

LITERATURE STUDY ON TUBERCULOSIS ELIMINATION 2030: CHALLENGES AND INNOVATIONS IN INDONESIA

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ABSTRACT

Indonesia occupies the second highest case burden in the world, so it faces a major challenge in reducing the death rate due to Tuberculosis (TB). This research aims to synthesize strategic barriers and map the most feasible innovations to accelerate the TB elimination target by 2030. This study used *Systematic Review*. This study used a Systematic Review. The search strategy was developed using Boolean operators with structured keywords, resulting in 185 articles spanning the period 2017-2026. These articles were re-identified using inclusion and exclusion criteria until 15 primary articles were obtained. Analyzed using the Thematic Analysis technique The analysis showed four main obstacles: catastrophic non-medical costs that trigger drug discontinuation, social stigma that hinders early detection, fragmentation of surveillance data, and uneven access to diagnostics. However, digital innovations such as AI and telemedicine offer new efficiencies in outbreak prediction and compliance monitoring. TB elimination requires a paradigm shift towards a holistic approach that integrates patient economic protection, national data synchronization, and adoption of Society 5.0 technology to permanently break the chain of transmission.

Keywords: Digital Innovation, Elimination 2030, Indonesia, Tuberculosis

INTRODUCTION

Tuberculosis (TB) is still a deadly public health challenge (WHO, 2024), despite its remarkable medical developments. Globally, Indonesia currently ranks second in the world with the highest burden of TB cases after India. This condition is driven by the complex interaction of social, economic, and geographical determinants, including poverty, low human development, limited healthcare access, and regional inequalities that collectively contribute to tuberculosis incidence and delayed disease control (Koltinger et al., 2023). Failure to significantly reduce the incidence rate will have an impact on the global inability to achieve the *End TB Strategy 2035* target (Uplekar et al., 2015; Rahevar et al., 2018).

Based on the *Global TB Report 2024*, the estimated incidence in Indonesia reaches 1,060,000 cases per year with a death rate of 134,000 people per year, or around 15 people/hour die from TB (Ministry of Health of the Republic of Indonesia, 2023). This condition is exacerbated by the phenomenon of missing cases, reflected in the substantial gap between estimated TB incidence and notified cases in Indonesia, which is driven by unequal access to healthcare services across the archipelago and persistent underreporting from private healthcare facilities (WHO, 2024). Despite subsidized treatment, MDR-TB patients in Indonesia face a significant catastrophic economic burden with total costs reaching \$2,804 USD per patient, with 82.81% experiencing healthcare expenditures exceeding 20% of their annual household income (Akalu YT, et al., 2023).

Various efforts have been made by the Indonesian government to accelerate TB elimination, one of which is through the *Directly Observed Treatment Short-course (DOTS)* strategy. However, this strategy faces challenges in the form of system fatigue and changes in

community behavior (Agustina et al., 2021). Countermeasures are also faced with the challenge of integrating the TB program into the National Health Insurance (JKN) which aims to eliminate financial barriers for patients. However, the COVID-19 pandemic disrupted TB control programs through the diversion of health resources, mobility restrictions, and overlapping clinical symptoms between TB and COVID-19, which significantly reduced TB case detection and reporting (Togun, 2020). Post-pandemic, Indonesia is now in a recovery phase that requires "aggressive acceleration" to catch up with the elimination target.

Another challenge, which often occurs to TB patients is the non-medical economic burden, even though TB drugs are provided free of charge by the government. More than 30% of TB patient households experience an expense burden of above 20% of their income for transportation costs, additional nutrition, and loss of income due to inability to work (Collins et al., 2017). This condition often triggers drug discontinuation, which then results in bacterial resistance (agustina et al., 2021). On the other hand, the social stigma felt by TB patients causes a tendency to hide their status to avoid discrimination both in the work environment and in their social environment, thus having an impact on delays in early detection and the expansion of the chain of transmission in the community (Nurhidayah et al., 2023).

In facing these challenges, Indonesia can no longer rely solely on conventional approaches; therefore, technological innovations such as Molecular Rapid Tests (TCM/Xpert MTB-RIF) are needed because they have been proven to improve diagnostic accuracy and accelerate TB detection compared with conventional microscopic methods (Lee et al., 2022). In addition, the use of artificial intelligence (AI) has demonstrated potential in predicting tuberculosis transmission and treatment adherence risks, while telemedicine-based monitoring offers more efficient real-time supervision of medication adherence among TB patients (Sekandi, 2023). However, this technological innovation must be integrated with the Indonesian government's policy in achieving the 2030 TB elimination target. This literature review was compiled to synthesize these challenges and map the most feasible innovations to be implemented in Indonesia to achieve TB elimination.

METHODS

This study uses the Systematic Review design to explore in depth the challenges and potential innovations in TB elimination in Indonesia. The literature search was conducted in January 2026 in Scopus, PubMed/MEDLINE, ScienceDirect, Cochrane Library, and SINTA with a time range of 2017 to 2026. The search strategy was developed using Boolean operators (*AND*, *OR*, *NOT*) with structured keywords, namely ("Tuberculosis" OR "MDR-TB" OR "Mycobacterium tuberculosis"), AND ("Indonesia" OR "National Health System"), AND ("Challenges" OR "Barriers" OR "Catastrophic Costs" OR "Stigma"), AND ("Innovation" OR "Digital Health" OR "Artificial Intelligence" OR "Society 5.0"). Of the 185 articles, they were re-identified using the inclusion and exclusion criteria until 15 main articles were obtained. The researcher applied inclusion criteria, namely 1) the population of TB patients, health workers, policy makers, or health systems 2) interventions/focus on elimination policies, DOTS/TCM programs, the use of digital technology, and sociological interventions, 3) outcomes: recovery rates, diagnostic accuracy, reduction in non-medical costs, and effectiveness of surveillance. Exclusion criteria were studies that only discussed new drug trials (clinical). The extracted data were analyzed using the Thematic Analysis technique.

RESULTS

Table 1. Literature Synthesis Matrix on TB Challenges and Innovations in Indonesia

No.	Researcher	Journal	Title	Method	Key Results
1	Pradipta et al. (2021)	<i>BMC Public Health</i>	Barriers and strategies to successful tuberculosis treatment	Qualitative	Psychosocial and economic factors are the main barriers to compliance.
2	Agustina et al. (2021)	<i>The Lancet</i>	Universal health coverage in Indonesia: concept, progress, and challenges	Policy Review	The fragmentation of the decentralized health system hinders TB programs.
3	Ahmad et al. (2020)	<i>Transactions of The Royal Society of Tropical Medicine and Hygiene.</i>	The economic burden of tuberculosis in Indonesia	Prospective Cohort Study	Approximately 30% of TB patients in Indonesia experience catastrophic costs, which significantly affect treatment adherence and treatment outcomes.
4	Lestari et al. (2023)	<i>PLoS ONE</i>	National tuberculosis research priority in Indonesia	Mixed-method	Identify 10 research priorities to support the elimination of TB by 2030.
5	Kurniawati et al (2019)	<i>BMC Res Notes</i>	Acceptability of mandatory tuberculosis notification among private practitioners in Yogyakarta, Indonesia	Program Evaluation	Low compliance of the private sector in reporting cases to the national system.
6	Ramires, et al. (2023)	<i>J. Clin. TB & Mycobact.</i>	Time to sputum conversion in patients with pulmonary TB	Prospective cohort	Nutritional factors significantly accelerate the conversion of phlegm in the early phases.
7	Akalu YT, et al. (2023)	<i>Scientific Reports</i>	Economic burden of MDR-TB on patients and households	Meta analysis	The cost of MDR-TB treatment is 10 times higher than drug-sensitive TB.
8	Alisjahbana et al. (2021)	<i>PLoS ONE</i>	Neighbourhoods of TB cases: A protocol for active intervention	Study Protocol	Active screening at the environmental level increases early case detection.
9	Nurhidayah et al. (2023)	<i>ASJN</i>	The relationship of self-stigma to medication adherence	Cross-sectional	Internal stigma of patients correlates negatively with adherence to therapy.
10	Nijman et al. (2025)	<i>The LANCET</i>	Operational Performance of Genexpert for Tuberculosis Diagnosis: A Public Health Evaluation	Mix Methods	Although GeneXpert improves TB diagnostic accuracy, its implementation in West Java remains constrained by limited

No.	Researcher	Journal	Title	Method	Key Results
					human resources, cartridge stockouts, and referral system barriers
11	Rizqiya (2021)	<i>J. Scientific Cases. Kep.</i>	The relationship between societal stigma and compliance	Descriptive Analytics	Family support is able to mitigate the impact of community stigma.
12	Collins et al. (2017)	<i>IJTL</i>	The economic burden of tuberculosis in Indonesia	Data Analysis	The estimated national GDP loss due to TB reaches trillions of rupiah.
13	Pradipta et al. (2022)	<i>Frontiers in Pharm.</i>	Barriers to optimal TB treatment at health centers	Qualitative	Patients' lack of literacy about the duration of treatment triggers resistance.
14	Ali et al. (2017)	<i>BMC Infect Dis</i>	Outcomes of TB treatment in HIV co-infected	Retrospective Analysis	HIV coinfection worsens clinical outcomes without service integration.
15	Sekandi et al. (2023)	<i>JMIR AI.</i>	Application of AI to the Monitoring of Medication Adherence for Tuberculosis Treatment	Digital Innovation	AI can mitigate delays in tuberculosis outbreak response by enabling early cluster prediction and identifying patients at high risk of treatment non-adherence through real-time data analysis.

Based on the analysis, there are four major themes in the challenges and innovations of TB elimination in Indonesia:

1. Theme of Non-Medical Economic Burden. The TB treatment program by the government is free but there are still costs that must be incurred by TB patients such as transportation to health facilities, nutritional needs, and loss of daily income due to weak physical condition, creating a very heavy economic burden. This condition can have an impact on the unsustainability or discontinuation of medication in patients because TB patients prefer to meet basic living needs. The non-medical economic burden directly impacts the risk of therapy failure and the increase in cases of drug resistance.
2. Themes of Stigma and Psychosocial Barriers. Social stigma can provide psychosocial barriers for TB patients. This stigma has 2 levels, namely from the outside environment (discrimination in the workplace and social environment) and within the patient himself (*self-stigma*) so that it triggers a sense of hopelessness and mental fatigue in TB patients. TB is a contagious disease and can be deadly, so most Indonesian people consider TB as a scary disease and must be avoided. This condition makes TB patients feel hopeless and mentally exhausted so they tend to hide their health status. The impact of social stigma is delays in seeking medical help and low much-needed family support during long treatment periods.
3. Theme of Fragmentation of Surveillance and Diagnostic Systems. This theme highlights the gap between the availability of advanced diagnostic technologies such as the Molecular Rapid Test (TCM) method, and the implementation in the field, namely the distribution is not evenly distributed to remote regions in Indonesia. This condition is exacerbated by reports of TB case data that are not synchronized between clinics or private practice doctors

are not reported into the national information system, so that the existing statistics do not reflect the actual number of TB patients in the community.

4. The theme of Technological Innovation and Digital Acceleration. The optimism of digital transformation or the use of artificial intelligence (AI) to automatically detect outbreak clusters, the use of telemedicine to monitor patients remotely, and the strengthening of community-based active screening show great potential. These innovations are considered to be able to break complicated bureaucratic chains and provide faster, more accurate, and personalized health responses for each patient.

DISCUSSION

The contents of the discussion section include an explanation of the results, references to previous studies, and opinions from researchers.

Theme 1: Economic Paradox and Non-Medical Cost Traps. The first theme that appears predominantly in the literature is the contradiction between the policy of free treatment and the reality of the financial burden of patients. Based on the study by Tanimura et al. (2014), the persistence of hidden costs, including transportation expenses, income loss, and additional non-medical expenditures, suggests that financial protection for medical treatment alone is insufficient to ensure successful tuberculosis elimination. In line with Fuady et al. (2018), despite the implementation of universal health coverage, hidden costs such as transportation expenses, nutritional support, and income loss remain major contributors to catastrophic costs among TB patients in Indonesia, indicating that medical cost coverage alone is insufficient for effective TB control. An in-depth analysis shows that non-medical costs are not only a matter of nominal numbers, but also a matter of household survival. TB patients in Indonesia are often the economic backbone of families working in the informal sector. When they are infected, there is a drastic decrease in productivity and is estimated to have an impact on national GDP losses of up to trillions of rupiah (Collins et al. 2017). In line with the research of Akalu YT, et al. (2023), the economic burden of MDR-TB patients is much heavier and significantly higher than that of regular TB patients. The duration of treatment, which reaches 20 months, requires patients to make regular trips to referral hospitals which are often located very far from the domicile. These transportation and accommodation costs are not covered by any health insurance. This creates a new cycle of poverty: patients become poor due to illness, and because of poverty they are unable to complete treatment, which ultimately leads to death or wider transmission (Pradipta et al., 2022). Clinically, these economic barriers are directly correlated with malnutrition. Ramires, et al. (2023) prove that poor nutrition slows down the conversion of phlegm, resulting in a longer infectious period for patients. Without social protection interventions that include nutrition subsidies and transportation, the elimination of TB in Indonesia will remain a rhetoric with no real results.

Theme 2: Social Construction of Stigma and Psychosocial Fatigue. Stigma remains an "invisible wall" that is often deadlier than the bacteria themselves. The results of the review show that stigma works on two levels: external (discrimination by society) and internal (*self-stigma*). Nurhidayah et al. (2023) found that *self-stigma* causes patients to withdraw from social environments due to deep shame. This results in a delay in diagnosis because individuals are afraid of being labeled as "dirty" patients. Sociologically, TB in Indonesia still carries the moral burden of the past. A qualitative study from Pradipta et al. (2021) revealed that patients often lose their jobs not because of physical incapacity, but because of co-workers' fear of transmission. This condition is exacerbated if the patient has HIV coinfection, where the stigma becomes multiplied and the clinical outcome becomes much worse (Daftary, 2012). Rizqiya (2021) argues that family support is the only modality that is able to mitigate the impact of the

stigma. However, the literature also shows that families are often mentally exhausted (*caregiver burden*), especially in the case of MDR-TB. Urgent sociological innovations are the deconstruction of the TB narrative in the mass media and the strengthening of peer support groups to create safe spaces for patients during the recovery period.

Theme 3: Fragmentation of Surveillance Systems and Data Leaks. Indonesia's biggest technical challenge lies in the asynchronous reporting system between the public and private sectors (*Public-Private Mix*). Recent evaluations of Indonesia's Tuberculosis Information System (SITB) revealed persistent underreporting from private healthcare facilities and inconsistent data entry practices, creating substantial gaps in the national epidemiological database and limiting accurate measurement of the TB burden (Pratiwi, 2025). Although Nijman et al. (2025) affirm the Molecular Rapid Test (TCM/GeneXpert) has superior diagnostic accuracy compared with conventional microscopy, its implementation in Indonesia remains constrained by referral delays, cartridge stockouts, and limited technical capacity of laboratory personnel in remote areas, resulting in continued reliance on low-sensitivity microscopic examination as the primary diagnostic method. This data fragmentation is exacerbated by the lack of integration between hospital electronic medical records and national databases, so that the tracking of patients who move health facilities (*transfer out*) is often unmonitored, which triggers the risk of patient discontinuation (Agustina et al., 2021).

Theme 4: Digitalization Innovation. Optimism for TB elimination in Indonesia now rests on the adoption of technology in *the Society 5.0* era. Digital innovation is no longer just a trend, but a solution that must be considered. Antonia et al. (2026) recent studies have shown that artificial intelligence (AI) can automatically identify tuberculosis transmission risk areas and support targeted active screening strategies, while AI-based Computer-Aided Detection (AI-CAD) for chest X-rays enables non-specialist healthcare workers in remote settings to perform accurate preliminary TB screening; however, the implementation of these digital innovations must remain inclusive to avoid widening existing healthcare disparities. Alisjahbana et al. (2021) remind that even the most advanced technology will be useless if it is not supported by community participation. An active screening model involving health cadres at the RT/RW level remains the main foundation. Future innovations must combine the power of AI with local wisdom such as the use of telemedicine for medication monitoring must be designed to be user-friendly for elderly patients or those with low technology literacy.

Indonesia has a real opportunity to permanently break the TB transmission chain before 2030, by synergizing TCM diagnostic innovations, social protection to address non-medical costs, and the use of big data (*Big Data*) (Lestari et al., 2023).

CONCLUSION

Based on the literature review, there are 4 challenges faced in the elimination of TB in Indonesia, namely the non-medical economy, social stigma, surveillance and diagnostic systems, and digitalization innovation so that there is a need for a paradigm shift from a vertical approach (focusing on bacteria) to a horizontal-holistic approach (focusing on the health system, economic protection, and patient rights). Therefore, there is a need for cash assistance for TB patients, the integration of electronic medical records with TB information systems, equal access to the internet and the provision of TCM diagnostic tools and the anti-stigma movement of TB as well as the use of AI for both the discovery of massive cases and TB education.

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