, masks, and social distancing have always played an important role in limiting the spread of the virus. Significantly, even in people who were vaccinated against COVID-19, it was recommended to constantly maintain social distance in interpersonal contacts and to wear masks, since vaccination did not provide a complete guarantee against protection from infection[8]. Due to the lack of drugs with complete efficacy in both prevention and treatment of COVID-19, vaccination by protecting against the symptoms of COVID-19 caused by the SARS-CoV-2 virus remains to this day the most favorable choice of society to inhibit the spread of the disease. It is through vaccination that it has become possible to take control of the spread of the SARS-CoV-2 virus and reduce the morbidity or mortality from COVID-19 disease. The WHO even estimates in one report that at least one million people in Europe have been saved after being administered the COVID-19 vaccine[1].

Referring to the negative impact of the pandemic on healthcare workers is particularly noticeable, despite the passage of time. For the steadily increasing number of infections and deaths during the peak of the pandemic, the fear of contracting the disease and sometimes actually getting sick, shortages of personal protective equipment supplies, or the risk of transmitting the SARS-CoV-2 virus to one's loved ones led to a heavy physical burden[9], but often also to trauma and disorders of the mental health sphere, among others, in the form of professional burnout, called in the era of the pandemic "covid burnout"[10]. Thus, healthcare workers have become one of the groups considering vaccination as a needed and long-awaited turning point in the fight against the COVID-19 pandemic. Their widespread acceptance of vaccination translates largely into the reception of vaccine preparations by the rest of the population, which is of great importance in achieving herd immunity and thus preventing further transmission of the SARS-CoV-2 virus.

On a mass scale worldwide, the vaccination program began in early December 2020. In Poland, the first vaccinations for COVID-19 were administered on 27 December 2020, at a hospital in Warsaw among health care workers. According to WHO data, as of 16 October 2023, 13,516,459,649 doses of the COVID-19 vaccine have been administered[1]. All approved COVID-19 vaccines to date have been thoroughly tested and remain monitored at all times.

The study aims to review the existing literature and determine the attitudes of healthcare workers toward COVID-19 vaccination, which was achieved.

2. Review methodology

Certainly, here is the methodology for conducting a literature review on the attitudes of healthcare workers toward the COVID-19 vaccination: The objective of this literature review is to gain a comprehensive understanding of healthcare workers' attitudes towards COVID-19 vaccination and to identify the various factors that influence these attitudes. Criteria for selecting relevant literature include the type of publications, such as scientific studies, systematic reviews, review articles, and research

reports. The review will consider literature published within the last 5 years (from 2018 onward) and will encompass literature in the English language, with the possible inclusion of translations or adaptations. The literature search will involve a thorough exploration of scientific databases such as PubMed, Scopus, the Web of Science, and university libraries. Relevant keywords, such as "healthcare workers", "COVID-19 vaccination", "attitudes", "beliefs", "barriers", "acceptance", and "hesitancy", will be used to refine the search. The process of literature selection will entail reviewing titles and abstracts to determine if the publications align with the objectives of the review. Works that do not meet the criteria will be excluded from consideration. After literature selection, the identified works will be categorized based on the type of study, including surveys, content analysis, and qualitative studies. The analysis will focus on examining the findings related to healthcare workers' attitudes toward COVID-19 vaccination and identifying the various factors that influence these attitudes. Results from the literature will be synthesized to create a comprehensive summary, highlighting key themes and trends in healthcare workers' attitudes toward COVID-19 vaccination. The review will conclude with the formulation of key conclusions drawn from the literature review, and it may provide recommendations for healthcare workers, public health institutions, and researchers based on the identified insights. The findings of the literature review will be reported in a structured report, including information on the objectives, methodology, results, and conclusions.

3. Vaccines against COVID-19

Before discussing COVID-19 vaccines, it is worthwhile at the outset to define the basic words of vaccinology so that it will be possible to understand how vaccination works and, subsequently, the attitudes of healthcare workers toward it. One of the words that is used daily by the public these days is the word vaccine, although its meaning, although simple, seems to be not fully understood. A vaccine is nothing more than a medicinal product that stimulates the human immune system to produce immunity to a particular disease, so it protects the recipient from the severity of a particular disease and its complications and thus has a preventive effect[11]. The immunity obtained through vaccination is analogous to the immunity obtained during the first contact with a pathogenic microorganism. Importantly, the immunity acquired by the recipient as a result of vaccination is much safer than the one that can be acquired during a natural disease[12]. Conventional vaccines, which contain ready-made antigens, but also the latest nucleic acid vaccines and vector vaccines, which contain information on antigen production, work in the mentioned manner[13] (**Table 1**).

Table 1. Types of vaccines[13].

Types of vaccines	
Live attenuated vaccines	They contain ready-made antigens that provide a stimulus to the immune system.
Inactivated vaccines	
mRNA vaccines	They contain genetic information on how to produce a viral protein called antigen and produce antibodies against it.
Vector vaccines	
Subunit protein vaccines	They contain a specific viral protein called antigen (rather than the entire genetic information), which induces an immune response in the body.

Another important term for understanding the topic is the word antigen. Antigens are substances that, after entering the body, trigger its immune response against a specific microorganism, involving the proliferation of lymphocytes as well as the production of specific antibodies[12]. An antibody, in turn, is a type of protein that is produced by plasma cells during a humoral immune response. Antibodies have the

specific ability to specifically recognize antigens[11].

All existing COVID-19 vaccines differ from each other primarily in their mechanisms of action. Thus, depending on the mechanism of action, several types of vaccines are distinguished. Namely: inactivated or live attenuated (with weakened virulence) vaccines, as well as the latest versions of vaccines in the form of viral vectors, recombinant proteins, and vaccines with a fragment of genetic material containing genetic information (such as matrix RNA-mRNA) of antigen production[13].

Since the outbreak of the COVID-19 pandemic, the first vaccine was developed and then marketed in less than a year[14]. Detailed work in the laboratory was initiated after the official announcement of the genetic sequence belonging to the SARS-CoV-2 virus, which took place in January 2020. Thus, the pace of production of the COVID-19 vaccine is extremely fast and so far unprecedented in history[15]. It is also worth noting that some of the vaccines use novel methods that were not used among the human population before the COVID-19 pandemic outbreak. Indeed, vaccines with ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) have never been licensed before, which is a breakthrough for vaccinology[16].

Inactivated vaccines contain dead SARS-CoV-2 virus, which has been previously inactivated either chemically, thermally, or by radiation. The recommended method is primarily chemical inactivation carried out based on formaldehyde and beta-propiolactone. The resulting virus is ultimately recognized by the human immune system to induce a response, but without causing COVID-19 disease[17]. This type of vaccination has previously been used on a large scale for centuries in vaccinations against influenza, measles, polio, and rotavirus, among others. The advantages of inactivated vaccines include a higher level of safety compared to live vaccines. In addition, they are less reactive, relatively easy to produce, and have fewer regulatory hurdles for licensing. Disadvantages, on the other hand, include lower immunogenicity and thus the need for multiple doses and/or the addition of adjuvants to achieve an adequate immune response[18]. Inactivated vaccines against COVID-19 include those from Sinovac, Sinopharm, and Bharat Biotech, which have been administered in China and India. These companies' vaccines were treated with beta-propiolactone, which, by damaging the genome without affecting the protein, made the vaccine particles similar to real viruses, in this case, the SARS-CoV-2 virus[19].

Live-attenuated vaccines are similar in technology to inactivated vaccines, with the difference that the virus in them is weakened, not dead. The weakening, or so-called attenuation, is made possible by exposing the virus to unfavorable conditions, which include low temperatures[20]. The virus is exposed to low temperatures until it loses its pathogenic properties while maintaining its immunogenicity. Once injected, the viruses sequentially replicate in the host, causing an immune response that resembles a natural infection without actually causing disease. Examples of this type of vaccination, which have previously been widely used for centuries, include the measles, mumps, and rubella vaccine (MMR combination formulation) or the herpes zoster vaccine[19]. Live-attenuated vaccines are one of the dominant and most widespread methods of vaccination on a mass scale around the world, as they very much mimic natural infection without the burden of disease. However, these vaccines also raise some questions. The reason for this is the problematic nature associated with the risk of the virus regaining virulence through mutation after vaccination. These vaccines are also not recommended for people with weakened immune systems. Among the live-attenuated vaccines against COVID-19 are those owned by the US company Codagenix, which uses this very technology[21].

Vector vaccines in the technology of action use a viral vector to carry the genetic material belonging

to the SARS-CoV-2 virus. This occurs through bioengineering of the viral vector backbone by integrating the genes encoding the antigen together with the viral genome from which the harmful genes have been eliminated[22]. In the human body, this material is used to produce a specific protein, which is then recognized by our immune system and induces a response. The response, in turn, guarantees the formation of an immune memory, which enables the human body to possibly fight off the virus in the future. Thus, the virus in this case is a kind of carrier that stimulates the host body to produce antibodies[23]. Importantly, vector vaccines are divided into replicating and non-replicating. The former infects target cells, to stimulate antigen production, and leads to replication and infection of new host cells to allow the formation of vaccine antigens, which will translate into a stronger immune response in the body. In contrast, the latter induces antigen production without simultaneously producing new viral particles[20]. Vaccines based on viral vectors include those from Oxford Vaccine Group—AstraZeneca (a vaccine called Vaxzevria/ChAdOx1 nCoV-19), Janssen Vaccines & Prevention BV—Johnson & Johnson (Ad26.COV2-S), which have been approved for marketing in the EU, or Russia's Gamaleya—Sputnik V (Gam-COVID-Vac)[20,23]. However, the controversial issue of these vaccines remains their future due to the possibility of developing inhibitory anti-vector immunity in people previously vaccinated with them. Well, it is not clear whether future vaccines based on the same vectors will be able to be administered again, in particular about new COVID-19 variants[23].

Recombinant protein vaccines are also often referred to in the literature as modified subunit protein vaccines[22]. They are based on synthetic peptides, or, as the name suggests, recombinant proteins of the target pathogen. In the construction of the vaccine, they contain antigen fragments without pathogenic components, thus eliminating the concerns of incomplete inactivation of the virus, restoration of virulence, and existing vector immunity, among others[20]. Vaccine production is made possible by integrating the target genes of the pathogenic microorganism into a vector that effectively expresses the antigen protein in an unrelated organism. This type of vaccination is currently used on a large scale in vaccination against hepatitis B, or HPV, among others[22]. In contrast, many recombinant SARS-CoV-2 virus subunit vaccines use the spike (S) protein and its fragments, such as RBD, as antigens. The RBD receptor domain of the spike protein is responsible for initiating the process by which the virus directly interacts with proteins on the surface of a human cell, which consequently starts the process of infecting the cell. The S protein has been shown to have multiple conformational neutralizing epitopes, making it suitable for vaccine development[24]. An example of a protein subunit vaccine against SARS-CoV-2 is Novavax's vaccine called Nuvaxovid (NVX-CoV2373), which contains protein S nanoparticles combined with Matrix-M adjuvant[25].

Nucleic acid vaccines are based on deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) and are the most modern method of vaccine development. In essence, these vaccines act similarly to vector vaccines in that they primarily transmit genetic instructions, i.e., DNA/mRNA encoding a protein antigen specific to a disease entity. The goal is to express the viral S protein in host cells, which triggers a specific humoral and cellular immune response[20]. After inoculation, cells in the human body produce proteins that mimic disease antigens using genetic material from the vaccine, which are ultimately recognized by the immune system and induce a specific response. This builds up a so-called immune memory, which will enable the body to fight the SARS-CoV-2 virus in the future. According to the literature, mRNA vaccines are theoretically safer compared to DNA vaccines because DNA vaccines need to enter the nucleus to achieve expression of the target antigen, while mRNA vaccines only need to enter the cytoplasm. Thus, it is enough to introduce mRNA into the cytosol of the cell to undergo ribosomal translation and lead to antigen production[22]. A major potential that makes vaccines relatively

easy and financially viable for mass production is that these vaccines do not require growing and propagating viruses in living cells in the laboratory[20]. Among the mRNA vaccines produced against the SARS-CoV-2 virus are those from Pfizer-BioNTech, the Comirnaty/BNT162b2 vaccine, or Moderna, a vaccine called Spikevax/mRNA-1273[26].

To summarize the theme of vaccination, in the last three years since the outbreak of the COVID-19 pandemic, there have been great advances in vaccine production and, thus, a breakthrough in vaccine technology worldwide. First of all, the pace of vaccine production has proved unprecedented in history. In addition, new vaccination methods like viral vectors and recombinant proteins had not been used before the pandemic among the human population, which also proved to be a major milestone. All of the existing types of COVID-19 disease vaccines discussed in the above section have both advantages and disadvantages in terms of efficacy, side effects, or duration of action, for example, which makes it impossible to conclusively determine which is the most effective or safest. Yet regardless of the choice, each vaccine brings society closer to finally winning the fight against the COVID-19 pandemic, and it is estimated that nearly 70% of the world's population should be vaccinated to achieve the desired result of group immunity[20]. The rapid production and mass distribution have also led to several concerns about the emergence of new strains of the virus for which the vaccine might not be effective, making it impossible to provide immunity to the human population. This makes the topic highly topical and requires constant monitoring due to the changing epidemiological situation and the emergence of new strains of the SARS-CoV-2 virus.

4. Attitudes of healthcare workers towards COVID-19 vaccination—Literature review

Healthcare workers' attitudes toward the COVID-19 vaccination played a key role in the fight against the pandemic. Medics were among the first groups to be vaccinated. Thus, this professional group's acceptance of the vaccine is extremely important to the general public, which certainly relies on the medics' attitudes toward vaccination. Therefore, it can be concluded that the attitudes of medical professionals related to advocacy and promotion of vaccination have often contributed to breaking down commonly existing barriers and fears that prevent the public from accepting vaccination.

One of the cross-sectional studies done to assess healthcare workers' attitudes toward COVID-19 vaccination is a study conducted in the United States by Shekhar et al.[27]. One of the non-random sampling methods used was the snowball method of recruiting new participants through others. Criteria for inclusion in the study included respondents' age >18 years, or professional work in healthcare facilities. Respondents' attitudes toward COVID-19 immunization were assessed based on their agreement with the author's statements, rated on a five-point Likert scale. For example, among the statements assessed by respondents were: "I am concerned about the effectiveness of the COVID-19 vaccine," "I am concerned about the speed of development of the COVID-19 vaccine," or "I am concerned about the adverse effects of the vaccine on my existing chronic diseases." The survey was conducted from 7 October to 9 November 2020, a period before the first vaccines for COVID-19 were launched, and 3479 healthcare workers participated. One of the main objectives of the survey's authors was to determine whether medics are willing to be vaccinated against COVID-19. Among other things, they were asked whether they are willing to "take the drug as soon as it is available", but "wait for a review of the safety data" for 3 months, 6 months, or a year consecutively, or are unsure about vaccination or do not want to take the COVID-19 vaccine. In addition, the majority of respondents (87% of the total) confessed that they are at risk of contracting COVID-19 due to their professional duties.

Approximately half of those surveyed (45% of the total) said they had direct contact with patients infected with the SARS-CoV-2 virus during their work. A key result of the study was the finding that approximately one-third of the medics surveyed (36% of the total) were willing to receive the vaccine if it became available. A larger proportion of those surveyed (56% of the total) said they were unsure because they planned to wait for data on its safety. In contrast, only 8% of all medics surveyed were not willing to accept the vaccine. In contrast, in one question, respondents overwhelmingly (48% of the total) answered that they believe the COVID-19 vaccine should be voluntary. Another important question was whether respondents would recommend COVID-19 vaccination to their relatives, to which most of them (46%) answered yes. The authors also made the following correlations using appropriate correlations: the widespread acceptance of the COVID-19 vaccine among medical professionals increased with age or education level, respectively[27]. In conclusion, this study showed that the level of interest in the COVID-19 vaccination among healthcare workers is high because only 8% of respondents were unwilling to accept the vaccination. This proves that medical workers were mostly positive about the vaccination even before the advent of the vaccine.

Another study published by Globevnik Velikonja et al.[28] examined the influence of psychological factors on the widespread acceptance of vaccination among healthcare workers in Slovenia during three different periods of the COVID-19 pandemic. The first period in which the study was conducted was the beginning of the pandemic (13–14 March 2020). The second period of the study took place a month later (13 April—8 May 2020). The third survey period was when the vaccination was already available on the market (7 March—26 May 2021). The study was conducted using an online survey to determine the propensity to be vaccinated against COVID-19 in the first and second periods and the status of vaccination in the third period, as well as general attitudes toward vaccination among medical professionals. In the first period, 851 healthcare workers participated in the survey; 86 medical professionals completed the survey in the second period; and 145 medical professionals were included in the third period. The group surveyed in each period was only roughly comparable because, as the authors determined, an identical sample was not possible due to the negative impact of the COVID-19 pandemic on employees' work schedule changes, overtime, or illness. Among the 21 questions of which the survey consisted were questions on mental strain, among others assessing anxiety levels using the Generalized Anxiety Disorder Questionnaire (GAD-7) scale. The GAD-7 scale is a seven-item generalized anxiety disorder scale developed by Spitzer et al. in 2006 as a screening tool to determine personal feelings about generalized anxiety syndrome. The scale's questions relate to well-being over the past 2 weeks and describe, among other things, feelings of tension and nervousness, worrying too much about various things, or fearing something terrible is about to happen. All of them are rated according to a 4-point Likert scale, in which 0 means not at all and 3 means almost every day. The scores are the sum of the individual questions and range from 0 to 21 points. A higher score correlates with more severe symptoms. With a score of 10 or higher, the likelihood of generalized anxiety disorder is high[29]. In the cited study, through the use of the GAD-7 scale, the authors determined that there was a statistically significant difference in the intention to receive vaccination between groups of respondents with different levels of anxiety in the first and third periods of the study. In the first period, respondents with higher levels of anxiety showed a greater willingness to be vaccinated. In the third period, on the other hand, the relationships between willingness to accept vaccination and anxiety levels were more complex. Well, in the group of respondents with minimal anxiety, the percentage of medics who were unwilling to undergo vaccination was relatively small, while in the groups with strong and moderate anxiety, it was much higher. In contrast, among respondents with severe anxiety, the majority planned to receive the vaccination, although they had a problem with hesitation in making the decision. The authors also noted

that there was a decrease in the percentage of participants who expressed a negative stance toward vaccination during the periods studied, which included two responses: "I have no intention of getting vaccinated" and "I'm not sure." Significantly, during the most recent survey period, 31% of participating medics were vaccinated for COVID-19, and another 42% of respondents expressed a willingness to undergo such vaccination[28]. In summary, the survey showed that during the different stages of the pandemic, the factors influencing the acceptance of the COVID-19 vaccines successively changed. It is particularly positive that the willingness to be vaccinated has successively increased among the surveyed healthcare workers. This is very important, as medical personnel play a key role in making the public aware of the need for COVID-19 vaccination as well as dispelling the ever-present conspiracy theories in public opinion.

The topic of hesitation to vaccinate against COVID-19 occurring among healthcare workers was also addressed in a paper published by Al-Sanafi and Sallam[30]. The study was conducted between 18–29 March 2021, on medical personnel in Kuwait, consisting of 1019 people. Its purpose was to study the acceptance of the COVID-19 vaccination among medics and to identify possible psychological factors that could influence the decision not to vaccinate. The 5C Scale and the Vaccine Conspiracy Beliefs Scale (VCBS)[30] were used to examine psychological factors influencing the acceptance of the COVID-19 vaccines. The 5C Scale, according to Betsch et al.[31], is an innovative tool for monitoring psychological motivations related to vaccination decisions affecting people's reluctance or acceptance, particularly in the context of the COVID-19 vaccination. Its name is derived from the first letters of each of the five key factors it assesses. These are confidence, complacency, constraints, calculation, and collective responsibility. The VCBS scale, on the other hand, assesses conspiratorial thinking about the COVID-19 vaccine and, more specifically, assesses the extent to which respondents share beliefs related to conspiracy theories about them[32]. The 5C scale, as well as the VCBS scale, used a 7-point Likert scale in which 1 meant "strongly disagree" and 7 meant "strongly agree." However, in the case of the trust and collective responsibility assessment, the scores were reversed[30]. Referring to the aforementioned survey, the authors, after analyzing the results, estimated that the total percentage of agreement with the COVID-19 vaccine was 83.3%. In contrast, 9% of the total respondents expressed reluctance to be vaccinated, and the remaining 7.7% were uncertain about their decision. Significantly, the highest support for the COVID-19 vaccination was observed among dentists (91.2%) and physicians (90.4%). In contrast, the lowest acceptance was observed among nurses (70.1%). It was also noted that the acceptance rate of the COVID-19 vaccination is higher among men, those with a higher level of education, as well as medical personnel employed in public rather than private facilities. In terms of preference for specific types of COVID-19 vaccines, most respondents favored mRNA-based vaccines (62.6% of the total), followed by inactivated vaccines (24.8% of the total). By vaccine manufacturer, on the other hand, respondents mostly opted for the Pfizer-BioNTech vaccine (69.7% of the total), followed by the Oxford-AstraZeneca vaccine (18.9% of the total). The authors also noted that a high degree of collective responsibility and trust, as well as a lower level of calculation and constraint, were the main psychological factors for acceptance of the COVID-19 vaccine according to the 5C scale. Analysis of the part related to the VCBS scale showed that the highest average score appeared among medical personnel who did not intend to undergo the COVID-19 vaccination. Thus, this means that a higher score according to the VCBS scale was related to the tendency to avoid COVID-19 vaccination. In addition, a higher score according to the VCBS scale was correlated with reliance on deriving information about the COVID-19 vaccination from TV shows, social networks, or press releases compared to reliance on scientific journals or the opinions of qualified medical personnel[30]. In conclusion, people who rely solely on unreliable sources of knowledge have limited access to reliable

information, which consequently translates into their misunderstanding and negative attitude towards vaccination. Only true information can influence the acquisition of solid knowledge on the effectiveness of vaccination against COVID-19, whether in terms of reducing severe cases of the disease or limiting the spread of the disease among the population. This is why it is so important to derive vaccination knowledge from proven sources, as this can help people make informed and responsible decisions related to the adoption of the COVID-19 vaccination.

A recent study I cited by Veger et al.[33] also addressed the attitudes of healthcare workers toward the COVID-19 vaccination. The survey was conducted in France and French-speaking parts of Belgium and Canada during October and November 2020. A total of 2678 healthcare workers participated. One of its objectives was to assess the willingness to accept future doses of the COVID-19 vaccination for that period and the willingness to recommend them to patients. The second objective was to analyze the factors influencing the acceptance of vaccination among different groups of medical professionals according to their personal beliefs toward COVID-19 vaccination. The results obtained by the authors were as follows: the vast majority of respondents (79.6% of the total) would certainly or probably recommend COVID-19 vaccination to their patients. In addition, slightly fewer than 72.4% of respondents would also certainly or probably agree to receive the vaccination in the future. The present study also found that the degree of vaccine acceptance was affected by the inability to guarantee the safety of vaccine preparations, which were created in an emergency such as the outbreak of the COVID-19 pandemic. The second major factor reducing vaccine acceptance was found to be a lack of confidence in the Ministry of Health's ability to guarantee the safety of vaccine preparations. The study's authors also noted slight differences in the attitudes of medical professionals toward vaccination after broadcasting press releases on the effectiveness and safety of SARS-CoV-2 vaccine preparations[33]. This study, like the previous ones, proves the necessity of basing one's views on the COVID-19 vaccination on reliable sources of information, which certainly do not include newspapers and any press releases.

5. Conclusion

Positive attitudes of healthcare workers toward COVID-19 vaccine preparations translate into their acceptance among the public. Well, any attitudes or positions of medical professionals in favor of the safety or efficacy of vaccination are an important element in promoting the adoption of the COVID-19 vaccination. This can have a positive impact not only on the public's acceptance of vaccination itself but also on the effective control of the spread of COVID-19 disease and perhaps even its full suppression in the future. It also seems important to say that there should be a constant response to the concerns of healthcare workers against the COVID-19 vaccination since they are the first to be vaccinated, and it is largely on them that society relies on and models. It is very often the medics who are seen by the public as the authority on health issues, especially when it concerns new preparations, which COVID-19 vaccines have been and for many still are.

Positive attitudes toward the effectiveness of healthcare in achieving herd immunity can be influenced by several factors, including psychological preparedness. Here are some reasons for this positive outlook: Scientific understanding: Individuals with medical or scientific backgrounds may better comprehend the immunology and epidemiology fundamentals. Having this knowledge can lead to greater trust in the effectiveness of vaccinations and other preventive measures in building herd immunity. Reliable information sources: Access to credible information sources, such as scientific research and expert opinions, can help in understanding healthcare effectiveness. People who follow

information from medical authorities may have more trust in the healthcare system. Social value: A positive attitude towards healthcare may stem from the belief that caring for society's health is important and responsible. Those who understand that their actions impact others may be more inclined to follow medical recommendations. Personal experiences: People who have had positive healthcare experiences, such as successful treatments or protection through vaccinations, are more likely to trust the healthcare system. Community and solidarity: A positive attitude towards healthcare can also result from a sense of community and solidarity. Individuals who understand that their actions aim to protect others may be more motivated to follow preventive measures. Psychological resilience: Psychological preparedness can play a significant role in a positive attitude toward healthcare effectiveness. People who cope better with stress and health-related concerns are more likely to take preventive actions and trust the healthcare system.

One of the many goals of existing COVID-19 vaccination programs is to achieve so-called herd immunity, which will make it possible to halt the spread of the virus. However, this will not be possible without widespread public acceptance of vaccination. For this reason, concerns about the decision to accept vaccination have recently emerged as a significant public health challenge on a global scale. Given that, a factor necessary for the complete control of the COVID-19 disease pandemic is the mass adoption of vaccination, which should intensify all possible activities against evasion. Only in this way will it be possible to finally defeat the COVID-19 pandemic by reducing the number of infections, hospitalizations, and deaths and, in the aftermath, repairing the existing economic damage or any health and psychological disorders. By vaccinating as many people as possible, there will also be an improvement in the overall safety of people, as the transmission of the SARS-CoV-2 virus will be reduced, as will the risk of new variants of the virus. This is why it is so important to raise public awareness of the need for vaccination, which has been proven to be hugely influenced by healthcare workers.

Author contributions

Conceptualization, DŁŻ and MG; methodology, MG; resources, MW and DŁŻ; writing—original draft preparation, DŁŻ and MW; writing—review and editing, IKS; supervision, MG. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors claim no conflict of interest in the paper.

References

1. WHO coronavirus (COVID-19) dashboard. Available online: https://covid19.who.int/ (accessed on 2 November 2023).
2. Coronavirus infection report (SARS-CoV-2) (Polish). Available online: https://www.gov.pl/web/koronawirus/wykaz-zarazen-koronawirusem-SARS-CoV-2 (accessed on 2 November 2023).
3. Robillard R, Saad M, Edwards J, et al. Social, financial and psychological stress during an emerging pandemic: Observations from a population survey in the acute phase of the COVID-19. *British Medical Journal* 2020; 10: e043805. doi: 10.1136/bmjopen-2020-043805
4. Catching A, Capponi S, Yeh MT, et al. Examining the interplay between face mask usage, asymptomatic transmission, and social distancing on the spread of the COVID-19. *Scientific Reports* 2021; 11: 15998. doi: 10.1038/s41598-021-94960-5
5. Durmuş H, Gökler ME, Metintaş S. The effectiveness of community-based social distancing for mitigating the spread of the COVID-19 pandemic in Turkey. *Journal of Preventive Medicine & Public Health* 2020; 53(6): 397–404. doi: 10.3961/jpmph.20.381
6. Salmon DA, Dudley MZ, Brewer J, et al. COVID-19 vaccination attitudes, values, and intentions among

United States adults before emergency use authorization. *Vaccine* 2021; 39(19): 2698–2711. doi: 10.1016/j.vaccine.2021.03.034

7. 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(42): 6500–6507. doi: 10.1016/j.vaccine.2020.08.043

8. Bailey RI, Cheng HH, Chase-Topping M, et al. Pathogen transmission from vaccinated hosts can cause a dose-dependent reduction in virulence. *PLoS Biology* 2020; 18(3): e3000619. doi: 10.1371/journal.pbio.3000619

9. Koontalay A, Suksatan W, Prabsangob K, Sadang JM. Healthcare workers' burdens during the COVID-19 pandemic: A qualitative systematic review. *Journal of Multidisciplinary Healthcare* 2021; 14: 3015–3025. doi: 10.2147/JMDH.S330041

10. Ardebili ME, Naserbakht M, Bernstein C, et al. Healthcare provider's experience of working during the COVID-19 pandemic: A qualitative study. *American Journal of Infection Control* 2021; 49(5): 547–554.

11. Abbas AK, Lichtman AH, Pillai S. *Basic Immunology: Functions and Disorders of the Immune System*, 7th ed. Elsevier; 2023. 352p.

12. Steele A (editor). *Immunology: Functions and Disorders of the Immune System*. States Academic Press; 2022. 241p.

13. Summary—COVID-19 vaccine: About the disease (Polish). Available online: https://szczepienia.pzh.gov.pl/szczepionki/covid-19-2/ (accessed on 2 November 2023).

14. Polack FP, Thomas SJ, Kitchin N, et al. Safety and efficacy of the BNT162b2 mRNA COVID-19 vaccine. *The New England Journal of Medicine* 2020; 383: 2603–2615. doi: 10.1056/NEJMoa2034577

15. Ndwandwe D, Wiysonge CS. COVID-19 vaccines. *Current Opinion in Immunology* 2021; 71: 111–116. doi: 10.1016/j.coi.2021.07.003

16. Rappuoli R, De Gregorio E, Del Giudice G, et al. Vaccinology in the post−COVID-19 era. *Proceedings of the National Academy of Sciences* 2021; 118(3): e2020368118. doi: 10.1073/pnas.2020368118

17. Gao Q, Bao L, Mao H, et al. Development of an inactivated vaccine candidate for SARS-CoV-2. *Science* 2020; 369: 77–81. doi: 10.1126/science.abc1932

18. Sanders B, Koldijk M, Schuitemaker H. Inactivated viral vaccines. In: Nunnally B, Turula V, Sitrin R (editors). *Vaccine Analysis: Strategies, Principles, and Control*. Springer; 2015.

19. Okamura S, Ebina H. Could live attenuated vaccines better control COVID-19? *Vaccine* 2021; 39(39): 5719–5726. doi: 10.1016/j.vaccine.2021.08.018

20. Wong LA, Yap CG, Jahan NK, Pillai N. COVID-19 vaccine: Review of the mechanism of action of different types of vaccine. *Open Access Library Journal* 2022; 9(4): 1–20. doi: 10.4236/oalib.1108624

21. Kushnir A, Mueller S, Tasker S, Robert Coleman J. 577. COVI-VAC™, a live attenuated COVID-19 vaccine, provides single dose protection against heterologous challenge with SARS-CoV-2 beta (B.1.351) in the Syrian golden hamster model. *Open Forum Infectious Diseases* 2021; 8(Supplement_1): S390. doi: 10.1093/ofid/ofab466.775

22. Peng XL, Cheng JSY, Gong HL, et al. Advances in the design and development of SARS-CoV-2 vaccines. *Military Medical Research* 2021; 8: 67. doi: 10.1186/s40779-021-00360-1

23. Mendonça SA, Lorincz R, Boucher P, et al. Adenoviral vector vaccine platforms in the SARS-CoV-2 pandemic. *NPJ Vaccines* 2021; 6(1). doi: 10.1038/s41541-021-00356-x

24. Yang J, Wang W, Chen Z, et al. A vaccine targeting the RBD of the S protein of SARS-CoV-2 induces protective immunity. *Nature* 2020; 586(7830): 572–577. doi: 10.1038/s41586-020-2599-8

25. Parums DV. Editorial: First approval of the protein-based adjuvanted Nuvaxovid (NVX-CoV2373) Novavax vaccine for SARS-CoV-2 could increase vaccine uptake and provide immune protection from viral variants. *Medical Science Monitor* 2022; 28: e936523. doi: 10.12659/msm.936523

26. Vitiello A, Ferrara F. Brief review of the mRNA vaccines COVID-19. *Inflammopharmacology* 2021; 29(3): 645–649. doi: 10.1007/s10787-021-00811-0

27. Shekhar R, Sheikh AB, Upadhyay S, et al. COVID-19 vaccine acceptance among health care workers in the United States. *Vaccines* 2021; 9(2): 119. doi: 10.3390/vaccines9020119

28. Globevnik Velikonja V, Verdenik I, Erjavec K, et al. Influence of psychological factors on vaccination acceptance among health care workers in Slovenia in three different phases of the COVID-19 pandemic. *Vaccines* 2022; 10(12): 1983. doi: 10.3390/vaccines10121983

29. Spitzer RL, Kroenke K, Williams JBW, et al. A brief measure for assessing generalized anxiety disorder. *Archives of Internal Medicine* 2006; 166(10): 1092. doi: 10.1001/archinte.166.10.1092

30. Al-Sanafi M, Sallam M. Psychological determinants of the COVID-19 vaccine acceptance among healthcare workers in Kuwait: A cross-sectional study using the 5C and vaccine conspiracy beliefs scales. *Vaccines* 2021; 9(7): 701. doi: 10.3390/vaccines9070701

31. Betsch C, Schmid P, Heinemeier D, et al. Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PLoS One* 2018; 13(12): e0208601. doi: 10.1371/journal.pone.0208601

32. Shapiro GK, Holding A, Perez S, et al. Validation of the vaccine conspiracy beliefs scale. *Papillomavirus Research* 2016; 2: 167–172. doi: 10.1016/j.pvr.2016.09.001

33. 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. *Eurosurveillance* 2021; 26(3): 2002047. doi: 10.2807/1560-7917.es.2021.26.3.2002047