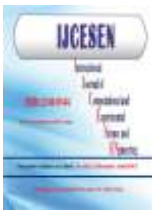
International Journal of Computational and Experimental Science and ENgineering (IJCESEN)

Vol. 10-No.4 (2024) pp. 2963-2970
http://www.ijcesen.com



ISSN: 2149-9144

Research Article

Prevention of Vaccine-Preventable Disease Outbreaks: A Review of Nursing and Public Health Roles

Anwar Hamd Musaa Hamzi[1]*, Basem Ahmed Ali Hamzi[2], Nawaf Awid Alsaadi[3], Othman Ahmed Hmed Shajiri[4], Abdullah Mohammed Qasem Muqri[5], Nazal Salem Mansour Aloshaysh[6], Badriyah Aqeel M Alruwaili[7], Maqbulh Nazal M Alshammari[8], Khalfah Salamh Ashi Alruwaili[9], Ohud Mohammed Alruwaili[10], Amal Mohammed Alruwaili[11]

[1]Public Health – Epidemiology Technician – Thiriban General Hospital, Makkah Health Cluster – Al-Qunfudhah – Makkah Region – Saudi Arabia
*** Corresponding Author Email:** aann1222333@gmail.com- **ORCID:** 0000-0002-0047-7850

[2]Public Health – Epidemiology Technician – Namerah General Hospital, Makkah Health Cluster – Al-Qunfudhah – Makkah Region – Saudi Arabia
Email: baseemhamzi@gmail.com - **ORCID:** 0000-0002-5147-7850

[3]Public Health Specialist – Population Management Department, Madinah Health Cluster – AlMadinah AlMunawwarah – AlMadinah Region – Saudi Arabia
Email: naawalsaadi@moh.gov.sa- **ORCID:** 0000-0002-5347-7850

[4]Public Health – Epidemiology Technician – Jazan Health Cluster, Ministry of Health – Jazan – Jazan Region – Saudi Arabia
Email: othman050@hotmail.com - **ORCID:** 0000-0002-5447-7850

[5]Public Health – Epidemiology Technician – Jazan Health Cluster, Ministry of Health – Jazan – Jazan Region – Saudi Arabia
Email: uuuhh90@gmail.com- **ORCID:** 0000-0002-5245-7850

[6]Public Health Technician – Public Health & Community Health, Environmental & Occupational Health Department, Al-Jouf Health Cluster – Sakaka – Al-Jouf Region – Saudi Arabia
Email: naloushishe@moh.gov.sa- **ORCID:** 0000-0002-5647-7850

[7]Nursing Specialist – Turaif Al-Awsat Primary Healthcare Center, Northern Borders Health Cluster – Turaif – Northern Borders Region – Saudi Arabia
Email: baalrwaili@moh.gov.sa- **ORCID:** 0000-0002-5277-7850

[8]Nursing Technician – Al-Zahrah Primary Healthcare Center, Hail Health Cluster – Hail – Hail Region – Saudi Arabia
Email: magbolaaa@moh.gov.sa - **ORCID:** 0000-0002-5847-7850

[9]Nursing Technician – Badnah Primary Healthcare Center, Northern Borders Health Cluster – Arar – Northern Borders Region – Saudi Arabia
Email: ksalruwaili@moh.gov.sa- **ORCID:** 0000-0002-5947-7850

[10]Nursing Technician – Al-Tuwair Primary Healthcare Center, Al-Jouf Health Cluster – Sakaka – Al-Jouf Region – Saudi Arabia
Email: ohalruwaili@moh.gov.sa - **ORCID:** 0000-0002-5277-7850

[11]Nursing Technician – Al-Safwa Primary Healthcare Center, Al-Jouf Health Cluster – Sakaka – Al-Jouf Region – Saudi Arabia
Email: aalruwaila@moh.gov.sa- **ORCID:** 0000-0002-5246-7850

Article Info:

DOI: 10.22399/ijcesen.4425
Received : 02 July 2024
Accepted : 29 July 2024

Keywords

vaccination,
disease outbreaks,
nursing role,
public health,
immunization,
community outreach

Abstract:

The prevention of vaccine-preventable disease outbreaks is a critical component of public health and nursing practice. Nurses play a vital role in immunization efforts, serving as key educators and advocates for the vaccination process in various healthcare settings. They engage with patients and their families to address misconceptions, share information about vaccine safety and efficacy, and alleviate fears surrounding immunizations. Public health initiatives, often spearheaded by health departments, focus on increasing vaccination coverage through community outreach programs and partnerships with local organizations. By employing strategies such as mobile vaccination clinics and public awareness campaigns, health professionals aim to improve access to vaccines and foster community resilience against outbreaks of diseases like measles, pertussis, and influenza. Collaboration between nursing professionals and public health organizations is essential in an effective vaccination strategy. Nurses not only administer vaccines but also play a critical role in monitoring adverse events and reporting them to relevant health authorities, contributing to ongoing safety evaluations. In addition, their close interaction with diverse communities allows them to identify and respond to barriers that may prevent individuals from accessing vaccinations. Public health policies that support mandatory vaccination programs, school entry requirements, and funding for vaccination drives further ensure a comprehensive approach. Ultimately, through education, advocacy, and the enforcement of sound public health policies, nurses and public health officials can significantly reduce the incidence of vaccine-preventable diseases, thereby enhancing community health and safety.

1. Introduction

The advent of vaccines stands as one of the most transformative achievements in the history of medicine and public health, having saved countless millions of lives and relegated once-common, devastating diseases to the realm of preventable threats. Diseases such as smallpox, which plagued humanity for millennia, have been eradicated, while others like polio and measles have seen their global incidence drastically reduced [1]. However, the persistence and resurgence of vaccine-preventable diseases (VPDs) in the 21st century presents a complex and urgent public health paradox. Despite the availability of safe and effective prophylactic tools, outbreaks of measles, pertussis, diphtheria, and influenza continue to occur with alarming frequency, even in nations with advanced healthcare infrastructures [2]. This reality underscores a critical truth: the existence of a vaccine does not equate to population-level immunity. The bridge between vaccine availability and disease prevention is constructed through the robust, coordinated, and unwavering efforts of healthcare professionals and public health systems. At the forefront of this endeavor are two inextricably linked forces: the nursing profession and the broader discipline of public health [1].

Nurses, as the largest contingent of healthcare providers globally, represent the most consistent point of contact between the public and the healthcare system. Their roles span direct clinical care, health education, advocacy, and community engagement, making them pivotal agents in the vaccination ecosystem [3]. Concurrently, public health operates at the population level, designing policy, conducting surveillance, managing supply chains, and orchestrating large-scale interventions. The prevention of VPD outbreaks is not a singular battle fought in isolation but a multifaceted campaign requiring synergy between bedside care and population-wide strategy. This review comprehensively examine the distinct yet interconnected roles of nursing and public health in sustaining high vaccination coverage, identifying and addressing immunity gaps, and ultimately preventing outbreaks of vaccine-preventable diseases.

2. Herd Immunity and Community Protection

To understand the imperative of vaccination efforts, one must first comprehend the principle of herd immunity, also known as community immunity. This concept is the cornerstone of public health strategy for contagious diseases. Herd immunity occurs when a sufficiently high proportion of a population is immune to an infectious agent, either through vaccination or prior illness, thereby providing indirect protection to those who are not immune [4]. This protective barrier disrupts chains of transmission, making it difficult for the pathogen to spread. It is a collective safeguard that protects vulnerable individuals who cannot be vaccinated, such as newborns, individuals with certain severe allergies, or those who are immunocompromised due to conditions like cancer or organ transplantation [5]. The threshold for herd

immunity varies by disease, depending on its contagiousness. For a highly infectious virus like measles, which has a basic reproduction number (R0) of 12-18, approximately 95% of the population must be immune to prevent sustained transmission [6]. For pertussis, the threshold is estimated at 92-94% [7]. These high targets are not mere suggestions but precise epidemiological requirements for outbreak prevention. Falling below these thresholds, even by small margins, creates pockets of susceptibility where outbreaks can ignite and spread. Therefore, the work of nursing and public health is fundamentally geared towards achieving and maintaining these critical coverage levels across all communities and demographic groups, recognizing that immunity gaps in one geographic or social cluster can have repercussions for the wider population.

3. The Multifaceted Role of Nursing in Vaccination Delivery and Advocacy

Nurses serve as the operational backbone of vaccination programs, translating public health policy into individual action. Their involvement is continuous, spanning the entire lifespan from the newborn nursery to geriatric care facilities.

3.1 Direct Vaccination Administration and Clinical Assessment.

The most visible role of the nurse is the direct administration of vaccines. This task requires far more than technical skill in injection. It encompasses a comprehensive clinical assessment to ensure the vaccine is appropriate and safe for the recipient at that moment. Nurses must expertly screen for contraindications and precautions, such as acute febrile illness, a history of severe allergic reactions to vaccine components, or specific conditions like Guillain-Barré syndrome for certain influenza vaccines [8]. They are responsible for managing vaccine supplies correctly, adhering to strict cold chain protocols to maintain potency, and accurately documenting the administration in medical records and immunization information systems [9]. This documentation is crucial for tracking an individual's vaccination history and for public health surveillance. Furthermore, nurses are trained to manage and alleviate common minor adverse reactions, such as fear, pain, or syncope, particularly in pediatric and anxious patients, thereby ensuring a positive experience that supports future vaccine acceptance [10].

3.2 Patient and Family Education: Combating Misinformation.

In an age of pervasive digital misinformation, the nurse's role as an educator and trusted communicator has never been more critical. Vaccine hesitancy, defined by the World Health Organization as a delay in acceptance or refusal of vaccines despite availability of vaccination services, is now a top-ten global health threat [11]. Nurses are uniquely positioned to address concerns through empathetic, non-judgmental, and evidence-based conversations. They must be prepared to explain the scientific rationale for vaccination, the rigorous safety testing vaccines undergo, the importance of schedule adherence, and the stark reality of disease risks versus vaccine risks [12]. This educational role involves active listening to identify specific fears—whether about ingredients, autism, or perceived "natural" immunity—and providing clear, understandable rebuttals grounded in science. The nurse-patient relationship, often built on trust over time, gives nurses a powerful platform to reinforce the social responsibility of vaccination for protecting the wider community, including vulnerable family members [13].

3.3 Advocacy and Accessibility within Healthcare Systems.

Beyond the examination room, nurses function as patient advocates and system navigators. They identify barriers to vaccination, such as financial constraints, transportation issues, or inconvenient clinic hours, and work to overcome them. This may involve connecting families with programs like the Vaccines for Children (VFC) program in the United States, scheduling follow-up appointments, or advocating for the implementation of standing orders that allow nurses to assess and vaccinate without a specific physician's order for each patient, thereby streamlining the process [14]. In pediatric, family practice, obstetric, and geriatric settings, nurses are instrumental in implementing reminder-recall systems to notify patients of upcoming or overdue vaccinations, a proven strategy to improve coverage rates [15]. Their advocacy extends to institutional policies, promoting a culture where vaccination is the default, normative choice for healthcare workers themselves, thereby protecting both staff and vulnerable patients [16].

3.4 The Population-Level Mandate: Public Health Roles in Outbreak Prevention

While nurses operate at the individual and community interface, public health entities function at the macro level, creating the infrastructure,

policies, and surveillance systems that make widespread vaccination possible and effective.

Policy Development, Guidelines, and Financing. Public health agencies, such as the World Health Organization (WHO), the U.S. Centers for Disease Control and Prevention (CDC), and national ministries of health, are responsible for establishing evidence-based vaccination recommendations. Committees like the Advisory Committee on Immunization Practices (ACIP) systematically review data on vaccine efficacy, safety, and epidemiology to develop schedules for children, adolescents, and adults [17]. These guidelines are foundational, informing clinical practice and insurance coverage. Public health also plays a crucial role in financing and procurement, ensuring a stable, affordable supply of vaccines. This includes negotiating prices, managing public sector purchases, and implementing subsidy programs for low-income populations. By securing financing and supply, public health removes fundamental economic barriers to access, creating the conditions under which clinical delivery can succeed [18].

3.5 Disease Surveillance and Outbreak Response.

A sophisticated disease surveillance system is the early warning radar for VPD outbreaks. Public health agencies maintain notifiable disease reporting systems, where healthcare providers, including nurses and physicians, are legally mandated to report cases of specific VPDs [19]. Epidemiologists analyze this data in real-time to detect anomalies, identify clusters, and map transmission trends. Laboratory networks confirm diagnoses through advanced testing. When an outbreak is detected, public health springs into action with a coordinated response: conducting intensive case investigations to identify the source and contacts, implementing isolation and quarantine measures, organizing targeted supplemental immunization activities (SIAs) or "catch-up" campaigns in affected areas, and communicating risks to the public and healthcare providers [20]. This rapid response capacity is essential for containing outbreaks before they become widespread epidemics.

3.6 Immunization Information Systems (IIS) and Data Management.

Often described as the central nervous system of immunization programs, Immunization Information Systems (IIS) are confidential, population-based databases that consolidate vaccination records from multiple providers [21]. Public health agencies develop and maintain these critical tools. For clinicians and nurses, an IIS provides a complete vaccination history for a patient, preventing unnecessary duplicate vaccinations and identifying overdue doses. For public health officials, aggregated, de-identified data from IIS is invaluable for assessing coverage rates at local, state, and national levels, identifying geographic or demographic pockets of under-vaccination, measuring the impact of policy changes, and evaluating the effectiveness of vaccine products in the real world [22]. This data-driven approach allows for targeted, efficient interventions where they are needed most.

3.7 Communication Campaigns and Community Engagement.

Public health agencies undertake large-scale communication initiatives to shape social norms and promote vaccine confidence. These campaigns utilize mass media, social media, and partnerships with community-based organizations to disseminate accurate, consistent messages about the value of vaccination [23]. Crucially, effective public health communication involves proactive engagement with community leaders, religious figures, and cultural influencers to tailor messages and address community-specific concerns. In an era of misinformation, public health also plays a vital role in "infodemic" management, monitoring false narratives online and partnering with technology companies to promote authoritative sources of information [24]. These efforts create a supportive societal environment that makes the work of frontline vaccinators more effective.

4. Synergistic Collaboration: Where Nursing and Public Health Intersect

The most powerful outcomes are achieved not when nursing and public health work in parallel, but when their efforts converge in synergistic collaboration. This intersection is the fertile ground where population health strategies are successfully actualized.

4.1 Community-Based Vaccination Clinics and Outreach.

A prime example of this synergy is the organization of community vaccination clinics. Public health agencies often provide the strategic direction, funding, vaccine supply, and logistical planning for large-scale clinics, such as those deployed during annual influenza campaigns or the COVID-19

pandemic response. Nurses, including public health nurses, school nurses, and volunteers from various healthcare settings, constitute the workforce that executes these plans [25]. They staff the clinics, perform screenings, administer vaccines, and monitor patients. School-based vaccination programs, which have been highly successful in improving adolescent vaccination rates for HPV, meningococcus, and Tdap, similarly rely on public health-school district partnerships, with school nurses playing a central role in parent communication, consent, and onsite delivery [26]. Mobile clinics that reach rural or underserved urban areas also exemplify this model, combining public health's mobility resources with nursing's clinical expertise to bridge geographic accessibility gaps.

4.2 Training, Competency, and Professional Development.

Public health agencies are frequently responsible for establishing and updating the training standards and competencies required for vaccine administration. They develop educational modules, guidelines for safe injection practices, and updates on new vaccine recommendations or changes to schedules. The nursing profession, through academic institutions, healthcare employers, and nursing associations, integrates this public health guidance into pre-service education and continuing professional development [27]. This ensures a standardized, high-quality knowledge base across the nursing workforce, from student nurses to seasoned practitioners, aligning frontline practice with the latest epidemiological evidence and best practices promulgated by public health authorities.

4.3 Addressing Vaccine Hesitancy: A Unified Front.

Combating vaccine hesitancy is perhaps the area where collaboration is most essential. Public health research identifies the sociological, psychological, and demographic drivers of hesitancy at a population level [28]. Nurses, through their direct interactions, gather qualitative, on-the-ground intelligence about local concerns and misinformation trends. This bidirectional flow of information is vital. Public health can equip nurses with targeted communication toolkits, answers to frequent questions, and strategies for motivational interviewing based on behavioral science research [29]. Conversely, feedback from nurses about emerging concerns can inform public health communication campaigns, making them more relevant and responsive. Together, they can develop and implement community engagement strategies, such as organizing forums where respected healthcare providers (often nurses) can dialogue with concerned parent groups in a setting facilitated by public health officials [30].

5. Challenges and Barriers to Optimal Prevention

Despite clear roles and collaborative potential, significant challenges impede the optimal functioning of both nursing and public health in preventing VPD outbreaks.

5.1 The Infodemic and Erosion of Trust.

The digital proliferation of anti-vaccine misinformation and deliberate disinformation campaigns represents an unprecedented challenge [31]. False claims about vaccine safety can spread globally in hours, seeding doubt and fear. This erosion of trust extends not only to vaccines but also to the institutions and professionals who recommend them. Nurses and public health officials often find themselves spending disproportionate time debunking myths rather than providing care or developing programs. The politicization of vaccination in some contexts further corrodes public trust in scientific and health authorities, making objective communication exceedingly difficult [32].

5.2 Resource Constraints and Workforce Issues.

Chronic underfunding of public health infrastructure and nursing services undermines outbreak prevention efforts. Public health departments often operate with limited budgets, affecting their ability to maintain robust surveillance, conduct outreach, and manage IIS [33]. For nursing, high patient-to-nurse ratios in clinical settings can compress the time available for thorough vaccine discussions and education. Burnout and workforce shortages, exacerbated by events like the COVID-19 pandemic, reduce the capacity of both fields to sustain the intensive, consistent efforts required to maintain high vaccination coverage [34].

5.3 Health Inequities and Access Disparities.

Structural inequities ensure that the burden of VPDs falls disproportionately on marginalized communities, including racial and ethnic minority groups, low-income populations, and rural residents. Barriers such as poverty, lack of insurance, transportation difficulties, language differences, and historical medical mistrust create

persistent coverage gaps [35]. While both nursing and public health strive to address these through targeted programs, deeply rooted social determinants of health are often beyond their direct control, requiring multisectoral policy solutions.

5.4 Global Interdependence and Logistics.

In a globalized world, pathogens know no borders. An outbreak in one country can quickly become an international threat, as seen with measles importations. This reality places immense importance on global vaccination equity, supported by mechanisms like Gavi, the Vaccine Alliance [36]. However, logistical challenges in vaccine distribution, particularly the maintenance of the cold chain in low-resource settings, and weaknesses in local health systems can hinder coverage. Nurses in these settings may work with intermittent supplies and limited support, while public health systems may struggle with data collection and campaign implementation.

6. Future Directions and Strengthening the Partnership

To overcome these challenges and enhance outbreak prevention, the partnership between nursing and public health must be fortified and adapted to the evolving landscape.

6.1 Leveraging Technology and Innovation.

Technology offers powerful new tools. Telehealth and mobile health (mHealth) applications can extend the reach of nursing consultations for vaccine counseling, particularly in remote areas [37]. Artificial intelligence and machine learning applied to data from IIS and social media can help predict outbreaks and identify emerging pockets of hesitancy with greater speed and precision, allowing for preemptive public health interventions [38]. Digital immunization records accessible to patients and providers can improve continuity of care.

6.2 Policy Advocacy for a Supportive Environment.

Both nurses and public health professionals must engage in collective advocacy to create a more supportive policy environment. This includes lobbying for sustained and increased funding for public health infrastructure, supporting policies that mandate insurance coverage for vaccines without cost-sharing, and advocating for legislation that supports school entry requirements based on scientific recommendations while allowing for appropriate medical exemptions [38]. They must also advocate for policies that address the social determinants of health, recognizing that vaccine equity cannot be achieved in a vacuum of broader inequality.

6.3 Enhanced Interprofessional Education and Leadership.

Training future nurses and public health professionals should emphasize interprofessional collaboration from the outset. Joint educational programs, shared case studies, and simulated outbreak response exercises can break down silos and foster a deep understanding of respective roles [12]. Furthermore, cultivating nursing leadership within public health agencies, and vice-versa, can ensure that policies and programs are informed by practical clinical reality and population science simultaneously.

6.4 Community-Based Participatory Research.

Moving beyond delivering programs *to* communities, the future lies in designing and implementing interventions *with* communities. Community-based participatory research (CBPR) involves partnering with community members as equal collaborators in all phases of research and intervention design [1]. This approach, led jointly by public health researchers and community-embedded nurses, can build trust, ensure cultural relevance, and develop more effective strategies for addressing vaccine hesitancy and improving access in historically underserved populations.

7. Conclusion

The prevention of outbreaks of vaccine-preventable diseases remains an achievable but demanding public health goal, one that is perpetually threatened by complacency, misinformation, and inequity. It is a goal that cannot be secured by any single profession or sector alone. The nursing profession, with its unparalleled reach, trusting relationships, and clinical expertise, operates at the critical juncture where public health policy meets human behavior. The public health discipline provides the essential scaffolding of surveillance, guidelines, financing, and population-level strategy. Their roles, while distinct in scope and scale, are functionally interdependent. The nurse administering a vaccine in a clinic is the final, vital step in a chain that begins with public health surveillance and policy. Conversely, the data

entered by that nurse into an immunization information system fuels the public health analysis that guides future resource allocation and outreach. In the face of evolving challenges—from the digital infodemic to entrenched health disparities—the need for a strengthened, dynamic, and respectful collaboration between nursing and public health has never been greater. By intentionally integrating their strengths, advocating for supportive policies, and innovating in practice, these two pillars of health protection can fortify the community immunity that safeguards individuals, families, and populations from the enduring threat of preventable diseases. Their partnership is, and will continue to be, the bedrock of a healthier, more resilient society.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
- **Acknowledgement:** The authors declare that they have nobody or no-company to acknowledge.
- **Author contributions:** The authors declare that they have equal right on this paper.
- **Funding information:** The authors declare that there is no funding to be acknowledged.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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