JOURNAL OF BIOMEDICAL INVESTIGATION (JBI) VOLUME 13 NUMBER 2: JULY-AUGUST 2025

ENDING MATERNAL AND NEONATAL TETANUS IN THE GLOBAL SOUTH BY 2030: A ONE HEALTH PERSPECTIVE ON ELIMINATION STRATEGIES

Authors:
Ofodile, C. A[1*]., Enitan, S. S[2]., Dada, M. O[2], Iduh, M. U[3]., Digban, K. A[4]., Idume, O. N[5]., Itodo, G. E[6]., Dogonyaro, B. B[7]., Gupta, S[8]., Tsague, M. C. L[9]

Author Affiliations:
[1]Department of Medical Microbiology, Faculty of Medical Laboratory Science, Nnamdi Azikiwe University, Awka. Nigeria.
[2]Department of Medical Laboratory Science, School of Allied Health Sciences, Babcock University, Ilishan-Remo, Ogun State, Nigeria.
[3]Department of Medical Microbiology, School of Medical Laboratory Science, Usmanu Danfodiyo University, Sokoto, Sokoto State Nigeria.
[4]Department of Medical Laboratory Science, College of Medical & Health Sciences, Novena University, Ogume, Kwale, Delta State, Nigeria.
[5]Education Department, Medical Laboratory Science Council of Nigeria FCT-Abuja, Nigeria.
[6]Department of Microbiology, Federal Teaching Hospital, Lokoja, Kogi State, Nigeria.
[7]Division of Virology, Parasitology and Bacteriology, National Veterinary Research Institute Vom, Plateau state, Nigeria.
[8]Department of Biotechnology, Himachal Pradesh University, Summer Hll, Shimla, India.
[9]Department of Public Health, School of Public Health, Douala University, IRAD, 2123, Cameroon.

***Corresponding Author:**
Chukwudi Amaechi Ofodile
Email: ac.ofodile@unizik.edu.ng

ABSTRACT

Maternal and Neonatal Tetanus (MNT) remains a preventable yet persistent cause of mortality in the Global South. Despite major progress since the 1989 WHO initiative, the goal of global elimination by 2030 is threatened by health inequities, fragile systems, and environmental exposure. This review examines MNT elimination through a One Health lens, integrating human, animal, and environmental perspectives to expose hidden transmission pathways and new intervention opportunities. It synthesizes current evidence on immunization, clean birth practices, surveillance, and community engagement,

while highlighting cross-sectoral strategies such as veterinary collaboration, sanitation reform, and environmental hygiene. Drawing lessons from successful elimination programs in India, Uganda, and Senegal, the paper argues that sustainable elimination depends on multisectoral coordination, gender equity, and culturally grounded community ownership. The path to ending MNT by 2030 lies not only in vaccines, but in aligning health systems, environmental management, and social structures under a unified One Health strategy.

This review highlights how integrating One Health principles can accelerate the elimination of maternal and neonatal tetanus in the Global South. It emphasizes cross-sectoral collaboration, community engagement, and innovative technologies as essential components of sustainable, equitable strategies.

Keywords: *Maternal and Neonatal Tetanus, One Health; Global South, Tetanus Elimination, Immunization Coverage, Clean Birth Practices, Environmental Health*

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

INTRODUCTION

Tetanus, caused by *Clostridium tetani*, is an acute and frequently fatal infection marked by severe neuromuscular dysfunction[1-3]. Among its forms, Maternal and Neonatal Tetanus (MNT) stands out as both highly preventable and deeply inequitable[4]. Neonatal tetanus typically follows unsterile cord cutting or application of contaminated substances such as ash or dung[5,6], while maternal tetanus arises from unhygienic obstetric or abortion practices[7-9]. Without prompt care, case-fatality rates remain above 80% in many low-resource settings[10,11].

Women in many regions still give birth outside formal health facilities, often in unsanitary environments, and may rely on unsafe traditional methods for postpartum care[12,13]. The incidence of maternal tetanus is strongly correlated with access to quality obstetric care, family planning services, and safe abortion—all of which are unevenly distributed and often subject to sociopolitical and religious constraints[14]. In patriarchal settings, women's limited mobility, decision-making power, and economic dependence further hinder timely access to preventive and curative care[15-18].

Despite widespread vaccine availability, MNT persists where social vulnerability, gender inequity, and fragile health systems intersect[19]. In 2018, an estimated 25 000 newborns died from neonatal tetanus—a dramatic decline from 787 000 in 1988, yet a reminder that progress is uneven[20,21]. Most deaths occur in low- and middle-income countries (LMICs) of sub-Saharan Africa, South Asia, and parts of Southeast Asia and Latin America. These regions are often characterized by limited health infrastructure, economic instability, and inequities in healthcare access[22-26].
The WHO's Maternal and Neonatal Tetanus Elimination (MNTE) initiative, launched in 1989, set an ambitious 1995 goal that spurred global mobilization[27-29]. By 2023, 52 of 59 priority countries had reached the elimination threshold of < 1 neonatal tetanus case per 1 000 live births per district per year[30]. Yet 12 countries—mainly in Africa

and Asia—remain endemic[31,32]. Persistent insecurity, poor immunization coverage, and weak health infrastructure threaten to stall momentum.

Achieving a proposed global elimination target by 2030 will require more than continued biomedical interventions[33]. MNT transmission occurs at the intersection of human behaviour, environmental contamination, and animal reservoirs—factors inadequately addressed by conventional health approaches[34]. Thus, the path to zero cases requires a One Health perspective—recognizing the ecological and social environment as inseparable from human health. This review critically synthesizes existing literature on MNT control through that framework. It examines disease trends and transmission pathways; assesses the effectiveness of vaccination, surveillance, and cross-sectoral initiatives; and proposes actionable strategies and policy priorities for achieving elimination by 2030.

Global Epidemiology and Burden of MNT

The global burden of non-neonatal tetanus is likely significantly underreported, as evidenced by inconsistent incidence and mortality estimates (Figure 1). While only 21,830 cases were officially reported to WHO in 2023, disease modelling suggests the true annual mortality from tetanus ranges between 30,000 and 50,000 deaths[18,34]. This disparity stems from underreporting in countries where tetanus is not a notifiable disease, as well as surveillance systems that emphasize mortality and overlook survivors requiring intensive care.

Over the past three decades, coordinated immunization and maternal-health initiatives have reduced MNT mortality by over 95%[19-21,35]. From nearly 800 000 neonatal deaths in 1988, the toll declined to approximately 25 000 by 2024[36]. More than 85 countries have validated elimination status, including India (2015), Indonesia (2016), Ethiopia (2017), and the Democratic Republic of Congo (2022)[37,38]. Yet a cluster of high-burden nations—Afghanistan, Angola, Central African Republic, Guinea, Mali, Nigeria, Pakistan, Papua New Guinea, Somalia, South Sudan, Sudan, and Yemen—still report cases[39].

These residual foci share structural fragility: conflict, humanitarian crises, low vaccine coverage, and shortages of skilled birth attendants[40]. Neonatal tetanus continues to drive neonatal mortality in many of these contexts, while maternal tetanus remains under-recognized due to weak surveillance and gender-blind reporting[41].

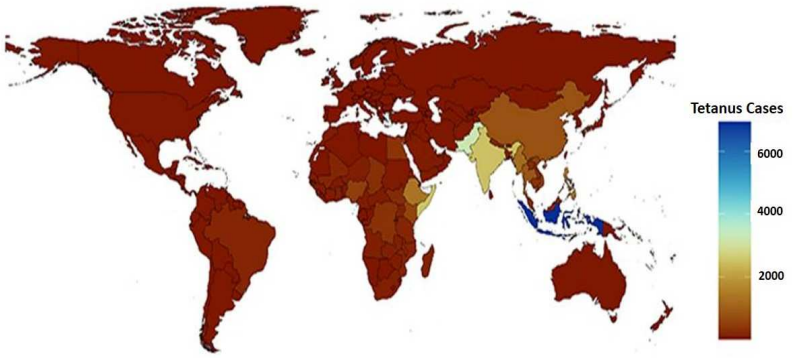

Figure 1: Global Tetanus Cases in patients aged ≥20 in 2021 [18].

New cases of tetanus in adults aged ≥20 in 2021. Differing case burden may reflect unequal reporting and can therefore under-represent certain regions

Table 1: Global and regional Trends in MNT[19-22,42]

Region/ Country Group	MNT Status (2000)	MNT Status (2024)	% Reduction in Neonatal Deaths	Key Drivers of Progress
Global	~170,000 neonatal deaths annually	~25,000 neonatal deaths annually	~85%	Expanded TTCV campaigns, SIAs, improved clean birth practices
Sub-Saharan Africa	High endemicity	8 countries remain non-eliminated (e.g., Nigeria, Mali, Chad)	~70%	Targeted campaigns, TBA training, community outreach
South Asia	Moderate-high burden	Eliminated in India (2015); Pakistan near elimination	~90%	Integration with maternal health, strong political commitment
Southeast Asia	Moderate burden	Most countries eliminated (e.g., Indonesia 2016)	~85%	Facility deliveries, birth kits, improved hygiene
Latin America and Caribbean	Mostly eliminated	All countries eliminated as of 2020	>95%	Strong regional coordination, urban health systems
Middle East/North Africa	Patchy elimination	Some countries still at risk due to instability (e.g., Yemen)	~75%	Vaccination drives, NGO support
High-Income Countries	Eliminated by 1990s	Sustained elimination	~100%	Robust EPI, institutional deliveries

Table 2: Global Status of MNT Elimination (as of 2024)[19.20,22]

Country	WHO Region	MNT Elimination Status	Year of Elimination
Afghanistan	EMRO	Not Eliminated	–
Angola	AFRO	Not Eliminated	–
Benin	AFRO	Eliminated	2011
Burkina Faso	AFRO	Eliminated	2011
Cameroon	AFRO	Eliminated	2013
Central African Republic	AFRO	Not Eliminated	–
Chad	AFRO	Eliminated	2017
Côte d'Ivoire	AFRO	Eliminated	2011
Democratic Republic of Congo	AFRO	Eliminated	2022
Ethiopia	AFRO	Eliminated	2017
Guinea	AFRO	Not Eliminated	–
India	SEARO	Eliminated	2015
Indonesia	SEARO	Eliminated	2016
Kenya	AFRO	Eliminated	2018
Liberia	AFRO	Eliminated	2015
Mali	AFRO	Not Eliminated	–
Mozambique	AFRO	Eliminated	2017
Nepal	SEARO	Eliminated	2005
Nigeria	AFRO	Not Eliminated	–
Pakistan	EMRO	Not Eliminated	–
Papua New Guinea	WPRO	Not Eliminated	–
Senegal	AFRO	Eliminated	2012
Sierra Leone	AFRO	Eliminated	2012
Somalia	EMRO	Not Eliminated	–
South Sudan	AFRO	Not Eliminated	–
Sudan	EMRO	Not Eliminated	–
Tanzania	AFRO	Eliminated	2018
Togo	AFRO	Eliminated	2012
Uganda	AFRO	Eliminated	2011
Yemen	EMRO	Not Eliminated	–
Zambia	AFRO	Eliminated	2007
Zimbabwe	AFRO	Eliminated	2013

Determinants and Pathways of Transmission

Maternal and neonatal tetanus (MNT) arises from infection by *Clostridium tetani*, a Gram-positive, spore-forming anaerobe ubiquitous in soil, dust, and animal faeces[1,2]. The spores can persist for years and germinate in necrotic tissue where oxygen tension is low, releasing the potent neurotoxin tetanospasmin[3,4]. This toxin blocks inhibitory neurotransmitters—gamma-aminobutyric acid (GABA) and glycine—causing the characteristic rigidity and spasms of tetanus[1,5]. Neonatal infection typically follows contamination of the umbilical cord through non-sterile cutting instruments or the application of traditional substances such as dung, ash, or oil[5-7]. Maternal cases occur after unsafe delivery or abortion using contaminated tools or unsterile conditions[2,4,7]. Both conditions are entirely preventable through vaccination and clean delivery practices (Figure 2).

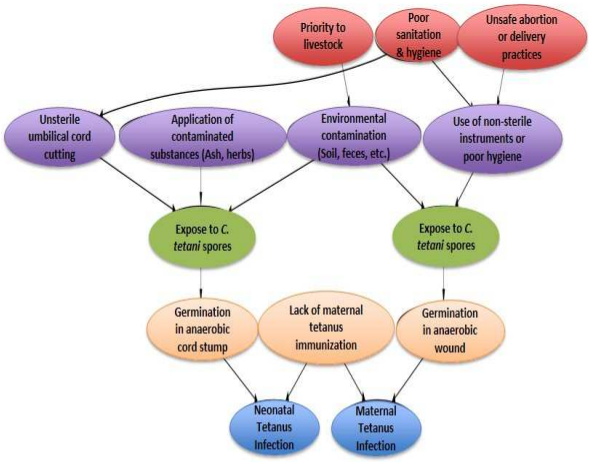

Figure 2: **Flow chart Illustrating MNT Transmission Pathways (*Image Credit:* Enitan, S. S.)**

The Role of Surveillance in combatting MNT

Surveillance for MNT remains a challenge in many countries, particularly for maternal cases, which are frequently underdiagnosed and underreported. Neonatal tetanus is often not recorded unless death occurs in a health facility, leading to substantial underestimation of its true burden. WHO and UNICEF recommend community-based surveillance and verbal autopsies, but implementation varies widely. Improving surveillance is essential not only for tracking progress but also for identifying geographic and demographic pockets of vulnerability. Investment in digital reporting systems, mobile health tools, and community health worker networks can enhance case detection and enable more rapid response to outbreaks[43,44].

The One Health Framework

The One Health approach (Figure 3) recognizes the interdependence of human, animal, and environmental health[45]. Though *C. tetani* is not zoonotic, its ecological persistence is strongly influenced by animal and environmental factors. Livestock excreta enrich soil spore loads; inadequate waste management and poor sanitation magnify exposure risk[46]. In many rural communities, women give birth near animal shelters or on bare ground, where umbilical stumps are exposed to contaminated soil and faeces.

Environmental sanitation plays a critical but underemphasized role in breaking MNT transmission. Poor waste disposal, open defecation, and stagnant water create conditions that sustain tetanus spores. A One Health strategy promotes improvements in livestock management, environmental hygiene, and cross-sector collaboration among ministries of health, agriculture, and environment[47].

In Uganda's Karamoja region, a One Health pilot linked veterinary services with maternal health programs. Joint training for veterinarians and midwives emphasized hygiene, clean birthing spaces, and co-delivery of vaccines for livestock and humans—strengthening community trust and reducing neonatal infections[47]. Similarly, in Nepal, integration of geospatial livestock density data into risk mapping guided distribution of clean birth kits to high-risk villages[48].

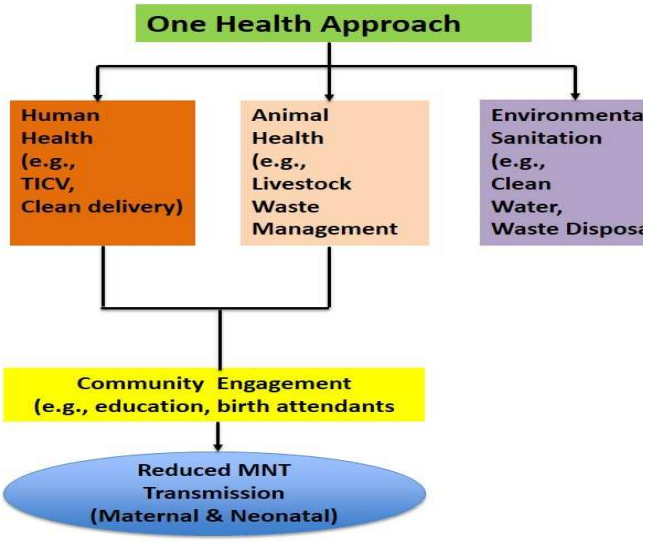

Figure 3: Flow chart illustrating One Health Framework in combatting MNT (*Image Credit:* Enitan, S. S.)

Strategies for Sustainable Elimination

Tetanus toxoid-containing vaccines (TTCVs) remain the cornerstone of prevention[49]. WHO recommends at least two doses for women of reproductive age, supplemented by routine immunization and periodic Supplementary Immunization Activities (SIAs)[50]. Despite proven efficacy, barriers such as inadequate cold chain systems, supply chain disruptions, and vaccine hesitancy persist. Innovative delivery models, including mobile outreach and linking immunization with antenatal care, have shown success in increasing uptake (Table 3)[49,50].

Hygienic delivery practices are equally vital. The WHO Clean Birth Checklist has improved infection control, but adoption remains inconsistent[48]. Training and integrating Traditional Birth Attendants (TBAs) into formal health systems, and incentivizing facility-based deliveries through infrastructure investment, have proven effective. Clean birth kits and supportive supervision are essential in low-resource settings.

Surveillance systems remain a weak point. Passive case detection underreports community cases, whereas mobile health (mHealth) tools enable real-time data reporting and rapid response[51]. Cross-sectoral interventions addressing sanitation, animal waste management, and WASH programs are integral[52]. Community engagement remains central, with behavioural change campaigns and gender-sensitive approaches critical for sustainability[50].

Table 3: Strategic Interventions for MNT Elimination[49,50]

Strategy	Core Components	Key Challenges	Examples of Successful Implementation
Immunization Programs	- TTCV for women of reproductive age	- Cold chain limitations	- Bangladesh: Outreach + mobile teams improved rural TTCV uptake
	- SIAs	- Supply chain disruptions	- Uganda: Use of CHWs to trace unvaccinated women
	- Integration with ANC visits	- Vaccine hesitancy	
Clean Birth Practices	- WHO Clean Birth Checklist	- Limited access to facilities	- India: Clean Birth Kit distribution in Uttar Pradesh
	- Distribution of Clean Birth Kits	- Poor TBA integration	- Nigeria: TBA training programs with referral incentives
	- Skilled Birth Attendance (SBA) promotion	- Inadequate training and supervision	
Surveillance Systems	- Active case detection	- Underreporting in remote areas	- Kenya: SMS-based reporting in rural counties
	- Community reporting networks	- Poor data infrastructure	- Nepal: Community health volunteers using mobile dashboards
	- mHealth tools	- Data privacy and tech access	
Cross-Sectoral Interventions	- Environmental sanitation	- Siloed sectoral planning	- Ethiopia: Health-Agriculture collaboration for safe birthing environments
	- Livestock waste management	- Resource competition	- Nepal: Village WASH + veterinary campaigns
	- Inter-ministerial coordination	- Lack of joint monitoring indicators	
Community Engagement	- BCC campaigns	- Gender norms limiting autonomy	- Senegal: Religious leader inclusion in maternal health advocacy
	- Engagement of male household heads	- Low health literacy	- Pakistan: Radio drama promoting safe cord care practices
	- School and youth education programs	- Resistance to behaviour change	

Challenges and Barriers

Despite decades of global effort, persistent structural and operational barriers continue to undermine elimination in many low- and middle-income countries[18,19]. Weak health systems, workforce shortages, gender inequality, and insecurity remain critical challenges[28,33]. Poor coordination between sectors, logistical constraints, and vaccine hesitancy exacerbate the problem[19,49]. Overreliance on donor funding and inadequate surveillance create fragility that threatens sustainability[52,53].

Opportunities in Elimination of MNT

The evolving global health landscape presents numerous opportunities to accelerate the elimination of maternal and neonatal tetanus (MNT), particularly through the strategic use of technological, financial, and systemic innovations (Figure 4). Emerging technologies offer new hope for MNT elimination. Artificial Intelligence and geospatial analytics help identify tetanus hotspots by integrating data on vaccination coverage, sanitation, and livestock density[54]. Mobile health (mHealth) platforms revolutionize surveillance and maternal follow-up by enabling community health workers to report suspected cases via SMS[33]. Drone-based delivery of vaccines in Rwanda and Ghana bypasses infrastructure gaps, while innovative financing models such as Results-Based Financing (RBF) and public–private partnerships improve program sustainability[55-59].

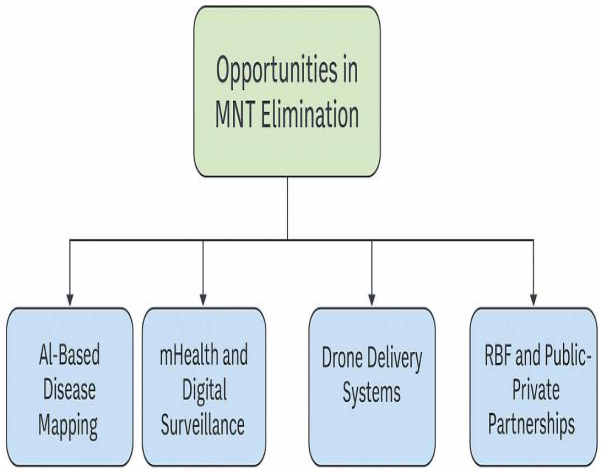

Figure 3: Flow chart illustrating opportunities in MNT elimination (Image Credit: Enitan, S. S.)

Case Studies of MNT Elimination and Lessons Learnt

The global fight against Maternal and Neonatal Tetanus (MNT) has yielded notable success stories, particularly from countries that have implemented integrated, context-specific strategies (Table 4). These examples underscore the importance of strong political commitment, cross-sectoral coordination, and community-based interventions. Conversely, countries still grappling with MNT highlight the persistent structural and operational challenges that hinder elimination efforts[54].

India:

India officially achieved MNT elimination in 2015, marking a major milestone for a country with vast geographic and socio-economic diversity. Key to this success was the integration of tetanus toxoid vaccination

into routine maternal and child health programs and the use of Supplementary Immunization Activities (SIAs) in hard-to-reach areas. The country leveraged Accredited Social Health Activists (ASHAs) to conduct extensive community outreach, promote facility-based deliveries, and distribute clean birth kits. India's experience illustrates the power of decentralized, incentive-driven workforce models and sustained political prioritization[51,52].

Uganda:

Uganda achieved MNT elimination in 2011, building upon a robust community health strategy. The Village Health Team (VHT) model enabled the delivery of health education and vaccination at the household level. In rural areas, TBAs were trained and gradually integrated into formal maternal health systems, ensuring continuity of clean birth practices. Uganda's emphasis on local ownership, coupled with support from international partners, fostered high immunization coverage and culturally appropriate outreach[53,54].

Senegal:

Senegal combined routine immunization with maternal education campaigns and health infrastructure development to reach MNT elimination status in 2012. A distinctive feature of Senegal's approach was the deployment of mobile health clinics to remote regions and the use of public-private partnerships for vaccine distribution. The country also invested in training midwives and TBAs in WHO's Clean Birth Checklist protocols, thereby ensuring safe delivery practices across diverse settings[58].

Despite substantial efforts, countries like Nigeria and Somalia continue to struggle with MNT elimination due to a combination of insecurity, fragile health systems, and limited community trust in government-led programs. In Nigeria, disparities in vaccination coverage between urban and rural populations remain a major hurdle. Conflict in the northeast further complicates service delivery and surveillance. Somalia faces even more profound difficulties, with sustained conflict, political instability, and limited access to maternal health services hindering both immunization and clean birth initiatives. These cases underscore the need for conflict-sensitive health strategies and stronger cross-sectoral collaboration, particularly in fragile states[59].

Table 4: Case Studies of MNT Elimination and Lessons Learnt[52-56]

Country	Elimination Status	Key Interventions	Challenges Overcome	Key Takeaway Lessons
India	Achieved in 2015	- SIAs in underserved areas - Use of ASHAs for outreach - Clean birth kits	- Large, diverse population - Low access in remote rural areas	Decentralized community healthcare workers and political commitment ensure wide coverage.
Uganda	Achieved in 2011	- Village Health Teams (VHTs) - Integration of TBAs - Routine TTCV via ANC	- Limited health infrastructure - Rural cultural practices	Community-based health structures can bridge gaps in rural maternal care.
Senegal	Achieved in 2012	- Mobile clinics in remote areas - Public-private vaccine delivery - Midwife/TBA training	- Geographic isolation - Inconsistent service delivery	Mobile outreach and PPPs improve equity in access.
Nigeria	*Not yet achieved*	- Partial immunization efforts - Targeted campaigns in high-risk states	- Regional conflict - Vaccine hesitancy - Weak surveillance	Conflict-sensitive planning and trust-building are critical in fragile settings.
Somalia	*Not yet achieved*	- Minimal MNT programming - NGO-led services in some regions	- Armed conflict - Political instability - Low health system capacity	State fragility demands humanitarian health solutions with NGO and global support.

Policy and Implementation Recommendations

To sustainably eliminate maternal and neonatal tetanus (MNT), countries must adopt integrated, evidence-based policies that leverage the One Health approach and align with broader global health goals. The following recommendations provide a roadmap for national governments, international partners, and community stakeholders[54,55]:

1. **Develop and Fund National Action Plans with One Health Integration**
   Governments should create or revise national MNT elimination strategies to explicitly incorporate One Health principles—recognizing the intersections between human, animal, and environmental health. These plans must be adequately financed, locally adaptable, and grounded in cross-sectoral collaboration between ministries of health, agriculture, environment, and education[58].
2. **Embed MNT Targets in SDG and UHC Frameworks**
   MNT elimination efforts should be formally integrated into national commitments to the Sustainable Development Goals (SDGs)—especially SDG 3 on good health and well-being—and Universal Health Coverage (UHC). This alignment ensures long-term accountability and leverages existing funding and monitoring infrastructure to advance MNT objectives[59].
3. **Strengthen Health Systems and Maternal Care Platforms**
   Routine immunization, antenatal care, and safe delivery services must be expanded and made accessible, particularly in remote and underserved areas. Investment in health worker training, clean birth kits, cold chain management, and mobile clinics will be essential to address operational gaps[60].
4. **Prioritize Community-Driven and Culturally Appropriate Approaches**
   Community engagement should guide implementation strategies. Empowering local leaders, traditional birth attendants (TBAs), and women's groups can enhance uptake of vaccines and clean delivery practices. Tailored behavior change communication (BCC) strategies should address harmful traditional practices and promote safe maternal health behaviors[60].
5. **Monitor One Health Implementation with Clear Indicators**
   To ensure accountability, countries should establish standardized indicators to monitor and evaluate the integration of One Health in MNT programs. Metrics might include cross-sectoral coordination frequency, environmental contamination levels near birth sites, and vaccination coverage among at-risk populations[61].
6. **Invest in Research and Local Capacity Building**
   Support for operational research, health systems innovation, and local workforce development is vital. Collaborations with academic institutions and civil society can foster

sustainable, context-specific solutions to emerging MNT challenges[56,60,61].

Unanswered questions seeking answers

1. How can we accurately measure MNT incidence in remote and conflict-affected areas? Underreporting due to weak surveillance systems, lack of vital registration, and logistical barriers in hard-to-reach or insecure regions. Expand community-based active surveillance**,** invest in mobile health technologies, and partner with humanitarian organizations to gather real-time data in fragile contexts.
2. What is the optimal model for integrating Traditional Birth Attendants (TBAs) into formal health systems? TBAs are often trusted in communities but lack formal medical training, leading to variable outcomes in clean delivery practices. Develop standardized training and certification programs**,** link TBAs with health facilities, and incorporate them into maternal incentive schemes for referrals and clean birth promotion.
3. How do environmental factors like livestock density and sanitation interact with tetanus transmission? Limited empirical data on the role of animal waste and environmental contamination in sustaining tetanus spores in birth environments. Support One Health field studies to map risk factors and inform cross-sectoral interventions in high-risk rural settings.
4. Why do immunization coverage gaps persist despite vaccine availability? Barriers include vaccine stock-outs, cold chain breakdowns, gender-based restrictions on healthcare access, and misinformation. Strengthen logistics and supply chains**,** empower female healthcare workers, and implement locally tailored behavioural change campaigns**.**
5. What are the long-term effects of combining MNT campaigns with other maternal-child health programs? While integration improves efficiency, it's unclear whether it dilutes focus or increases impact. Conduct longitudinal evaluations of integrated health programs to assess sustainability, coverage, and quality of MNT services over time.
6. How can data privacy be ensured in mobile and AI-based surveillance for MNT? Ethical concerns around patient confidentiality, especially in settings lacking robust digital health governance. Establish clear data protection protocols**,** build capacity among local healthcare workers, and use de-identified data systems in digital MNT platforms.
7. What are the most cost-effective financing mechanisms for sustaining MNT elimination? Donor fatigue and national budget constraints make long-term funding uncertain. Explore Results-Based Financing (RBF)**,** public-private partnerships, and integrate MNT into **national**

health insurance schemes and SDG-aligned investment plans.

CONCLUSION

Ending maternal and neonatal tetanus by 2030 is both achievable and urgent. Despite decades of progress, tens of thousands of preventable deaths persist each year. A One Health approach offers a comprehensive, sustainable framework—bridging human, animal, and environmental health to tackle the roots of transmission. The successes of India, Uganda, and Senegal demonstrate that elimination is possible even in resource-limited settings when political commitment, community engagement, and cross-sectoral collaboration converge. To meet the 2030 target, governments and partners must act decisively: fund One Health–based plans, integrate MNT with maternal and child health initiatives, and leverage technology and gender equity as enablers of change. MNT elimination will not be achieved in laboratories or ministries alone—it will be realized in communities that safeguard every mother and newborn from a preventable tragedy.

Key Research Highlights

1. This review emphasized that maternal and neonatal tetanus is not solely a medical issue—it is also driven by environmental contamination, animal waste exposure, and traditional practices. By framing MNT within the One Health paradigm**,** the paper highlights how cross-sectoral collaboration (human, animal, environmental health) is crucial to sustainable elimination**.**
2. Community engagement and culturally tailored behavior change strategies significantly improve vaccine uptake and clean delivery practices. However, these approaches are often underfunded and sidelined in favor of clinical interventions, despite their proven cost-effectiveness and impact on behavioral norms.
3. Emerging tools like AI-based disease mapping, drone-assisted vaccine delivery, and mHealth platforms offer new pathways to bridge logistical and surveillance gaps. Yet, their deployment remains uneven across socio-economic and geographical lines**,** calling for inclusive implementation frameworks that prioritize accessibility and ethical safeguards.

Abbreviations

MNT - Maternal and Neonatal Tetanus
NT - Neonatal Tetanus
MT - Maternal Tetanus
WHO - World Health Organization
UNICEF - United Nations Children's Fund
TTCV - Tetanus Toxoid-Containing Vaccine
SIA - Supplementary Immunization Activity
TBA - Traditional Birth Attendant
UHC - Universal Health Coverage
SDG - Sustainable Development Goal
LMIC - Low- and Middle-Income Country
mHealth - Mobile Health
RBF - Results-Based Financing
AI - Artificial Intelligence
GIS - Geographic Information System
WASH - Water, Sanitation, and Hygiene

EPI - Expanded Programme on Immunization
CSO - Civil Society Organization
NGO - Non-Governmental Organization
ANC - Antenatal Care
CHW - Community Health Worker
PHC - Primary Health Care
GHSA - Global Health Security Agenda
NHP - National Health Policy
HIS - Health Information System

Ethical approval
Not applicable.

Informed Consent
Not applicable.

Competing Interests
The authors declare no competing interests.

Data Availability
Not applicable

Conflict of Interest
There is no conflict of interest reported by the authors.

Funding
None

Author contribution
Research concept and design: CAO & SSE; Literature search: CAO, SSE, MOD, MUI, KAD, ONI, GEI, BBD, SG & TMCL; Writing of the first draft of the manuscript: CAO, SSE, MOD, MUI, & KAD; Critical revision of the manuscript for intellectual content: CAO, SSE, ONI, GEI, BBD, SG & TMCL; Final approval of the manuscript: All authors gave final approval of the manuscript

REFERENCES

1. Faqih F, Aritiah MA, Solihatin I, Afifah F, Faranajhia H, Wicaksono TB, Irmayanto T. Getting to Know More about Tetanus. PROMOTOR. 2025 Jun 2;8(3):346-51. https://doi.org/10.32832/pro.v8i3.1188
2. Karna P, Thakur AK. Tetanus–a lethal and neglected infectious disease. Annals of Medicine and Surgery. 2025 Jul 1;87(7):4567-9. https://doi.org/10.1097/MS9.0000000000003407
3. Afshar M, Raju M, Ansell D, Bleck TP. Narrative review: tetanus—a health threat after natural disasters in developing countries. Annals of internal medicine. 2011 Mar 1;154(5):329-35. https://doi.org/10.7326/0003-4819-154-5-201103010-00007
4. Stock I. Tetanus and Clostridium tetani--a brief review. Medizinische Monatsschrift fur Pharmazeuten. 2015 Feb 1;38(2):57-60.
5. Zahra FA, Sugianto P. Severe Tetanus In Elderly With Minor Wound: A Case Report. International Journal of Environmental Sciences. 2025 Jun 24:392-6. https://doi.org/10.64252/qdc0rv11
6. Stopyra L, Kozłowski J, Żaczek B, Kamińska A. Case of Tetanus with Streptococcus Pyogenes Superinfection in a Thirteen-Year-Old Boy with Unknown Vaccination History: A Diagnostic and Therapeutic Study. Journal of Education, Health and Sport. 2025

Mar 6;79:58144-. https://doi.org/10.12775/JEHS.2025.79.58144.

7. Abdolmohammadi Khiav L, Zahmatkesh A. Major pathogenic Clostridia in human and progress toward the clostridial vaccines Iran J Basic Med Sci. 2022 Sep;25(9):1059-1068. doi: 10.22038/IJBMS.2022.65518.14417.
8. Kamath GD, Kukreja S, Mukherjee P, Kolhapure S, Sathyanarayanan S. Maternal immunization: trends in South and Southeast Asian countries J Matern Fetal Neonatal Med. 2022 Dec;35(25):8372-8381. doi: 10.1080/14767058.2021.1974389. Epub 2021 Sep 13.
9. Sobanjo-Ter Meulen A, Abramson J, Mason E, Rees H, Schwalbe N, Bergquist S, Klugman KP. Path to impact: A report from the Bill and Melinda Gates Foundation convening on maternal immunization in resource-limited settings; Berlin - January 29-30, 2015 Vaccine. 2015 Nov 25;33(47):6388-95. doi: 10.1016/j.vaccine.2015.08.047. Epub 2015 Aug 24.
10. Abu-Raya B, Maertens K, Edwards KM, Omer SB, Englund JA, Flanagan KL, Snape MD, Amirthalingam G, Leuridan E, Damme PV, Papaevangelou V, Launay O, Dagan R, Campins M, Cavaliere AF, Frusca T, Guidi S, O'Ryan M, Heininger U, Tan T, Alsuwaidi AR, Safadi MA, Vilca LM, Wanlapakorn N, Madhi SA, Giles ML, Prymula R, Ladhani S, Martinón-Torres F, Tan L, Michelin L, Scambia G, Principi N, Esposito S. Global Perspectives on Immunization During Pregnancy and Priorities for Future Research and Development: An International Consensus Statement Front Immunol. 2020 Jun 24;11:1282. doi: 10.3389/fimmu.2020.01282. eCollection 2020.
11. Kolsuz S, Güllü D, Karahan KD, Ergönül Ö. Risk factors and preventive role of vaccination in adult tetanus fatality: a systematic review of reported cases (1990-2024) and meta-analysis. International Journal of Infectious Diseases. 2025 Jan 13:107781. https://doi.org/10.1016/j.ijid.2025.107781
12. Zambrano B, Peterson J, Deseda C, Julien K, Spiegel CA, Seyler C, Simon M, Hoki R, Anderson M, Brabec B, Áñez G, Shi J, Pan J, Hagenbach A, Von Barbier D, Varghese K, Jordanov E, Dhingra MS. Quadrivalent meningococcal tetanus toxoid-conjugate booster vaccination in adolescents and adults: phase III randomized study Pediatr Res. 2023 Sep;94(3):1035-1043. doi: 10.1038/s41390-023-02478-5. Epub 2023 Mar 10.
13. Dhingra MS, Namazova-Baranova L, Arredondo-Garcia JL, Kim KH, Limkittikul K, Jantarabenjakul W, Perminova O, Kobashi IAR, Bae CW, Ojeda J, Park J, Chansinghakul D, B'Chir S, Neveu D, Bonaparte M, Jordanov E. Immunogenicity and

safety of a quadrivalent meningococcal tetanus toxoid-conjugate vaccine administered concomitantly with other paediatric vaccines in toddlers: a phase III randomised study Epidemiol Infect. 2021 Apr 5;149:e90. doi: 10.1017/S0950268821000698.

14. Nolan T, Booy R, Marshall HS, Richmond P, Nissen M, Ziegler JB, Baine Y, Traskine M, Jastorff A, Van der Wielen M. Immunogenicity and Safety of a Quadrivalent Meningococcal ACWY-tetanus Toxoid Conjugate Vaccine 6 Years After MenC Priming as Toddlers Pediatr Infect Dis J. 2019 Jun;38(6):643-650. doi: 10.1097/INF.0000000000002334.
15. Yamoah P, Bangalee V, Oosthuizen F. A review of the safety of vaccines used in routine immunization in Africa Afr Health Sci. 2020 Mar;20(1):227-237. doi: 10.4314/ahs.v20i1.28.
16. Ayouni I, Amponsah-Dacosta E, Noll S, Kagina BM, Muloiwa R. Interventions to Improve Knowledge, Attitudes, and Uptake of Recommended Vaccines during Pregnancy and Postpartum: A Scoping Review Vaccines (Basel). 2023 Nov 21;11(12):1733. doi: 10.3390/vaccines11121733.
17. Alhassan JAK, Wariri O, Onuwabuchi E, Mark G, Kwarshak Y, Dase E. Access to skilled attendant at birth and the coverage of the third dose of diphtheria-tetanus-pertussis vaccine across 14 West African countries - an equity analysis Int J Equity Health. 2020 Jun 1;19(1):78. doi: 10.1186/s12939-020-01204-5.
18. Sudarshan R, Sayo AR, Renner DR, de Saram S, Godbole G, Warrell C, Duong HT, Thwaites CL, Mehta AR, Coughlan C. Tetanus: recognition and management. The Lancet Infectious Diseases. 2025 Jun 18. https://doi.org/10.1016/S1473-3099(25)00292-0
19. Venturini E, Piccini P, Tersigni C, Chiappini E, Galli L. Systematic review shows that immunising internationally adopted children is a major challenge for primary health care Acta Paediatr. 2019 Mar;108(3):411-418. doi: 10.1111/apa.14625. Epub 2018 Nov 19.
20. Jain M, Shisler S, Lane C, Bagai A, Brown E, Engelbert M, Vardy Y, Eyers J, Leon DA, Parsekar SS. Use of community engagement interventions to improve child immunisation in low- and middle-income countries: A systematic review and meta-analysis Campbell Syst Rev. 2022 Jul 27;18(3):e1253. doi: 10.1002/cl2.1253. eCollection 2022 Sep.
21. Abdullahi LH, Kagina BM, Ndze VN, Hussey GD, Wiysonge CS. Improving vaccination uptake among adolescents Cochrane Database Syst Rev. 2020 Jan 17;1(1):CD011895. doi: 10.1002/14651858.CD011895.pub2.

22. Ortiz JR, Perut M, Dumolard L, Wijesinghe PR, Jorgensen P, Ropero AM, Danovaro-Holliday MC, Heffelfinger JD, Tevi-Benissan C, Teleb NA, Lambach P, Hombach J. A global review of national influenza immunization policies: Analysis of the 2014 WHO/UNICEF Joint Reporting Form on immunization Vaccine. 2016 Oct 26;34(45):5400-5405. doi: 10.1016/j.vaccine.2016.07.045. Epub 2016 Sep 16.
23. Blakney AK, Tchakoute CT, Hesseling AC, Kidzeru EB, Jones CE, Passmore JA, Sodora DL, Gray CM, Jaspan HB. Delayed BCG vaccination results in minimal alterations in T cell immunogenicity of acellular pertussis and tetanus immunizations in HIV-exposed infants Vaccine. 2015 Sep 11;33(38):4782-9. doi: 10.1016/j.vaccine.2015.07.096. Epub 2015 Aug 7.
24. Gera T, Shah D, Garner P, Richardson M, Sachdev HS. Integrated management of childhood illness (IMCI) strategy for children under five Cochrane Database Syst Rev. 2016 Jun 22;2016(6):CD010123. doi: 10.1002/14651858.CD010123.pub2.
25. Bura VK, Srivastava R, Chawla AK, Njambe TOE, Khanal S, Sangal L, Jha S, Bahl S. Essential programme on immunization in WHO South-East Asia: A five-decade journey of saving millions of lives & ending diseases Indian J Med Res. 2024 Sep&Oct;160(3&4):267-278. doi: 10.25259/IJMR_1527_2024.
26. Hoest C, Seidman JC, Lee G, Platts-Mills JA, Ali A, Olortegui MP, Bessong P, Chandyo R, Babji S, Mohan VR, Mondal D, Mahfuz M, Mduma ER, Nyathi E, Abreu C, Miller MA, Pan W, Mason CJ, Knobler SL; MAL-ED Network Investigators. Vaccine coverage and adherence to EPI schedules in eight resource poor settings in the MAL-ED cohort study Vaccine. 2017 Jan 11;35(3):443-451. doi: 10.1016/j.vaccine.2016.11.075. Epub 2016 Dec 18.
27. Booy R, Nolan T, Reynolds G, Richmond P, Nissen M, Marshall H, Stoney T, Van Der Wielen M, Kolhe D, Miller JM. Five-year Antibody Persistence and Safety After a Single Dose of Combined Haemophilus influenzae Type B Neisseria meningitidis Serogroup C-Tetanus Toxoid Conjugate Vaccine in Haemophilus influenzae Type B-primed Toddlers Pediatr Infect Dis J. 2015 Dec;34(12):1379-84. doi: 10.1097/INF.0000000000000898.
28. Yusuf N, Raza AA, Chang-Blanc D, Ahmed B, Hailegebriel T, Luce RR, Tanifum P, Masresha B, Faton M, Omer MD, Farrukh S, Aung KD, Scobie HM, Tohme RA. Progress and barriers towards maternal and neonatal tetanus elimination in the remaining 12 countries: a systematic review Lancet Glob Health. 2021 Nov;9(11):e1610-e1617. doi: 10.1016/S2214-109X(21)00338-7.

29. Madhi SA, López P, Zambrano B, Jordanov E, B'Chir S, Noriega F, Feroldi E. Antibody persistence in pre-school children after hexavalent vaccine infant primary and booster administration Hum Vaccin Immunother. 2019;15(3):658-668. doi: 10.1080/21645515.2018.1546524. Epub 2019 Jan 31.
30. Davies B, Olivier J, Amponsah-Dacosta E. Health Systems Determinants of Delivery and Uptake of Maternal Vaccines in Low- and Middle-Income Countries: A Qualitative Systematic Review Vaccines (Basel). 2023 Apr 19;11(4):869. doi: 10.3390/vaccines11040869.
31. Dhir SK, Dewan P, Gupta P. Maternal and Neonatal Tetanus Elimination: Where are We Now? Res Rep Trop Med. 2021 Nov 23;12:247-261. doi: 10.2147/RRTM.S201989. eCollection 2021.
32. Brillo E, Tosto V, Giardina I, Buonomo E. Maternal tetanus, diphtheria, and acellular pertussis (Tdap) and influenza immunization: an overview J Matern Fetal Neonatal Med. 2021 Oct;34(20):3415-3444. doi: 10.1080/14767058.2019.1680633. Epub 2019 Oct 24.
33. Yusuf N, Steinglass R, Gasse F, Raza A, Ahmed B, Blanc DC, Yakubu A, Gregory C, Tohme RA. Sustaining Maternal and Neonatal Tetanus Elimination (MNTE) in countries that have been validated for elimination - progress and challenges BMC Public Health. 2022 Apr 8;22(1):691. doi: 10.1186/s12889-022-13110-2.
34. Desta M, Akalu TY, Alamneh YM, Talie A, Alemu AA, Tessema Z, Yibeltal D, Alamneh AA, Ketema DB, Shiferaw WS, Getaneh T. Perinatal mortality and its association with antenatal care visit, maternal tetanus toxoid immunization and partograph utilization in Ethiopia: a meta-analysis Sci Rep. 2021 Oct 4;11(1):19641. doi: 10.1038/s41598-021-98996-5.
35. Woldeamanuel YW, Andemeskel AT, Kyei K, Woldeamanuel MW, Woldeamanuel W. Case fatality of adult tetanus in Africa: Systematic review and meta-analysis J Neurol Sci. 2016 Sep 15;368:292-9. doi: 10.1016/j.jns.2016.07.025. Epub 2016 Jul 14.
36. Liu S, Wang CL, Wang HB, Liu C, Li XY, Xiong H. [Meta-analysis on tetanus antibody protection rate of healthy population born after 1978 in China] Zhonghua Yu Fang Yi Xue Za Zhi. 2020 Feb 6;54(2):203-208. doi: 10.3760/cma.j.issn.0253-9624.2020.02.017.
37. Oyo-Ita A, Wiysonge CS, Oringanje C, Nwachukwu CE, Oduwole O, Meremikwu MM. Interventions for improving coverage of childhood immunisation in low- and middle-income countries Cochrane Database Syst Rev. 2016 Jul

10;7(7):CD008145. doi: 10.1002/14651858.CD008145.pub3.

38. Yen LM, Thwaites CL. Tetanus Lancet. 2019 Apr 20;393(10181):1657-1668. doi: 10.1016/S0140-6736(18)33131-3. Epub 2019 Mar 29.
39. Megighian A, Pirazzini M, Fabris F, Rossetto O, Montecucco C. Tetanus and tetanus neurotoxin: From peripheral uptake to central nervous tissue targets J Neurochem. 2021 Sep;158(6):1244-1253. doi: 10.1111/jnc.15330. Epub 2021 Mar 14.
40. Finkelstein P, Teisch L, Allen CJ, Ruiz G. Tetanus: A Potential Public Health Threat in Times of Disaster Prehosp Disaster Med. 2017 Jun;32(3):339-342. doi: 10.1017/S1049023X17000012. Epub 2017 Feb 20.
41. Alshanqiti FM, Al-Masaudi SB, Al-Hejin AM, Redwan EM. Adjuvants for *Clostridium tetani* and *Clostridium diphtheriae* vaccines updating Hum Antibodies. 2017;25(1-2):23-29. doi: 10.3233/HAB-160302.
42. Khoury A, Cahill JD. Tetanus Vaccination 2020 and Collateral Protections against Pertussis and Diphtheria R I Med J (2013). 2020 Aug 3;103(6):38-40.
43. Meregildo-Rodriguez ED, Asmat-Rubio MG, Vásquez-Tirado GA. Tetanus secondary to oral and odontogenic infections: a case report and systematic literature review Infez Med. 2023 Mar 1;31(1):93-102. doi: 10.53854/liim-3101-13. eCollection 2022.
44. Dinga JN, Akinbobola JS, Afolayan FID, Njoh AA, Kassa T, Lazarus DD, Dieye Y, Kassa GM, Duedu KO, Tshifhiwa N, Oumouna M; AfVANET -African Vaccinology Network. Association of gross domestic product with equitable access to childhood vaccines in 195 countries: a systematic review and meta-analysis BMJ Glob Health. 2025 Jan 19;10(1):e015693. doi: 10.1136/bmjgh-2024-015693.
45. Hoseini Tavassol Z, Sajjadpour Z, Hasani-Ranjbar S, Pejman Sani M, Aghaei Meybodi H, Larijani B. Do patients with diabetic foot ulcer need booster dose of tetanus vaccine? J Diabetes Metab Disord. 2022 Jan 30;21(1):1023-1027. doi: 10.1007/s40200-021-00966-1. eCollection 2022 Jun.
46. Vouking MZ, Tadenfok CN, Ekani JME. Strategies to increase immunization coverage of tetanus vaccine among women in Sub Saharan Africa: a systematic review Pan Afr Med J. 2017 Jun 22;27(Suppl 3):25. doi: 10.11604/pamj.supp.2017.27.3.11535. eCollection 2017.
47. Tikmani SS, Ali SA, Saleem S, Bann CM, Mwenechanya M, Carlo WA, Figueroa L, Garces AL, Krebs NF, Patel A, Hibberd PL, Goudar SS, Derman RJ, Aziz A, Marete I, Tenge C, Esamai F, Liechty E, Bucher S, Moore JL, McClure EM, Goldenberg RL. Trends of antenatal care during

pregnancy in low- and middle-income countries: Findings from the global network maternal and newborn health registry Semin Perinatol. 2019 Aug;43(5):297-307. doi: 10.1053/j.semperi.2019.03.020. Epub 2019 Mar 16.

48. Khan R, Vandelaer J, Yakubu A, Raza AA, Zulu F. Maternal and neonatal tetanus elimination: from protecting women and newborns to protecting all. International journal of women's health. 2015 Feb 3:171-80.
49. Beigi RH, Fortner KB, Munoz FM, Roberts J, Gordon JL, Han HH, Glenn G, Dormitzer PR, Gu XX, Read JS, Edwards K. Maternal immunization: opportunities for scientific advancement. Clinical infectious diseases. 2014 Dec 15;59(suppl_7):S408-14.
50. Iqbal S, Ali I, Ekmekcioglu C, Kundi M. Increasing frequency of antenatal care visits may improve tetanus toxoid vaccination coverage in pregnant women in Pakistan. Human Vaccines & Immunotherapeutics. 2020 Jul 2;16(7):1529-32. https://doi.org/10.1080/21645515.2019.1705693
51. Bairwa M, Sk S, Rajput M, Khanna P, Malik JS, Nagar M. India is on the way forward to maternal and neonatal tetanus elimination!. Human vaccines & immunotherapeutics. 2012 Aug 1;8(8):1129-31. https://doi.org/10.4161/hv.20262
52. Das A, Nawal D, Singh MK, Karthick M, Pahwa P, Shah MB, Mahapatra T, Ranjan K, Chaudhuri I. Evaluation of the mobile nurse training (MNT) intervention–a step towards improvement in intrapartum practices in Bihar, India. BMC pregnancy and childbirth. 2017 Aug 23;17(1):266. https://doi.org/10.1186/s12884-017-1452-z
53. Mbonye AK, Sentongo M, Mukasa GK, Byaruhanga R, Sentumbwe-Mugisa O, Waiswa P, Naamala Sengendo H, Aliganyira P, Nakakeeto M, Lawn JE, Kerber K. Newborn survival in Uganda: a decade of change and future implications. Health policy and planning. 2012 Jul 1;27(suppl_3):iii104-17.
54. Ridpath AD, Scobie HM, Shibeshi ME, Yakubu A, Zulu F, Raza AA, Masresha B, Tohme R. Progress towards achieving and maintaining maternal and neonatal tetanus elimination in the African region. The Pan African Medical Journal. 2017 Jun 22;27(Suppl 3):24. doi: 10.11604/pamj.supp.2017.27.3.11783
55. Kanu FA. Progress toward achieving and sustaining maternal and neonatal tetanus elimination—worldwide, 2000–2020. MMWR. Morbidity and Mortality Weekly Report. 2022;71. http://dx.doi.org/10.15585/mmwr.mm7111a2
56. Giles ML, Mantel C, Muñoz FM, Moran A, Roos N, Yusuf N, Diaz T,

Ahun M, Nic Lochlainn LM, Wootton E, Pathirana J. Vaccine implementation factors affecting maternal tetanus immunization in low-and middle-income countries: Results of the Maternal Immunization and Antenatal Care Situational Analysis (MIACSA) project. Vaccine. 2020 Jul 14;38(33):5268-77.

57. Scobie HM, Patel M, Martin D, Mkocha H, Njenga SM, Odiere MR, Pelletreau S, Priest JW, Thompson R, Won KY, Lammie PJ. Tetanus Immunity Gaps in Children 5-14 Years and Men ≥ 15 Years of Age Revealed by Integrated Disease Serosurveillance in Kenya, Tanzania, and Mozambique Am J Trop Med Hyg. 2017 Feb 8;96(2):415-420. doi: 10.4269/ajtmh.16-0452. Epub 2016 Dec 5.
58. Ogundare EO, Ajite AB, Adeniyi AT, Babatola AO, Taiwo AB, Fatunla OA, Airemionkhale A, Odeyemi OA, Olatunya OS, Oyelami OA. A ten-year review of neonatal tetanus cases managed at a tertiary health facility in a resource poor setting: The trend, management challenges and outcome. PLoS neglected tropical diseases. 2021 Dec 7;15(12):e0010010.
59. Amani A, Saidu Y, Asaah CT, Cheuyem FZ, Njoh AA, Kabir HA. Immunization in Cameroon: Uncovering Progress, Confronting Challenges, and Paving the Path towards Achieving Sustainable Development Goal 2030 Targets. J Vaccines Vaccin. 2023;14(3):1-0.
60. MacDougall DM, Halperin SA. Improving rates of maternal immunization: challenges and opportunities. Human vaccines & immunotherapeutics. 2016 Apr 2;12(4):857-65.
61. Burgess C, Gasse F, Steinglass R, Yakubu A, Raza AA, Johansen K. Eliminating maternal and neonatal tetanus and closing the immunity gap. The Lancet. 2017 Apr 8;389(10077):1380-1.