International Journal of Community Medicine and Public Health
Kaur P et al. Int J Community Med Public Health. 2023 Dec;10(12):5084-5090
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20233543

Review Article

Strength in struggle: unravelling the journey of national vector borne disease control programme India: a comprehensive SWOT analysis

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Received: 01 November 2023
Accepted: 08 November 2023

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ABSTRACT

India, like many other regions, faces the substantial burden of vector-borne diseases. Initially confined to tropical and sub-tropical regions, vector-borne diseases are now spreading to new geographies due to increasing unplanned urbanization, changes in land use, growing international travel, and the impact of climate and environmental dynamics. To address these challenges, India implemented the National Vector Borne Disease Control Program (NVBDCP) in 2003-04, which targets the prevention and control of the six vector-borne diseases. Over the years, numerous initiatives have been undertaken to combat the challenges posed by vector-borne diseases in India. The successes, such as streamlined resource utilization and the introduction of effective tools, have led to substantial reductions in disease burden. Nevertheless, issues like manpower shortages, logistical hurdles, and a lack of research resources remain as challenges. Moreover, the program must confront emerging threats posed by urbanization, climate change, and resistance to treatments. NVBDCP's roadmap for the future includes embracing opportunities like vaccine development, and research, as well as fostering collaborations with partners. By addressing its weaknesses and effectively managing the threats at hand, the program can continue its vital mission of combatting vector-borne diseases in India. The implementation of these strategies is essential to ensure the sustained success of disease control and prevention efforts in the country.

Keywords: Vector borne diseases, National Vector Borne Diseases Control Programme, SWOT analysis, Health programme, Malaria, Dengue

INTRODUCTION

Vector-borne diseases pose a significant global health challenge, causing approximately 0.7 million deaths annually and contributing to over 17% of all infectious diseases.[1] Among these diseases, malaria, a parasitic infection, remains one of the most prevalent, with an estimated 219 million cases worldwide and resulting in 0.4 million deaths each year. Dengue, the most widespread viral infection, affects around 96 million symptomatic cases and causes 40,000 deaths annually.[1] Initially confined to tropical and sub-tropical regions, vector-borne diseases are now spreading to new geographies due to increasing unplanned urbanization, changes in land use, growing international travel, and the impact of climate and environmental dynamics.[2]

India, like many other regions, faces the substantial burden of vector-borne diseases. Among the important vector-borne diseases in India are Chikungunya, Dengue, Japanese encephalitis, Kala Azar, Lymphatic Filariasis, and Malaria. Malaria is particularly prevalent, affecting approximately 90% of the population in malaria-endemic regions, with 80% of cases reported from just 20% of the population.[3] Dengue has also been a cause of concern, with 193,245 cases and 346 deaths reported until 2021. Moreover, 257 districts in 21 states and Union territories, with a population of 650 million, are at risk for lymphatic filariasis, while an estimated 165.4 million people in 54 endemic districts across 4 states are at risk for kala azar.[3] The country has experienced various outbreaks of Japanese encephalitis, with an annual incidence ranging between 1714 and 6594 cases, leading to deaths in the range of 367 to 1665. Chikungunya has also affected a significant number of people, with 119,070 suspected cases and 11,890 confirmed cases reported so far.[3]

To address these challenges, India had implemented the National Vector Borne Disease Control Program (NVBDCP) in 2003-04, which targets the prevention and control of these six vector-borne diseases.[3] Although efforts to decrease the burden and prevent mortality have shown progress, vector-borne diseases remain a major public health concern in the country. Continued and increased prevention and control measures are crucial to mitigate their impact and protect the health of the population. The general strategies for NVBDCP are given in Table 1.

Table 1: The general strategies for NVBDCP.

Strategy	Components under the strategy
Integrated vector management	Anti-larval measures
	Anti-adult measures
	Protection against mosquito bites
Disease management	Early case detection, complete effective treatment, strengthening of referral services
Supportive interventions	Behavioural change communication, intersectoral convergence, and human resource development through capacity building
Vaccination	Against Japanese encephalitis
Annual mass drug administration	Against lymphatic filariasis

SWOT ANALYSIS

Strengths

Umbrella programme for 6 vector-borne diseases, an integrated approach, which all have the same basic strategies for vector control and management

The National Vector Borne Disease Control Programme (NVBDCP), launched in 2004, marked a ground-breaking milestone as the first-ever umbrella program that encompassed six vector-borne diseases and four national programs. This innovative approach unified various programs that shared similar strategies for vector control and management. However, prior to NVBDCP, these programs operated independently, each with its own staff, policies, and measures.[4,5] By consolidating these diverse programs under one roof, the NVBDCP achieved several significant advantages. Firstly, it alleviated the overburden of resources, as it eliminated the need for redundant efforts and duplicated resources across multiple programs. This consolidation also saved valuable time and manpower, as administrative tasks, planning, and coordination were streamlined.

Time-to-time modifications and well-developed policy development process for drugs and diagnostics in vector management

In 2005, for example, when the case detection efforts for malaria were found to be insufficient, the NVBDCP introduced rapid diagnostic tests (RDT) and artemisinin combination therapy (ACT) for early diagnosis and treatment.[4] The impact of these interventions became apparent in 2006 when malaria case detection significantly increased.[1] Likewise, in 2009, India prohibited the use of artemisinin monotherapy.[6] To address the resistance to the partner drug sulfadoxine-pyrimethamine (SP), the program in North Eastern States transitioned to artemether-lumefantrine as the ACT.[7] The drug policy then recommended commencing antimalarial therapy only after confirming the diagnosis through parasitological means. This approach aimed to reduce the development of drug resistance, minimize side effects, lower drug expenses, and enhance the management of other febrile illnesses. During 2009 and 2010, the current first-line therapy for *P. falciparum*, AS+SP, exhibited a 98.8 percent treatment success rate across 25 sites in India over a 28-day follow-up period.[8]

The joint NIMR-NVBDCP national drug resistance monitoring system conducts comprehensive and long-term assessments of the treatments used for both species, employing concurrent in vivo and molecular methods. The policy development process is now well-established, collaborative, and grounded in evidence-based practices, complemented by expert opinion. Lastly, the policy has been translated into easily understandable case management guidelines for use by clinicians.[6,9]

A study was conducted (2006–2011) to assess the impact of artemisinin combination therapy and long-lasting insecticidal nets on forest malaria incidence in tribal villages of India, 2006–2011. ACT, and LLINs along with ACT, effectively reduced malaria incidence in a closely monitored population living in a forest ecotype.[11] Furthermore, in 2012, the NVBDCP introduced bivalent RDTs to address the challenge of dual strains of malaria. This step was taken to improve the accuracy of diagnosis and ensure appropriate treatment for patients.

These collective efforts aimed at integrated vector management, focusing on early diagnosis and treatment of vector-borne diseases. (Figure 1). From 2007 to 2015, there was a remarkable reduction in malaria morbidity by 25.3% (against a target of 25%) and a significant decline in malaria-related deaths by 78.1% (against a target of 50%), with 89 and 83 deaths reported in 2021 and 2022 (Figure 2).[4]

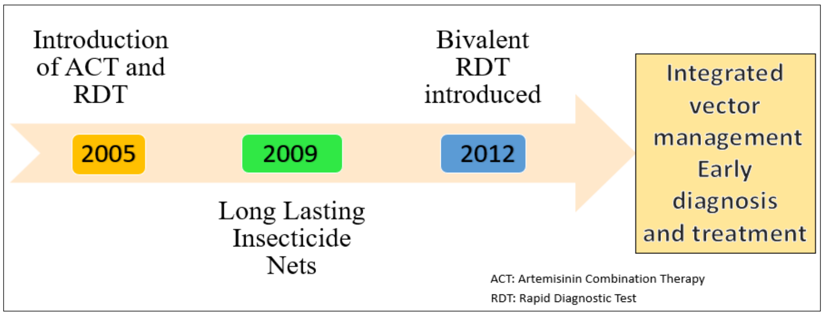

Figure 1: Timely modifications in NVBDCP for malaria control.

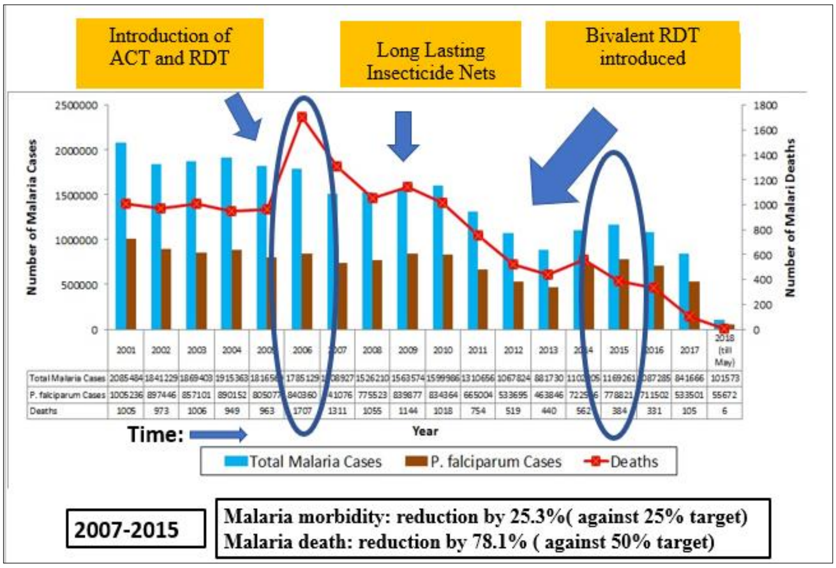

Figure 2: Initiatives and achievements in malaria control in India (2001-2018).[4]

Surveillance and monitoring

For Dengue, a comprehensive surveillance system has been established. In 2007, Sentinel Surveillance Hospitals equipped with laboratory support were set up in endemic states to enhance the diagnostic capacity for Dengue. Over the years, the number of these hospitals has increased significantly, reaching 170 in 2009 and further expanding to 673 by 2019. This wider network of surveillance hospitals ensures broader coverage for disease monitoring and diagnosis.[4]

Similarly, for malaria, NVBDCP has implemented the malaria monthly information system (MMIS). This digital system is designed to collect data related to malaria cases according to the categories defined in the National Malaria Elimination Framework. MMIS allows for the systematic and comprehensive collection of data on malaria cases, including information on disease transmission, treatment outcomes, and other relevant epidemiological data.[4] A study conducted on Evaluation of Malaria Surveillance System in Punjab, India, 2020 found that malaria surveillance system was useful in analyzing the trends of morbidity and mortality and for generating data to drive policy decisions.[12]

Focused interventions

The National Framework for Malaria Elimination 2016-2030 outlines a comprehensive plan for focused interventions to achieve the ambitious goal of eliminating malaria, and eradicating all indigenous cases, across the entire country of India by 2030.[13] In 2017, the malaria elimination demonstration project (MEDP) was initiated in Mandla, aiming to completely eliminate indigenous malaria cases. This project employed active surveillance and case management through the T4 approach (Track fever, test fever, treat patient, and track patient), along with vector control measures such as indoor residual sprays and long-lasting insecticidal nets. The interventions implemented as part of MEDP have successfully led to the sustainable achievement of zero indigenous malaria cases in Mandla.[14]

Similarly, to attain the elimination of Kala Azar (which is endemic in eastern States of India namely Bihar, Jharkhand, Uttar Pradesh and West Bengal), a comprehensive strategy has been implemented since 2016. One of the key components of this strategy is the implementation of Indoor Residual Spray (IRS) twice a year in all households across all districts. Synthetic pyrethroids are used during IRS to effectively target and control the vector responsible for transmitting Kala Azar.[4]

External and government aid to the programme

In 2010, the Global Fund supported the intensified malaria control project (IMCP) in northeastern Indian states and Odisha, with inputs like human resources, mobility support, and RDT kits. By 2015, the IMCP led to a 30.69% increase in surveillance activities and a 68.71% reduction in malaria-related deaths in project states, surpassing the figures for other states.[13,15,16] Government support, including financial aid from NITI Aayog, strengthened India's National Vector Borne Disease Control Program (NVBDCP). NITI Aayog provided 20 crore rupees to Bihar, Jharkhand, and West Bengal for better disease control, addressing implementation issues in these areas.[4]

Behavioural change communication

A study conducted by the Indian Council of Medical Research (ICMR) in 2017 examined the impact of Behavioral Change Communication (BCC) on the usage of long-lasting insecticide nets (LLINs).[17] The study involved interviewing 2,970 households, comprising 15,003 individuals who were present in their respective households on the night before the survey. The results of the study revealed that nearly 98% of the households owned at least one LLIN. Furthermore, it was found that 59.4% of the surveyed population reported using an LLIN on the previous night, indicating a significant adherence to LLIN usage.[17] Similarly, in 2022, social media toolkits were launched for mass drug administration, and regional BCC/IEC tools were introduced in endemic areas to further enhance awareness regarding vector-borne diseases.[4]

Weaknesses

Shortage of manpower

Shortages in key personnel are undermining the effectiveness of vector-borne disease control in India. With 15 unfilled district VBD consultant positions out of 95, supervision and guidance for vector control activities at the district level are compromised. A shortage of 124 lab technicians out of 178 positions leads to delays in diagnosis and treatment. Inadequate Multipurpose Health Workers, with 40,000 positions unoccupied out of 80,000, limits community outreach and health education efforts. Moreover, a scarcity of qualified entomologists' hampers vector surveillance and the collection of crucial entomological data, impacting the understanding of vector-borne disease dynamics. [4]

Implementation challenges in roll-out of interventions

One of the most pressing issues is the distribution of insecticide-treated bed nets (ITNs) in remote and geographically inaccessible areas, particularly in the northeastern states of India. These remote regions often lack the necessary infrastructure, transportation facilities, and logistical support to effectively deliver essential vector control measures, making it a significant hurdle.[18]

Additionally, a cross-sectional study conducted in malaria-endemic ethnic communities of Assam, Northeast India, revealed challenges related to the residual bio-efficacy and durability of field-distributed long-lasting insecticidal nets (LLINs). The study found that LLINs distributed in 2011, following three years of community use, retained residual bio-efficacies ranging from 57% to 79%. However, the serviceable life of these nets was slightly less than three years, indicating a need for replacement.[19] Furthermore, reasons for the refusal to use LLINs included various factors such as inadequate time for rearranging household items, the presence of young children, concerns about unpleasant smells, staining of walls, and potential threats to activities like bee-keeping or Eri silk moth cultivation.[20] To address these challenges, strategies such as social marketing of LLINs at subsidized prices or providing them for free to socially/economically disadvantaged populations, coupled with ensuring the availability of nets during harvesting seasons, could encourage their adoption.[21]

Variable state government commitment and improper implementation of vector control measures

A study conducted for Evaluation of malaria control programme in three selected districts of Assam, India found that reported rates of 69-99% contrasting sharply with actual rates of 17-43%.

Additionally, discrepancies in 67 out of 180 blood smears raise concerns about the accuracy of malaria diagnosis, and key program components like Village Health Sanitation Committees and communication activities are insufficiently executed. Similarly, essential criteria for preparing micro action plans are not consistently adhered to, and several critical program components, such as the formation of village health sanitation committees and information education communication (IEC) activities, are inadequately executed.[22,23]

Legislation limited to only a few cities

A limitation of the NVBDCP is that certain measures and legislations are enforced only by a few cities, such as Mumbai, Chandigarh, and Delhi Municipal Corporations. These cities have specific regulations in place to address vector-borne diseases, including regulations related to water storage, waste management, and vector control activities.[4]

The lack of comprehensive legislation in all cities and regions undermines the consistency and coherence of vector control efforts nationwide, potentially leaving other areas vulnerable to outbreaks and transmission.

Opportunities

Opportunities for vaccine development

JAIVAC-1: In 2015, the International Centre for Genetic Engineering and Biotechnology in New Delhi developed JAIVAC-1, the first Indian recombinant vaccine targeting two blood-stage antigens of *P. falciparum*, the malaria parasite. This was a significant step in vaccine development for a disease that affects millions of people worldwide, particularly in tropical and subtropical regions. However, JAIVAC-1 is still in the experimental phase, and its efficacy had not been conclusively determined through extensive clinical trials.[24]

Operational research

Given India's vast size and diverse landscapes, tailoring strategies and treatment policies to specific settings is crucial. Utilizing micro-stratification and local data enables the development of context-specific interventions, especially in regions with varying epidemiology, ecological habitats, and health infrastructure. To effectively combat drug and vector resistance, operational research is imperative. This research should encompass diverse geographical areas, including small towns, medium-sized cities, and townships, to gain insights into local resistance dynamics. These insights inform targeted interventions, improving disease management and public health outcomes.[22]

Screening of migrated laborers

Screening the population of migrant laborers from endemic districts at construction sites and industries is a significant preventive measure. By implementing this preventive approach, early identification and treatment of vector-borne diseases can be achieved, mitigating the risk of disease transmission to new regions. This proactive strategy not only safeguards the health of the migrant population but also contributes to the containment of potential disease outbreaks, promoting overall public health and well-being.[4,13]

GIS mapping

Geographic Information System (GIS) can be used to map the prevalence of vector-borne diseases. This technology serves as a valuable tool for surveillance and allows for the identification of trouble spots at the village level within a district, which is the smallest administrative unit with computer facilities. Adopting these advancements can strengthen the program's effectiveness in detecting and responding to vector-borne diseases.[26]

Threats

Rap*id unplanned urbanization*

Urban planning and development policies must prioritize sustainable and well-regulated urban growth to create healthier and safer living environments. Ensuring access to clean drinking water, proper sanitation facilities, and efficient waste management systems are essential steps in mitigating the breeding of disease-carrying vectors. Public health authorities must focus on proactive vector control measures in urban slums, such as targeted mosquito eradication campaigns and community-based awareness programs. These efforts can not only reduce the mosquito population but also empower residents to take preventive actions.[4]

Climate change

Climate change can lead to changes in rainfall patterns, humidity, and temperature, all of which can influence mosquito breeding and the survival of pathogens within their vectors. Warmer temperatures can shorten the incubation period of the malaria parasite inside mosquitoes, allowing for more rapid transmission. One region where evidence of climate change and its impact on vector-borne diseases has been documented is the Nanital district of Uttarakhand, India. In 2011, studies conducted in this area revealed unusual ecological shifts. Notably, higher densities of Anopheles fluviatilis mosquitoes were observed during the months of March and April, which were previously unaffected by malaria transmission. Concurrently, cases of *P. falciparum* malaria, a severe form of the disease, were reported in these months, raising concerns about the changing disease landscape.[27]

Drug and insecticide resistance

Widespread resistance in *Anopheles culicifacies* to DDT, a once highly effective insecticide for mosquito control, has reduced its impact on malaria transmission due to overuse and misuse. Resistance to malathion, another common insecticide, has also been identified in these mosquitoes.[4] Resistance to artemisinin and its derivatives, the primary anti-malarial drugs, poses a growing concern with the potential to complicate treatment and control of Plasmodium falciparum, increasing morbidity and mortality rates.

Effective management strategies for insecticide resistance are vital to support malaria control efforts.[28,29] Additionally, the emergence of chloroquine resistance in *P. vivax*, as seen in the Western Pacific region, further complicates malaria control.[30] Appropriate case management is essential to achieve malaria elimination goals. India's malaria treatment policy, last revised in 2013, requires informed updates, guided by evidence-based WHO guidelines, to select tailored strategies for malaria prevention and case management, considering different transmission settings.[31]

Geographical and seasonal challenges

The geographical inaccessibility of certain remote areas, particularly in the northeastern states of India, presents a formidable challenge. These regions often lack proper infrastructure, transportation facilities, and logistical support, making it difficult to reach them with essential vector control measures such as the distribution of insecticide-treated bed nets or indoor residual spraying. In some areas, such as Dakshina Kannada and other regions, vector-borne diseases are more prominent during specific seasons, notably during winter and monsoon periods. These seasonal spikes create added complexity for disease control efforts, as the heightened risk during these periods demands increased vigilance and rapid response to prevent outbreaks.[22,23]

Table 2 summarizes the SWOT analysis of NVBDCP.

Table 2: SWOT analysis of NVBDCP.

Strengths	Weaknesses
Umbrella programme for 6 vector-borne diseases, an integrated approach, which all have the same basic strategies for vector control and management	Shortage of manpower
Time-to-time modifications and successful initiatives in vector management	Implementation challenges in roll-out of interventions
Surveillance and monitoring	Variable state government commitment and improper implementation of vector control
Government and external Aid to the programme	Measures
Focused interventions	Legislation limited to only a few cities
Behavioural change communication	
Opportunities	**Threats**
Opportunities for vaccine development	Rapid unplanned urbanization
Operational research	Climate change
Screening of migrated laborers	Drug and insecticide resistance
GIS mapping	Geographical and seasonal challenges

CONCLUSION

In conclusion, the NVBDCP has charted an innovative path in public health since its inception in 2004. By consolidating various programs and introducing novel interventions, it has significantly improved the landscape of vector-borne disease control in India. While the program has demonstrated remarkable strengths and opportunities, it also faces persistent challenges and threats. The successes, such as streamlined resource utilization and the introduction of effective tools, have led to substantial reductions in disease burden.

Nevertheless, issues like manpower shortages, logistical hurdles, and a lack of research resources remain as challenges. Moreover, the program must confront emerging threats posed by urbanization, climate change, and resistance to treatments. NVBDCP's roadmap for the future includes embracing opportunities like vaccine development, and research, as well as fostering collaborations with partners.

By addressing its weaknesses and effectively managing the threats at hand, the program can continue its vital mission of combatting vector-borne diseases in India. The implementation of these strategies is essential to ensure the sustained success of disease control and prevention efforts in the country.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Kaur P, Verma P. Strength in struggle: unravelling the journey of national vector borne disease control programme India: a comprehensive SWOT analysis. Int J Community Med Public Health 2023;10:5084-90.