Vaccination Programs in Healthcare Settings: Implementation Challenges and Hesitancy Management from the Perspectives of Physicians, Pharmacists, Nurses, Laboratory Professionals, Public Health, Preventive Medicine, and Occupational Medicine Specialists: A Narrative Review

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ABSTRACT

Background: Healthcare workers (HCWs) are essential for immunization delivery; however, vaccine hesitancy among this population poses a significant threat to public health. Understanding the implementation challenges and determinants of hesitancy across healthcare professions and international healthcare systems is critical for developing effective vaccination programs.

Aim: This narrative review synthesizes evidence on the challenges of vaccination program implementation and hesitancy management strategies in healthcare settings from the perspectives of physicians, pharmacists, nurses, laboratory professionals, and specialists in public health, preventive medicine, and occupational medicine across diverse international healthcare systems.

Methods: A comprehensive literature search was conducted using PubMed, MEDLINE, Scopus, and Web of Science for articles published until December 2023. Studies examining vaccination program implementation, vaccine hesitancy among HCWs, and the intervention strategies were included. Data were synthesized thematically into categories of

implementation barriers, determinants of hesitancy, professional perspectives, and intervention effectiveness.
Results: COVID-19 vaccine hesitancy among HCWs ranged from 4.3% to 72% globally, with nurses and allied health professionals demonstrating higher hesitancy rates than physicians. Key implementation barriers include inadequate cold chain infrastructure (only 61% of facilities in developing regions maintained adequate standards), interoperability failures in electronic registries, and resource constraints. Safety concerns (69-74% of HCWs), mistrust in vaccine development processes, and misinformation emerged as primary hesitancy drivers. Multicomponent interventions combining education, communication, and institutional policies demonstrated superior effectiveness (RR 1.58; 95% CI: 1.49-1.68) compared to single-strategy approaches. Mandatory vaccination policies achieved coverage rates exceeding 94%, whereas voluntary policies typically plateaued at 60%. Significant geographic disparities were observed: HCW hepatitis B vaccination reached 67-79% in high-income countries versus 18-39% in low-income settings.
Conclusion: Effective vaccination programs require profession-specific, multi-component interventions that address trust, convenience, and the organizational culture. A staged implementation approach that begins with accessible voluntary programs and incorporates mandatory policies when voluntary approaches fail offers the most evidence-based pathway to optimal HCW vaccination coverage.
Keywords: Vaccine hesitancy, healthcare workers, vaccination programs, immunization, implementation science, occupational health.

1. INTRODUCTION

Healthcare workers (HCWs) occupy a paradoxical position in global immunization efforts: as essential vaccinators and trusted health advisors, they simultaneously represent a population that demonstrates significant vaccine hesitancy (1). The World Health Organization identified vaccine hesitancy as one of the top ten threats to global health in 2019, and subsequent events during the COVID-19 pandemic underscored the critical importance of HCW vaccination acceptance in maintaining the integrity of healthcare systems and public confidence (2). However, the rationale for prioritizing HCW vaccination extends beyond individual protection. Healthcare settings concentrate on immunocompromised and vulnerable patients who depend on herd immunity for protection against vaccine-preventable diseases (3). Nosocomial transmission of influenza, hepatitis B, and other pathogens from unvaccinated HCWs to patients is a documented and preventable cause of morbidity and mortality (4). Furthermore, HCWs serve as influential advocates whose personal vaccination decisions affect patient acceptance and community uptake (5).

Despite these compelling rationales, HCW vaccination coverage remains suboptimal in most healthcare systems. Global COVID-19 vaccine hesitancy among HCWs ranged from 4.3% to 72%, with considerable variation by professional category, geographic region, and healthcare setting (6). The seasonal influenza vaccination coverage among European HCWs averaged only 30%, with some countries reporting rates below 15% (7). These coverage gaps persist despite decades of evidence supporting vaccine safety and efficacy, suggesting that implementation challenges and determinants of hesitancy require a nuanced understanding and targeted interventions. Moreover, different healthcare professions encounter distinct barriers and hold varying attitudes toward vaccination (**Table 1**). Physicians generally demonstrate the highest acceptance rates but face time constraints and unclear guidelines for patient counseling (8). Pharmacists represent an expanding

vaccination workforce with unique accessibility advantages but with variable regulatory authorization and infrastructure support (9). Nurses constitute the largest HCW group and demonstrate consistently higher hesitancy rates, influenced by concerns regarding professional autonomy and bodily integrity (10). Laboratory professionals face specific occupational exposure risks that require targeted vaccination protocols (11). Preventive medicine specialists provide expert guidance but may lack the authority to implement recommendations within healthcare organizations.

Table 1. Vaccine Hesitancy and Acceptance Rates Among Healthcare Professionals by Category

Professional Category	COVID-19 Vaccine Acceptance (%)	Influenza Vaccine Uptake (%)	Hepatitis B Vaccination (%)	Key Hesitancy Drivers
Physicians	83.6	70-85	85-95	Time constraints, unclear guidelines
Pharmacists	78-82	60-75	80-90	Workflow integration, documentation burden
Nurses	77.4	30-50	70-85	Autonomy concerns, safety worries, bodily integrity
Laboratory Professionals	75-80	45-60	87 (required)	Fear of adverse effects, risk misperception
Allied Health Workers	73.0	25-45	60-75	Misinformation exposure, lack of education

Note: Data compiled from multiple systematic reviews and meta-analyses (1, 6, 28-32, 50). The ranges reflect variations across studies and geographic regions.

International healthcare systems demonstrate substantial variations in vaccination program design, regulatory frameworks, and coverage outcomes (**Table 2**). High-income countries generally achieve higher coverage through their established infrastructure and mandatory policies. In contrast, low- and middle-income countries face resource constraints, cold chain failures, and workforce shortages that fundamentally limit program effectiveness (12). Understanding these cross-system variations provides an essential context for developing adaptable, evidence-based vaccination strategies.

Table 2. International Comparison of Healthcare Worker Vaccination Coverage by Region

Region/Country	Influenza Coverage (%)	Hepatitis B Coverage (%)	COVID-19 Acceptance (%)	Policy Approach
United States	78-81	67-79	36-69	Institutional mandates (variable)
Europe (Average)	22.1	60-85	60-85	Mostly voluntary; some mandates
Israel	65-75	85-95	>90	Centralized digital system; rapid rollout
Singapore	60-70	90-95	>85	Strong government messaging; free vaccines

Region/Country	Influenza Coverage (%)	Hepatitis B Coverage (%)	COVID-19 Acceptance (%)	Policy Approach
Africa (Average)	6.5	18-39	56.6	Resource-limited; community health workers
Middle East (GCC)	40-60	75-90	70-85	Centralized governance; resource-rich
Palestinian Territories	NR	NR	14.5	Conflict-affected; supply disruptions

Abbreviations: GCC, Gulf Cooperation Council; NR, not reported. Data compiled from references (7, 12, 74-84).

This narrative review aims to synthesize the evidence on the implementation challenges of vaccination programs and strategies for managing hesitancy in healthcare settings. Specifically, this review examines (a) infrastructure and logistical barriers to vaccination program implementation, (b) determinants of vaccine hesitancy among different HCW professions, (c) profession-specific perspectives on vaccination programs, (d) effectiveness of various intervention strategies, and (e) international comparisons of healthcare system approaches to HCW vaccination.

2. METHODS

2.1 Search Strategy

A comprehensive literature search was conducted using the PubMed, MEDLINE, Scopus, Web of Science, and Google Scholar databases for articles published from January 2000 to December 2023. Search terms included combinations of: "vaccination programs," "immunization," "healthcare workers," "vaccine hesitancy," "vaccine acceptance," "implementation," "barriers," "physicians," "pharmacists," "nurses," "laboratory professionals," "occupational health," and "healthcare settings." The reference lists of the included articles and relevant systematic reviews were manually searched to identify additional sources.

2.2 Inclusion and Exclusion Criteria

Studies were included if they (a) examined vaccination program implementation in healthcare settings, (b) assessed vaccine hesitancy or acceptance among HCWs, (c) evaluated interventions to improve HCW vaccination coverage, (d) compared vaccination approaches across healthcare systems, or (e) provided professional perspectives on vaccination programs. Systematic reviews, meta-analyses, randomized controlled trials, observational studies, and institutional reports were eligible for inclusion. Studies were excluded if they were published in languages other than English, focused exclusively on patient vaccination without HCW components, or lacked methodological details sufficient for quality assessment.

2.3 Data Synthesis

Data were extracted and synthesized thematically according to five major domains: (a) implementation barriers (infrastructure, cold chain, information systems); (b) hesitancy determinants (demographic, professional, and attitudinal factors); (c) professional perspectives (physicians, pharmacists, nurses, laboratory professionals, preventive medicine specialists); (d) intervention strategies (educational, promotional, policy-based); and (e) international healthcare system comparisons. Quantitative findings were reported with original effect sizes and confidence intervals, where available.

3. RESULTS

3.1 Implementation Challenges in Vaccination Programs

3.1.1 Cold Chain Infrastructure Failures

The foundation of effective vaccination programs, a reliable cold chain infrastructure, remains inadequate across healthcare systems worldwide (**Table 3**). A 2021 cross-sectional study in Ethiopia found that only 61% of public health facilities maintained good cold chain management practices, with significant deficiencies in temperature monitoring, storage capacity, and contingency planning for power outages (13), as shown in **Figure 1**. Similar assessments have revealed even lower compliance rates in other developing regions: 24% in Northwest Cameroon and 7% in Gujarat, India (14). These infrastructure failures have tangible consequences; improper vaccine storage, which can lead to subpotent vaccine administration, has been associated with outbreaks of vaccine-preventable diseases in multiple settings (15).

Table 3. Implementation Barriers in Vaccination Programs Across Healthcare Systems

Barrier Category	Specific Challenges	Prevalence/Impact	Most Affected Settings
Cold Chain Infrastructure	Temperature monitoring failures; storage capacity deficits; power interruptions; ultra-cold requirements for mRNA vaccines	7-61% facilities are compliant; 30% wastage rates	LMICs; rural areas
Registry & Data Systems	Interoperability failures; data quality issues; lack of unique identifiers; non-mandatory adult recording	12.1% with reminders; 38.4% pharmacist reporting	All settings; worse in fragmented systems
Workforce Shortages	Insufficiently trained vaccinators; time constraints; brain drain; rural maldistribution	3/10,000 physicians (Africa); 23% rural workforce globally	LMICs; rural areas; LTC facilities
Financial Constraints	Vaccine procurement costs, delivery infrastructure investment, and health budget limitations	COVID-19 delivery costs = 20% pre-pandemic health budgets (LMICs)	LMICs; resource-limited settings
Policy & Regulatory	Variable authorization for pharmacy vaccination; unclear mandate legality; exemption management	Only 6.7% small pharmacies vaccinate; legal challenges to mandates	Variable by jurisdiction
Conflict & Instability	Facility destruction; supply chain disruption; HCW displacement; security concerns	14.5% HCW COVID-19 vaccination (Palestinian territories)	Conflict zones; post-conflict areas

Abbreviations: LMICs, low- and middle-income countries; LTC, long-term care. Data compiled from references (13-27, 78-84).

The emergence of mRNA vaccines during the COVID-19 pandemic has intensified infrastructure challenges. Pfizer-BioNTech's initial requirement for ultra-cold storage at -75°C exposed global freezer capacity deficits, particularly in resource-limited settings (16).

These temperature requirements contribute to substantial wastage rates, reaching 30% after one year of COVID-19 vaccine distribution in some regions (17). Multi-dose vial policies compound wastage problems; Cambodian facilities reported mean wastage rates of 4% for single-dose vaccines versus 60% for 10-dose measles-containing vaccines (18). Financial constraints exacerbate these challenges; for low- and middle-income countries, additional COVID-19 vaccine delivery costs accounted for nearly 20% of their pre-COVID-19 health budgets (19).

3.1.2 Electronic Immunization Registry Limitations

Electronic immunization registries (IIS) represent an essential infrastructure for vaccination tracking; however, their implementation remains inconsistent globally. A systematic review of 32 publications identified 14 major challenges to IIS implementation, with interoperability and data quality being the most frequently discussed (20). The absence of nationally recognized identification systems prevents vaccination records from following patients across locations, creating gaps in immunization histories that compromise clinical decision-making and public health surveillance (21). However, adult vaccination recording remains non-mandatory in most jurisdictions, resulting in incomplete immunization histories. Only 12.1% of European immunization information systems feature automated reminder capabilities, and only 10.2% can document vaccine refusal or hesitancy (22). These limitations constrain healthcare systems' ability to identify under-vaccinated populations, appropriately target interventions, and evaluate program effectiveness. Furthermore, only 38.4% of pharmacists submit vaccination records to immunization information systems, creating significant gaps in care coordination when vaccines are administered outside traditional medical settings (23).

3.1.3 Workforce and Resource Constraints

Healthcare workforce shortages fundamentally limit the capacity of vaccination programs, particularly in low- and middle-income countries (LMICs). African healthcare systems operate with chronic underfunding (approximately $70 per capita versus $10,000 in the United States), severe staffing shortages (three physicians per 10,000 population versus 30 in OECD countries), and substantial brain drain affecting 63% of newly trained doctors (24). Rural areas face disproportionate shortages: only 23% of the global health workforce is based there, even though 50% of the world's population resides in rural areas (25). Moreover, time constraints are the most frequently cited barriers by clinicians in high-income settings. Physicians report dedicating approximately six hours per week to patient vaccine conversations but face competing clinical demands that limit the depth of their vaccination counseling (26). Only 6.7% of independent and small-chain pharmacies administer vaccines, citing barriers such as competition from physician offices (29.6%), time constraints (23.5%), and lack of staff interest (23.5%) (27).

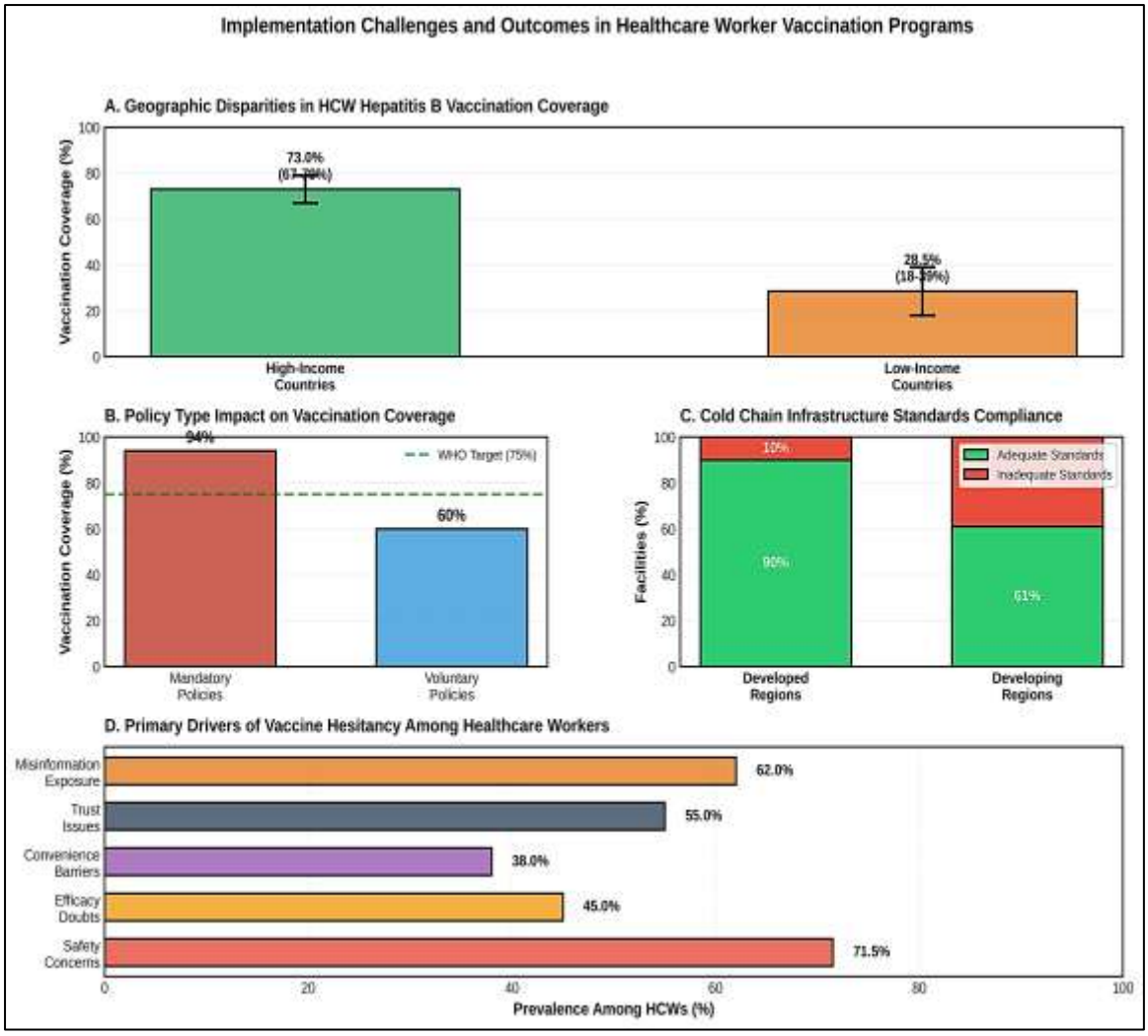

Figure 1. Implementation Challenges and Outcomes in Healthcare Workers Vaccination Programs. Multi-panel figure illustrating key implementation barriers and the policy outcomes. (A) Geographic disparities in hepatitis B vaccination coverage among HCWs, showing significant gaps between high-income countries (67-79%) and low-income countries (18-39%). The error bars represent the reported range across countries within each income category. (B) Comparison of the effectiveness of mandatory versus voluntary vaccination policies, demonstrating that the former achieved 94% coverage compared to 60% for the latter. The green dashed line indicates the WHO target coverage of 75%. (C) Cold chain infrastructure standards compliance across developed and developing regions, highlighting infrastructure gaps as critical barriers to implementation. (D) Prevalence of primary hesitancy drivers among HCWs globally, with safety concerns (71.5%) as the most prominent barrier, followed by exposure to misinformation (62%) and trust issues (55%). Data were synthesized from implementation studies and qualitative assessments. HCW = healthcare worker; WHO = World Health Organization.

3.2 Vaccine Hesitancy Determinants Among Healthcare Workers

3.2.1 Demographic and Professional Patterns

Vaccine hesitancy among HCWs demonstrates consistent demographic and professional patterns across different studies. A systematic review of studies from multiple countries found that male HCWs showed significantly higher vaccine acceptance in 71.4% of the studies. In contrast, older workers demonstrated greater willingness in 65.7% of studies, likely reflecting age-related awareness of COVID-19 susceptibility (28). Racial disparities emerged prominently in United States data: only 19% of Black HCWs expressed immediate COVID-19 vaccination willingness compared to 36% overall, with Latinx workers at 30%

and rural workers at 26% (29). However, professional hierarchy strongly predicted vaccination behavior. Physicians consistently demonstrated the highest acceptance across vaccine types, with COVID-19 uptake reaching 83.6% compared to 77.4% among nurses and 73% among other allied health professionals (30). The odds of physicians receiving vaccination ranged from an OR of 1.80 to 11.11 compared with other HCWs across the studies (31). Prior influenza vaccination was the strongest behavioral predictor of COVID-19 vaccine acceptance, appearing significant in 51.4% of studies, with adjusted odds ratios reaching 7.52 among correctional HCWs (32), as shown in **Figure 2**.

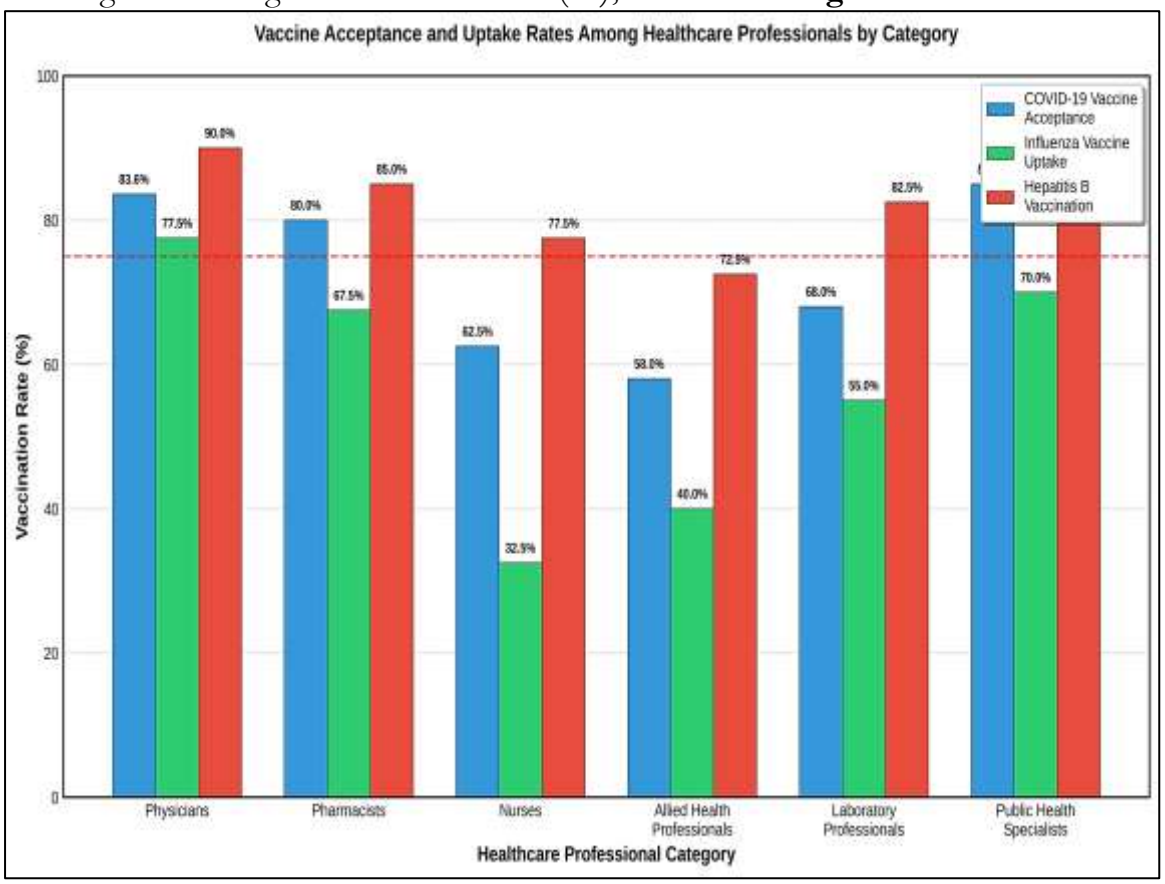

Figure 2. Vaccine Acceptance and Uptake Rates Among Healthcare Professionals by Category. Comparison of COVID-19 vaccine acceptance, seasonal influenza vaccine uptake, and hepatitis B vaccination rates across six healthcare professional categories. Data were extracted from a systematic review and meta-analysis of global studies. COVID-19 vaccine acceptance rates ranged from 58% (allied health professionals) to 85% (public health specialists). Influenza vaccine uptake showed the largest disparities, with nurses demonstrating significantly lower coverage (32.5%) than physicians (77.5%). The dashed red line indicates the WHO 'starget coverage of 75%. HCW = healthcare worker; WHO = World Health Organization.

3.2.2 Safety Concerns and Development Process Mistrust

Safety concerns predominated among the drivers of hesitancy across professional categories. An extensive survey of United States HCWs found that 69% expressed safety concerns and 74% cited concerns about development speed as the primary reasons for COVID-19 vaccine hesitancy (33). Specific problems include unknown long-term effects, potential impact on fertility, and persistence of adverse event risks despite extensive safety data from clinical trials and post-marketing surveillance (34). Trust dynamics reveal interesting patterns in the literature. HCWs trust regulatory agencies more for intentions (86.6%) than for competence (73.8%), whereas they trust pharmaceutical manufacturers more for competence (91.8%) than for intentions (76.6%) (35). The mean pharmaceutical

company trust score fell below the midpoint at 2.60/5.0, reflecting widespread concerns about commercial profiteering that may influence vaccine safety communications (36). These trust differentials suggest that messaging emphasizing regulatory oversight independence may be more effective than messaging emphasizing manufacturer quality processes.

3.2.3 Misinformation Exposure and Social Media Influence

Exposure to misinformation significantly affects vaccine decisions among HCWs. A systematic review identified 19 studies that found adverse effects of misinformation on vaccine hesitancy and uptake (37). Social media platforms, particularly Facebook, are the primary conduits of misinformation. Anti-COVID-19 vaccine accounts exceeded 85,000 within one year of vaccine availability, approaching 60 million total followers (38). Paradoxically, healthcare providers remain largely absent from online vaccine conversations. Medical community tweets constituted less than 10% of the COVID-19 vaccine discourse, creating an information vacuum filled by misinformation sources (39). This absence represents a missed opportunity, as HCWs are uniquely positioned to provide credible, evidence-based vaccine information through social media channels if appropriately supported and trained.

3.3 Professional Perspectives on Vaccination Programs

3.3.1 Physicians

Physicians occupy unique positions as both vaccine advocates and recipients, with 78.1% strongly believing that promoting vaccination is their professional duty (40). They dedicate approximately six hours per week to patient-vaccine conversations but face significant barriers, including anticipated patient resistance, unclear guidelines, time constraints, and cost considerations (41). Specialty differences emerge in vaccine-related practices: pediatricians demonstrate significantly greater empathy for patients' concerns than general practitioners, whereas emergency medicine physicians are less likely to provide communication strategies than primary care or infectious disease specialists (42). A concerning minority of vaccine-hesitant physicians developed their attitudes during extracurricular training in complementary and alternative medicine, suggesting that exposure to non-evidence-based practices in medical education may influence subsequent vaccination attitudes (43). Physician attitudes significantly influence patient vaccine acceptance; studies have demonstrated that strong physician recommendations increase patient vaccination rates by 30-50% compared to neutral information provision (44).

3.3.2 Pharmacists

Pharmacists represent an expanding vaccination workforce with substantial accessibility. All 50 U.S. states now authorize pharmacists to administer vaccinations, with over 300,000 pharmacists trained through the American Pharmacists Association's national immunization program (45). A systematic review of 14 randomized controlled trials and 79 observational studies demonstrated that pharmacist involvement significantly increased immunization uptake, particularly for influenza vaccination (46). Despite these capabilities, significant barriers to implementation persist. Only 6.7% of independent and small-chain pharmacies administer vaccines, citing competition from physician offices (29.6%), time constraints (23.5%), and lack of staff interest (23.5%) as the primary barriers (47). Critical documentation gaps persist: only 38.4% of pharmacists submit records to immunization information systems, limiting care coordination with other providers (48). International variation in pharmacist vaccination authority remains substantial, with some European countries restricting pharmacist vaccination to specific vaccines or requiring physician supervision (49).

3.3.3 Nurses

Nurses constitute the largest HCW vaccination workforce and consistently exhibit higher levels of hesitancy than physicians. A scoping review of 51 studies encompassing 41,098 nurses across 36 countries found an overall COVID-19 vaccine refusal rate of 20.7%, declining from 23.4% in 2020 to 18.3% in 2021 as vaccine safety data accumulated (50). Nurses in long-term care facilities had the lowest vaccination coverage despite the highest patient contact, raising concerns for vulnerable older adults (51). Professional autonomy concerns featured prominently in the nurses' hesitancy discourse. Qualitative studies have revealed frequent citation of the "right to bodily integrity" and resistance to perceived moral pressure as justifications for vaccine refusal (52). The American Nurses Association officially supports mandatory HCW vaccination and opposes philosophical or religious exemptions; however, this position remains contested among rank-and-file nurses (53). Understanding these concerns regarding professional autonomy is essential for designing interventions that respect nurses' perspectives while promoting vaccination.

3.3.4 Laboratory Professionals

Laboratory professionals face unique occupational exposure risks that require specific vaccination protocols. The Occupational Safety and Health Administration's (OSHA) Bloodborne Pathogens Standard requires employers to offer hepatitis B vaccination to all workers with occupational exposure within 10 days of the initial assignment (54). The Federal Select Agent Program guidance requires commercial vaccines for workers with Tier 1 biological select agent and toxin exposure, including vaccinations against diseases such as anthrax for those working with Bacillus anthracis (55). A study of laboratory workers in Pennsylvania found that 87% had received smallpox vaccination when required for their work. However, fear of adverse effects remained the primary barrier to vaccination among those who refused to be vaccinated (56). Notably, workers perceived vaccination as more likely to result in adverse outcomes than accidental infection, suggesting a misalignment between perceived and actual occupational risks that could be addressed through targeted education (57).

3.3.5 Preventive Medicine Specialists

Preventive medicine specialists provide expert guidance on the design and implementation of vaccination programs but may lack the direct authority to implement them within healthcare organizations. Their perspectives emphasized population-level benefits, cost-effectiveness considerations, and evidence-based policy development (58). These specialists increasingly advocate for integrating behavioral science principles into vaccination program design, recognizing that knowledge alone is insufficient to change vaccination behavior (59).

Occupational medicine physicians, a subspecialty of preventive medicine, directly manage workplace vaccination programs and navigate tensions between individual worker autonomy and organizational health protection mandates (60). Their dual responsibilities to employees and employers uniquely position them to mediate the implementation of vaccination policies while addressing individual concerns.

3.4 Intervention Strategies and Effectiveness

3.4.1 Multi-Component Interventions

Evidence strongly favors multi-component interventions over single-strategy approaches (**Table 4**). A meta-analysis of 48 studies encompassing 768,402 HCWs found that multi-component interventions achieved a relative risk of 1.58 (95% CI: 1.49-1.68) for vaccination in randomized controlled trials, whereas mono-component educational interventions showed a non-significant effect at RR 1.16 (95% CI: 0.89-1.51) (61). Intervention effectiveness varied by profession: nurses showed the strongest response (RR 1.59), followed by healthcare assistants (RR 1.41) and physicians (RR 1.37), suggesting that interventions are most impactful among hesitant groups (62).

Table 4. Effectiveness of Intervention Strategies for Improving Healthcare Worker Vaccination Coverage

Intervention Type	Effect Size (RR or Coverage %)	Evidence Quality	Key Considerations
Multi-component interventions	RR 1.58 (95% CI: 1.49-1.68)	High (meta-analysis of 48 studies)	Most effective overall; synergistic effects
Mandatory vaccination policies	Coverage: 94-99%	High (systematic reviews)	Highest coverage; ethical concerns; legal challenges
Motivational interviewing	+7-15% intention/uptake	Moderate-High (RCTs)	Respects autonomy; requires training
Peer champion programs	20% → 90%	Moderate (observational)	Scalable; sustainable; peer influence effects
Leadership engagement	Variable (+10-30%)	Moderate (observational)	Culture change; role modeling effects
Vaccinate-or-mask policies	Coverage: 80-90%	Moderate (observational)	Intermediate approach; legal challenges
Education alone	RR 1.16 (95% CI: 0.89-1.51)	High (meta-analysis)	Non-significant effect; insufficient alone
Access improvements	+5-20%	Moderate (observational)	Removes convenience barriers; most effective with other components

Abbreviations: RR, relative risk; CI, confidence interval; RCT, randomized controlled trial. Data compiled from references (61-73).

Effective multi-component interventions typically combine educational elements (information provision, myth debunking), promotional activities (leadership endorsement, peer influence), access improvements (convenient vaccination sites, extended hours), and reminder systems (automated notifications, personal outreach) (63). The synergistic effects of these combined approaches exceed those predicted by summing the individual component effects, suggesting that addressing multiple barriers simultaneously yields multiplicative rather than additive benefits.

3.4.2 Motivational Interviewing and Communication Strategies

Motivational interviewing (MI) has consistently been effective across healthcare settings. The PromoVac multicenter randomized controlled trial of over 3,300 families showed that a brief MI-based postpartum intervention increased maternal vaccination intention by 15%, infant coverage at 7 months by 7%, and complete immunization at 24 months by 9% (64). A Romanian field test comparing MI with Empathetic Refutational Interviewing (ERI) among 334 vaccine-hesitant patients found that ERI produced greater improvements in attitudes. In contrast, MI achieved higher vaccination scheduling rates than the controls (65). MI principles align with psychological theories of health behavior change by emphasizing autonomy support, collaborative exploration of ambivalence, and elicitation of personal motivations rather than directive persuasion (66). Training HCWs in MI techniques equips them to address hesitancy in colleagues and patients using evidence-based communication approaches.

3.4.3 Mandatory Vaccination Policies

Mandatory vaccination policies achieve the highest coverage rates but generate significant ethical and practical concerns. Implementation data demonstrated that coverage increased from 67% to 94.7% with influenza mandates. In comparison, the Vanderbilt University Medical Center achieved 99% vaccination rates for influenza, MMR, varicella, and hepatitis

B through comprehensive mandatory policies (67). Systematic review findings indicate that mandates do not cause major service disruptions in most settings, although rural areas and minority HCWs may experience disproportionate impacts (68). "Vaccinate or mask" policies represent an intermediate approach that requires unvaccinated HCWs to wear masks during clinical activities. These policies are effective but face legal challenges. An Ontario arbitrator ruled such policies as "coercive" and created a "false sense of security" (69). The ethical considerations surrounding mandatory vaccination continue to evolve, with professional organizations increasingly supporting mandates while acknowledging the importance of medical and religious exemption provisions (70).

3.4.4 Peer Influence and Leadership Engagement

Peer influence and leadership engagement are potent drivers of vaccination, complementing formal policies. A Suffolk County program increased vaccination from 20% to over 90% through trust-building conversations with nursing supervisors, subsequently becoming a Centers for Disease Control and Prevention model program (70). HCW vaccination decisions are more influenced by colleagues' opinions than by mass media, underscoring the importance of cultivating pro-vaccination organizational cultures (72). Vaccine champion programs have demonstrated both scalability and sustainability. An Australian initiative that delivered 91 sessions achieved a 94% improvement in participant confidence, with over 80 participants becoming formal champions who independently delivered more than 100 locally tailored sessions (73). These multiplier effects suggest that initial investments in champion training yield sustained benefits through ongoing peer influence networks.

3.5 International Healthcare System Comparisons

3.5.1 High-Income Countries

In the United States, HCW influenza coverage reaches 78-81% in acute care hospitals but drops to 45-47% in long-term care facilities, reflecting variations in institutional vaccination policies and workforce characteristics (74). European coverage averages only 22.1%, declining from pandemic peaks of 52% during the 2020-21 season, with substantial country-level variation, ranging from 7% in the Czech Republic to 59.1% in Portugal (75). These coverage gaps persist despite uniform recommendations from public health authorities, suggesting that policy implementation, rather than policy existence, determines outcomes. Israel achieved the world's fastest COVID-19 vaccination campaign through centralized digital health records, which enabled the rapid identification of eligible individuals, broadened eligibility criteria, minimized access barriers, facilitated engagement with religious leaders, built community trust, and established approximately 250 nationwide vaccination sites, ensuring geographic accessibility (76). Singapore achieved remarkably low COVID-19 mortality (0.05%) through free vaccination, strong government messaging, and phased prioritization, which helped build public confidence in the equitable allocation of vaccines (77).

3.5.2 Low- and Middle-Income Countries

Healthcare system development fundamentally shapes the vaccination capacity of low- and middle-income countries. HCWs in high-income countries achieve 67-79% hepatitis B vaccination compared to only 18-39% in low-income settings (78). In Africa, HCW influenza vaccination coverage is 6.5%, the lowest of any region, and COVID-19 vaccine acceptance is only 56.6% (79). Only 36 low- and middle-income countries have published HCW vaccination data, representing just 26% of such nations worldwide, limiting evidence-based program development (80). Despite these resource constraints, successful innovations have emerged. Rwanda and Ethiopia deployed 45,000 and 35,000 community health workers, respectively, to expand vaccination coverage in underserved areas (81). Nigeria's Immunization Collaborative connected over 2,900 HCWs across 36 states,

facilitating knowledge sharing and problem-solving through peer networks (82). These workforce multiplication strategies demonstrate that human capital investments can partially compensate for infrastructure limitations.

3.5.3 Middle East and Conflict-Affected Regions

Middle Eastern countries exhibit heterogeneous capacities for vaccination programs, reflecting the varying levels of economic development and healthcare system maturity. The Gulf Cooperation Council countries leveraged substantial resources and centralized governance to achieve rapid COVID-19 vaccination coverage, with the United Arab Emirates among the first countries globally to offer vaccines to all adult residents (83). In contrast, conflict-affected areas face extreme challenges in implementation. In Palestinian territory, HCW COVID-19 vaccination coverage reached only 14.5% due to supply delays and political and logistical barriers that disrupted vaccine procurement and distribution (84). Regional conflicts destroy healthcare facilities, disrupt cold chains, cause HCW displacement, and create cascading effects on vaccination program sustainability that persist long after the cessation of active conflict (85). Humanitarian organizations increasingly recognize vaccination program support as an essential component of post-conflict health system reconstruction.

4. DISCUSSION

This narrative review synthesizes evidence on the challenges of implementing vaccination programs and managing hesitancy across diverse healthcare settings and international systems. Several actionable insights have emerged for the design and implementation of healthcare vaccination programs. First, professional targeting is essential for effective marketing. Nurses and healthcare assistants exhibit the highest hesitancy rates but also the greatest responsiveness to interventions, suggesting that disproportionate resource allocation to these groups could maximize coverage (61,62). Interventions should acknowledge profession-specific concerns: autonomy and bodily integrity concerns for nurses; time and workflow integration concerns for pharmacists; and role-modeling responsibilities for physicians. Generic interventions that fail to address these distinct perspectives are unlikely to achieve optimal effectiveness across professional categories.

Second, standalone education is ineffective. Evidence clearly shows that educational interventions alone have no significant effect on vaccination behavior, necessitating their combination with promotional, access, and policy components (61). These findings challenge traditional approaches that assume that knowledge deficits underlie hesitancy and that information provision resolves resistance. Instead, effective programs must simultaneously address convenience barriers, social influence patterns, and trust dynamics. Third, mandatory policies remain the only intervention consistently achieving coverage rates exceeding 90%, although their implementation requires careful attention to their impact on rural and minority workforces (67,68). The ethical considerations surrounding mandates demand ongoing evaluation as pandemic experiences reshape societal views of public health authority and individual autonomy. Programs should establish transparent exemption processes, provide support for workers with legitimate concerns, and monitor disparate impacts across demographic groups.

Fourth, infrastructure investment is a prerequisite for program success. Cold chain failures, registry interoperability gaps, and workforce shortages create fundamental constraints that no behavioral intervention can overcome. Low- and middle-income countries, in particular,

require sustained investment in healthcare infrastructure before improvements in vaccination coverage become achievable (13,14,24). Fifth, trust building requires sustained engagement rather than episodic campaigns. The documented mistrust of pharmaceutical manufacturers and concerns about the speed of vaccine development reflect broader societal dynamics that single vaccination programs cannot resolve (35,36). Healthcare systems should invest in ongoing relationships with HCW communities, transparent communication about vaccine safety monitoring, and engagement with trusted messengers, including peer champions and local leaders to improve vaccination uptake.

Several limitations affect the interpretation of this study. Publication bias may have led to an overrepresentation of positive findings relative to null results. The preponderance of COVID-19-focused studies published between 2020 and 2023 may limit the generalizability of these findings to routine vaccination. Heterogeneity in outcome definitions, measurement approaches, and healthcare system contexts limits direct comparisons between studies. Evidence from low- and middle-income countries remains severely underrepresented, limiting the applicability of the findings to settings where vaccination challenges are often most acute.

5. CONCLUSION

Effective vaccination programs in healthcare settings require multi-component, profession-specific interventions that simultaneously address trust, convenience, and organizational culture. A staged implementation framework offers the most evidence-based pathway to optimal coverage: beginning with free, convenient access combined with active promotion to establish baseline coverage; adding peer champions and leadership modeling programs to shift organizational culture; incorporating motivational interviewing training for staff conducting patient education; and reserving mandatory policies for settings where voluntary approaches plateau below target levels. Digital immunization registries require substantial investment in interoperability standards and data quality processes before they can serve as reliable tools for monitoring coverage. Global disparities in HCW vaccination coverage reflect fundamental inequities in healthcare systems that require sustained infrastructure investment rather than behavioral interventions alone. However, critical research gaps remain. Long-term sustainability assessments beyond study periods remain rare, cost-effectiveness analyses are limited, and evidence from low- and middle-income countries is severely underrepresented. The sharp decline in European HCW vaccination coverage from the pandemic peaks suggests pandemic fatigue or other factors that require urgent investigation. Future programs must balance the optimization of vaccination coverage with workforce retention and professional autonomy concerns, recognizing that coercive approaches may yield short-term gains at the expense of the long-term erosion of trust. HCWs remain essential to global immunization success, both as vaccine recipients protecting themselves and vulnerable patients and as trusted advocates influencing community acceptance. Investing in evidence-based approaches to HCW vaccination represents a high-leverage strategy for strengthening immunization programs and improving pandemic preparedness worldwide.

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