

Review Article

Asian Pacific Journal of Tropical Medicine

doi: 10.4103/apjtm.apjtm_283_26

The urgent vaccine imperative: Sustaining visceral leishmaniasis elimination

Md. Abdus Salam[✉]*Health and Epidemiology Research Group, Department of Statistics, University of Rajshahi, Rajshahi-6205, Bangladesh*

ABSTRACT

In October 2023, Bangladesh became the first country validated by the World Health Organization for eliminating visceral leishmaniasis (VL) as a public health problem. This achievement rests on robust case detection, effective treatment, and sustained vector-control interventions; however, these measures are resource intensive, vulnerable to political and funding disruptions, and may be undermined by population displacement and emergent drug resistance. Post-kala-azar dermal leishmaniasis reservoirs now outnumber primary VL cases in Bangladesh, while East Africa accounts for 73% of global VL cases with zoonotic transmission and exophilic sand fly behavior complicating control. The human vaccine pipeline remains concerningly thin: no licensed human vaccine exists, no phase III VL-specific efficacy trials are underway, and correlates of immune protection remain undefined. On the balance of current evidence, vaccination offers a potentially durable strategy to interrupt transmission independently of passive case detection and to reduce reliance on programmatic activities that are operationally fragile. Several factors in 2026 create a strategic inflection point for accelerated vaccine development and deployment, including Bangladesh's validation, East Africa's 2023-2030 elimination framework, and advances in next generation platforms (for example, mRNA and reverse-vaccinology approaches). We recommend planning multi-country phase III trials by 2027 with VL-relevant endpoints, establishing dedicated funding mechanisms, and integrating a future vaccine into regional elimination frameworks to maximize publichealth impact. Rapid, coordinated progress toward an effective vaccine is essential to safeguard and sustain the gains achieved to date. This review synthesizes current evidence on epidemiology, vaccine development, and programmatic challenges and proposes pragmatic priorities to accelerate VL vaccine evaluation and policy translation.

KEYWORDS: Visceral leishmaniasis; Elimination sustainability; Vaccine development; Bangladesh; East Africa

1. Introduction

In October 2023, Bangladesh became the first country validated by the World Health Organization for eliminating visceral leishmaniasis (VL) as a public health problem. Historically concentrated in the Indian subcontinent and locally known as Kala-azar, VL has imposed a disproportionate burden on the most socioeconomically vulnerable populations. The disease, characterized by chronic fever, hepatosplenomegaly, pancytopenia, and high untreated case-fatality, has long challenged health systems because of complex transmission dynamics, diagnostic limitations, and reliance on sustained vector control. Nearly two centuries after VL was first described in Jessore, Bangladesh, the country's validation reflects coordinated public health actions and sustained programmatic effort. The elimination threshold, annual incidence below 1 case per 10 000 population at the subdistrict (upazila) level for three consecutive years, was reached by 2017 and maintained through 2023^[1,2]. This outcome was supported by a national strategy combining early case detection, complete

[✉]To whom correspondence may be addressed. E-mail: drsalammr@gmail.com

This is an open access article distributed under the terms of the Creative Commons Attribution-Non-Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

For reprints contact: reprints@medknow.com

©2026 Asian Pacific Journal of Tropical Medicine Produced by Wolters Kluwer-Medknow.

How to cite this article: Salam MA. The urgent vaccine imperative: Sustaining visceral leishmaniasis elimination. Asian Pac J Trop Med 2026; 19(9): 392-400.

Article history: Received 3 June 2026 Revision 24 July 2026
Accepted 31 August 2026 Available online 14 September 2026

treatment, use of rapid diagnostic tests, for example rK39, effective case management with liposomal amphotericin B, and vector control through indoor residual spraying. These measures were accompanied by strengthened surveillance, active case-finding, and community engagement activities, which have been reported to enhance health-seeking and treatment adherence in program evaluations[3].

Yet despite this historic milestone, the global VL elimination effort remains vulnerable. While South Asia has achieved marked progress, East Africa has emerged as the current epicenter of transmission, accounting for 73% of global VL cases in 2023, with Ethiopia, Kenya, and Sudan each reporting more than 1 000 cases (Brazil is a separate zoonotic focus outside East Africa). In East Africa, children under 15 years account for approximately half of cases, and females represent nearly 25% of affected individuals. VL remains endemic in about 80 countries worldwide, with roughly 30 000 new cases reported annually[4,5].

The fundamental challenge to sustaining long-term elimination is unambiguous because no proven vaccine exists. In the absence of vaccine-induced immunity, maintaining elimination depends entirely on uninterrupted case detection, effective treatment, and sustained vector control programs[6]. These interventions are inherently resource intensive, requiring substantial financial investment, well-functioning health systems, and dedicated human resources. Moreover, programs remain politically vulnerable to shifting governmental priorities, competing public health agendas, and the erosion of commitment that frequently follows successful elimination[7]. Crucially, these programmatic efforts remain highly susceptible to disruption by several destabilizing factors. Population displacement and cross-border migration can interrupt continuity of care, and persistent funding shortfalls risk eroding years of hard-won progress. In the absence of an effective vaccine capable of inducing durable population-level immunity, elimination remains fragile and dependent on uninterrupted implementation of intensive interventions that are difficult to sustain indefinitely in resource-limited endemic settings. This review critically examines the epidemiological trajectory, strategic interventions, and health system innovations that enabled Bangladesh to achieve VL elimination as a public health problem. It also explores the challenges that remain in the post-elimination phase without a preventive vaccine and highlights lessons applicable to other endemic countries pursuing elimination under the WHO neglected tropical diseases roadmap. In addition, the review argues that vaccine development should be accelerated from clinical trial progress to implementation readiness, drawing on Bangladesh's experience while addressing the critical gaps that continue to threaten global elimination efforts[8].

2. Current status and fragility of VL elimination

2.1. South Asia's historic achievement

Bangladesh's elimination journey provides an important blueprint for what can be achieved through sustained, coordinated public health action. The National Kala-azar Elimination Programme, established in 2006 and operational by 2008, implemented six interlinked strategies to interrupt transmission and reduce disease burden. These included early diagnosis using rapid tests such as rK39 and effective treatment with liposomal amphotericin B, together with indoor residual spraying to control the sand fly vector. Active case detection was strengthened through community-based search approaches, while social mobilization improved awareness and timely healthcare seeking. Operational research informed ongoing program refinement, and integrated digital surveillance systems enabled efficient case reporting, monitoring, and response[9]. Between 1994 and 2011, VL cases were reported across 140 upazilas in 37 districts, indicating widespread endemicity throughout Bangladesh. Transmission was heterogeneous, with eight hyperendemic upazilas accounting for most cases. These high-burden areas were associated with sustained transmission and presented important challenges for control efforts, which supported the need for targeted interventions in priority settings. Key interventions included the introduction of rK39 rapid diagnostic tests at upazila health complexes between 2012 and 2015, replacing the less sensitive aldehyde test and invasive splenic aspiration procedures[8,10]. The treatment revolution represented a paradigm shift from 28-day sodium stibogluconate injections, which demonstrated 50% to 65% resistance in Bihar, India, to single-dose LAmB at 10 mg/kg, achieving cure rates exceeding 97%[11]. Blanket deltamethrin IRS initiated in 2012 across 8 hyperendemic upazilas was expanded to all 100 endemic upazilas by 2014. Active case detection through fever camps and index case approaches achieved cost-effective case detection at USD 22 per case. The implementation of digital surveillance through the District Health Information System 2 platform in 2015 enabled real-time monitoring[9]. The results were unequivocal, as VL cases in Bangladesh declined by more than 94%, from 9 379 in 2007 to 87 in 2024. By 2017, all upazilas had achieved and maintained the elimination threshold, and in 2023 Bangladesh received WHO validation for eliminating VL as a public health problem[1].

2.2. The East African crisis

South Asia's remarkable progress in VL elimination contrasts with an increasingly concerning situation elsewhere, where the disease continues to persist and, in some settings, is increasing. East Africa

has emerged as the world's VL major burden area, accounting for the largest share of the disease burden in the African Region and representing 37% of all global VL cases. Six countries, Chad, Eritrea, Ethiopia, Kenya, South Sudan, and Uganda contribute the majority of this burden, with high transmission in conflict-affected, displaced, and immunocompromised populations. Outbreaks in the region have been especially pronounced, such as those in Ethiopia and South Sudan, where humanitarian crises, limited access to health services, and malnutrition have worsened transmission and mortality. The Eastern Mediterranean Region bears 42% of the global VL burden, making it the second-largest VL-affected region after South Asia. Ethiopia, Sudan, Kenya, and Brazil each contribute significantly to this burden, with Ethiopia and Sudan alone accounting for a notable proportion of cases in the Eastern Mediterranean and African Regions[4]. In May 2025, six African nations including Chad, Djibouti, Ethiopia, Somalia, South Sudan, and Sudan signed a landmark Memorandum of Understanding to eliminate VL, formally endorsing the WHO Strategic Framework for the Elimination of Visceral Leishmaniasis as a public health problem in Eastern Africa (2023-2030), launched in June 2024. The regional

targets are ambitious, aiming to reduce new VL cases by 60% by 2027 and by 90% by 2030, while ensuring that 90% of cases are detected and started on treatment within 30 days of symptom onset. In addition, the plan seeks to achieve a 100% decline in VL-related deaths in children by 2030 and universal access to antiretroviral therapy for VL HIV coinfection cases[12].

Despite this commitment, challenges are daunting. Unlike South Asia, where VL is primarily caused by *Leishmania donovani* transmitted by sandflies in a focal pattern, East African transmission involves distinct ecological and epidemiological dynamics, including zoonotic cycles, more exophilic in sand fly behavior and mobile reservoirs, which may complicate elimination efforts. Moreover, VL transmission and control are further constrained by factors such as conflict, displacement, malnutrition, limited access to diagnosis and treatment, and constrained funding. The region's high VL burden reflects ongoing challenges in vector control, case detection, and health system capacity. This stands in sharp contrast to South Asia's elimination experience and suggests the context-specific need for interventions in endemic settings. The African elimination framework also emphasizes the need for

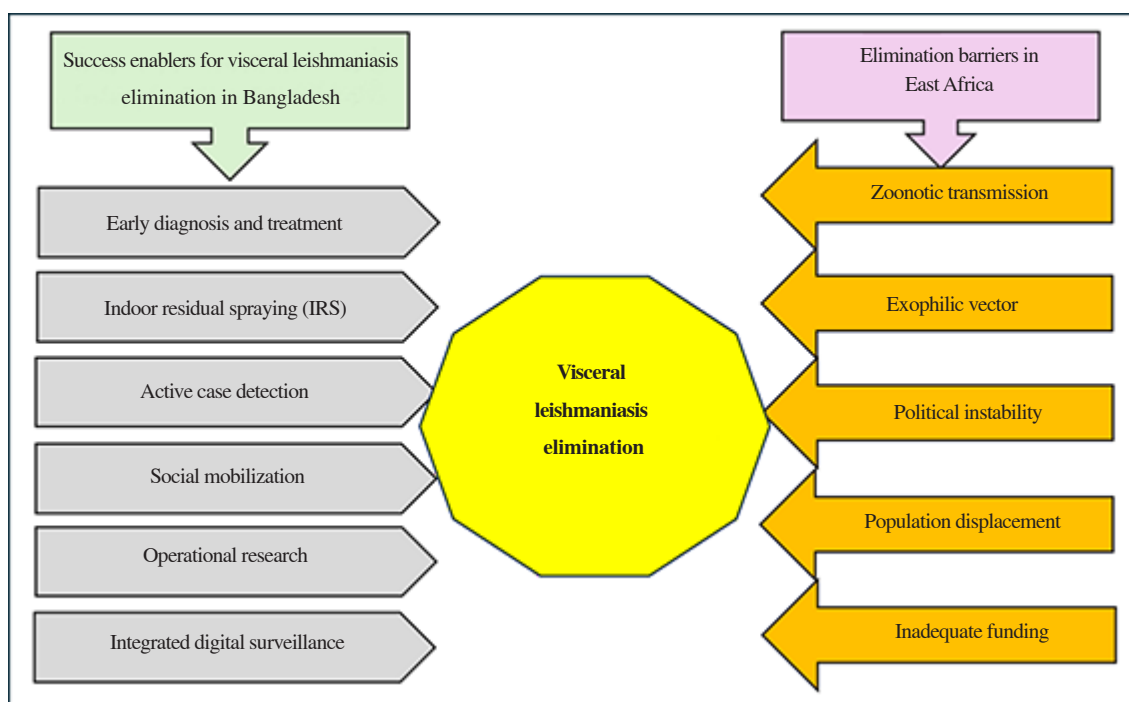


Figure 1. Conceptual framework contrasting strategic success enablers supporting visceral leishmaniasis elimination in Bangladesh with major contextual barriers affecting elimination efforts in East Africa. The left panel highlights key programmatic pillars, including early diagnosis and treatment, indoor residual spraying, active case detection, social mobilization, operational research, and integrated digital surveillance, while the right panel summarizes major constraints such as zoonotic transmission, exophilic vector behavior, political instability, population displacement, and inadequate funding. The central node indicates visceral leishmaniasis elimination as the shared public health goal.

improved diagnostic, treatment, and prevention tools, indicating that current approaches still leave important gaps[13].

Figure 1 illustrates the National Kala-azar Elimination Programme strategic pillars that enabled successful VL elimination in Bangladesh along with barriers underlying the ongoing elimination crisis in East Africa.

3. Critical challenges to elimination and sustainability

3.1. *Post Kala-azar dermal leishmaniasis as hidden reservoir*

Post-Kala-azar dermal leishmaniasis (PKDL) is an important challenge to VL elimination sustainability. It is a polymorphic cutaneous manifestation that may develop in a proportion of clinically cured VL patients within a few years of treatment. Because patients are often not systemically ill, diagnosis may be delayed, and PKDL may act as a parasite reservoir with the potential to infect sand flies[14]. Bangladesh surveillance data reveal a troubling trend: PKDL cases now outnumber primary Kala-azar cases. From 2020 to 2022, PKDL consistently exceeded new VL cases, 58 *vs.* 46 in 2020, 37 *vs.* 35 in 2021, and 77 *vs.* 47 in 2022. This shift threatens elimination sustainability because PKDL patients can harbor parasites and serve as a silent transmission reservoir. Sustaining elimination also depends on strengthened PKDL surveillance, early detection, and effective treatment to reduce the risk of continued transmission[9]. Modeling studies suggest that as kala-azar incidence declines, PKDL may account for a larger proportion of the residual infection reservoir. Diagnostic confirmation remains challenging because serologic tests such as rK39 may not reliably distinguish active PKDL from prior VL infection, and parasite demonstration from skin lesions is often invasive and insensitive. This paucity of parasitic disease most commonly presents as the macular form, which accounts for most South Asian PKDL cases, which can further complicate clinical recognition. The treatment burden for PKDL is substantial, requiring 84 days of oral miltefosine, a long course that carries a significant risk of adverse effects and leads to poor adherence. This prolonged regimen challenges treatment completion, increases the likelihood of parasite exposure to suboptimal drug levels, and raises concerns about potential resistance and ongoing transmission if cases remain untreated or inadequately managed[9,15]. If active case detection stops after validation, PKDL detection may decline in parallel, leaving some cases undetected in the community with the potential to sustain transmission. Without continued surveillance and case-finding efforts, PKDL patients may remain undiagnosed for prolonged periods and may contribute to ongoing

transmission and re-emergence. Consequently, Bangladesh's post-validation strategy highlights PKDL surveillance as a critical priority. However, the specific mechanisms and operational approaches for sustaining effective PKDL detection over the long term remain insufficiently defined[9,16].

3.2. *Drug resistance and limited treatment options*

The VL therapeutic arsenal remains limited. First-line treatment includes LAmB, given as a single intravenous infusion at 10 mg/kg, with high efficacy but limited by high cost and the need for healthcare infrastructure. Miltefosine is administered orally for 28 days, with variable efficacy and important limitations including gastrointestinal toxicity, teratogenicity and emerging resistance. Pentavalent antimonials, traditionally administered intravenously or intramuscularly for 28 days, have shown substantially reduced effectiveness in parts of the Indian subcontinent. Reduced effectiveness has been linked to parasite resistance and other programmatic factors, particularly in regions of India and Bangladesh and significant safety concerns, including cardiotoxicity and other severe adverse effects are also noted. Intramuscular paromomycin is effective when administered over 21 days, but its use is limited by injection site pain and the requirement for regular healthcare facility visits. This reliance on clinic-based administration may pose challenges for patients in remote or resource-limited settings, where access to medical services may be inconsistent, affecting treatment adherence and program feasibility[17]. Miltefosine resistance is emerging after years of widespread use, with a growing number of treatment failures reported across the Indian subcontinent, which raises concerns about the long term utility of miltefosine as a cornerstone oral therapy for VL. These concerns include declining efficacy, the possible spread of resistant parasites, and the need for vigilant monitoring, antimicrobial stewardship, and alternative treatment options to avoid setbacks in elimination efforts. Validated molecular markers for drug resistance are limited for VL, so surveillance currently relies largely on phenotypic assays to detect drug resistance. This limitation hinders rapid, scalable monitoring of resistance patterns and underscores the need for investment in molecular diagnostics and research. A recent 2025 review on VL pharmacological treatments emphasizes that monochemotherapy is frequently limited by toxicity, high cost, and the emergence of drug resistance. These constraints underscore the strong need for synergistic drug combinations and novel compounds to improve efficacy, reduce treatment duration, minimize adverse effects and mitigate the risk of resistance, critical steps for sustaining VL elimination[18].

3.3. Vector control limitations and behavioural shifts

Indoor residual spraying was important component to Bangladesh's elimination success, although its impact has not been firmly established through controlled trials. Available programmatic evidence supports its use, but some uncertainty remains regarding the magnitude of its effect[19]. The suspension of IRS from 2020 through 2023 due to insecticide unavailability raised serious concerns about the risk of VL resurgence[9]. Vector behavior is changing and recent studies from India suggest that *Phlebotomus argentipes* may be far more exophilic and exophagic than previously assumed. This behavioural shift has critical implications for control strategies, because it may reduce the effectiveness of IRS and may contribute to continued outdoor transmission. It also suggests that elimination efforts may need to rely more heavily on integrated vector surveillance, tailored interventions, and strategies that account for changing sand fly behavior[20]. Indoor interventions, including IRS and insecticide-treated nets (ITNs), may become less effective as transmission shifts outdoors. Exposure to sand flies during outdoor activities, including open defecation, may increase the risk of kala-azar, while post-elimination vector control strategies remain undefined[21]. The only cluster-randomized trial of ITNs in South Asia, the KalaNet study conducted in 2010, found no significant impact on VL infection incidence. This null result led India and Nepal to exclude ITNs from their national elimination strategies. However, post hoc analyses from Bangladesh suggested potential benefits from ITN use, highlighting important geographic and behavioural variability in sandfly feeding patterns, human-nighttime activities, and net usage that may influence effectiveness. These contrasting findings underscore the complexity of translating trial results into policy and the need for context-specific vector control strategies[9,22].

3.4. Funding, political will and health system fragility

Elimination sustainability requires sustained investment, yet funding for neglected tropical diseases like VL may compete with other public health priorities. This competition can lead to resource gaps, interruptions in essential interventions such as surveillance and vector control and reduced program capacity, which may affect the sustainability of elimination gains. Ethiopia's government covers 76% of VL diagnosis and treatment costs, a notable commitment that is important for long-term sustainability. However, some endemic countries may not have similar fiscal capacity[23].

Political instability may disrupt the elimination programs by interrupting surveillance, limiting access to affected communities, weakening health system coordination and delaying diagnosis

and treatment[24]. Conflict in Sudan, South Sudan, and Ethiopia substantially impedes case detection and limits access to treatment, disrupting control efforts and may contribute to continued transmission. Population movement across borders further complicates geographic elimination targets, as at-risk populations often concentrate in remote, hard-to-reach border areas where health services are weak and surveillance is fragmented. These dynamics may contribute to localized ongoing transmission that may increase the risk of cross-border re-emergence, posing a major challenge to sustaining elimination gains in South Asia[25]. Sustainable elimination depends on effective systems that translate surveillance data into timely programmatic action. In many VL-endemic settings, however, these systems remain limited, which may reduce the ability of programs to detect outbreaks early, target interventions effectively, and adjust strategies based on real-time evidence[26].

4. The vaccine imperative and urgent gaps

4.1. A vaccine may prove critical for sustainable elimination

An effective vaccine may provide a viable path toward sustainable VL elimination, as it could help interrupt transmission independently of case detection. Unlike treatment and vector control, which require continuous programmatic effort, an effective VL vaccine is supposed to provide population-level protection that persists even when interventions scale down. A preventive vaccine would not only reduce VL cases but also decrease the PKDL reservoir, which serves as a critical source of ongoing transmission in the post-elimination era[27]. Vaccines are typically more cost-effective than sustained active case detection, whose per-case cost rises sharply as incidence declines and cases become harder to find. Vaccination may offer greater resilience against disruptions, as mass campaigns can achieve rapid, high coverage even during conflict, humanitarian crises, or periods of health system strain[28]. Bangladesh has achieved elimination of VL as a public health problem, but attaining the more ambitious goal of complete transmission elimination is likely possible only through effective vaccination. In the absence of a proven vaccine, Bangladesh's post-validation strategy explicitly emphasizes that sustained surveillance for case clusters and PKDL, combined with continued preventive measures such as vector control, will be essential to prevent resurgence and maintain elimination gains. This recognition highlights the fragility of Bangladesh's elimination gains and the need for sustained vigilance. Without continued surveillance and preventive measures, elimination gains may quickly reverse, leading to renewed transmission and undermining the country's public health success[9].

4.2. Current vaccine development landscape

The leishmaniasis vaccine pipeline remains concerningly thin, and a WHO PDVAC 2025 presentation on vaccine development highlighted only limited progress. Despite the clear need for an effective preventive vaccine to secure sustainable VL elimination, few candidates have advanced beyond early-stage research, with most lacking robust clinical data or clear pathways to licensure. This scarcity of reliable vaccine options underscores the urgency of accelerating investment, coordinating global research and development efforts and prioritizing vaccine development as a central pillar of post-elimination strategy[29]. Promising candidates include the live attenuated *Leishmania major* Centrin-negative vaccine (*LmCen-/-*), for which results are expected by the end of 2026, and the REPLEISH vaccine, which is reported to be less reactogenic, safer, and easier to manufacture than existing approaches. However, REPLEISH's development timeline remains uncertain and neither candidate has yet completed pivotal clinical trials or secured regulatory approval. These pipelines represent critical hopes for VL elimination, but their uncertain trajectories highlight the gap between current evidence and the urgent need for a scalable effective preventive vaccine[30].

Critical gaps remain substantial, with no Phase III efficacy trials currently underway for VL-specific vaccines. Most candidates target cutaneous leishmaniasis rather than visceral disease and no vaccine is currently licensed for human use against any form of leishmaniasis[31]. Funding for leishmaniasis vaccine development remains minimal compared with funding for other WHO priority pathogens, reflecting the disease's neglect despite its significant health burden. This chronic underinvestment limits the capacity to advance promising candidates through clinical trials, scale up manufacturing and conduct the operational research needed for vaccine introduction[32]. A December 2025 review on *Leishmania* vaccine development estimated 30 000 annual VL cases and over 1 million cutaneous leishmaniasis cases yet emphasized that vaccine development faces multiple challenges including complex parasite biology, lack of correlates of protection, and limited commercial incentive[33]. The 2015 article, Development of *Leishmania* vaccines in the era of visceral leishmaniasis elimination, argued that vaccine development becomes increasingly urgent as elimination advances, since vaccines are essential to prevent resurgence and sustain long-term gains. Nearly a decade later, that warning remains largely unheeded: vaccine development continues to lag, funding remains insufficient, and the pipeline stays thin despite Bangladesh's validation of elimination and the clear risk of transmission rebound[27].

4.3. 2026 marks the inflection point

Multiple factors converge to make 2026 the critical year for accelerating VL vaccine development. Bangladesh's validation has intensified the urgency, as the first country to achieve elimination must now address the long-term challenge of sustaining that achievement. In the absence of an effective vaccine, Bangladesh will be required to maintain intensive surveillance and preventive measures indefinitely, creating a burden that is both financially demanding and programmatically difficult to sustain[1]. East Africa's 2023-2030 elimination framework places strong emphasis on prevention, explicitly identifying research and development of improved diagnostic, treatment, and prevention tools as a key priority. This strategic focus reflects the potential to adapt technologies such as mRNA vaccine platforms, reverse vaccinology and systems vaccinology, approaches that accelerated COVID-19 vaccine development, for leishmaniasis. These modern approaches may offer opportunities to design safer, more effective vaccines with faster development timelines. They also have the potential for scalable manufacturing, providing a realistic pathway to overcome the current stagnation in the leishmaniasis vaccine pipeline[4,33]. The European Partnership on One Health Antimicrobial Resistance 2026 call, along with other global health funding mechanisms, could support vaccine development if strategically directed[34]. Political momentum is building and the May 2025 African Union-led Memorandum of Understanding signed by six nations demonstrates unprecedented political commitment that should be leveraged to advance vaccine investment[35].

5. Advancing vaccine development in 2026

5.1. Immediate priorities

Multi-country Phase III efficacy trials will be an important next step for VL vaccine development. The promising *L. major* Centrin-negative candidate could be evaluated in South Asian and East African settings, with trial designs powered to assess protection against VL rather than cutaneous disease alone. Such studies would provide important efficacy data to inform regulatory review and future vaccine policy, although questions about durability of protection, setting-specific performance, and implementation feasibility would likely remain[36]. Correlates of protection remain to be established, as the lack of reliable immunological markers that predict vaccine efficacy continues to be an important barrier to licensure. Further research using systems vaccinology may help identify immune signatures associated with protection and could

Table 1. Strategic imperatives for visceral leishmaniasis vaccine development and sustainable elimination.

Theme	Key message	Implication
Sustainable elimination	Vaccination offers the most durable route to visceral leishmaniasis (VL) elimination by interrupting transmission independently of case detection.	Surveillance, treatment, and vector control alone may not sustain elimination over the long term.
Bangladesh context	Bangladesh's elimination validation is a major achievement, but the post validation phase remains fragile without a vaccine.	Sustained vigilance will still be required unless a preventive vaccine becomes available.
Development landscape	The leishmaniasis vaccine pipeline is thin: no licensed human vaccine exists, and no phase III VL-specific efficacy trials are underway.	Translational progress remains insufficient for near term public health impact.
Leading candidates	<i>LmCen</i> –/– and REPLEISH are among the most promising candidates, but their development pathways remain uncertain.	These candidates warrant accelerated advancement and rigorous evaluation.
Scientific barriers	Correlates of protection remain undefined, and <i>Leishmania</i> biology complicates vaccine design.	Systems vaccinology and immune signature studies are needed to support licensure.
Funding gap	Leishmaniasis vaccine development remains under-funded relative to other WHO priority pathogens.	Dedicated funding from global and national mechanisms is urgently needed.
Why 2026 matters	Bangladesh's VL elimination validation, East Africa's elimination agenda, and next-generation vaccine platforms converge in 2026.	This is a strategic inflection point for accelerating vaccine development.
Trial priorities	Multi country phase III trials should be planned by 2027, including VL relevant endpoints.	Evidence generation must focus on protection against visceral disease, not only cutaneous forms.
Programmatic integration	Vaccine milestones should be embedded within elimination frameworks and introduction plans.	Countries can prepare for timely deployment once a vaccine is licensed.
Combined strategy	Vaccination should complement better treatment, vector control, and surveillance.	Integrated approaches could achieve transmission elimination, not just public health elimination.

support vaccine development, trial design, and regulatory evaluation for leishmaniasis vaccines[33].

Sustainable funding mechanisms are needed because VL vaccine development currently depends partly on philanthropic support. WHO, Gavi, CEPI, and national governments could help by establishing dedicated funding streams for vaccine development, particularly since investment in a vaccine may be modest relative to the long-term costs of maintaining elimination programs[37]. Vaccine development could be incorporated into elimination frameworks, and the East African VL strategy could outline vaccine development milestones and preparatory steps for introduction if and when a licensed vaccine becomes available. Such planning would allow regulatory, logistical, and operational considerations to be addressed alongside research and development, potentially facilitating timely deployment and helping to sustain elimination gains while reducing the risk of resurgence[7].

5.2. Longer-term strategic considerations

Mucosal vaccine platforms may merit further development, as sand fly transmission occurs through the skin and may require robust local immune protection at the site of inoculation. Vaccine strategies that induce tissue resident memory T cells in the skin could potentially provide more rapid and durable protection by promoting a localized

immune response upon parasite exposure[33]. Additionally, vaccines, combined with more effective treatments such as shorter-course LAmB regimens and vector control strategies such as insecticide treated wall linings, could help move VL programs closer to transmission elimination rather than only achieving public health elimination[4]. Vaccine deployment in post-validation settings should be planned in advance. Bangladesh and other countries that achieve elimination may need context-specific strategies for vaccine introduction to help preserve elimination gains and reduce the risk of resurgence from imported cases or hidden reservoirs such as PKDL. These strategies could identify target populations (*e.g.*, endemic upazilas, border regions, high-risk groups), integration with existing surveillance and health systems, cold-chain and delivery logistics, and monitoring frameworks to assess vaccine impact on transmission. Early planning may help to ensure that once a vaccine is licensed, it can be deployed more efficiently to support elimination gains and reduce the risk of future outbreaks[9,16].

Table 1 summarizes the current status of VL vaccine development, highlights major scientific and programmatic gaps, and outlines priority actions needed to support sustainable elimination. The table synthesizes key themes spanning the vaccine imperative, current development landscape, scientific and funding barriers, and strategic priorities for 2026 and beyond.

6. Conclusions

Bangladesh's 2023 VL elimination validation was a landmark public health achievement, showing that elimination is achievable with existing tools. However, this achievement remains fragile and depends on sustained programmatic vigilance to prevent resurgence. Vaccination may become an important tool for sustaining VL elimination, but its precise role remains uncertain until stronger clinical and programmatic evidence is available. Although current control strategies have achieved major gains in some settings, their long-term durability will depend on context-specific factors, continued surveillance, and health-system capacity. The current vaccine pipeline remains limited, and the absence of Phase III VL-specific efficacy data means that near-term public health impact should be interpreted cautiously. Accordingly, vaccine development should be viewed as a high-priority research and implementation agenda rather than a proven solution at this stage. Bangladesh has demonstrated what is possible; the remaining challenge is to make elimination durable rather than precarious. Future progress will depend on generating robust efficacy data, defining target product profiles, and aligning vaccine development with elimination program needs.

Conflict of interest statement

No potential conflicts of interest are reported by the author.

Funding

The research received no external funding.

AI disclosure

During preparation of this manuscript, the author used Perplexity for the purposes of section drafts. The author has reviewed and edited the output and takes full responsibility for the content of this publication.

Authors' contributions

MAS was responsible for conceptualization, writing original draft, reviewing and editing of the manuscript.

References

- [1] World Health Organization. *Bangladesh achieves historic milestone by eliminating kala-azar as a public health problem*. 2023. [Online]. Available from: <https://www.who.int/news/item/31-10-2023-bangladesh-achieves-historic-milestone-by-eliminating-kala-azar-as-a-public-health-problem>. [Accessed on 3 June 2026].
- [2] Gupta PCS. History of Kala-Azar in India. *Ind Med Gaz* 1947; **82**(5): 281-286.
- [3] Nagi N. Bangladesh eliminates visceral leishmaniasis. *Lancet Microbe* 2024; doi: [https://doi.org/10.1016/S2666-5247\(24\)00028-4](https://doi.org/10.1016/S2666-5247(24)00028-4).
- [4] World Health Organization. *Leishmaniasis: 20 years of progress towards elimination in the WHO African Region*. 2025. [Online]. Available from: <https://www.who.int/publications/i/item/9789290315766>. [Accessed on 3 June 2026].
- [5] Geto AK, Berihun G, Berhanu L, Desye B, Daba C. Prevalence of human visceral leishmaniasis and its risk factors in Eastern Africa: A systematic review and meta-analysis. *Front Public Health* 2024; **12**: 1488741. doi: <https://doi.org/10.3389/fpubh.2024.1488741>.
- [6] Chatterjee M, Roy S, Croft SL. Challenges in sustaining the elimination of visceral leishmaniasis in India. *Int Health* 2025; **17**(6): 863-865.
- [7] Mo AX, Pesce J, Fenton Hall B. Visceral leishmaniasis control and elimination: Is there a role for vaccines in achieving regional and global goals? *Am J Trop Med Hyg* 2016; **95**(3): 514-521.
- [8] World Health Organization. *Strategic framework for the elimination of visceral leishmaniasis as a public health problem in eastern Africa 2023–2030*. 2024. [Online]. Available from: <https://www.who.int/publications/i/item/9789240094208>. [Accessed on 3 June 2026].
- [9] Chowdhury R, Hazarika A, Sultana S, Hossain MS, Saha S, Nabi SG, et al. Elimination of visceral leishmaniasis as a public health problem in Bangladesh: Lessons learned and questions remaining. *PLoS Negl Trop Dis* 2026; **20**(2): e0013949. doi: <https://doi.org/10.1371/journal.pntd.0013949>.
- [10] Paul S, Basher A, Aftab KA, Murshed KM, Kader MA, Chowdhury FR. Relapse Kala-azar: A potential threat to sustaining public health elimination in Bangladesh and ways to overcome it. *J Med* 2025; **26**: 131-141.
- [11] Sundar S. Drug resistance in Indian visceral leishmaniasis. *Trop Med Int Health* 2001; **6**(11): 849-854. doi: [10.1046/j.1365-3156.2001.00778.x](https://doi.org/10.1046/j.1365-3156.2001.00778.x).
- [12] World Health Organization. *African Nations unite to eliminate visceral leishmaniasis and boost cross-border collaboration for NTDs*. 2025. [Online]. Available from: <https://www.who.int/news/item/22-05-2025-african-nations-unite-to-eliminate--visceral-leishmaniasis-and-boost-cross-border-collaboration>. [Accessed on 3 June 2026].
- [13] Alvar J, den Boer M, Dagne D. Towards the elimination of visceral leishmaniasis as a public health problem in east Africa: Reflections on an enhanced control strategy and a call for action. *Lancet Global Health* 2021; **9**: e1763-e1769. doi: [https://doi.org/10.1016/S2214-109X\(21\)00392-2](https://doi.org/10.1016/S2214-109X(21)00392-2).
- [14] Rao GR, Kishore MRR, Singh R, Haritha K. Diagnosis of post Kala Azar dermal leishmaniasis in nonendemic areas: A clinical challenge. *Clin Dermatol Rev* 2022; **6**(1): 56.
- [15] Zijlstra EE, Alves F, Rijal S, Arana B, Alvar J. Post-kala-azar dermal leishmaniasis in the Indian subcontinent: A threat to the South-East Asia

[1] World Health Organization. *Bangladesh achieves historic milestone by*

- Region Kala-azar Elimination Programme. *PLoS Negl Trop Dis* 2017; **11**(11): e0005877. doi: <https://doi.org/10.1371/journal.pntd.0005877>.
- [16] Ghosh D, Sagar S, Uddin MR, Rashid MU, Maruf S, Nath R, et al. Post kala-azar dermal leishmaniasis burden at the village level in selected high visceral leishmaniasis endemic upazilas in Bangladesh. *Int J Infect Dis* 2024; **147**: 107213. doi: <https://doi.org/10.1016/j.ijid.2024.107213>.
- [17] Fan Y, Gu Y, Tong X, He Y, Li Q, Chen K, et al. Efficacy and safety of different drugs for the treatment of leishmaniasis: A systematic review and network meta-analysis. *Front Cell Infect Microbiol* 2025; **15**: 1717863. doi: <https://doi.org/10.3389/fcimb.2025.1717863>.
- [18] Zhang H, Yan R, Liu Y, Yu M, He Z, Xiao J, et al. Progress in antileishmanial drugs: Mechanisms, challenges, and prospects. *PLoS Negl Trop Dis* 2025; **19**(1): e0012735. doi: <https://doi.org/10.1371/journal.pntd.0012735>.
- [19] Chowdhury R, Chowdhury V, Faria S, Islam S, Maheswary NP, Akhter S, et al. Indoor residual spraying for kala-azar vector control in Bangladesh: A continuing challenge. *PLoS Negl Trop Dis* 2018; **12**(10): e0006846. doi: <https://doi.org/10.1371/journal.pntd.0006846>.
- [20] Poché DM, Garlapati RB, Mukherjee S, Torres-Poché Z, Hasker E, Rahman T, et al. Bionomics of *Phlebotomus argentipes* in villages in Bihar, India with insights into efficacy of IRS-based control measures. *PLoS Negl Trop Dis* 2018; **12**(1): e0006168. doi: <https://doi.org/10.1371/journal.pntd.0006168>.
- [21] Garlapati R, Iniguez E, Serafim TD, Mishra PK, Roj B, Sinha B, et al. Towards a sustainable vector-control strategy in the post Kala-Azar elimination era. *Front Cell Infect Microbiol* 2021; **11**: 641632. doi: <https://doi.org/10.3389/fcimb.2021.641632>.
- [22] Picado A, Das ML, Kumar V, Kesari S, Dinesh DS, Roy L, et al. Effect of village-wide use of long-lasting insecticidal nets on visceral leishmaniasis vectors in India and Nepal: A cluster randomized trial. *PLoS Negl Trop Dis* 2010; **4**(1): e587. doi: <https://doi.org/10.1371/journal.pntd.0000587>.
- [23] Ochol D, Haile K, Onduma N, Yohanes T, Kamara K. Elimination of visceral leishmaniasis in Ethiopia: Cross-sector collaboration and cost sharing to promote sustainability. *Int J Infect Dis* 2025; **152**: 107800. doi: <https://doi.org/10.1016/j.ijid.2025.107800>.
- [24] Alvar J, Beca-Martínez MT, Argaw D, Jain S, Aagaard-Hansen J. Social determinants of visceral leishmaniasis elimination in Eastern Africa. *BMJ Global Health* 2023; **8**: e012638. doi: <https://doi.org/10.1136/bmjgh-2023-012638>.
- [25] Oliaro P, Mondal D, Diro E, Mpanju-Shumbusho W. Visceral leishmaniasis elimination in South Asia: Lessons learnt can inform disease elimination in East Africa. *BMJ Global Health* 2026; **11**: e023521. doi: <https://doi.org/10.1136/bmjgh-2026-023521>.
- [26] Stanford University. *Human-Centered Artificial Intelligence*. 2026. [Online]. Available from: <https://hai.stanford.edu/ai-index/2026-ai-index-report/medicine>. [Accessed on 3 June 2026].
- [27] Engwerda CR, Matlashewski G. Development of Leishmania vaccines in the era of visceral leishmaniasis elimination. *Trans R Soc Trop Med Hyg* 2015; **109**(7): 423–424.
- [28] Le Rutte EA, Coffeng LE, Malvoti S, Kaye PM, de Vlas SJ. The potential impact of human visceral leishmaniasis vaccines on population incidence. *PLoS Negl Trop Dis* 2020; **14**(7): e0008468. doi: <https://doi.org/10.1371/journal.pntd.0008468>.
- [29] Dinc R. *Leishmania* vaccines: The current situation with its promising aspect for the future. *Korean J Parasitol* 2022; **60**(6): 379–391.
- [30] World Health Organization. *Leishmaniasis vaccines product development and existing challenges*. 2024. [Online]. Available from: https://cdn.who.int/media/docs/default-source/immunization/pdvac/pdvac-2025/day-2/5.-leishmaniasis-vaccine-development.pdf?sfvrsn=e0d9df06_1. [Accessed on 3 June 2026].
- [31] Yona C, Dey AK, Moshiri E, Lupala A, Macha M. Leishmaniasis vaccine development: A review of current candidates and cross-species protection potential. *Parasitologia* 2026; **6**(2): 16.
- [32] Ayala A, Llanes A, Leonart R, Restrepo CM. Advances in *Leishmania* vaccines: Current development and future prospects. *Pathogens* 2024; **13**(9): 812.
- [33] Passero LFD, Cavallone IN, Araújo Flores GV, de Lima Melchert SS, Laurenti MD. An overview of the factors related to *Leishmania* vaccine development. *Vaccines (Basel)* 2026; **14**(1): 54.
- [34] European partnership on one health antimicrobial resistance (OHAMR). *Joint transnational call* 2026. 2026. [Online]. Available from: <https://ohamr.eu/calls/call-2026-new-treatments-to-tackle-amr/>. [Accessed on 3 June 2026].
- [35] Drugs for neglected diseases initiative (DNDi). *Six African nations commit to eliminate deadly neglected disease visceral leishmaniasis*. 2025. [Online]. Available from: <https://dndi.org/press-releases/2025/six-african-nations-commit-eliminate-visceral-leishmaniasis/>. [Accessed on 3 June 2026].
- [36] Kaye PM, Matlashewski G, Mohan S, Rutte EL, Mondal D, Khamesipour A, et al. Vaccine value profile for leishmaniasis. *Vaccine* 2023; **41**(2): S153–S175.
- [37] Mohan S, Revill P, Malvoti S, Malhame M, Sculpher M, Kaye PM. Estimating the global demand curve for a leishmaniasis vaccine: A generalisable approach based on global burden of disease estimates. *PLoS Negl Trop Dis* 2022; **16**(6): e0010471. doi: <https://doi.org/10.1371/journal.pntd.0010471>.

Publisher's note

The Publisher of the *Journal* remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Edited by Pan Y, Lei Y, Zhang Q