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Factors Affecting Tuberculosis in Asia: A Literature Review

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Abstract
Tuberculosis (TB) remains a major public health concern in Asia, particularly in South and Southeast Asia. Comorbidities such as diabetes mellitus and HIV/AIDS substantially contribute to the regional TB burden, while multidrug-resistant tuberculosis (MDR-TB) continues to challenge TB control efforts. This study aimed to identify key factors associated with the high prevalence of TB in Asia and to highlight the need for integrated prevention and treatment strategies. A quasi-systematic literature review was conducted following PRISMA-based screening procedures. Peer-reviewed articles and official health reports published between 2015 and 2024 were systematically searched and assessed. After screening and eligibility evaluation, 15 studies were included in the final analysis. The results revealed consistent patterns indicating that diabetes mellitus significantly increases the risk of TB and worsens treatment outcomes, particularly in countries such as Indonesia, while HIV infection remains a major driver of active TB cases in Thailand and other high-burden settings. MDR-TB emerged as a critical regional threat, primarily associated with delayed diagnosis, limited laboratory capacity, shortages of trained healthcare personnel, and weak surveillance systems. Additionally, socioeconomic inequalities and inadequate healthcare infrastructure were recurrently identified as major barriers to effective TB control. In conclusion, reducing the TB burden in Asia requires a multifaceted and integrated approach addressing medical, social, economic, and health system factors. Strengthening diagnostic capacity, improving data reporting consistency, and enhancing regional collaboration are essential to achieving global TB elimination targets.

Keywords: Tuberculosis, Mycobacterium Tuberculosis, Pulmonary Tuberculosis.

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1. INTRODUCTION

Tuberculosis (TB) remains one of the deadliest infectious diseases worldwide and continues to pose a major challenge to global health systems, particularly in Asia (Chakaya et al., 2021; Nyarko et al., 2021; Siddiqi et al., 2021; Awan et al., 2022; Khalil et al., 2025). Despite the availability of effective treatment for decades, TB remains the leading cause of death from infectious diseases, especially in countries with a heavy socioeconomic burden. According to the Global Tuberculosis Report by the World Health Organization (WHO), approximately 10.6 million people suffered from TB in 2021, with an estimated 1.6 million deaths reported (World Health Organization, 2022). South and Southeast Asia account for more than 60% of global TB cases, with countries such as India, China, the Philippines, Pakistan, and Bangladesh ranking among those with the highest prevalence (Abdullah et al., 2022; World Health Organization, 2022; Oh et al., 2023; Kumar et al., 2024; Lv et al., 2024; Jiang et al., 2025). These data indicate that TB control efforts in Asia continue to face substantial challenges, despite extensive public health interventions.

The TB burden in Asia is highly complex and shaped by the interaction of social, economic, environmental, and biological determinants. In addition to pulmonary TB, the increasing incidence of extrapulmonary TB (EPTB), which is often difficult to diagnose, further amplifies the regional disease burden (Gopalaswamy et al., 2021; Sharma, Mohan, & Kohli, 2021; Azad & Chowdhury, 2022; Niu et al., 2023; Rolo et al., 2023; Hassan et al., 2025). Environmental conditions such as overcrowded housing, poor ventilation, high humidity, and inadequate housing infrastructure have been consistently associated with increased transmission of Mycobacterium tuberculosis (Deol et al., 2022; Lee et al., 2022; Etim et al., 2024; Marni et al., 2024; Kurniawati, Isnawati, & Santoso, 2025; Nurbaya, Juanda, & Erminawati, 2025). In parallel, medical comorbidities particularly diabetes mellitus and HIV/AIDS have emerged as major drivers of TB vulnerability. Awad et al. (2022) reported that diabetes mellitus contributed to approximately 18.8% of TB cases in Indonesia in 2020, with projections rising to 25.8% by 2050 in the absence of comprehensive interventions. Similarly, HIV infection substantially increases the risk of active TB, even among individuals receiving antiretroviral therapy (ART) (Suwanpimolkul et al., 2022). These findings support the conceptualization of TB as a syndemic condition shaped by the convergence of infectious, metabolic, and social determinants.

In South and Southeast Asia, including Pakistan, India, Bangladesh, and Afghanistan the prevalence of EPTB continues to rise (Jawed et al., 2023). However, public awareness of EPTB symptoms remains limited, while early detection systems and diagnostic facilities are unevenly distributed. Consequently, delayed diagnosis and treatment remain common, contributing to increased morbidity and mortality. Gender disparities, social inequalities, and unequal access to healthcare services further exacerbate TB outcomes across the region. An analysis of Global Burden of Disease (GBD) data from 1990 to 2021 demonstrated declining trends in TB incidence and mortality in countries such as Bangladesh and Bhutan, while persistent or increasing trends were observed in Pakistan and Nepal (World Health Organization, 2024). This divergence highlights substantial heterogeneity in TB control effectiveness across Asian countries.

Another critical challenge lies in therapeutic innovation and health system responsiveness. Although TB is treatable using WHO-standardized regimens, inconsistent adherence and limited health system capacity have contributed to the emergence of multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB). Recent studies have highlighted nanomedicine-based drug delivery systems as a promising strategy to enhance drug bioavailability and reduce adverse effects (Ezhilarasan & Felix, 2022). However, evidence regarding the feasibility and implementation of such innovations in resource-limited Asian settings remains fragmented and underexplored.

While numerous systematic reviews have examined individual TB determinants such as socioeconomic factors, environmental conditions, medical comorbidities, or drug resistance most have addressed these dimensions in isolation or within single-country contexts. Few reviews have synthesized evidence across South and Southeast Asia to examine how these determinants interact with health system capacity and emerging medical technologies. As a result, there remains a critical gap in understanding the combined influence of environmental exposure, socioeconomic vulnerability, medical comorbidities, and health system responses on TB epidemiology at the regional level.

Therefore, the novelty of this literature review lies not merely in adopting a multidimensional perspective, but in integrating and comparing evidence across Asian countries to identify convergent patterns, systemic gaps, and context-specific challenges in TB control. This review aims to provide a comprehensive analysis of TB risk factors in Asia based on empirical evidence from selected scientific studies, emphasizing the interrelationships among environmental conditions, socioeconomic status, medical comorbidities, health system capacity, and emerging therapeutic approaches in shaping TB outcomes across the region.

2. RESEARCH METHOD

This literature review employed a systematic search strategy to identify and analyze studies related to the factors influencing the prevalence and incidence of tuberculosis (TB) in Asia. The search process was conducted comprehensively across three major electronic databases Google Scholar, PubMed, and ScienceDirect to ensure the inclusion of relevant and high-quality literature. The search utilized a combination of keywords and Boolean operators, including “tuberculosis,” “risk factors,” “Asia,” and “determinants of tuberculosis incidence in Asia.” To maintain the relevancy and validity of the data, the search was limited to peer-reviewed journal articles published between 2015 and 2025, written in English, and available in full-text format. In addition, the reference lists of the selected studies were screened manually to identify additional relevant publications that may not have appeared in the initial database search. This entire process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency, reproducibility, and scientific rigor throughout the review process.

The inclusion criteria for this review consisted of studies conducted in one or more Asian countries that focused on determinants, risk factors, or comorbidities influencing the incidence or prevalence of TB. Only articles published in English within the specified period, available in full text, and peer-reviewed were included. Conversely, studies conducted outside the Asian region, laboratory-based or molecular research without an epidemiological context, and non-research articles such as reviews, editorials, commentaries, or conference abstracts lacking primary data were excluded from the analysis.

All identified articles were imported into reference management software to facilitate organization and the removal of duplicate records. The screening process was conducted in two stages. Initially, titles and abstracts were reviewed to assess relevance, followed by a full-text review to ensure that each study met the inclusion criteria. From the initial 225 articles identified across the three databases, 185 articles remained after removing duplicates. Following the title and abstract screening, 40 studies were considered potentially relevant. After the full-text assessment, 15 studies met all eligibility criteria and were included in the final synthesis.

Data extraction was carried out systematically from each selected study, encompassing essential details such as the author(s) and year of publication, study location and population, research design, and key findings related to TB risk factors and determinants. The extracted data were then synthesized narratively, allowing for the integration of findings across different studies and contexts.

A narrative synthesis approach was used to organize and interpret the findings, which were categorized into four major thematic domains. The first domain addressed socioeconomic factors, including poverty, education level, and occupation, which are known to affect TB vulnerability. The second domain focused on environmental determinants such as overcrowding, air quality, and sanitation, which play a crucial role in TB transmission. The third domain involved medical comorbidities, including HIV/AIDS, diabetes mellitus, and malnutrition, which increase susceptibility and complicate treatment outcomes. Lastly, the fourth domain explored health system and policy factors, encompassing diagnostic access, healthcare infrastructure, and surveillance mechanisms. These thematic insights were compared and integrated to develop a comprehensive understanding of the multifactorial drivers contributing to TB incidence across the Asian region.

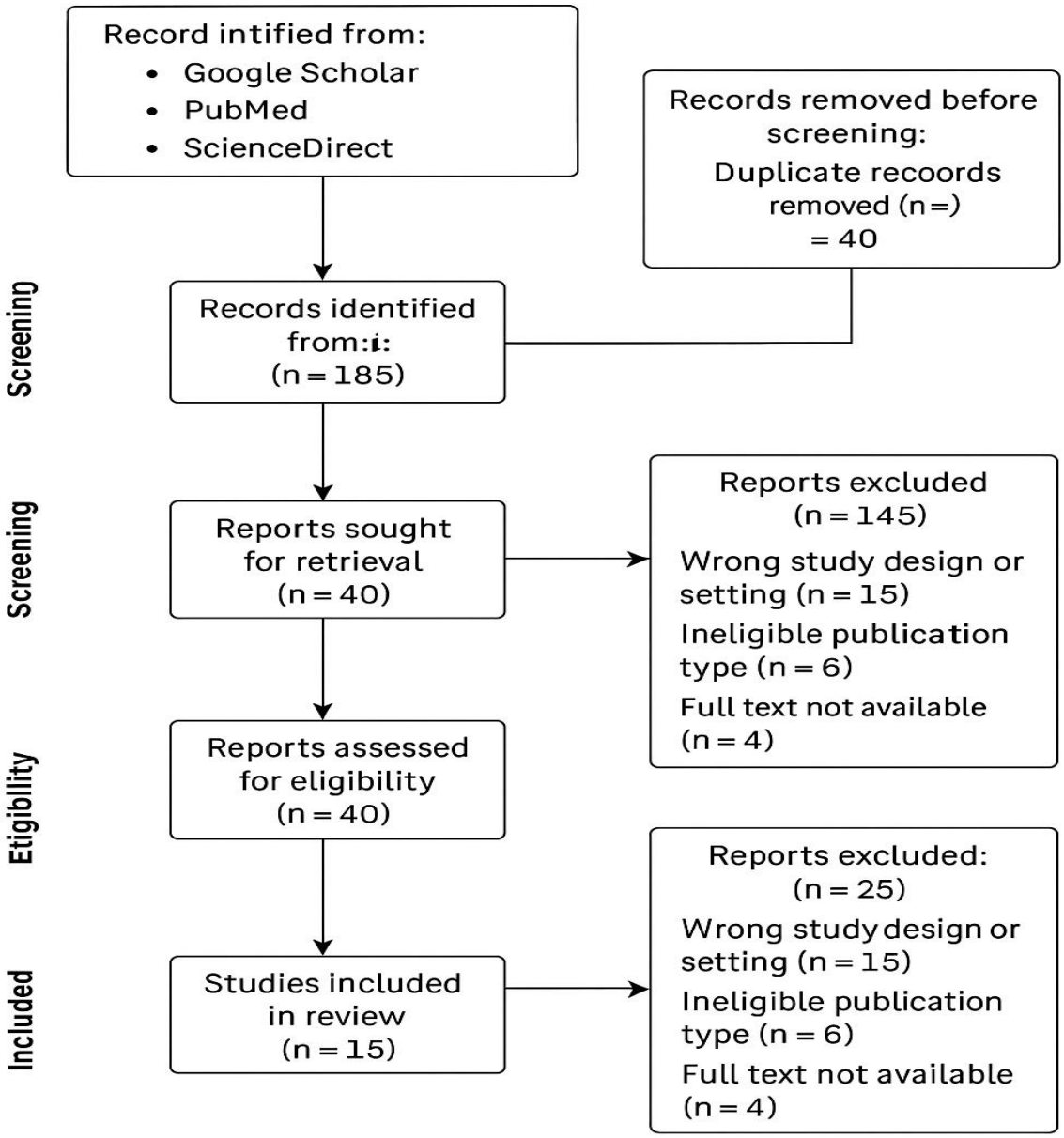

Diagram 1. The PRISMA flowchart illustrates the literature selection process.

3. RESULTS AND DISCUSSION

Tuberculosis (TB) remains one of the most pressing public health challenges in Asia, caused by *Mycobacterium tuberculosis*, and continues to burden millions each year. South and Southeast Asia, in particular, contribute to the majority of global TB cases, reflecting persistent socioeconomic and structural disparities that exacerbate transmission and hinder disease control. This literature review synthesizes findings from ten major studies, which were categorized into several key themes: socioeconomic determinants, comorbidities, environmental factors, extrapulmonary tuberculosis, healthcare system challenges, drug resistance, and innovations in TB management.

Socioeconomic conditions exert both direct and indirect effects on TB burden across Asia. In developing countries such as India, Bangladesh, Pakistan, and Indonesia, poverty serves as a root cause of multiple health determinants. Poor housing conditions, limited access to health facilities, low levels of education, and inadequate public awareness about TB remain formidable barriers to prevention and control. The high cost of TB treatment and substantial out-of-pocket expenses often lead patients to delay or even discontinue therapy (Li, Zhao, & Xu, 2024). Among low-income populations, informal employment and fear of income loss during treatment worsen adherence, thereby increasing the risk of transmission and the emergence of drug resistance. Furthermore, disparities in the distribution of healthcare resources especially between urban and rural areas hinder early detection efforts (Kumar et al., 2024). Many rural facilities still lack diagnostic equipment and trained personnel, delaying accurate diagnosis and initiation of treatment.

Comorbidities such as diabetes mellitus and HIV/AIDS present major obstacles to TB control in Asia. Diabetes mellitus substantially increases TB incidence through impaired immune responses, elevated bacterial loads, and a higher risk of latent TB reactivation (Awad, Critchley, & Abu-Raddad, 2022). Mathematical modeling projects that by 2050, up to 25.8% of total TB cases in Indonesia may be linked to diabetes if no effective interventions are implemented. Similarly, individuals living with HIV are reported to have a 20-fold higher risk of developing active TB compared to those without HIV (Suwanpimolkul, 2022). A study in Thailand found exceptionally high TB incidence within the first three months of antiretroviral therapy, with significant risk factors including low CD4 counts, high viral load, low body weight, and prior TB history. The coexistence of HIV and TB creates a synergistic syndemic that demands integrated treatment approaches. WHO recommends tuberculosis preventive therapy (TPT) for HIV-positive patients initiating ART, yet its implementation remains limited across many Asian nations.

Environmental factors play an equally critical role in shaping TB epidemiology. Poor ventilation, high humidity, and earthen floors in residential areas of small islands in South Sulawesi have been significantly associated with increased TB prevalence (Susilawaty et al., 2024). High population density intensifies droplet transmission, while geographical isolation and fragmented health infrastructure in archipelagic regions hinder timely detection and treatment. In addition, malnutrition, smoking, and alcohol consumption have been found to significantly increase TB risk in several Asian populations (Yanagawa et al., 2023). Occupational exposure such as in mining or industrial settings with inadequate ventilation further elevates TB vulnerability, particularly among informal workers who comprise a substantial portion of the Asian workforce.

Extrapulmonary tuberculosis (EPTB) often receives insufficient public attention due to its atypical presentation and complex diagnostic requirements. Forms such as lymph node, pleural, abdominal, central nervous system, and bone TB occur more frequently in women and immunocompromised individuals. The absence of respiratory symptoms complicates clinical diagnosis without advanced tools such as CT scans or biopsies, which are often unavailable at primary healthcare facilities. This leads to delayed diagnosis and disease progression. Therefore, continuous education and training for healthcare professionals in recognizing

extrapulmonary manifestations are crucial, along with strengthening referral and reporting systems to accelerate detection and management.

The rise of multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) presents another escalating threat in Asia. Resistance typically results from incomplete or inappropriate treatment regimens. The increasing prevalence of MDR-TB in Southeast Asia and the Pacific poses a critical challenge, with only a fraction of patients receiving WHO-standardized therapy (Yanagawa et al., 2023). Factors such as poor patient satisfaction, substandard drug quality, and inadequate monitoring contribute significantly to this issue. Resistance to second-line drugs further complicates treatment, prolonging recovery, elevating costs, and worsening side effects ultimately diminishing both patient quality of life and the effectiveness of national TB programs.

The quality of healthcare systems remains a decisive factor in TB control success. Common systemic weaknesses include insufficient laboratory diagnostics, inadequate numbers of trained healthcare workers, weak surveillance systems, and inefficient manual reporting. Many Asian countries still lack digital TB reporting systems (Yanagawa et al., 2023), resulting in delayed responses and poor resource allocation. Despite evidence supporting community-based TB care in improving adherence, its implementation remains limited. Strengthening community engagement, training local health cadres, and improving logistics and transport networks are vital strategies to reinforce the healthcare system's capacity.

Meanwhile, technological innovation offers renewed hope in combating TB. Advances in nanotechnology-based drug delivery systems have shown promise in improving therapeutic efficacy while minimizing side effects and reducing dosing frequency (Ezhilarasan & Felix, 2022). However, adoption remains limited in Asia due to funding constraints, inadequate infrastructure, and resistance to innovation. Digital health technologies such as mobile-based patient tracking and medication reminder platforms have begun to emerge in countries like India and the Philippines, albeit on a small scale. Similarly, diagnostic innovations such as GeneXpert have improved rapid TB detection and drug resistance screening in several referral centers, yet accessibility remains restricted in remote regions.

Ultimately, TB control in Asia demands a collaborative and integrated approach**.** Several studies underscore the importance of synergy between TB programs and other health initiatives particularly HIV, diabetes, and maternal-child health programs to reach vulnerable populations effectively. Cross-border collaborations and regional strategies, such as the ASEAN TB Strategy and cooperative efforts between India and Bangladesh**,** have demonstrated promising models for sharing epidemiological data, enhancing laboratory capacity, and strengthening healthcare workforce training.

This literature review, while comprehensive, is not without limitations. The analysis relied on a selection of ten primary sources, potentially omitting relevant studies published in non-English or regional languages. Variability in study design, population demographics, and research methodologies across the included literature may also limit the generalizability of findings. Moreover, the absence of a meta-analytical approach restricts the ability to quantify relationships among the identified factors. Nevertheless, this synthesis provides a valuable overview of the multifactorial determinants of tuberculosis in Asia and highlights critical areas for future investigation, policy development, and technological advancement in TB control.

4. CONCLUSION

The factors influencing tuberculosis (TB) incidence in Asia are highly complex and interrelated, encompassing socioeconomic disparities, comorbid conditions, environmental determinants, and systemic health challenges. The findings of this literature review indicate that effective TB control in Asia requires an integrated, multisectoral approach one that simultaneously addresses medical, social, and economic determinants. Priority should be given to managing comorbid diseases such as diabetes mellitus and HIV/AIDS, improving living and

environmental conditions, expanding equitable access to healthcare services, and strengthening national health systems.

This review underscores the importance of evidence-based interventions and cross-sectoral collaboration in reducing TB burden across the region. Coordinated action between healthcare providers, policymakers, and communities is essential to enhance early detection, treatment adherence, and health education. Furthermore, regional cooperation, particularly through platforms such as ASEAN, can play a pivotal role in strengthening surveillance, data sharing, and capacity building to achieve the global target of TB elimination.

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