



Beneficial effects of SARS-CoV-2 vaccination resulting from the COVID-19 pandemic with regard to the uptake of influenza virus, pneumococcal, and herpes zoster adult vaccination – a narrative literature review

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Abstract

Introduction and Objective. Analysis of factors influencing COVID-19 vaccination coverage in various countries raised the question whether the recent pandemic affected the vaccination rates of other pathogens in adults. Therefore, the aim of this review article was to analyse the literature to find potentially beneficial effects of the introduction of the large-scale vaccinations resulting from the COVID-19 pandemic, with regard to the influenza virus, pneumococcal and herpes zoster adult vaccinations, in order to identify factors and strategies to increase the uptake of these vaccines.

Review Methods. The review of the literature was based on scientific articles indexed in the PubMed Database published between 2022–2023, during the COVID-19 pandemic. Data search was performed from 24–30 July 2023.

Brief description of the state of knowledge. It was found that the COVID-19 pandemic has had a beneficial effect on the acceptance and coverage of influenza and pneumococcal vaccination in the vulnerable elderly populations, and among healthcare workers in the case of influenza. Furthermore, the COVID-19 outbreak affected the designs of vaccine clinical trials, resulting in a lower frequency of age-related exclusion criteria, broadening the group of vaccine recipients.

Summary. Acceptance of COVID-19 vaccination increased willingness to accept other vaccines. The attitude to vaccination is a personal decision-making process based on previous experience and interpersonal interactions, greatly affected by information and recommendation from medical professionals. The COVID-19 pandemic vaccination implementation opened new opportunities to develop prevention efforts and build vaccination strategies in middle-income countries.

Key words

vaccine, influenza, pneumococcus, COVID-19, pandemic

INTRODUCTION AND OBJECTIVE

The COVID-19 pandemic of 2019 had a health impact on affected people, including deterioration of well-being, absence from work, long-term complications, and nearly 7 million deaths worldwide. Healthcare workers in particular suffered from the consequences of the pandemic burden [1, 2]. The studies, which have already ended and those that are still ongoing, show the effectiveness of vaccines in preventing the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, hospitalisation and death [3, 4]. Despite these scientific facts, vaccine hesitancy remains a threat to public health. The decision to accept or refuse a vaccine is personal and involves not only the intellectual process, but is also based on beliefs [5–7]. Especially vulnerable populations,

e.g. the elderly (> 60 years of age), patients with chronic diseases, cancer, or immunosuppressed, are at the highest risk of COVID-19 and severe complications, including death [8].

Studies from different regions of the world that evaluate attitudes towards the vaccination of SARS-CoV-2 show various results. For example, in the case of Russia, a surprising difference was observed between the low frequency of vaccination rates throughout the COVID-19 pandemic, and the high levels of morbidity and mortality in the presence of a wide availability of vaccines in this country. The refusal rate was a significant barrier despite common access to vaccines. The authors of the Russian study reported that although 40% of the vaccine refusers finally received the shot, 16% of vaccine supporters changed their minds. They refused because of, as declared, insufficient information on vaccine safety and effectiveness [9]. Another example of public health challenges is the situation of low-income and middle-income countries (LMICs) with a high proportion

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of a young population, and less precisely designed adult vaccination programmes. What is important is that these countries are open to vaccinations, but in need of financial and organizational assistance [10]. Another example are countries like Cuba and Japan which are characterised by higher vaccination rates [11]. A prospective Japanese one-year cohort study on the mass vaccination process revealed an efficient strategy. Recognising priority groups: health care workers, people 65 years old and those aged 18 to 64 years with underlying medical conditions, had a significant impact on vaccination coverage. Higher vaccination rates between these groups created the possibility of gaining important space for improvement among the non-priority group [12]. In turn, the beneficial situation of Cuba resulted from complex tactics, and a widespread vaccination campaign complemented by a fast booster rollout, including the use of Cuban vaccines. By January 2022, 87% of the population had been fully vaccinated within a three-dose schedule. This is indeed a remarkable achievement, believed to be the result of adequate research financing, regulatory oversight and compliance, professional training, and increased production capacity. All these factors contributed to the high vaccination rate in that country [13].

A recently published study on a panel dataset of COVID-19 vaccination policies in 185 countries summarised all circumstances influencing pandemic decision-making strategies [14]. The authors of this report selected indicators such as cost, eligibility, availability, and others, which were then analysed in relation to 52 standardized categories. As a result, it was possible to describe a pattern of strategies; for example, 'eliminator' countries aimed to block virus entry and further transmission, so they prioritised border workers and, as another example, 'mitigator' countries which focused on reducing the impact of community transmission and prioritized some population subgroups, such as healthcare workers and/or the elderly. The choice of course of action depended to a large extent on the financial background. Early vaccination implementation was characteristic for high-income countries. It is also worth noting that availability of medical professionals, such as pharmacists, increased the vaccination rate during the COVID-19 pandemic. Community pharmacies have changed their purpose from being a place to buy drugs and supplements, to a place where one can obtain health advice [15].

Analysis of factors influencing COVID-19 vaccination rates in different regions of the world led us, as Chairs of the Scientific Section and Chair of the COVID-19 Section of the Polish Society of Family Medicine, to question whether the recent pandemic affected the vaccination rates of other pathogens in adults. On the one hand, anti-vaccination attitudes and beliefs are present worldwide and can extend to all types of vaccines, but on the other hand, fear of infection can include not only SARS-CoV-2. These attitudes and beliefs may depend on the personalised decision-making process, but can also be influenced by relatives and friends or the socio-cultural environment. Another aspect is the certain capacity of the healthcare system, and decision of the policy makers regarding population health.

Last, but not least, the country income level is of great significance. All these factors influence vaccines acceptance and refusal, and should be taken into consideration when planning adequate prevention strategies. Therefore, this review had three objectives: to assess the literature concerning

the impact of the COVID-19 pandemic, the introduced COVID-19 vaccination and the willingness to vaccinate, vaccination levels against influenza, pneumococcus, and herpes zoster, among the adult population in order to identify factors and strategies increasing the uptake of these vaccines.

RESEARCH METHODS

The review of the literature was based on scientific articles indexed in the PubMed Database, and performed between 24 – 30 July 2023. Articles published between January 2020 – July 2023 were included in the search. The following key words and phrases, entered one at a time, were used to identify the studies of interest: influenza vaccine, pneumococcal vaccine, herpes zoster vaccine, COVID-19 pandemic, COVID-19 vaccination, adult vaccination, vaccination acceptance, vaccination attitude, vaccination hesitancy, pandemic vaccination coverage. The search found 22 articles potentially eligible. Final selection of the reviewed articles was subject to discussion and depended on the joint, consensual decision of the coauthors based on the research area: vaccines awareness, hesitancy, acceptance and refusal. The studies were analysed in relation to (inclusion criteria) vulnerable adult populations (elderly, people with chronic diseases and/or immunocompromised), healthcare workers, campus students and regarding vaccination coverage assessments (Fig. 1). Studies involving only paediatric populations were excluded from the analysis. This study did not require the approval of the Bioethics Committee.

DESCRIPTION OF THE STATE OF KNOWLEDGE

Influenza virus vaccination before and during the pandemic. Although the influenza virus is widespread around the world and is associated with numerous health consequences and is a great economic burden, its vaccination rates remain unsatisfactory. Data from the Organization for Economic Cooperation and Development (OECD) show high (80%) influenza vaccination coverage in the older population (65 years of age) of the United Kingdom and Korea, average (55–60%) in France, Belgium, Italy, Israel, Finland and Iceland, and low (10% or less) in Poland, Bulgaria, Latvia and Turkey [16]. From the example of the COVID-19 pandemic, we know that the attitude towards the vaccination process is crucial to achieve the goals of community immunity [17]. Past experience, in the case of influenza, also shows that skepticism was the main reason for vaccine refusal [18]. Unfortunately, this perception is present not only among the general population, but also among medical professionals. This topic was taken up by a Greek study highlighting that the World Health Organization (WHO) has proposed a 75% coverage in the case of seasonal influenza vaccination of healthcare workers [19]. However, the vaccination rate of most EU member countries remains significantly below this point. The European Centre for Disease Prevention and Control (ECDC) Report, published before the COVID-19 pandemic (2018) showed a wide range of vaccination rates – from 15.6% in Italy to 63.2% in Belgium. One of the main factors associated with these results is the lower socio-economic status of the analysed country, which is a common correlation. According to the authors, there was an increase

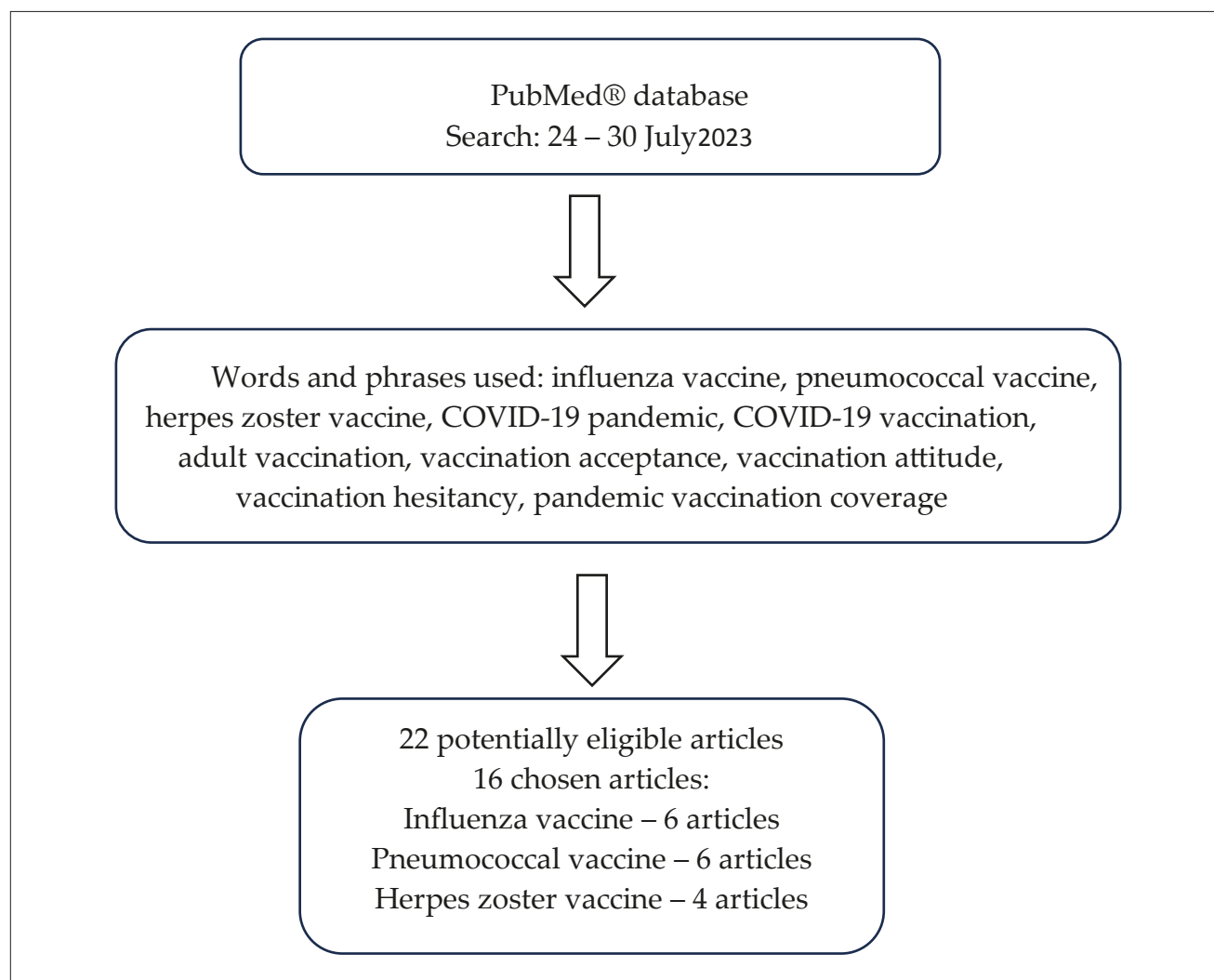


Figure 1. Flowchart of selecting articles to review.

in influenza vaccination rates among healthcare workers in Greece during the pandemic (2020–2021). A self-reported rate was almost 70%, which was the highest during the last half decade. For comparison, the vaccination coverage of the 65+ Greek population, according to OECD data in the same time period, is 65.3% [16]. On the basis of the findings of the study, an assumption was made – that the better adherence to vaccination resulted from the pandemic threat.

Different approaches are used to address the most disease-vulnerable populations in relation to preventive interventions, and are assessed in terms of implementation possibility, efficacy, and cost-effectiveness. In recent years, the development of information and communication technologies has been of particular interest. A systematic review, published just recently by Italian authors, assessed these technology-based strategies in the context of the uptake of adult vaccinations [20]. It took into consideration 22 studies, published from 2000 – 2022, describing the use of phone calls (including automated calls), text messages, messages sent via electronic medical records, remote monitoring, and emails. Of these reports, 15 were dedicated to analysing the improvement of the influenza vaccination coverage. Other vaccinations included pneumococcal, herpes zoster, and COVID-19. Twelve studies provided favourable results with regard to the use of information and communication

technologies in increasing vaccination rates, 5 studies showed beneficial aspects of directing such an intervention to specific population groups, and the remaining 5 indicated no significant results. The COVID-19 pandemic accelerated and popularised remote medical care and teleconsultations have entered everyday medical practice and can be used for various purposes, including preventive actions [21–23].

A cross-sectional study in the elderly Chinese population indicated that there is an association between COVID-19 and influenza vaccinations [24]. The analysed data was gathered during autumn of 2021 and more than 88% of the participants expressed the conviction that the older population should be vaccinated against influenza, and 47% of the individuals actually took the shot during the pandemic. It turned out that uptake of the COVID-19 vaccine was positively associated with receiving the influenza vaccination (OR 1.92, 95% CI 1.32–2.80). People 60+ years of age are considered one of the most disease-vulnerable groups and, as such, are targeted by planned health strategies. Usually, these are preventive actions, including vaccination supported by educational and information campaigns. In the case of this study, COVID-19 vaccination history increased the odds ratio for accepting influenza shot almost two times. This is another example of the beneficial effect of preventive strategies during the pandemic. The next report from China included an analysis

of influenza and the pneumococcal vaccination coverage among patients with chronic obstructive pulmonary disease (COPD) [25]. This subgroup of chronically ill people is usually targeted with infection prevention strategies similar to the elderly population. Due to the characteristics of the use of preventive measures against flu (seasonal vaccination every year) and pneumococcal infection (1 or 2 shots among adults), the data lasted from 2017 – 2021. The vaccination rates were very low – 2% in the case of influenza and 1.25% in the case of pneumococci. Patients with higher education levels were more likely to be vaccinated. It should be emphasised that these vaccines are not included in the National Immunisation Programme in China, thus a potentially interested individual has to pay for them. Unfortunately, the authors of the study did not consider the impact of the COVID-19 pandemic as a factor influencing vaccination coverage. But their work shows the reality before and at the beginning of the pandemic among patients with chronic lung disease. However, another report describing the USA veterans' attitude from the United States showed that this population was indeed affected by the change of heart from the COVID-19 pandemic with regard to vaccination. Comparison of 2021 – 2022 influenza vaccination rates between those who received or denied the COVID-19 vaccine, revealed that those who accepted the COVID-19 vaccination were 5 times more likely to get the influenza shot as well [18]. This observation was made in individuals who previously declined the flu vaccine (declination over at least 2 consecutive years). Thus, the authors suggest that their data show a positive association between the COVID-19 pandemic and increased influenza vaccine acceptance rates.

The young adult population, especially college students living on campuses, should not be excluded from evaluation of the association between the vaccinations. Another study in the USA showed that different attitudes and experiences affected vaccine acceptance [26]. The main factors directly associated with the hesitance toward the vaccination of SARS-CoV-2 were age, COVID-19 infection status, and seasonal influenza vaccination. Those who received the flu shot were more likely to accept the COVID-19 vaccine. In this study, variations in vaccine hesitancy across different student groups were highlighted and showed that experience of acceptance of one type of vaccine opened the possibility of receiving the other. This association was observed in the afore-mentioned studies on the elderly population of China and USA veterans – COVID-19 vaccination increased the acceptance rate of influenza vaccine [18, 24, 26].

Pneumococcal vaccination before and during the pandemic. Similar to influenza, the groups at particular risk of pneumococcal infection in adulthood include the elderly population and immuno-compromised individuals and/or with chronic diseases. Pneumonia is one of the leading causes of death worldwide and is a significant public health and economic burden [27]. Vaccinations are effective in preventing pneumococcal disease, and conjugate vaccines (PCVs) cover an increasing number of serotypes [28].

A study from Brazil evaluated the impact of the COVID-19 pandemic on pneumococcal vaccination coverage in children and older adults by collecting data from 2018 – 2021. Physical distancing measures resulted in less frequent contact with medical professionals and deterioration of standard healthcare. Almost 22 million shots of pneumococcal

vaccine were administered in general (children and adults), with a decline of almost 20% from the start to the end of the evaluation period. Not all Brazilian states observed a significant decrease in vaccination coverage but, if present, it was associated with the COVID-19 pandemic. This is an example that shows some results contrary to those mentioned above. The experience from Brazil indicates a negative influence of the pandemic on vaccination status [29]. In many countries, the capacity of the systems has been exceeded, the quality of care decreased and healthcare workers began to experience burnout syndrome more often [30, 31]. Similar observations were made in the USA, where the effect of the COVID-19 pandemic on routine vaccinations was assessed. Two time periods were compared, January 2020 – August 2022 and January 2018 to December 2019. Due to social distancing, fear about Coronavirus infection and decreased capacity of healthcare units, routine practice declined; Thus, a decrease in adult pneumococcal vaccinations was observed and continued throughout 2022 [32]. While this scenario would also be possible in other countries, it turns out that there were differences in the approach to pneumococcal vaccination depending on the region. In a study of the Taiwan community response towards both the pneumococcal conjugate vaccine and the pneumococcal polysaccharide vaccine, before and during the COVID-19 pandemic was evaluated. The retrospective analysis included the time period from January 2018 – December 2021, and enrolled 105,386 adult individuals who visited healthcare facilities for a vaccine shot. This study design allowed the observation of changes over time and comparison of the results, and showed that pneumococcal vaccinations increased after the COVID-19 outbreak. Moreover, willingness to receive the shot increased not only in vulnerable populations, but also among women, adults without underlying disease, and younger adults. This finding is of particular interest because it can be interpreted as a real concern for own health, not just following public health recommendations. The authors conclude that the COVID-19 pandemic influenced the awareness of the importance of vaccinations [33].

Perception of immunisation through vaccines is modulated not only by the pandemic trend, but also by cultural background, experience, and beliefs. It may seem that health care workers, due to their education, are free from dilemmas related to vaccinations. However, they also have their fears, doubts, and need for information [34, 35]. A qualitative study from the UK was designed to improve the understanding of the vaccination programme by older adults (55+). This programme is quite extensive and includes government-funded influenza, pneumococcal, herpes zoster, and COVID-19 vaccines. Online interviews showed that the most important element of hesitance/acceptance towards vaccination is based on the personal decision-making process. Interestingly, previous experience and interpersonal interactions have a greater impact than factors associated with the larger community. At the same time, this study exposed a very important deficiency – the lack of the ability to obtain information from a physician and further discuss the potential concerns, which significantly affect readiness to be vaccinated [36].

Ageing societies are a global reality that requires adequate preventive, therapeutic, and care activities. This is of great significance to ensure safety and comfort not only for the person requiring care, but also for their family and closest environment, and especially for those who provide the care.

These are the reasons why influenza and pneumococcal vaccinations are extremely important among older family caregivers. Just before the pandemic, a Japanese study enrolled 26,177 individuals (65+ years old) who cared for a family member. Coverage of one – influenza or pneumococcal or both vaccines – was the main outcome measured. Simultaneously, the burden of providing care to other person was also evaluated. More than 50% of the analyzed group of caregivers received both vaccines or the pneumococcal vaccine alone. Interestingly, the burden understood as the frequency of care and the condition of the person needing care was associated with influenza, but not with pneumococcal vaccination, and the help of a physician decreased this burden impact. This observation agrees with the conclusion of a study described earlier. Health professional support is an important factor in accepting vaccination [37]. The authors of this review consider this is extremely important information; employed as family physicians, they are involved in preventive activities, including vaccinations, and the knowledge that patients base their decision to vaccinate on the information obtained from the authors builds a bridge of mutual trust.

It is well recognised, and also mentioned in this review, that the income of a country is significantly related to access to vaccinations and vaccination coverage. Surprisingly, the COVID-19 pandemic created opportunities to accelerate immunization progress in middle-income countries. According to the modelling process estimating expected benefits, the introduction of some of the vaccines – including pneumococcal – in middle-income countries with the assumption of 90% coverage, could have saved the lives of up to 70,000 people. The COVID-19 outbreak and dissemination of SARS-CoV-2 vaccination improved and strengthened regional mechanisms to address the challenges of immunisation. This situation offers different strategies that can be used depending on the country's public health needs [38]. It has been reported that a lower-middle income country, for instance India, used the opportunity to scale-up the implementation of PCV due to the COVID-19 pandemic. Facilitating factors were leadership, political commitment, prioritisation, and support from institutional partners [39].

Another significant area of research interest, apart from the assessment of attitudes, is the pandemic-related change in the approach of scientists and medical professionals to vulnerable populations. An international study, published this year, aimed to assess the inclusion of older patients in the influenza, pneumococcal and COVID-19 vaccine trial before and during the pandemic. The years 2011 – 2021 were evaluated and 322 studies were enrolled. Age-related exclusion was shown to decrease by 18% in the analyzed time period in the case of influenza and pneumococcal vaccine trials. However, this observation was not confirmed for immunosuppressed individuals. The authors conclude that the COVID-19 pandemic affected the change in approach to age-related exclusion in scientific studies. In other words, the amount of research on vaccines without age limits has increased [40]. This direction is consistent with the reality described earlier – aging societies require increasing support, but also reliable scientific research assessing the effects and safety of preventive interventions.

Herpes zoster vaccine. In addition to influenza and pneumococcal vaccines, other adult vaccines already mentioned in the text are also being implemented worldwide.

Studies on the attitudes and coverage of the herpes zoster vaccine during the COVID-19 pandemic are especially scarce. It is not easy to assess why we had difficulty finding adequate papers, given that herpes zoster is a prevalent disease resulting from reactivation of varicella-zoster virus, and has a negative toll on patients and healthcare systems [41]. It may have been significant that the vaccine had been commonly available on the market only in the last few years, and during the pandemic, the scientific focus was primarily on COVID-19 vaccines. However, there are 2 papers worth mentioning: a Chinese report which analysed the willingness to receive the herpes zoster vaccine which had been available on the market since June 2020. In an online questionnaire, 43% of respondents declared the intention to be vaccinated, and 10% reported that they had already received at least one shot. The most important factors that influenced the decision were the level of education and income [42]. These results are consistent with previous reports and factors identified as significantly related to vaccine hesitancy and acceptance. Therefore, once again, the necessity to provide information and education to the population is of great importance.

Another interesting study was aimed at elderly residents of care nursing homes in Australia. Care programmes for the elderly population in high-income countries assume preventive actions; thus, local vaccination policies, the status of influenza, pneumococcal, and herpes zoster vaccination uptake, and its dynamics were evaluated. Data from 2018 – 2022 were collected which revealed high rates of influenza vaccination coverage (92.1%), lower pneumococcal (78.9%), and in the case of herpes zoster – a 75.6% uptake. It is interesting that an increase was observed only for herpes zoster, which had the lowest baseline uptake rates, and the study concludes with a recommendation to develop adequate strategies to further enhance this rate [43]. In the opinion of the authors of the presented review, Australia can be an example of how high rates of vaccination coverage can be achieved among aged care institutions.

A particularly interesting perspective is to explore missed opportunities for adult vaccinations. A retrospective cohort study from Italy analysed the co-administration of seasonal influenza, pneumococcal disease, herpes zoster, and COVID-19 vaccines as the 'big four' recommended for seniors. Although the specific reasons for missed opportunities to receive the vaccine among individuals aged ≥ 65 years of age could not be investigated, the authors believe that they were associated with vaccine hesitancy. They also suggest that the relatively low rates of co-administration of seasonal influenza vaccine with other recommended vaccines, contributed to missing the opportunity to immunise [44]. Another Italian study enrolled oncologists who were asked about vaccination recommendations for their cancer patients. They advised taking seasonal flu (96%), anti-SARS-CoV-2 (93%), pneumococcal (60%), and anti-herpes zoster (42%). The respondents admitted that the COVID-19 pandemic urged them to discuss vaccination coverage with their patients. In the case of herpes zoster, oncologists were asked about its complications and although 89% knew about post-herpetic neuralgia, only 11% were aware of post-herpes zoster vasculopathy. Thus, the study concludes with expressing the need for both – educating the oncologists in vaccine-preventable diseases and increasing vaccine awareness [45].

An overview of the major studies discussed in this article is provided in Table 1.

Table 1. Overview of the most relevant research discussed in this article.

Type of vaccine	Study/population/ country/duration	Beneficial effect	Negative effect
Influenza virus	Avakian I et al. (2023), healthcare workers, Greece 02 - 06.2021	Higher vaccination rates correlated with the attitude and coverage of COVID-19 vaccination attitude and coverage	-
	Buja A et al. (2023), older adults. Italy 1.01.2000-10.11.2022	Use of information and communication technologies in increasing vaccination rates	-
	You Y et al. (2023), older adults. China 09 - 10.2021	History of COVID-19 vaccination increased the odds ratio for accepting the influenza shot almost two times	-
	He R et al. (2023), COPD patients. China 2017-2021	Patients with higher education levels were more likely to be vaccinated	-
	Patel UC et al. (2023), USA veterans, USA 2021-2022	Individuals who accepted the COVID-19 vaccination were 5 times more likely to have the influenza shot	-
	Gilbert-Esparza E et al. (2023), college students, USA 06 - 07.2021	Positive correlation between accepting COVID-19 and influenza vaccines	-
Pneumococci	Novaes JVLC et al. (2023), older adults, Brazil 2018-2021	-	Significant decrease in vaccination coverage because of pandemic restrictions
	Eiden AL et al. (2023), older adults, USA 01.2020-08.2022	-	Decrease in vaccination coverage due to pandemic impact (e.g. decreased capacity of healthcare units)
	Lan C et al. (2023), adult, Taiwan 01.2018-12.2021	The COVID-19 pandemic influenced awareness of vaccinations significance	-
	Silvonen T et al. (2023), older adults, UK 07.2021-05.2022	The possibility of consultation with a medical professional significantly affected the readiness to vaccination	-
	Iwai-Saito K et al. (2023), older caregivers, Japan 11.2019-01.2020	The family physician mitigated all the negative effect of the caregiving burdens on the vaccinations	Burden negatively associated with the influenza vaccine, but not the pneumococcal vaccine
	Bukan K et al. (2023), older adults, international study 2011-2021	Age-related exclusion from vaccine trials decreased by 18% because of pandemic impact	-
Herpes zoster	Jiang B et al. (2022), adults, China 10.2021	Level of education and income affected acceptance	-
	Bennett N et al. (2023) aged care residents, Australia 2018-2022	Development of care programme	-
	Domnich et al. (2023), adults, Italy 2022/2023	Co-administration of recommended vaccines increased their coverage	-
	Lasagna A et al. (2023), oncologists, Italy 09.2022-01.2023	COVID-19 pandemic forced them to discuss vaccinations schedules	-

SUMMARY

The studies assessed in this review show the varying effect of the COVID-19 pandemic, especially on influenza the virus and pneumococcal adult vaccinations. Scientific reports on this subject are very diverse. Research from Asia showed greater acceptance of vaccinations other than the SARS-CoV-2 vaccine after the outbreak of the COVID-19 pandemic. Two of the most important factors were previous vaccination against COVID-19 and the care of own health. Awareness of the importance of vaccination has risen significantly. Studies from Europe showed an increase in the uptake of the influenza virus vaccine among the healthcare workers after the COVID-19 outbreak. The usefulness of telemedicine and remote medical care which developed especially during the pandemic in informing and educating about vaccinations was proven. Remote medical care expanded more dynamically in some European countries during the pandemic, but in other regions of the world where it was already advanced, it was unfortunately not considered relevant [23]. All these effects of the COVID-19 outbreak can be assessed as beneficial for increasing awareness about vaccination and increasing vaccination coverage.

On the other hand, reports from Brazil and the USA indicate that social distancing measures, together with lower capacity of health units and decline in everyday medical practice, resulted in a decrease in the uptake of influenza and pneumococcal vaccines.

There are areas related to the pandemic that can also be assessed as beneficial, even though they are not directly related to vaccination coverage. Surprisingly, the COVID-19 pandemic has opened new opportunities to develop prevention efforts and build vaccination strategies in middle-income countries. The support of institutional partners such as the WHO is not without significance. The United Nations International Children's Emergency Fund (UNICEF) or The United Nations Development Programme (UNDP) aim to improve the public health situation of lower-income countries. And last, but not least, a change was observed in vaccine clinical trial designs during the pandemic – the age-related exclusion criterion is currently less frequent than before the COVID-19 outbreak. It is quite obvious as an indirect observation that the evaluation of the analysed articles in the review indicated a great need to study other vaccinations for adults' attitudes and coverage, including herpes zoster.

This review of the literature is an introduction to a broader analysis of the impact of the pandemic on vaccinations, not only anti-SARS CoV-2, but also others recommended for adults. Therefore, the future prospects of scientific studies include the need for constant monitoring of the acceptance of the level of vaccination among adults, and the necessity of the COVID-19 pandemic contribution to raising the discussion about vaccinations, their validity, safety and long-term effects. The focus should be on how to use this trend to raise awareness about vaccinations. Especially, the most important element of hesitancy/accepting vaccination is a personal decision-making process based on previous experience and interpersonal interactions.

The first studies to evaluate the impact of the COVID-19 pandemic on vaccination uptake have just been published. The most significant suggestions arising from them are the implementation of innovative interventions that expand

access to vaccines and increase their availability, education provided on many levels, good communication, reducing health inequity between heterogenic populations, and providing access to health professionals, such as pharmacists, who are capable of providing reliable information [46–50].

Due to some beneficial effects of introduction of large-scale vaccinations resulting from the COVID-19 pandemic on vaccination perception and awareness, the scientific community should follow-up and use this positive trend to further promote the prevention of infectious diseases through vaccinations among adults. A positive attitude toward one type of vaccine covers acceptance on another type; thus, transparent guidelines, the education of society and health care professionals, strategies based on programmes with target groups, and co-administration of vaccines seem to be the most important factors in increasing vaccination coverage. The income of a country is not without significance when planning adequate strategies, but the pandemic has shown that this is an area that can be improved with appropriate support.

In conclusion, the acceptance of COVID-19 vaccination increased the willingness to accept other vaccines. The attitude to vaccination is a personal decision-making process based on previous experience and interpersonal interactions, greatly affected by information and recommendation from medical professionals. The implementation of the COVID-19 pandemic vaccination opened new opportunities to develop prevention efforts and build vaccination strategies in middle-income countries.

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