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Review Article

Nursing Leadership in Vaccine Delivery in Low-resource Settings: Evidence from Nepal's National Immunization Program

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Abstract

Background: Vaccination is one of the most cost-effective public health interventions, preventing an estimated three to five million deaths annually worldwide (WHO, 2023). Nepal has achieved substantial progress through its National Immunization Program (NIP), supported by international partners including GAVI, the Vaccine Alliance (which has provided over USD 150 million since 2002), UNICEF, and WHO. Despite this progress, ensuring equitable vaccine access across geographically diverse and resource-constrained settings remains a persistent challenge. Nurses constitute the primary frontline workforce responsible for vaccine delivery across health facilities, outreach clinics, and large-scale national campaigns, yet their leadership contributions remain underexplored in the academic literature. Objective: To examine the multi-dimensional leadership roles of nurses within Nepal's immunization system, identify structural strengths and workforce challenges, and propose evidence-based policy recommendations for strengthening nursing-led immunization programs in low-resource settings. Methods: A narrative review was conducted of peer-reviewed literature, national policy documents, and reports from WHO, UNICEF, GAVI, and Nepal's Ministry of Health and Population (MoHP) relating to Nepal's NIP. Five key domains were analyzed: vaccine administration, cold chain management, community engagement, immunization surveillance, and health workforce dynamics. Results: Nurses perform central roles across all five domains. More than 27,000 health workers--predominantly nurses and Auxiliary Nurse Midwives--were deployed during Nepal's 2025 HPV vaccination campaign targeting over 1.46 million adolescent girls, supported by over 51,000 Female Community Health Volunteers (FCHVs). Nepal achieved 82.48% first-dose COVID-19 coverage. However, persistent challenges include health workforce shortages, limited competency-based immunization training, geographic barriers, vaccine hesitancy, and continued dependence on external donor funding. Conclusion: Nurses are the backbone of Nepal's immunization system and are indispensable for sustaining vaccination coverage in resource-constrained settings. Strengthening nursing competencies, expanding workforce capacity in underserved areas, and enhancing policy recognition of nursing leadership are essential to achieving the goals of the Immunization Agenda 2030 and Universal Health Coverage.

Keywords

Nursing Leadership, Immunization Programs, Vaccine Delivery, Nepal, Cold Chain Management, Community Health, Low-resource Settings

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1. Introduction

Vaccination is one of the most powerful and cost-effective public health interventions ever developed, preventing an estimated three to five million deaths annually and protecting individuals from life-threatening infectious diseases (WHO, 2023) [1]. Globally, immunization has been instrumental in reducing the burden of vaccine preventable diseases, contributing directly to the achievement of Sustainable Development Goal 3 (SDG 3) ensuring healthy lives and promoting well-being for all [2].

Despite this remarkable progress, global immunization coverage remains fragile. The COVID-19 pandemic disrupted health systems worldwide, causing the largest sustained decline in childhood vaccination in three decades. As of 2023, global coverage with the first and third doses of diphtheria-tetanus-pertussis-containing vaccine (DTP1 and DTP3) remained at 89% and 84% respectively still below pre-pandemic levels of 86% [3]. The Immunization Agenda 2030 (IA2030), endorsed by the World Health Assembly, sets ambitious targets including halving the number of zero-dose children and strengthening primary healthcare embedded immunization systems by 2030 [4].

In low and middle-income countries (LMICs), health workforce capacity is the most critical bottleneck to vaccine delivery. The World Health Organization estimates a projected global shortage of 18 million health workers by 2030, concentrated primarily in South-East Asia and Sub-Saharan Africa [5]. Nurses and midwives constitute the largest segment of the global health workforce, and in many LMICs represent the primary or sole clinical cadre responsible for vaccination services at the community level [6].

Nepal presents a compelling case study of nursing leadership in immunization. Since the launch of its Expanded Programme on Immunization (EPI) in 1977, Nepal has demonstrated sustained and high vaccination coverage compared to regional peers. The National Immunization Program (NIP), led by the Ministry of Health and Population (MoHP), delivers routine vaccination services through a nationwide network of health posts, primary health care centers, hospitals, and community outreach clinics [7]. This system is significantly strengthened by international partnerships: GAVI, the Vaccine Alliance, has provided over USD 150 million in Nepal's immunization system since 2002, supporting vaccine procurement, cold chain infrastructure, and health system strengthening [8]. UNICEF and WHO provide critical technical assistance, supply chain support, and programmatic oversight [9].

Within Nepal's immunization architecture, nurses occupy an irreplaceable central role extending from clinical vaccine administration to cold chain management, community mobilization, AEFI surveillance, campaign leadership, and real-time immunization data reporting. The 2025 HPV vaccination campaign exemplified this effort: more than 27,000 health workers and vaccinators predominantly nurses, Auxiliary Nurse Midwives (ANMs), and Health Assistants were deployed alongside approximately 51,483 Female Community Health Volunteers (FCHVs) to immunize over 1.46 million adolescent girls against cervical cancer across Nepal. The campaign was supported by Gavi, the Vaccine Alliance, which helped provide the HPV vaccine doses and technical support for implementation [10].

Despite these substantial contributions, nursing leadership in immunization remains under theorized and underrepresented in policy discussions. Systematic documentation of nurses' roles, operational challenges, and enabling factors is essential for evidence-based workforce planning, policy advocacy, and sustainable strengthening of immunization systems. This review aims to address this gap by comprehensively examining nursing leadership roles within Nepal's NIP, contextualizing them within global frameworks, and identifying priority areas for policy action.

2. Methods

2.1. Study Design

A narrative review was conducted to synthesize evidence on nursing leadership in vaccine delivery within Nepal's immunization system. This approach was selected to capture a broad range of evidence types including policy documents, programmatic reports, and peer-reviewed literature and to contextualize Nepal's experience within global immunization frameworks.

2.2. Data Sources

Evidence was drawn from multiple complementary sources: (i) peer-reviewed literature published between 2015 and 2025 retrieved from PubMed, Google Scholar, and Scopus; (ii) official reports and policy documents from WHO, UNICEF, GAVI, and Nepal's MoHP and Department of Health Services (DoHS); (iii) the WHO/UNICEF Estimates of National Immunization Coverage (WUENIC) database; (iv) Nepal's National Immunization Strategy 2030 development documentation; and (v) programmatic experience from routine immunization activities and national vaccination campaigns.

2.3. Study Context

Nepal’s National Immunization Program delivers routine vaccination services through a network of health facilities and outreach clinics across the country. Immunization services are provided in both facility-based and community-based settings to ensure access for populations living in geographically remote areas.

2.4. Data Analysis

A thematic analytical approach was used to organize find-

ings across five pre-specified domains: (1) clinical vaccine administration and adverse event management; (2) cold chain and logistics management; (3) program coordination and campaign leadership; (4) community engagement and health promotion; and (5) immunization surveillance and data management. Evidence was synthesized narratively, with quantitative data presented descriptively where available.

3. Results

3.1. Nepal's National Immunization Program: Architecture and Achievements

Nepal's National Immunization Programme (NIP), established as the Expanded Programme on Immunization (EPI) in 1977, and has evolved into one of the most successful immunization systems in South Asia. As of 2025, the programme provides protection against 14 vaccine-preventable diseases, including tuberculosis, polio, diphtheria, pertussis, tetanus, hepatitis B, *Haemophilus influenzae* type b (Hib), pneumococcal disease, rotavirus diarrhoea, measles, rubella, Japanese encephalitis, typhoid, and cervical cancer through the introduction of the human papillomavirus (HPV) vaccine as the 14th antigen in the national immunization schedule. The NIP has consistently maintained high immunization coverage and is widely recognized as a regional benchmark for equitable vaccine delivery, community engagement, and sustained immunization system performance in South Asia. [11].

Nepal's immunization architecture rests on a tiered delivery system spanning federal, provincial, district, municipal, and ward levels. At the community level, routine vaccination services are delivered through hospitals, health posts, urban health centers, primary health care centers, and community outreach sessions. The 2021 Nepal Health Facility Survey (NHFS) reported that approximately 75% of health facilities (excluding stand-alone HIV testing and counseling centers) offered a full package of basic client services that included child vaccination [8].

International partner support has been foundational. GAVI has invested over USD 150 million in Nepal since 2002, supporting health system strengthening, cold chain equipment, new vaccine introduction, and community engagement interventions [8]. Nepal developed its National Immunization Strategy 2030 (NIS 2030) in alignment with IA2030 goals through a consultative process involving MoHP, WHO, UNICEF, GAVI, World Bank, USAID, and national stakeholders [12]. Recent vaccine introductions include the typhoid conjugate vaccine (TCV) in 2022, targeting 7.5 million children under 15, and the HPV vaccine campaign launched on World Cancer Day (4 February 2025) [13].

3.2. Nursing Leadership in Routine Immunization Services

Nurses represent the primary workforce responsible for routine immunization in Nepal's health facility network. Their clinical responsibilities encompass pre-vaccination screening and eligibility assessment, vaccine preparation and administration following national immunization schedules, real-time monitoring for immediate adverse reactions, post-vaccination counseling, and documentation in immunization registers [14].

Beyond direct clinical service delivery, nurses play a central role in maintaining the integrity of the cold chain the temperature-controlled supply chain essential to vaccine potency. They routinely monitor vaccine storage temperatures using thermometers and freeze-tag indicators, maintain vaccine inventories, conduct stock management to minimize wastage, and ensure safe transportation of vaccines in cold boxes to outreach sites. Given Nepal's challenging terrain spanning high Himalayan Mountains, mid-hills, and southern Terai plains maintaining cold chain continuity is a technically demanding and mission-critical responsibility [15].

The transition in Nepal's health system following the 2015 constitutional restructuring replaced traditional community-based cadres (Village Health Workers and Maternal and Child Health Workers) with broader clinical roles including ANMs, Staff Nurses, AHW and Health Assistants. While this integration expanded the scope of nursing-led services, it simultaneously increased workload by distributing immunization responsibilities alongside other competing clinical duties, potentially diluting immunization-specific focus [7].

3.3. Leadership in Outreach Immunization Services

Reaching geographically remote and underserved populations is one of the most significant operational challenges in Nepal's immunization program. Community outreach clinics conducted monthly in remote wards are the primary mechanism for extending vaccine access beyond facility walls. Nurses and ANMs frequently serve as session leaders for these outreach activities, organizing vaccination teams, coordinating with ward-level local governments, managing vaccine cold chain logistics, and supervising FCHVs [11].

Nepal's approximately 51,000 FCHVs serve as a critical bridge between the formal health system and communities. FCHVs receive a 10 day basic training covering multiple primary healthcare topics including immunization. Their responsibilities include generating community demand through household visits and mothers' group sessions, mobilizing caregivers to attend outreach clinics, tracking defaulters for follow-up, and providing first-line health education about vaccines [8]. UNICEF evidence from Nepal demonstrates that FCHV-facilitated mothers' group meetings and door-to-door engagement have been pivotal in building community trust in immunization and identifying vaccine-hesitant families [9].

The importance of this community health infrastructure was powerfully demonstrated during Nepal's 2024 Measles-Rubella (MR) vaccination campaign (February-March 2024),

where GAVI and UNICEF mobilized community volunteers alongside FCHVs to conduct intensive social and behavioral change interventions, particularly targeting vaccine-hesitant pockets and families with zero-dose children [16]. Similarly, during the 2022 TCV introduction campaign, FCHVs played an essential role in community mobilization while health workers led predominantly by nurses administered vaccines, together reaching 7.5 million children within approximately one month [13].

3.4. Leadership in National Vaccination Campaigns

Mass vaccination campaigns require complex, large-scale operational leadership and execution. Nurses have served as operational leaders in Nepal's most significant recent campaigns, including the COVID-19 vaccination rollout and the 2025 HPV campaign.

During Nepal's COVID-19 vaccination program, nurses were central to establishing and operating vaccination sites, managing vaccine logistics and cold chain, coordinating service delivery, educating communities about vaccine safety, and monitoring and reporting adverse events following immunization (AEFI). As a direct result of this nursing-led operational capacity, Nepal achieved 82.48% first-dose and 82.55% full-dose COVID-19 vaccination coverage of the total population as of January 2023 a remarkable achievement by LMIC standards [7].

The 2025 HPV vaccination campaign, launched on World Cancer Day in collaboration with MoHP, GAVI, WHO, and UNICEF, targeted over 1.6 million adolescent girls (grades 6-10, and out-of-school girls aged 10-14) to protect against cervical cancer - the second most common cancer and the leading cause of cancer-related death among women in Nepal [10, 17]. GAVI supplied 1,770,400 vaccine doses and funded operational costs. More than 27,000 health workers predominantly nurses and ANMs were deployed alongside 51,000+ FCHVs at over 8,200 health facilities and 18,900 schools nationwide. Nurses led school-based vaccination sessions, coordinated with teachers, managed vaccine cold chain logistics, and engaged parents to address hesitancy [10]. The government subsequently announced integration of the HPV vaccine into the routine immunization schedule, institutionalizing the school-based nursing-led delivery model [17].

The October 2025 emergency oral cholera vaccine response in southern Nepal further underscored nursing and health worker leadership: 1,000 government health workers and approximately 2,200 FCHVs were trained and deployed within three days to immunize over 723,000 people in an affected area, successfully halting disease transmission [18].

3.5. Community Engagement, Vaccine Hesitancy Reduction, and Health Education

Community trust is a fundamental determinant of immunization success, and nurses serve as its frontline architects. Through counseling sessions, community meetings, school programs, and mothers' group facilitation, nurses provide evidence-based information about vaccine benefits and safety, address misconceptions rooted in cultural beliefs or misinformation, and foster sustained demand for vaccination [14].

Vaccine hesitancy defined by the WHO Strategic Advisory Group of Experts (SAGE) as the reluctance or refusal to vaccinate despite the availability of vaccination services represents an escalating challenge in Nepal and globally. Nurses serve as trusted health communicators whose credibility with communities is often higher than that of other health authorities. The International Council of Nurses (ICN) has explicitly called on member states to involve nurses and nursing organizations in planning, implementation, and monitoring of immunization programmes at all levels, recognizing their unique capacity to address hesitancy and build vaccine confidence [19].

GAVI and UNICEF evidence from Nepal demonstrates that FCHV-facilitated community mobilization supervised and supported by nurses is highly effective in addressing hesitancy among hard-to-reach populations, including religious minorities, migrant families crossing the Nepal-India border, and communities in remote rural areas [16].

3.6. Operational Challenges

Despite their critical contributions, nurses in Nepal face a series of persistent structural and operational challenges that constrain their effectiveness:

Health Workforce Shortage: Nepal faces a critical shortage of health workers relative to the WHO benchmark of 44.5 basic health workers per 10,000 population. The shortage is most acute in remote hill and mountain districts, where single-nurse bear responsibility for both curative services and immunization delivery [5].

Limited Competency-Based Immunization Training: A systematic review of pre-service training globally found that vaccine administration was covered in nursing education in only a minority of programs, and competency-based in-service immunization training for practicing nurses remains limited in Nepal [20]. Staff rotations further disrupt institutional immunization expertise.

Geographic Barriers: Nepal's diverse topography creates significant barriers to outreach immunization delivery and cold chain maintenance. Reaching communities in remote mountain districts requires travel over difficult terrain, often on foot, creating physical demands on nurses and risks to vaccine cold chain integrity [15].

Multiple Competing Duties: Following health system restructuring, immunization responsibilities are integrated within broader clinical roles, competing with curative care demands. During periods of high outpatient volume or emergencies, immunization sessions may be deprioritized [7].

Vaccine Hesitancy: Persistent vaccine hesitancy in certain communities driven by misinformation, religious beliefs, and

past adverse events increases the time and effort required from nurses for community engagement, and contributes to zero-dose and under-immunized children [16].

Dependence on External Funding: Nepal's immunization program remains substantially dependent on external funding from GAVI and other international donors. Domestic resource mobilization for immunization including for nursing workforce costs remains insufficient to ensure long-term programmatic sustainability without continued international support [12].

3.7. Cold Chain Management and Logistics

Effective cold chain management is a prerequisite for vaccine efficacy and program integrity. Nepal's mountainous terrain presents unique challenges, with vaccines needing to travel from central storage facilities through provincial and district cold stores to health facilities and ultimately to outreach sessions in remote communities. Nurses at facility level are primary responsible for daily temperature monitoring and recording, stock rotation using first expiry first out principles, AEFI kit maintenance, and coordination with district cold stores for timely resupply [14].

International partners have made sustained investments in Nepal's cold chain infrastructure. UNICEF, with support from GAVI and the U.S. CDC, has expanded cold storage capacity through installation of additional cold rooms, refrigerators, and freezers in vaccine storage facilities, and increased supplies of refrigerated containers and cold boxes for transport to remote communities. Solar-powered cold chain solutions have been installed in health facilities in areas lacking reliable electricity, further strengthening the cold chain's resilience [9].

3.8. Immunization Surveillance and Data Management

Timely and accurate immunization data are foundational to program monitoring, resource allocation, and equity-focused intervention. Nurses play an essential role in the data ecosystem of Nepal's NIP: completing immunization registers, generating facility-level reports for submission to municipality and higher level, tracking defaulters for targeted follow-up, identifying zero-dose children, and reporting AEFI to the national pharmacovigilance system [7].

Nepal reports immunization coverage data annually to WHO and UNICEF through the Joint Reporting Form on Immunization (JRF), contributing to the WUENIC global estimates. The accuracy and completeness of these submissions depends directly on the quality of facility-level data collection and reporting by nurses. Strengthening nurses' data management competencies is therefore inseparable from strengthening national immunization surveillance systems [3].

4. Discussion

This review provides comprehensive evidence that nursing leadership is not peripheral but foundational to Nepal's immunization success. Nurses function simultaneously as clinicians, cold chain technicians, community mobilizers, health educators, and data managers performing an irreplaceable multi-role function that no other single health cadre currently replicates within the NIP.

Nepal's sustained high immunization coverage relative to income-group peers reflects the effectiveness of a health system model that leverages strong frontline nursing leadership embedded within community-facing structures. The critical role of FCHVs in Nepal supervised and supported by nurses in achieving high immunization coverage has been documented across multiple studies [8, 11] and is consistent with global evidence that community health worker programs substantially improve vaccine coverage in LMICs [21].

The 2025 HPV campaign provides a particularly compelling recent demonstration of nursing capacity: the ability to deploy, train, coordinate, and execute a national vaccination campaign targeting 1.46 million girls through 27,000+ health workers across 18,900 schools within a compressed timeline [10, 17]. This operational capacity largely nursing-led reflects both the strengths of Nepal's immunization system and the foundational role of nurses within it.

However, Nepal's immunization achievements remain vulnerable. The COVID-19 pandemic's disruption of routine immunization which increased Nepal's zero-dose children from approximately 1% to 4% underscores the fragility of gains when health system resilience is tested [13]. The IA2030 "Big Catch-Up" initiative launched in 2023 by WHO, UNICEF, and GAVI aims to restore immunization trajectories in countries including Nepal, and nurses will be central to the operational execution of catch-up activities [4].

Globally, the ICN and WHO have increasingly emphasized that nurses must not only be included in immunization delivery but actively involved in national immunization governance, strategy development, and monitoring systems [19]. Nepal's NIP -while leveraging nurses operationally has not yet fully translated this operational centrality into formal nursing representation within immunization advisory committees or policy-making bodies. Closing this governance gap represents a key opportunity to strengthen both nursing leadership and program effectiveness.

The challenge of limited competency-based immunization training deserves specific attention. A global systematic review found that immunization-specific training gaps exist even in settings where nurses are the primary vaccinators [20]. Nepal's transition from dedicated community vaccination cadres to generalist clinical roles has increased the scope of expected competencies without a commensurate increase in specialized immunization training. Standardized, regularly updated, competency-assessed immunization training integrated into both pre-service nursing curricula and continuing professional development programs is an evidence-based priority [20].

Vaccine hesitancy is an emerging challenge that requires

nurse-specific communication training. Nepal's experiences during the 2024 MR and 2025 HPV campaigns where targeted community engagement led by FCHVs and supported by nurses was key to achieving high coverage in previously hesitant communities [16] provide a practical model for addressing hesitancy through trusted health communicator approaches.

Finally, the financial sustainability of Nepal's immunization program requires urgent attention. Continued dependence on GAVI and other external donors creates vulnerability to funding transitions. Nepal's NIS 2030, developed with WHO and UNICEF support, includes financial analysis through 2028, but domestic budget allocation for immunization including for the nursing workforce needs to increase substantially to ensure the program's resilience and independence [12].

5. Conclusion

Nursing leadership is a critical and irreplaceable pillar of Nepal's National Immunization Program and of vaccine delivery systems in low-resource settings more broadly. Nurses in Nepal administer vaccines, maintain cold chains, lead outreach sessions in remote communities, coordinate major national campaigns, and engage communities to build vaccine demand, manage immunization data, and respond to public health emergencies all within resource-constrained environments and often with limited workforce support.

Nepal's immunization achievements including high routine coverage, successful introduction of new vaccines, and the operational execution of the 2025 HPV campaign reaching 1.46 million adolescent girls are founded upon the dedication, competence, and leadership of the nursing workforce. Sustaining and advancing these achievements requires commensurate investment: in competency-based nursing education, rural workforce expansion, cold chain infrastructure, domestic immunization financing, and formal recognition of nursing leadership within immunization governance.

As the world works toward the Immunization Agenda 2030's vision of leaving no one behind, nurses will be on the frontlines of that effort. Empowering them through training, supportive supervision, and policy recognition is not optional it is essential to achieving equitable immunization coverage and universal health coverage.

6. Policy Implications

Based on the evidence synthesized in this review, the following evidence-based policy recommendations are proposed:

Invest in competency-based immunization training: Integrate standardized, competency-assessed immunization modules into pre-service nursing curricula, and institute annual in-service refresher training for all frontline vaccination providers, with specific modules on AEFI management, cold chain procedures, and communication for vaccine acceptance.

Expand nursing workforce in remote and underserved areas: Introduce targeted rural deployment incentive schemes including hardship allowances, career development pathways, and housing support to attract and retain nurses in mountain and hill districts with the lowest coverage and highest workforce gaps.

Strengthen and sustain cold chain infrastructure: Continue expanding solar-powered cold chain solutions in facilities lacking reliable electricity, increase cold box and refrigerated container supplies for outreach teams, and institute regular cold chain performance audits led by trained nursing staff.

Include nurses in immunization governance: Formally integrate nurse representatives into Nepal's National Immunization Technical Advisory Group and provincial immunization coordination committees, consistent with ICN and WHO recommendations on nursing participation in immunization governance.

Invest in domestic immunization financing: Progressively increase the domestic government budget allocation for immunization including for nursing workforce costs, cold chain maintenance, and outreach operations to reduce dependence on external donor funding and ensure long-term program sustainability.

Commission nursing-led immunization research: Support generation of high-quality evidence on nursing leadership in immunization through operational research, cost-effectiveness analyses, and implementation science studies to inform evidence-based policy at national and global levels.

Abbreviations

AEFI	Adverse Events Following Immunization
COVID-19	Coronavirus Disease of 2019
GAVI	Global Alliance for Vaccines and Immunization
HPV	Human Papillomavirus
NIP	National Immunization Program

Author Contributions

Parvati Bista: Conceptualization, Methodology, Data Curation, Resources, Writing – original draft

Nabin Raj Joshi: Formal Analysis, Investigation, Writing – review & editing

Conflicts of Interest

The authors declare that there are no conflicts of interest related to this work.

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