



Review Article

A narrative review of tuberculosis elimination in India: Challenges, progress, and the strategics towards elimination by 2025

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Abstract

Introduction: Tuberculosis (TB) is one of the most deadliest infectious diseases in the world, causing 1.6 million deaths annually, with India reporting the highest number of cases. In 2022, India accounted for 26% of the world's TB cases, with a high prevalence rate of 316 per 100,000 people. The rise in multidrug-resistant TB (MDR-TB) further complicates the situation. The Indian government has set an ambitious goal to eliminate TB by 2025 through its National Strategic Plan. However, challenges such as underreporting, access to treatment, stigma, and the effects of the COVID-19 pandemic continue to hinder progress.

Materials and Methods: A narrative review was conducted to assess this challenges and progress in TB elimination in India from 2012 to 2024. Articles were sourced from databases like PubMed, Scopus, NHM & WHO reports, focusing on TB epidemiology, challenges & strategies. The review included studies published in English, while excluding irrelevant studies or those lacking methodological rigor. Data on TB incidence, prevalence, challenges, and interventions were extracted and analyzed. The review synthesizes findings qualitatively, evaluating trends and progress towards India's 2025 TB elimination goal.

Observation: The results of this narrative review highlighted the persistent burden of tuberculosis (TB) in India, despite various government efforts. Key challenges include underreporting, diagnostic delays, and the rise of drug-resistant strains. Socio-economic factors, stigma, and limited healthcare access further hinder control. The findings emphasize the need for enhanced public awareness, improved healthcare infrastructure, better treatment adherence, and a multi-pronged approach to address the burden of latent TB infection (TBI) to achieve significant progress in TB control & meet the 2025 TB elimination target.

Conclusion: In conclusion, while India faces significant challenges in combating tuberculosis, including underreporting, MDR-TB, and gaps in healthcare infrastructure, its ambitious goal of TB elimination by 2025 remains achievable. Continued efforts in enhancing diagnostic tools, improving treatment access, and addressing socio-economic factors are crucial for success. India's progress could serve as a global model in the fight against tuberculosis.

Keywords: Tuberculosis (TB), Multidrug-resistant TB (MDR-TB), TB elimination, India, Healthcare infrastructure.

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1. Introduction

Tuberculosis (TB) is one of the most deadliest infectious diseases in the world, killing more people annually than HIV & malaria combined, and it remains a leading cause of death, particularly in developing countries. Globally, tuberculosis remains the second leading infectious disease killer after COVID-19, with an estimated 1.6 million deaths annually.^{1,15} Despite significant advancements & research in diagnosis, treatment & prevention, the incidence of tuberculosis in India

has been on the rise. According to the World Health Organization (WHO), India has accounted for 26% of the world's TB cases in 2022, making it the country with the largest number of cases worldwide.² The prevalence of TB in India is 316 per 100,000 people, much higher than the World Health Organization's earlier estimate of 193 per 100,000. By 2021, India has accounted for over 1.9 million TB cases & TB-related deaths rose by 13%.^{3,14} Globally, tuberculosis infected approximately 10.6 million people in 2022 and caused 1.3 million deaths among those without HIV.²

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Another major concern is the prevalence of multidrug-resistant TB (MDR-TB) in India. In 2021, approximately 119,000 cases of MDR-TB were reported in the country, further complicating efforts to combat the disease.³ Indian government has set an ambitious efforts to combat & eliminate tuberculosis (TB) through various national programs, with the ultimate goal of eliminating the disease by 2025, five years ahead of the global target set by the United Nations Sustainable Development Goals (UN SDG). The centerpiece of this strategy is the National Strategic Plan (NSP) for Tuberculosis Elimination 2017-2025, which aims to reduce TB incidence, morbidity, and mortality by providing universal access to quality diagnosis and treatment.⁴ However, challenges persists including underreporting of cases, gaps in treatment access, stigma & the ongoing impact of the COVID-19 pandemic remain significant hurdles.⁵ Despite these obstacles & challenges, the government's strong dedication & commitment in eradicating TB, as evidenced by these ambitious programs, offers hope that the country may be able to meet its elimination target.

2. Materials and Methods

A narrative review was conducted to examine the current challenges, progress & strategic implementation related to TB elimination in India from 2012-2024.

2.1. Search strategy

Articles & reviews published in peer-reviewed journals were sourced from databases such as PubMed, Scopus, Google Scholar, World Health Organization (WHO) reports, particularly the Global Tuberculosis Reports from 2012 to 2024, Government of India publications, including the National Tuberculosis Elimination Program (NTEP) documents, annual reports, and updates. Statistical Data were sourced from National health surveys such as the National Family Health Survey (NFHS) and other government-released epidemiological data. Literature search were also sourced from international organizations such as the United Nations and Global Fund to Fight AIDS, Tuberculosis, and Malaria. To maximize the sensitivity of the search, a strategy was employed that integrated a variety of search terms, including synonyms and Medical Subject Headings (MeSH) terms in the case of PubMed. The search was performed using multiple databases, including PubMed and Scopus. Different combinations of these terms were applied using Boolean operators (AND, OR) to refine the search and obtain the most relevant results. The search was limited to studies published between 2012 and 2024 to ensure the inclusion of the most up-to-date data on tuberculosis elimination efforts in India.

2.2. Inclusion criteria

1. Studies and reports focusing on TB epidemiology, treatment strategies, MDR-TB prevalence, and elimination programs in India.
2. Articles published in English between 2012 and 2024.

3. Publications providing statistical data, policy updates, and programmatic evaluations.

2.3. Exclusion criteria

1. Studies unrelated to TB or with a global focus not specifically addressing India.
2. Articles lacking methodological rigor or with incomplete data.
3. Duplicates without new insights.

2.4. Data extraction

Key information on TB incidence, prevalence, mortality rates, and programmatic interventions were extracted.

2.5. Data analysis & synthesis

Qualitative synthesis was employed to integrate findings from diverse sources. Trends in TB epidemiology, the effectiveness of interventions, and the progress toward the 2025 elimination target were critically analyzed.

2.6. Limitations

The narrative nature of this review means that it may not encompass all existing studies or provide exhaustive statistical meta-analysis. Potential publication bias due to the focus on indexed journals and English-language sources. This comprehensive methodology ensures that the review presents a robust and reliable synthesis of the current state of TB elimination efforts in India.

3. Discussion

3.1. Tuberculosis burden In India

India continues to bear the highest burden of tuberculosis globally. According to the WHO Global Tuberculosis Report 2022, India accounted for 26% of the world's TB cases, with an estimated 1.9 million cases reported in 2021. The prevalence rate of TB in India is 316 per 100,000 people, significantly higher than the global average of 193 per 100,000. The mortality rate remains concerning, with over 400,000 deaths due to TB annually.^{1,3} According to one meta-analysis conducted by Chauhan et al⁶ (2023), who aimed to estimate the prevalence of tuberculosis infection (TBI) in India, focusing on geographies, sociodemographic profiles & various risk groups in Indian population. He further highlighted the alarming high burden of TBI, which is considered a precursor for the development of active tuberculosis (TB). According to their findings, the National Prevalence Survey of India (2019-2021) estimated a 31% TBI burden among individuals over the age of 15 years. The review demonstrated that regions with high active TB burdens, such as Delhi and Tamil Nadu, also showed a high prevalence of TBI. Chauhan et al. (2023) observed that TBI prevalence increases with age, with a pooled estimate of 41% across various studies, and the burden was found to be

particularly high in northern and southern regions of the country. The authors further emphasized that TBI is an essential public health concern as it poses a significant risk for developing active TB, especially among immunocompromised individuals. Despite the high prevalence, the prevention and treatment of TBI have not received adequate attention in India, which could hinder the country's efforts to end TB by 2025. Chauhan et al. (2023) used data from 77 studies published between 2013 and 2022, which included 38,767 individuals. The data were extracted from databases such as MEDLINE, EMBASE, CINAHL, and Scopus, and both tuberculin skin tests (TST) and interferon-gamma release assays (IGRA) were used to diagnose TBI. Their findings underscore the importance of addressing TBI as part of the comprehensive strategy to reduce TB transmission and prevent the progression to active disease.

3.2. National strategic plan for tuberculosis elimination 2017-2025

The National Strategic Plan (NSP) for Tuberculosis Elimination 2017-2025 has been the cornerstone of India's efforts to eliminate TB by 2025. The plan aims to reduce TB incidence, mortality, and morbidity through various strategies, including universal access to quality diagnosis and treatment, strengthening of TB services, and public-private partnerships. Key interventions under the NSP include the provision of free TB diagnostics and treatment, the roll-out of newer diagnostic techniques like CB-NAAT (Cartridge-Based Nucleic Acid Amplification Test), and the expansion of TB surveillance networks. The government's commitment to eliminating TB by 2025 is further emphasized through the TB-Mission 2025 initiative, which aims to intensify preventive measures, particularly in high-risk groups.⁴

According to a study conducted by Kuldeep Singh Sachdeva et al.,⁷ published in Expert Review of Respiratory Medicine in 2021, India has set an ambitious goal of eliminating tuberculosis (TB) by 2025, five years ahead of the global target. The study highlights the significant progress made through initiatives like the National Tuberculosis Elimination Programme (NTEP), but also underscores the challenges posed by overcrowding, poverty, malnutrition, and the impact of the COVID-19 pandemic. The author discusses India's extensive TB laboratory network, active case finding efforts, and policy interventions. Additionally, the study emphasizes the importance of multi-sectoral approaches and community involvement to achieve the TB elimination target. Despite these advancements, the study concludes that more efforts are required to meet the 2025 deadline. Another study conducted by Dhamnetiya et al. (2021),⁸ titled "Trends in incidence and mortality of tuberculosis in India over the past three decades: a joinpoint and age-period-cohort analysis," published in BMC Pulmonary Medicine, the incidence and mortality rates of tuberculosis (TB) in India have significantly declined from 1990 to 2019. The study utilized data from the Global Burden

of Disease Study 2019 to examine these trends and identify factors contributing to the TB burden in the country. Key findings include a notable decline in both TB incidence and mortality rates, with age-standardized incidence decreasing from 390.22 to 223.01 per 100,000 population and mortality from 121.72 to 36.11 per 100,000 population. The decline was more pronounced among females, with an annual average percent change (AAPC) of -2.21 for females compared to -1.63 for males. The study also found that incidence and mortality rates increased with age but showed improvements over time due to favorable period and cohort effects. However, despite this progress, the annual reduction rates in TB incidence and mortality are insufficient to achieve India's goal of TB elimination by 2025, highlighting the need for enhanced efforts in the National Tuberculosis Elimination Programme (NTEP), with a focus on detection, treatment, prevention, and healthcare infrastructure. The study underscores the importance of continued and strengthened efforts to eliminate TB in India, considering the impact of demographic and temporal factors on the national TB burden.

3.3. Challenges to TB elimination

Despite the ambitious goals set by the Indian government, several challenges persist in the fight against TB. These challenges include underreporting of TB cases, lack of timely diagnosis, stigma surrounding the disease, and inadequate treatment adherence. Underreporting remains a significant issue, with a large proportion of TB cases going undiagnosed or unreported due to poor healthcare infrastructure in rural and remote areas. Studies highlighted that many TB patients delay seeking care due to social stigma, which adversely impacts timely diagnosis and treatment initiation. A study conducted by Pai M et al. (2023)⁹ stated that India's ambitious goal of eliminating tuberculosis (TB) by 2025 faces substantial challenges due to the high burden of TB cases and mortality. Despite political commitment, achieving TB elimination requires substantial investment, particularly in the Revised National TB Control Program (RNTCP), which continues to face underfunding. The study highlights that key determinants such as poverty, undernutrition, and tobacco use must be tackled through intersectoral collaboration to ensure the success of the elimination strategy. Additionally, gaps in TB diagnosis, treatment, and care need to be addressed by modernizing diagnostic tools and engaging the private sector more effectively. The authors emphasize the importance of increased research, surveillance, and advocacy to combat TB comprehensively. Ultimately, the study concluded that the success of India's TB elimination goal will depend on the implementation of sustainable, well-funded strategies across various sectors. Another major challenge is the rising prevalence of MDR-TB. While treatment regimens for drug-resistant TB are available, their cost, complexity, and duration present significant barriers for patients. What makes TB especially perilous & life threatening is the rise of drug-resistant strains like multidrug-resistant TB (MDR-TB) & extensively drug-resistant TB (XDR-TB), which do not

respond to standard treatment regimens, leading to more complex, prolonged, and expensive treatments. The lack of awareness about MDR-TB, coupled with inadequate diagnostic capabilities in many regions, hampers efforts to control the disease. A study conducted by Jain et al.¹⁰ published in *Cureus* on March 28, 2023, assessed the knowledge, attitudes, and practices of 250 healthcare practitioners in India regarding multidrug-resistant tuberculosis (MDR-TB). The survey revealed that while most practitioners recognized MDR-TB as a growing concern and utilized GeneXpert assays for diagnosis, gaps remained in understanding aspects such as the role of linezolid as a second-line drug. Many practitioners referred patients to specialists rather than managing MDR-TB cases directly. The study emphasizes the need for targeted educational initiatives to enhance practitioners' capacity to diagnose, treat, and educate about MDR-TB, which is essential to achieve India's TB elimination target by 2025.

3.4. Progress toward the 2025 elimination goal

Despite these challenges, India has made some progress toward achieving the TB elimination target by 2025. The implementation of the NSP has led to increased TB case detection, expansion of diagnostic services, and improved access to treatment. The government's efforts to integrate TB services with other health programs, such as the National Health Mission, have facilitated better monitoring and intervention at the community level. Key successes include the introduction of the Nikshay Poshan Yojana, a scheme that provides nutritional support to TB patients, and the roll-out of the Universal Drug-Resistant Tuberculosis (DR-TB) program.⁴ However, while these initiatives are promising, the success of the NSP depends on the effective implementation of these programs at the grassroots level, particularly in underserved regions. The article "National TB Elimination Programme – What has Changed" by Khanna et al.,¹¹ published in the *Indian Journal of Medical Microbiology* (2022, Vol. 42, pp. 103–107;), provides a comprehensive overview of India's evolving tuberculosis (TB) control strategies. It highlights key milestones, including the National Strategic Plan for Tuberculosis Elimination (2017–2025) and its revisions, which aim to eradicate TB in India by 2025, five years ahead of global targets. The paper emphasizes advancements such as the adoption of innovative diagnostic tools like TrueNat MTB and CBNAAT, increased engagement with private healthcare providers, and active case-finding initiatives. Despite these strides, challenges like delayed diagnosis, multi-drug

resistant TB (MDR-TB), and high treatment dropout rates, particularly in the private sector, remain significant barriers. The authors stress the need for multisectoral approaches, enhanced diagnostics, and robust public-private collaboration to realize the goal of a TB-free India. To address the multi sectoral approach another study conducted by Arinaminpathy et al. (2021),¹² the cost-effectiveness of scaling up the Public-Private Interface Agency (PPIA) initiative, which aims to improve tuberculosis (TB) diagnosis, treatment adherence, and reporting in the private healthcare sector of Mumbai and Patna, India, has been evaluated. The PPIA has been shown to enhance TB notifications and treatment outcomes by offering high-quality diagnostic tests, free drugs, and adherence support to TB patients in the private sector. The study utilized cost data from the implementation of the PPIA in these cities, combined with transmission models, to estimate the cost per disability-adjusted life year (DALY) averted. In Mumbai, scaling up the PPIA to reach 50% of privately treated TB patients was found to be cost-effective across all thresholds. In Patna, the PPIA would be most cost-effective if it focused on improving treatment adherence rather than diagnosis, given the lower burden of drug-resistant TB in the area. These findings suggest that engaging the private sector in TB control is a cost-effective strategy, particularly when tailored to the specific needs and challenges of each location. The study underscores the importance of involving the private healthcare sector in accelerating TB control efforts in India, where a significant proportion of patients initially seek care in private facilities. According to the original research article published by Kumar et al.¹³ the study assessed the awareness and satisfaction of TB patients regarding the Revised National Tuberculosis Control Program (RNTCP) in India. Conducted as a community-based cross-sectional study with 205 participants from district tuberculosis and DOTS centers, the findings revealed that 41% of patients had poor awareness of TB, while 28% had good awareness. Satisfaction with the services was generally positive, with 56% rating the services as good, though 31.7% expressed dissatisfaction due to the untimely distribution of financial assistance under the Nikshay Poshan Yojna. The study also found a significant positive correlation between awareness and satisfaction, with patients showing greater satisfaction when their awareness was higher. **(Table 1)**

Table 1: Summary of studies included in the review

S.No.	Author	Year	Conclusion
1.	Sachdeva et al. ⁷	2021	India's vision to end TB by 2025 relies on collaborative efforts, innovative research, and rapid implementation of advanced tools, supported by strong state-level commitments and a patient-focused approach.
2.	Dhamnetiya et al. ⁸	2021	While TB incidence and mortality declined from 1990 to 2019, the reduction rate remains inadequate to meet the 2025 target, emphasizing the need to fortify India's "Detect-Treat-Prevent-Build" strategy for a TB-free future.
3.	Arinaminpathy et al. ¹²	2021	To accelerate TB incidence reduction, effective engagement with the private sector is crucial, with mechanisms like the PPIA offering cost-effective, context-specific solutions.
4.	Khanna et al. ¹¹	2022	India has made significant progress in TB control over the past 50 years, but the NSP 2020–2025 outlines bold and transformative actions required to accelerate progress and eliminate TB by 2025.
5.	Pai M et al. ⁹	2023	India's ambitious 2025 TB elimination plan requires unwavering commitment, backed by adequate funding and effective implementation of the 2017–2025 NSP.
6.	Jain et al. ¹⁰	2023	Improving healthcare practitioners' knowledge on MDR-TB is essential for proper diagnosis, treatment, and patient education, ensuring progress toward India's TB elimination goal by 2025.
7.	Chauhan et al. ⁶	2023	The significant prevalence of TBI in India, mirroring active TB patterns, highlights the critical need for region-specific, evidence-driven strategies to prevent its progression to active disease.
8.	Kumar et al. ¹³	2023	The overall awareness and satisfaction about RNTCP services was good among TB patients with a greater satisfaction among people with high awareness.

3.5. Strategic recommendations

Based on the review of existing studies and reports, we propose several strategic recommendations toward TB elimination in India. These include:

1. Strengthening community-based TB care through enhanced awareness campaigns and improved public health education to reduce stigma.
2. Expanding access to quality diagnostics and treatment in rural and remote areas, including the use of mobile diagnostic units and telemedicine.
3. Ensuring sustained funding for TB programs, particularly for the management of MDR-TB cases, awareness and preventive treatments.
4. Improving TB surveillance and reporting mechanisms to ensure that all cases are detected and treated in a timely manner.
5. Enhancing collaboration between public and private healthcare sectors to create a unified approach for TB control, ensuring that both sectors contribute effectively to diagnosis, treatment, and patient support.
6. Strengthening training programs for healthcare providers to enhance their knowledge and skills in TB diagnosis, treatment protocols, and patient management, with a focus on emerging drug-resistant strains.
7. Implementing innovative approaches like rapid molecular testing and digital technologies to improve early diagnosis and reduce diagnostic delays, particularly in underserved regions.
8. Promoting research and development in TB vaccines, novel drug regimens, and new diagnostic tools to

accelerate the development of more effective treatments and preventive measures.

9. Increasing patient-centered care by improving support systems for TB patients, including nutritional support, mental health services, and social reintegration programs, to improve treatment adherence.
10. Establishing stronger monitoring and evaluation frameworks to track progress, identify gaps, and assess the impact of TB control programs at the national and regional levels.
11. Developing a national TB elimination strategy that aligns with global frameworks while tailoring interventions to local epidemiological contexts and the specific needs of different states and regions.

4. Conclusion

Tuberculosis (TB) remains a major health concern globally, with India bearing the highest burden, accounting for 26% of the world's cases in 2022.

India's efforts to eliminate tuberculosis by 2025 remain ambitious but achievable with sustained commitment and focused interventions. Despite substantial efforts, such as the National Strategic Plan (NSP) for Tuberculosis Elimination 2017-2025 and the ambitious goal to eliminate TB by 2025, significant challenges persist. These include underreporting of cases, gaps in healthcare infrastructure, stigma, and the rising prevalence of multidrug-resistant TB (MDR-TB), which complicates treatment. Our studies have shown that TB prevalence in India is much higher than the global average, and factors such as poverty, malnutrition, and

inadequate access to timely diagnosis continue to hinder progress. This narrative review also highlighted the government's initiatives, including the National Tuberculosis Elimination Programme (NTEP), have made progress in expanding diagnostic tools and treatment access, but obstacles such as poor healthcare access in rural areas and insufficient funding for TB control programs remain. Continued efforts are needed, especially in improving diagnostic capabilities, addressing MDR-TB, and implementing multi-sectoral strategies to meet the 2025 elimination target.

The success of this mission will not only have a profound impact on public health in India but will also serve as a powerful example for the world in the fight against tuberculosis. India is a nation of immense potential, where innovation, resilience, and unity drive progress, making it a beacon of hope and inspiration for the world.

5. Source of Funding

None.

6. Conflict of Interest

None.

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