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Effectiveness of Vaccination Programs for Healthcare Workers in reducing Occupational Transmission: A Systematic Review

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ABSTRACT

Background: Vaccination programs targeted at healthcare workers (HCWs) play a vital role in reducing these risks, not only protecting the workers themselves but also safeguarding their patients, colleagues, and the broader community. However, the effectiveness of such programs depends on several factors, including vaccine uptake, program design, and workplace policies.

Aim: To explore the effectiveness of vaccination programs for healthcare workers in reducing occupational transmission of infectious diseases.

Methods: This is an updated systematic analysis of papers conducted between 2020 and 2024 that specifically examine the interventions of managing primary headaches among pregnant, postpartum and breastfeeding women. Using the databases from Google Scholar, Web of Science, Cochrane, and PubMed, we searched the literature for pertinent studies on our subject. Various combinations of the terms "Effectiveness, Vaccination, Programs, Healthcare Workers, Reducing, Occupational and Transmission" were utilized. Additionally, a review of original studies that assessed the interventions of managing primary headaches among pregnant, postpartum and breastfeeding women was done. Based on full-text articles, the inclusion criteria were developed.

Results: Only seven of the 55 articles that were gathered met the criteria for inclusion. The papers used included three cross-sectional studies, two observational studies and two retrospective studies. All the studies included healthcare workers (HCWs).

Conclusion: Vaccination among HCWs is pivotal to controlling infectious diseases and safeguarding public health. The studies discussed highlight successes and persistent challenges in HCW vaccination programs. Moving forward, comprehensive approaches that address educational, behavioral, and systemic barriers are essential for improving vaccine uptake and compliance. By prioritizing HCWs, we not only protect a vulnerable population but also enhance the resilience of healthcare systems globally.

Keywords: ***Effectiveness, Vaccination, Programs, Healthcare Workers, Reducing, Occupational and Transmission***

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INTRODUCTION

Healthcare workers (HCWs) are the backbone of the medical system, providing care and support to patients while often putting their own health at risk [1]. Their daily exposure to infectious diseases makes them particularly vulnerable to occupational transmission of illnesses, ranging from influenza and hepatitis B virus (HBV) to more recent concerns like COVID-19. Vaccination programs targeted at healthcare workers play a vital role in reducing these risks, not only protecting the workers themselves but also safeguarding their patients, colleagues, and the broader community. However, the effectiveness of such programs depends on several factors, including vaccine uptake, program design, and workplace policies [2].

Vaccines are among the most effective tools in modern medicine for preventing infectious diseases [3]. For HCWs, they serve a dual purpose: protecting individuals from becoming infected and reducing the likelihood of transmitting diseases to others. This is especially important in healthcare settings where patients often have compromised immune systems and are more susceptible to infections. For example, annual influenza vaccinations for healthcare workers have been shown to significantly decrease flu outbreaks in hospitals and long-term care facilities, directly benefiting patient populations [4]. Similarly, hepatitis B vaccination programs have drastically reduced occupationally acquired infections among healthcare workers since their widespread implementation in the 1980s [5].

The benefits of vaccination programs extend beyond direct health outcomes. By reducing absenteeism due to illness, these programs also ensure that healthcare systems can maintain adequate staffing levels, even during disease outbreaks [6]. This was evident during the COVID-19 pandemic when vaccination efforts among healthcare workers were prioritized to protect the workforce and ensure the continuity of care. Vaccination programs can also improve workplace morale and foster a culture of safety, emphasizing the importance of collective responsibility in preventing the spread of infectious diseases [7].

Despite the clear advantages, challenges remain in implementing and optimizing vaccination programs for healthcare workers. Vaccine hesitancy, driven by factors such as misinformation, fear of side effects, or distrust in the healthcare system, continues to hinder uptake among some healthcare workers [8]. Structural barriers, such as limited access to vaccination services or lack of employer support, further complicate efforts to achieve high vaccination coverage. Addressing these challenges requires a multi-faceted approach, including targeted education, incentives, and policies that prioritize convenience and accessibility [9].

This study explores the effectiveness of vaccination programs for healthcare workers in reducing occupational transmission of infectious diseases. It examines the direct health impacts of these programs in addition their broader implications for healthcare systems and patient safety. By analyzing key factors such as vaccine efficacy, uptake rates, and program implementation strategies, the study aims to identify best practices for maximizing the benefits of vaccination efforts. As healthcare systems continue to face threats from both emerging and re-emerging infectious diseases, the importance of protecting healthcare workers cannot be overstated. Vaccination programs represent a critical strategy in this effort, ensuring that healthcare environments remain as safe as possible for both providers and patients. Understanding and addressing the factors that influence their effectiveness is essential for building resilient healthcare systems capable of responding to future public health challenges.

Aim of Work:

To explore the effectiveness of vaccination programs for healthcare workers in reducing occupational transmission of infectious diseases

METHOD AND SEARCH STRATEGY

This systematic review adheres to the PRISMA checklist recommendations for systematic reviews and meta-analyses [10]. Google Scholar, Web of Science, Cochrane, and PubMed were the databases that were analyzed. We searched the four databases for literature pertaining to our main topic; "the effectiveness of vaccination programs for healthcare workers in reducing occupational transmission of infectious diseases". The included studies were published between 2020 and 2024.

The search technique included using several keywords such as "Effectiveness, Vaccination, Programs, Healthcare Workers, Reducing, Occupational and Transmission". Furthermore, the pertinent keywords were used to gather all applicable articles. As a consequence of this preliminary investigation, all titles were revised.

ELIGIBILITY CRITERIA

After analyzing the titles, only publications specifically addressing the effectiveness of vaccination programs for healthcare workers in reducing occupational transmission of infectious diseases were eliminated. This exclusion was limited to papers published between 2020 and 2024. In the second step, we focused on choosing only authentic studies written in English that specifically addressed the effectiveness of vaccination programs for healthcare workers in reducing occupational transmission of infectious diseases. This selection process required carefully reviewing the abstracts of the remaining papers. However, review articles, editor letters, and case reports were excluded. The last phase included authentic English-language literature that explored the effectiveness of vaccination programs for healthcare workers in reducing occupational transmission of infectious diseases. The articles underwent further scrutiny to eliminate duplicates, articles without full-text, and articles with unacceptable material, such as data that was overlapped or incomplete. Figure 1 provides a comprehensive illustration of the search methodology.

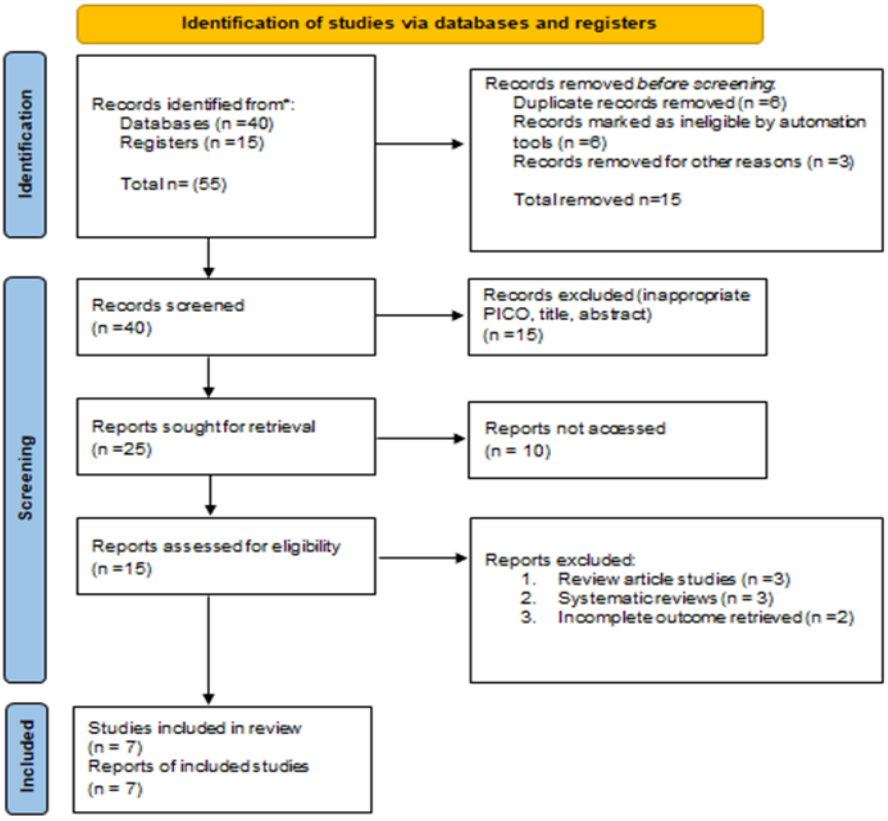

Fig1: Planning of Eligible criteria

DATA REVIEWING AND ANALYSIS

The full text and abstracts of the publications were assessed in order to extract the pertinent data and transfer it to a pre-existing excel spreadsheet. The selected data were then modified in the excel spreadsheet, and the data were merged to condense the information for the purpose of facilitating data analysis.

RESULTS

Seven papers [11- 17] met the inclusion criteria of this systematic review (table 1). The papers used included three cross-sectional studies [11, 12, 13] and two observational studies [14, 15] and two retrospective studies [16, 17]. The papers were either published in 2020 [16], 2021 [14, 15], 2021 [17] and 2024 [11, 12, 13]. All the studies included HCWs.

One study [11] examined the knowledge, attitudes, and behaviors of HCWs on seasonal influenza vaccines (SIV), while another [12] examined senior staff nurses' knowledge of managing and preventing HBV. One study [13] examined how HCWs followed all three parts of the HBV immunization program. Another study [14] compared HCWs' vaccination rates, favorable rates, and laboratory-confirmed SARS-CoV-2 infections to those in the general population .

Additionally, one more study [15] investigated the impact of vaccination on COVID-19 transmission in HCWs and their households. In contrast, one study [14] investigated HCWs' adherence to vaccination requirements as part of a program for occupational health surveillance. A study [17] investigated and analyzed data from HCWs to study vaccination offers during the Occupational Health Surveillance Program for HCWs and work suitability.

HBV vaccine coverage was 60.9%, whereas adherence to the three-dose immunization schedule and post-vaccination serological testing was 46.8%, 38%, and 13%, respectively. Population-level adherence was moderate, with just 6.2% of research participants complying with all three elements of the HBV vaccine regimen. HCWs with a diminished risk perception for HBV had the lowest likelihood of fully complying with all three suggested parameters for HBV immunization. Furthermore, male healthcare workers exhibit a reduced likelihood of complying with all three elements of HBV immunization in comparison to their female counterparts [13].

One study showed that HBV was the most common susceptibility (23%), followed by measles (7%), rubella (11%), varicella (9%), and mumps (8%). [16], Measles and mumps had the highest non-protective antibody titers among the recruited participants (13%), followed by varicella (8%) and rubella (11%) [17]. All vulnerable HCWs were administered the appropriate immunizations, and a month after receiving the shots, the HCWs underwent another test. The two studies showed that the seroconversion rate after booster dose delivery was more than 80% for all vaccinations. Overall, 15% of HCWs declined the recommended vaccine or vaccines, and being a doctor ($P < .05$) and being younger ($P < .0001$) were the primary factors influencing vaccination compliance. Achieving high immunization rates among healthcare workers remains a problem despite several guidelines and programs to encourage immunization [16, 17]. The primary factor influencing vaccination compliance was younger age; 2.5% of the individuals declined the recommended vaccine or vaccines. VPDs may still pose a risk in nosocomial settings, particularly during the COVID-19 pandemic [17].

Similar to population rates, only 3.3% of HCWs were infected, with a peak positive of 9.1%, as opposed to 11.8% in the community. Despite a spike with mostly VOC, SARS-CoV-2 infections among healthcare workers decreased dramatically as vaccination coverage rose; unprotected workers had an infection incidence of 1.3/10,000 person-days, while fully vaccinated workers had an infection rate of 0.89 and 0.30. One dosage offered substantial protection against infection until at least day 42; VE was 37.2% 14 days after the first dose and 79.2% 7 days after the second dose compared to unvaccinated HCWs. VE was 54.7% after one dose and 84.8% after complete vaccination compared to population infection rates [14]. Vaccination of healthcare personnel was linked to a significant decrease in COVID-19 cases in house members [15].

Senior staff nurses demonstrated a thorough understanding of HBV, transmission, and prevention. Misconceptions about non-transmission pathways and some preventative measures, however, still exist. Higher knowledge levels were shown by married nurses and those who were fully immunized [12]. Increasing the acceptance of SIV among healthcare professionals may enhance the likelihood that they will recommend immunizations to their patients, which may amplify the positive benefits of vaccination [11].

DISCUSSION

HCWs face several hazards at work, including biological infectious illnesses [18]. In addition, there is a chance that pathogens might spread to patients and colleagues. One preventive measure that might reduce the possibility of vaccine-preventable diseases (VDP) spreading, especially to the most vulnerable individuals (such as cancer patients or patients with impaired immune systems), is the vaccination of medical staff [19]. Additionally, it is suggested to guarantee the provision of healthcare during epidemics and lower employee absenteeism [20]. This systematic study investigated the effectiveness of vaccination programs in preventing infectious occupational disease transmission.

This systematic review reveals that the HBV coverage is 60.9%, with adherence to the three-dose immunization schedule and post-vaccination serological testing being 46.8%, 38%, and 13%, respectively. Population-level adherence was moderate, with only 6.2% of research participants complying with all three elements of the HBV vaccine regimen. Healthcare workers with a diminished risk perception for HBV had the lowest likelihood of fully complying with all three suggested parameters for HBV immunization. Male healthcare workers also exhibited a reduced likelihood of complying with all three elements of HBV immunization compared to their female counterparts. Healthcare workers at risk of coming into contact with blood or bodily fluids are highly advised to receive three doses of the HBV vaccine early in their careers on a schedule of 0, 1, and 6 months. According to the CDC, WHO, NCIRS, post-vaccination serological testing should be conducted 1-2 months after vaccination [18, 19]. Following these three crucial steps in the HB vaccination procedure is the best way for healthcare workers to prevent exposure before an event. The Hepatitis B Foundation defines complete vaccination as having received three doses of the HB vaccine. HCWs and other individuals who are at a high risk of acquiring HBV should pay special attention to following the three-dose vaccination schedule [21]. Several studies have shown that when people younger than 40 get vaccinated against HBV three times as recommended, they develop antibodies against it that are at least 10 mlU/mL [22]. As a result, adherence to the 3-dose regimen is essential for achieving full seroprotection.

Despite several guidelines and programs encouraging immunization, achieving high immunization rates among HCWs still needs to be solved. Younger age was the primary factor influencing vaccination compliance, with 2.5% of individuals declining the recommended vaccine or vaccines. There is evidence that circulating antibodies are more likely to be found in older people [23]. Antibody titers are often lower after vaccination, even though the immunological response elicited by the vaccine is qualitatively similar to that caused by infection [24]. According to multivariate analysis, male participants were less likely than female subjects to have circulating anti-mumps IgG when it came to mumps. Researchers have examined how men's and women's immune systems respond differently to illnesses and immunizations. They discovered that the immune systems of women typically function better than those of males. Genetic, hormonal, environmental, and microbial variables contribute to this discrepancy [25]. Lastly, vaccination has a distinct function in determining serosusceptibility for varicella and rubella. While the VZV vaccine is linked to a lower risk of susceptibility at serologic assessment, the MMR vaccine is protective for seroprotection, perhaps due to the objective of eliminating rubella (and measles) and the corresponding vaccination effort. The time between VZV vaccination and antibody level evaluation is, in fact, a significant factor in the degradation of circulating antibody serum and, consequently, protection against the wild virus, as numerous studies in the literature have reported [26, 27]. The duration of circulating antibodies for the MMR vaccine seems more than twice that of the VZV vaccine.

Vaccination of HCWs was linked to a significant decrease in COVID-19 cases in family members. Senior staff nurses thoroughly understand Hepatitis B infection, transmission, and prevention, but misconceptions

about non-transmission pathways and some preventative measures still exist. Increasing the acceptance of SIV among healthcare professionals may enhance the likelihood of them recommending immunizations to their patients, potentially amplifying the positive benefits of vaccination. Our findings and those of international reviews and high-income countries consistently demonstrated that belief in the benefits of influenza vaccination for oneself, patients, family, and community drove vaccination [4, 28]. Our research and the literature consistently demonstrated that SIV significantly lowered the risk of influenza and absenteeism in HCWs [29, 30]. Similarly, HCWs were more likely to advise vaccination to their patients if they thought SIVs were successful [31]. Low belief in the social advantages (e.g., decreased absenteeism, protection of patients or family), lack of trust in the efficacy of vaccination, and worries about vaccine safety were notable obstacles to vaccination [4, 28].

CONCLUSION

The findings of this systematic review underscore the critical importance of vaccination among healthcare workers (HCWs) to ensure occupational safety, reduce nosocomial infections, and bolster public health initiatives. Despite the progress in vaccine development and delivery, challenges persist in achieving optimal vaccination coverage and adherence among HCWs.

The studies on Hepatitis B vaccination revealed significant knowledge gaps and poor adherence to complete vaccination protocols, including booster doses and serological testing. Key barriers, such as low-risk perception and lack of educational interventions, impede the effective implementation of these programs. Similarly, compliance with other vaccination protocols, as observed in studies focusing on vaccine-preventable diseases (e.g., measles, mumps, rubella, and varicella), remains suboptimal, with vaccine refusal rates and age-related discrepancies presenting persistent obstacles.

On a more positive note, research on COVID-19 vaccination highlighted its significant impact in reducing infection rates among HCWs and curbing transmission to their households. These findings reinforce the critical role of HCWs in pandemic response and the far-reaching benefits of ensuring their protection through vaccination. Seasonal influenza vaccination studies also emphasized the dual benefit of immunizing HCWs, who then serve as advocates for vaccination among the general population.

Addressing the identified challenges requires a multi-pronged approach. This includes targeted educational campaigns to address misconceptions, behavior change models to enhance motivation, and systemic measures to ensure access and affordability of vaccines. Where voluntary uptake remains insufficient, the adoption of mandatory vaccination policies may be warranted to protect HCWs, their patients, and the broader community.

In conclusion, strengthening vaccination programs for HCWs is not only a matter of individual safety but also a public health imperative. By prioritizing HCW immunization, we can mitigate the risks of infectious disease outbreaks, enhance healthcare system resilience, and protect vulnerable populations globally.

APPENDIX

Table 1

Author and Publication year	Study design	Population, Sample Size, and Characterization	Main points	Results and main findings
1. McCarron *et al.* 2024 [11]	A pooled analysis from 2018 to 2020	During the period of 2018–2020, cross-sectional surveys about SIV were carried out among HCWs in a total of twelve low- and middle-income countries.	To examine of the knowledge, attitudes, and behaviors of healthcare professionals on SIV in order to identify variables related with and changeable obstacles to the uptake of SIV.	Increasing the acceptance of SIV among healthcare professionals may enhance the likelihood that they will recommend immunizations to their patients, which may amplify the positive benefits of vaccination. To achieve the objective of increasing the number of individuals who get medical vaccinations, effective strategies include free access to vaccines, interventions based on behavior modification models, and clear instructions from health authorities.
2. Begum et al. 2024 [12]	cross-sectional study	210 HCWs responded to a poll on the Hepatitis B vaccine.	The senior staff nurses' knowledge on managing and preventing hepatitis B.	Senior staff nurses demonstrate a thorough understanding of Hepatitis B infection, transmission, and prevention. Misconceptions about nontransmission pathways and some preventative measures, however, still exist. Higher knowledge levels were shown by married nurses and those who were fully immunized. These results emphasize the need of focused training initiatives to close knowledge gaps and support nurses'

					preventative behaviors. .
3.	**Efua et al. 2024 [13]**	A hospital-based analytical cross-sectional study.	340 randomly selected. HCWs.	To evaluate compliance with all three elements of the HBV immunization program among healthcare workers.	HBV vaccine coverage was 60.9%, whereas adherence to the three-dose immunization schedule and post-vaccination serological testing was 46.8%, 38%, and 13%, respectively. Population-level adherence was moderate, with just 6.2% of research participants complying with all three elements of the HBV vaccine regimen. Healthcare workers with a diminished risk perception for HBV had the lowest likelihood of fully complying with all three suggested parameters for HBV immunization. Furthermore, male healthcare workers exhibit reduced likelihood of complying with all three elements of HBV immunization in comparison to their female counterparts.

4.	**Yassi et al. 2021 [14]**	An observational study	25,558 HCWs were included to examine their vaccination uptake, positive rates, and laboratory-confirmed SARS-CoV-2 infections by employment and subsector and compared them to the general population.	HCWs are protected by infection control, occupational health, and public health interventions, such as mRNA-based vaccine against SARS-CoV-2 infections.	Similar to population rates, only 3.3% of HCWs were infected, with a peak positive of 9.1%, as opposed to 11.8% in the community. Despite a spike with mostly VOC, SARS-CoV-2 infections among healthcare workers decreased dramatically as vaccination coverage rose; unprotected workers had an infection incidence of 1.3/10,000 person-days, while fully vaccinated workers had an infection rate of 0.89 and 0.30. One dosage offered substantial protection against infection until at least day 42; VE was 37.2% 14 days after the first dose and 79.2% 7 days after the second dose when compared to unvaccinated HCWs. VE was 54.7% after one dose and 84.8% after complete vaccination as compared to population infection rates.
5.	**Shah et al. 2021[15]**	an observational study	194,362 household members and 144,525 HCWs	Impact of vaccination on COVID-19 transmission in HCWs and their household	Vaccination of HCWs was linked to a significant decrease in COVID-19 cases in house members.

6.	**Bianchi et al. 2020 [16]**	an observational retrospective study	A sample of HCWs participating in a biological risk assessment program in a southern Italian university hospital between December 2017 and January 2019.	HCWs adherence to vaccination requirements as part of a program for occupational health surveillance	HBV was the most common susceptibility (23%), followed by measles (7%), rubella (11%), varicella (9%), and mumps (8%). For all vaccinations, the seroconversion rate after booster dose delivery was more than 80%. Overall, 15% of HCWs declined the recommended vaccine or vaccines, and being a doctor (P <.05) and being younger (P <.0001) were the primary factors influencing vaccination compliance. Achieving high immunization rates among healthcare workers remains a problem, despite several guidelines and programs to encourage immunizations. In this situation, public health organizations must decide whether to implement a required policy or enforce the promotion.
7.	**Bianchi et al. 2022 [17]**	Retrospective Cohort Study	To analyzed data from HCWs attending the biological risk assessment protocol who were evaluated for the immune status for measles, mumps, rubella, and varicella.	To study Vaccination Offers During the Occupational Health Surveillance Program for Healthcare Workers and Work suitability	Measles and mumps had the highest non-protective antibody titers among the recruited participants (13%), followed by varicella (8%), and rubella (11%). All vulnerable HCWs were administered the appropriate immunizations, and a month after receiving the shots, the HCWs underwent another test. Following the delivery of one or more booster doses,

	the seroconversion rate exceeded 80%. The primary factor influencing vaccination compliance was younger age; in total, 2.5% of the individuals declined the recommended vaccine or vaccines. VPDs may still pose a risk in nosocomial settings, particularly during the COVID-19 pandemic.

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