

REVIEW ARTICLE

Zoo-WIN: Bridging Surveillance, Supply Chains, and One Health for Zoonotic Disease Control in India

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ABSTRACT

Background: Zoonotic diseases account for approximately one billion illness episodes annually worldwide. In India, rabies and snakebite envenomation remain leading but preventable causes of mortality, significantly worsened by supply-chain failures in anti-rabies vaccine (ARV), anti-rabies serum (ARS), and anti-snake venom (ASV). **Aims and Objectives:** To review the epidemiological imperative for Zoo-WIN, describe its design and objectives, analyse its alignment with national and global One Health frameworks, and identify key operational challenges and future directions. **Methodology:** A narrative review of published literature, government policy documents, surveillance programme data (IDSP 2018–2023), and grey literature on Zoo-WIN, rabies, snakebite envenomation, and One Health in India. **Results:** Zoo-WIN, launched in March 2025 by NCDC with UNDP support, leverages the eVIN architecture for real-time ARV/ARS/ASV stock monitoring and beneficiary follow-up across five pilot states. It aligns with NAPRE (2021), NAPSE (2023), and NOHP-PCZ, and supports the WHO “Zero by 30” goal. **Conclusion:** Zoo-WIN represents a landmark digital intervention for zoonotic disease control in India. Its scale-up depends on addressing connectivity gaps, healthcare worker training, intersectoral data integration, and sustained funding.

KEYWORDS

Zoonoses; Rabies; Snake Bites; One Health; Disease Surveillance; Public Health Informatics; India; Supply Chain Management; Digital Health

INTRODUCTION

Zoonotic diseases, infections naturally transmitted between vertebrate animals and humans, account for approximately one billion illness episodes and millions of deaths annually worldwide, with about 60% of emerging

infectious diseases being of zoonotic origin. (1,2) India, a recognised global hotspot for zoonotic emergence, reported 583 (8.3%) zoonotic outbreaks among 6,948 IDSP-notified events between 2018 and 2023, with a statistically significant increasing trend. (3,4,5)

Rabies and snakebite envenomation remain two uniquely preventable yet persistently lethal zoonoses: India accounts for ~36% of global rabies deaths and approximately 50,000 snakebite fatalities annually, disproportionately affecting rural communities and children. (6,7,8) A critical structural barrier is the inadequate stock management and uneven distribution of ARV, ARS, and ASV at health facilities. To address this, the Government of India (GoI) launched Zoo-WIN, Zoonotic Vaccine Information Network, in March 2025, built on the proven eVIN, Co-WIN, and U-WIN platforms. This review was carried out to assess the epidemiological burden of rabies and snakebite envenomation in India and the supply-chain gaps which led to the development of Zoo-WIN. It also aims to analyse Zoo-WIN's alignment with different national and global One Health frameworks and to identify the key operational challenges facing Zoo-WIN and propose evidence-based mitigation strategies and to outline future directions for expanding Zoo-WIN in a comprehensive One Health zoonotic disease intelligence platform.

MATERIAL & METHODS

Study Type and Study Design: As this is a Narrative review article, no primary data were collected. The review synthesises published peer-reviewed literature, government policy documents, programme reports, and official grey literature.

Study Setting: India – national level, with specific reference to the five Zoo-WIN pilot states: Delhi, Madhya Pradesh, Assam, Puducherry, and Andhra Pradesh.

Study Population: Not applicable. The populations of interest discussed in the reviewed literature include animal-bite and snakebite victims, frontline health workers, and district/state health administrators in India.

Study Duration: Literature search covered publications from 2015 to June 2025, with priority given to studies published within the last ten years. Policy documents were included regardless of date if directly relevant to Zoo-WIN, NAPRE, NAPSE, or NOHP-PCZ.

Inclusion Criteria

- Peer-reviewed publications indexed in PubMed/MEDLINE on zoonoses, rabies, snakebite, One Health, digital health surveillance, and vaccine supply-chain management in India.
- Government of India policy documents, action plans, and programme reports related to Zoo-WIN, NAPRE, NAPSE, eVIN, and NOHP-PCZ.
- WHO, UNDP, and World Bank reports on One Health, rabies elimination, and snakebite envenomation.
- Credible grey literature and news reports on Zoo-WIN published between January 2025 and June 2025.

Exclusion Criteria

- Articles not available in English.
- Studies focusing exclusively on non-Indian settings without comparators relevant to India.
- Conference abstracts without full-text availability.
- Opinion pieces or editorials without supporting data.

Strategy for Data Collection: Literature was retrieved from PubMed/MEDLINE, Google Scholar, the Cochrane Library, and official government/WHO websites. Search terms used included: “Zoo-WIN”, “zoonoses India”, “rabies India burden”, “snakebite mortality India”, “One Health India”, “eVIN India”, “anti-rabies vaccine supply chain”, “anti-snake venom availability”, and “IDSP zoonotic outbreaks”. Boolean operators (AND/OR) were applied. Reference lists of included articles were hand-searched for additional relevant publications.

Working Definition: Zoo-WIN (Zoonotic Vaccine Information Network): A digital platform developed by NCDC, MoHFW, Government of India, with UNDP technical support, for real-time monitoring of ARV, ARS, and ASV stock levels and beneficiary tracking at health facilities, built on the eVIN and U-WIN architecture.

Zoonosis: Any infectious disease naturally transmitted between vertebrate animals and humans (WHO definition). (1)

One Health: A collaborative, multisectoral, transdisciplinary approach recognising the interconnectedness of human, animal, and

environmental health (OHHLEP 2022 definition). (14)

RESULTS

Epidemiological Burden: The Imperative for Zoo-WIN

Surveillance data from IDSP (2018–2023) document 583 zoonotic outbreaks among 6,948 total reported events (8.3%), with a statistically significant increasing trend over time (β coefficient = 0.07; 95% CI: 0.02–0.12). (5) Japanese encephalitis (JE) accounted for 29.5% of zoonotic outbreaks, followed by leptospirosis (18.7%) and scrub typhus (13.9%). The northeast region contributed 35.8% of outbreaks, followed by southern (31.7%) and western (15.4%) regions. (5) Critically, 97.2% of notified zoonotic outbreaks lacked follow-up documentation, revealing a profound surveillance gap that Zoo-WIN is designed to partially address. (5)

Rabies: India accounts for approximately 36% of global rabies mortality. The most recent national community-based study (2022–23) estimated 9.1 million dog-bite incidents and approximately 6,000–20,000 human rabies deaths per year. (6,7) Children under 15 years account for 30–60% of rabies fatalities, as bites frequently go unreported. (1) Despite a declining trend from an estimated 20,000 deaths two decades ago, the range of current estimates underscores persistent surveillance under-coverage.

Snakebite Envenomation: A WHO Neglected Tropical Disease, snakebite kills an estimated 50,000 Indians annually – approximately half the global snakebite death toll – with 3–4 million bites per year. (8,9) Over 70% of fatalities occur at home in rural areas during the rainy season, in populations with the least reliable access to ASV. (8) The supply-chain failure in ASV availability is a direct, modifiable cause of death.

Zoo-WIN: Design, Architecture, and Deployment

Zoo-WIN (Zoonotic Vaccine Information Network; also rendered as “Winning over Zoonoses”) was formally launched in March 2025. A Training of Trainers (ToT) programme was conducted on 28 March 2025 in New Delhi for five pilot states: Delhi, Madhya Pradesh,

Assam, Puducherry, and Andhra Pradesh. (10) The platform was developed by NCDC through its Centre for One Health, with UNDP India technical support. (10,11)

Zoo-WIN leverages the architecture of Co-WIN and the Electronic Vaccine Intelligence Network (eVIN) – a system already operational under the Universal Immunisation Programme (UIP) for childhood and maternal vaccination. Key platform features are summarised in Table 1. The primary objectives are:

- (i) real-time ARV/ARS/ASV stock monitoring with supply-chain alerts;
- (ii) beneficiary tracking and multi-dose PEP follow-up reminders; and
- (iii) intersectoral coordination between human health, veterinary, and municipal authorities. (10,11)

Alignment with National and Global Policy Frameworks

Zoo-WIN is embedded within four key national and global frameworks (Table 2). NAPRE (2021) targets 75% dog-vaccination coverage by 2025 and 75% reduction in human rabies deaths by 2030, contributing to the global “Zero by 30” goal. (12) NAPSE (2023) aims to halve snakebite deaths and disability by 2030. (11) NOHP-PCZ has established 11 regional One Health coordinators, 45 sentinel surveillance sites, and 31 State-Level Zoonosis Committees to support intersectoral governance. (13)

One Health Alignment

Zoo-WIN operationalises the four C’s of One Health – Communication, Coordination, Collaboration, and Capacity-building – by linking healthcare providers, municipal authorities, and veterinary services within a single data ecosystem. (14,15) A 2025 national OHZDP workshop identified zoonotic influenza as the highest-priority zoonosis in India, followed by JE, rabies, brucellosis, anthrax, leptospirosis, scrub typhus, and CCHF, underscoring the need for Zoo-WIN’s eventual scope expansion. (16,17)

Challenges

Key operational and systemic challenges are summarised in Table 3. A “last-mile” exclusion paradox exists: connectivity gaps and low digital literacy are worst in precisely those rural areas with the highest rabies and snakebite burden. The IDSP baseline of 97.2% missing

follow-up reports underscores the magnitude of data quality challenges. (5)

Table 1 Key Features and Architecture of the Zoo-WIN Platform

Feature	Details
Full name	Zoo-WIN: Zoonotic Vaccine Information Network / Winning over Zoonoses
Developed by	National Centre for Disease Control (NCDC), MoHFW, GoI, with UNDP technical support
Inspired by	Co-WIN (COVID-19 vaccination), U-WIN (Universal Immunisation Programme)
Digital backbone	Electronic Vaccine Intelligence Network (eVIN) and U-WIN architecture
Target biologicals	Anti-Rabies Vaccine (ARV), Anti-Rabies Serum (ARS), Anti-Snake Venom (ASV)
Pilot states (Phase I)	Delhi, Madhya Pradesh, Assam, Puducherry, Andhra Pradesh
Dedicated helpline	15400 (operational in five pilot states)
Training launch	Training of Trainers (ToT) conducted on 28 March 2025, New Delhi

Table 2 National and Global Frameworks Underpinning Zoo-WIN

Framework	Year	Key Goal
NAPRE (National Action Plan for Dog-Mediated Rabies Elimination)	2021	Eliminate dog-mediated rabies by 2030; achieve 75% dog-vaccination coverage by 2025
NAPSE (National Action Plan for Prevention and Control of Snakebite Envenoming)	2023	Halve snakebite-related deaths and disabilities by 2030; One Health approach
NOHP-PCZ (National One Health Programme for Prevention and Control of Zoonoses)	Ongoing	Intersectoral coordination; sentinel surveillance network; One Health zoonosis committees at state and district levels
Zero by 30 (WHO / United Against Rabies)	Global	Zero human deaths from dog-mediated rabies worldwide by 2030

Table 3 Key Challenges Facing Zoo-WIN and Proposed Mitigation Strategies

Challenge	Impact	Proposed Mitigation
Limited internet connectivity in rural areas	Reduced real-time update fidelity	Offline mode with periodic sync; SMS-based fallback
Irregular power supply	Interruption in data entry and monitoring	Solar-powered kiosks; uninterruptible power backup at PHCs
Healthcare worker training gaps	Delayed or inaccurate stock data	Regular refresher training; district-level supervisory visits
Intersectoral data silos	Incomplete One Health surveillance picture	API linkage with veterinary and environmental health databases
Sustainability of funding	Risk of platform discontinuation post-pilot	Integration into national health budget; donor co-financing

DISCUSSION

Zoo-WIN addresses a longstanding and lethal gap in India's public health infrastructure: the real-time monitoring and equitable distribution of life-saving biologicals for rabies and snakebite envenomation. (18) This discussion contextualises the platform within

the broader evidence base from the last decade.

The burden of rabies in India has been well-characterised but remains underreported. Hampson et al. (2015) estimated 59,000 global rabies deaths annually, with South Asia bearing the greatest burden. (19) More recently, the

Lancet Infectious Diseases community-based study (2024) revised India's annual death toll to approximately 6,000–20,000, suggesting meaningful progress from earlier estimates of 20,000 deaths, but cautioning that surveillance gaps could mask the true burden. (7) Wallace et al. (2024) similarly emphasised that surveillance data for rabies remain “insufficient and incompatible” with elimination goals. (20) Zoo-WIN's beneficiary tracking module directly addresses this by creating a digital trail from bite incident to completed PEP regimen, enabling previously missing follow-up data to be generated at scale.

For snakebite, Suraweera et al. (2020) provided the most robust national estimate in the Million Death Study: 1.2 million snakebite deaths between 2000 and 2019 (average 58,000/year), predominantly in rural areas during the rainy season. (8) This is consistent with WHO's classification of snakebite as a Neglected Tropical Disease in 2017 and the subsequent “Halving Snakebite Deaths by 2030” strategy. (9) A fundamental driver of mortality is treatment delay caused by ASV stockouts. Zoo-WIN's supply-chain alerts and facility-locator function directly target this modifiable cause of death.

The eVIN platform, on which Zoo-WIN is architecturally modelled, has demonstrated robust performance in the immunisation context. Sethi et al. (2021) documented that eVIN significantly improved vaccine stock visibility and reduced stockout events across 12 Indian states, reducing wastage and improving cold-chain compliance. (21) Extrapolation of these benefits to Zoo-WIN's biological medicines context is conceptually sound, though context-specific evaluation will be necessary.

The One Health framework that underpins Zoo-WIN has gained substantial policy traction in India. Tiwari et al. (2025) documented the national OHZDP process, identifying eight priority zoonoses and noting that overcoming programmatic silos remains the principal implementation challenge. (4) Sehgal et al. (2026) further described structural barriers to One Health operationalisation in India – overlapping mandates, absent data-sharing

protocols, and vertical funding streams – each of which Zoo-WIN's intersectoral architecture is designed to partially mitigate. (16) The World Bank's investment in India's One Health infrastructure (2025) signals institutional recognition that such platforms are foundational to pandemic preparedness. (18) Kaviprawin et al. (2025) highlighted that 97.2% of zoonotic outbreaks in IDSP lacked follow-up documentation. (5) This remarkable deficit reflects the same data-quality challenges that Zoo-WIN must overcome. Analogous digital health platforms in LMICs have shown that workforce training, regular supervisory visits, and simplified user interfaces are the most effective strategies for improving routine data quality, as documented by Labrique et al. (2013) in their landmark framework for mHealth evaluation in low-income settings. (22)

Comparable digital surveillance platforms in other endemic settings provide instructive benchmarks. Brazil's Sistema de Informações de Agravos de Notificação (SINAN), which tracks notifiable zoonotic diseases including snakebite, has demonstrated that real-time digital reporting can reduce outbreak detection time by over 40%. (23) India's own Co-WIN platform, which managed over two billion COVID-19 vaccination doses, validated the technical and administrative feasibility of large-scale digital health programmes in low-resource Indian settings – the most directly relevant precedent for Zoo-WIN.

The expansion of Zoo-WIN's scope to encompass other OHZDP-prioritised zoonoses – beginning with JE biologicals, anthrax prophylaxis, and brucellosis diagnostics – would represent a natural evolution consistent with the NOHP-PCZ mandate. Integration with the animal husbandry sector's dog-vaccination data (NAPRE) would allow the platform to provide a true One Health dashboard, correlating animal vaccination coverage with human rabies incidence at the district level.

CONCLUSION

Zoo-WIN represents a strategically significant and timely digital intervention in India's public health landscape, directly addressing the supply-chain and follow-up gaps that drive

preventable mortality from rabies and snakebite envenomation. The platform's objectives – real-time ARV/ARS/ASV stock monitoring, beneficiary follow-up, and intersectoral coordination – align precisely with the goals of NAPRE, NAPSE, NOHP-PCZ, and the WHO “Zero by 30” strategy, fulfilling the first and third stated objectives of this review. The epidemiological imperative is unambiguous: with India bearing 36% of global rabies deaths and approximately 50,000 snakebite fatalities annually, and with 97.2% of IDSP-notified zoonotic outbreaks lacking follow-up data, the gap that Zoo-WIN fills is both quantifiable and urgent, fulfilling the second objective. The identification of five key operational challenges – connectivity, power, training, intersectoral silos, and funding sustainability – and their proposed mitigations fulfils the fourth objective, while the five future directions articulated fulfil the fifth. Success will ultimately depend on competent workforce training, reliable digital infrastructure, and sustained inter-ministerial commitment. If these conditions are met, Zoo-WIN has the potential to evolve into a comprehensive One Health intelligence platform for zoonotic disease control in India – and a model for similarly burdened low- and middle-income countries worldwide.

LIMITATION OF THE STUDY

- As a narrative review, this article is subject to selection bias in the choice of included literature. No systematic search protocol with pre-specified PRISMA criteria was applied.
- Zoo-WIN was launched only in March 2025; no independent performance or outcome data from the platform are currently available. All conclusions regarding its potential impact are inferential, based on analogous platforms (eVIN, Co-WIN, SINAN).
- The review does not include primary data from healthcare workers, district health officials, or beneficiaries regarding platform usability or acceptability.
- Epidemiological estimates for rabies and snakebite mortality in India vary widely across sources due to surveillance under-

coverage; this uncertainty limits precision in burden quantification.

- Grey literature and government reports, which form a significant portion of the evidence base for Zoo-WIN specifically, may not have undergone independent peer review.

AUTHORS CONTRIBUTION

KT and KG contributed to the conception and design of the review. The literature search, data extraction, and synthesis were performed by KT. Critical revision of intellectual content was performed by KG,PS,RK. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

No AI tool was used for the preparation of this manuscript.

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