

# Surveillance-Based Analysis of Tuberculosis Incidence in ASEAN: The Role of Expenditure, Infrastructure, and Surveillance Systems

Mohamed Sesay<sup>1\*</sup>, Hariyono Hariyono<sup>2</sup>, Wahyu Aditama Putra  
Mukti Wibawa<sup>3</sup>, Hijrah Saputra<sup>4</sup>, Abdul Rhoda Sankoh<sup>5</sup>

<sup>1,2,3</sup>Health Economics Department, Postgraduate School, Airlangga University,  
Surabaya, Indonesia

<sup>4</sup>Disaster Management Department, Postgraduate School, Airlangga University,  
Surabaya, Indonesia

<sup>5</sup>Department of Public Health-School of Nursing,  
George Mason University, America

E-mail: [mohamed.sesay-2023@pasca.unair.ac.id](mailto:mohamed.sesay-2023@pasca.unair.ac.id)

(Article history) Received: 2025-08-20, Revised: 2025-12-12, Accepted: 2025-12-13,

DOI: 10.24252/ecc.v7i1.13382

## Abstract

Tuberculosis is still a serious threat to public health worldwide. This study examines the impact of infrastructure inequalities and surveillance indicators on the incidence of tuberculosis in nine ASEAN countries from 2000 to 2021. The primary research question examines how infrastructure conditions, health system features, and surveillance performance collectively impact TB incidence within ASEAN. The study employed panel data and fixed-effects regression to investigate the relationships between TB incidence and various variables, including case detection rate, treatment success rate, government health spending, out-of-pocket expenses, access to sanitation, and electricity coverage. By giving the first surveillance-driven, multi-indicator comparative assessment of TB incidence throughout ASEAN, this work contributes by providing region-specific insights to improve resource allocation and monitoring. Data were extracted from the World Bank database and analysed using STATA 17.0 software. The findings indicate that improved sanitation, greater access to electricity, better case detection, and higher urbanisation significantly decrease TB incidence, whereas higher government health spending shows an unexpected positive association. Treatment success and out-of-pocket expenditure were not statistically significant. Effective TB control requires strong surveillance systems, equitable health funding, and improved infrastructure. These results emphasise the importance of enhanced monitoring, better facilities, and fair financing, especially in heavily affected areas within ASEAN.

**Keywords:** Tuberculosis surveillance; Health expenditure; Infrastructure, Population, Public health policy.

## 1. Introduction

Tuberculosis (TB) is still the most lethal infectious disease globally, and it is the cause of death resulting from a single infectious agent (The Lancet Microbe, 2024; Sahu *et al.*, 2025). In the ASEAN region, tuberculosis (TB) continues to pose a significant challenge to both health and economic stability (Bhatia *et al.*, 2023).

© 2025 The Author(s). Published by Department of Economics, Faculty of Economic and Islamic Business, Universitas Islam Negeri Alauddin Makassar, Indonesia. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by-sa/4.0/>)



Inadequate health funding and inconsistent monitoring restrict the control measures throughout the region (Satyanarayana *et al.*, 2020a). Even after decades of successful chemotherapy and international control initiatives, tuberculosis still has a devastating impact on public health systems (Villar-Hernández *et al.*, 2023). In 2015 alone, an estimated 10.4 million new cases of TB were reported worldwide, and 1.8 million deaths, while in 2018, 10 million new cases and 1.5 million deaths were reported (Mtetwa *et al.*, 2023). TB is closely linked to socioeconomic factors, such as rapid population growth, urbanisation, government healthcare spending, and income inequality (Ledesma *et al.*, 2024). Strong surveillance systems are essential for early case detection, treatment progress monitoring, and transmission reduction (Nguyen *et al.*, 2024). Environments that are conducive to tuberculosis growth include high population density, inadequate sanitation infrastructure, and inadequate health coverage (Nguyen *et al.*, 2024; Spies *et al.*, 2024). To comprehend, manage, and lessen the spread of tuberculosis, surveillance is essential (Garrido-Cardenas *et al.*, 2020). Effective surveillance systems promote early diagnosis, lower transmission, and allow for prompt interventions (Zannetos *et al.*, 2022).

In ASEAN, where reporting gaps, delayed diagnosis, and uneven system performance continue to impact tuberculosis management, bolstering surveillance capability is especially important (De Lombaerde *et al.*, 2024). The assessment of national strategies requires strong surveillance systems, particularly in high-burden settings (Dean *et al.*, 2022). The main ways that TB burdens impact countries economically are through decreased labour force participation, lost productivity, and higher medical expenses (Bio *et al.*, 2024; Jeyashree *et al.*, 2024; Youngkong *et al.*, 2024). Across ASEAN, tuberculosis remains unevenly distributed due to differences in development, infrastructure, and surveillance capacity. For instance, WHO and ASEAN data show that over half of the region's TB cases come from Indonesia and the Philippines, which rank among the countries most affected worldwide (World Health Organization, 2024; Jennifer Frances Dela, 2025). Cambodia continues to record high TB rates with ongoing underreporting and late detection, while Lao PDR and Vietnam still face diagnostic challenges in remote and low-income communities (Law *et al.*, 2015; Teo *et al.*, 2020; Vo *et al.*, 2020). Malaysia and Thailand benefit from better health systems, but struggle with treatment adherence and migrant case follow-up (Tschirhart, Nosten and Foster, 2016; Tok *et al.*, 2020).

Brunei Darussalam and Singapore keep TB rates low but face risks from imported and latent cases (Lim *et al.*, 2021; Syafiq *et al.*, 2023). No study has yet compared how surveillance, infrastructure, and socioeconomic factors affect TB across all nine ASEAN countries. Filling this gap is vital for creating fair and lasting control strategies. The relationship between tracking tuberculosis surveillance and macroeconomic outcomes remains underexplored in most regions, such as ASEAN (Bhatia *et al.*, 2023). Although many studies concentrate on health-related factors, the wider economic impacts, like loss of productivity and financial strain, are seldom measured (Kirigia and Muthuri, 2016; Ardhana and Dariatno Sihaloho, 2025). Grasping this link is crucial for assessing how monitoring and funding for health influence economic growth over time. As a result, surveillance indicators serve two purposes: tracking disease and calculating its financial cost (Dodd *et al.*, 2014; Vesga *et al.*, 2019; Hogan *et al.*, 2020).

In keeping with the shifting goals of ASEAN health systems, this study fills these gaps by analysing TB incidence through a surveillance-based and health-impact lens. The study offers an integrated viewpoint on the factors influencing TB incidence by highlighting the ways in which detection rates, treatment effectiveness, sanitation availability, and electricity coverage affect TB outcomes. Combining macroeconomic metrics with TB indicators such as incidence, detection, and treatment helps show how surveillance systems impact economic growth (Gandy and Zumla, 2002; Fløe *et al.*, 2018; Doulla, 2021; Reis *et al.*, 2021). Stronger surveillance and infrastructure

investment boost labour productivity and economic growth by reducing disease burden and income loss (Puiu and Bilbîie, 2025). This supports the human capital model, which links public health improvements to a more productive workforce (Lee *et al.*, 2007). Even though its sensitivity varies, sputum smear microscopy is still used in many resource-constrained nations for TB diagnosis to detect smear-positive pulmonary TB (Nooy *et al.*, 2024). TB is still strongly associated with substandard living conditions, malnutrition, and restricted access to medical care (Brown *et al.*, 2015). It is imperative to maintain investment in TB control systems (Nunn *et al.*, 2014). In high-burden areas, inadequate surveillance and underreporting jeopardise public health planning (Wright *et al.*, 2009; Iskandar *et al.*, 2023). Effective TB case detection and treatment success reporting are required through national surveillance frameworks (Mijiti *et al.*, 2016). Timely and precise diagnosis in conjunction with treatment support systems greatly improves case detection and treatment success rates (Nahid, 2006; Huda *et al.*, 2024). The key element in TB control programmes is the high level of case detection and treatment success (Lu *et al.*, 2017). Reducing tuberculosis incidence in high-burden nations largely depends on raising the rate of tuberculosis case detection (Bui *et al.*, 2025).

Only a few studies link TB, health financing, and socioeconomic factors within ASEAN (Lim *et al.*, 2023). This study fills that gap by combining global data with ASEAN-specific insights (Pradipta *et al.*, 2018; Dheda *et al.*, 2022). The results at the end of this study can help shape tuberculosis policies in ASEAN and other areas. The study's main research question, which aims to close this gap, is: How do infrastructure conditions, health-system features, Population characteristics, and tuberculosis monitoring indicators collectively affect TB incidence and health outcomes among ASEAN countries?

The ongoing prevalence of tuberculosis in ASEAN, where underreporting, delayed diagnosis, unequal access to sanitation, rapid population growth, dense urban environments and inadequate health funding continue to obstruct disease control efforts, is the driving force for this study. This study is innovative in three important ways. First, it offers the first multi-indicator surveillance-driven comparison analysis of TB incidence among nine ASEAN nations. Secondly, it incorporates infrastructure variables, health-system indicators, population dynamics and surveillance quality aspects that are rarely included in regional TB research. Third, it provides evidence-based, region-specific insights that can support more robust TB control policies in line with ASEAN health priorities, enhance surveillance performance, and guide equitable resource distribution. The results will also emphasise the need for improved monitoring, enhanced facilities, and more equitable health funding to reach the End TB Strategy policies, Matched Resources (Liu *et al.*, 2024a). This research links indicators of tuberculosis monitoring with large-scale economic and infrastructure elements to enhance understanding of their combined impacts. It emphasises the influence of monitoring effectiveness and distribution of resources on local growth and health safety (Liu *et al.*, 2024b). This study aims to analyse how tuberculosis surveillance efforts, health system characteristics, infrastructure conditions, and population factors influence TB cases in 9 ASEAN countries from 2000 to 2021. This study will demonstrate how the unique epidemiological, demographic, and socioeconomic conditions of ASEAN affect tuberculosis outcomes by integrating global comparative data with regional insights. It also aims to generate policy suggestions relevant to improving TB control within the ASEAN region.

## 2. Literature Review

Health Capital Theory sees health as a valuable resource that contributes to progress (Schneider-Kamp, 2021). Some research suggests that just spending more doesn't guarantee better results because of waste and poor management (Oliveres-Tirado and Zanga, 2024). In other scenarios, putting money into health is important, but how well it works relies on how funds are raised and allocated (Witter *et al.*, 2025). The correlation between higher domestic

government health spending and improved health outcomes highlights national investments in health (Pradipta *et al.*, 2018). In developing nations, the incidence rate of tuberculosis is greatly influenced by socioeconomic and environmental factors (Pescarini *et al.*, 2017). Public health funding increases availability and safeguards families (Zhang *et al.*, 2025). Payments made directly by patients lead to money troubles and postpone treatment (Schmidt *et al.*, 2024). The overall scenario above shows that government spending on health reduces the burden of tuberculosis, while personal expenses increase it (Khaing *et al.*, 2024). From the above literature, the following hypothesis (H) is developed.

**H1a:** Higher government health spending lowers TB incidence.

**H1b:** Higher out-of-pocket spending increases TB incidence.

Issues that impede treatment success and surveillance effectiveness include low bacteriological confirmation rates and delays in clinical diagnosis (De La Rua-Domenech *et al.*, 2006; Hong *et al.*, 2023). To assess program performance, the significance of trustworthy surveillance and case notification is constantly emphasised (Fuady, 2023). Across a range of population structures, empirical results indicate that such initiatives significantly lower the incidence of tuberculosis (Jia *et al.*, 2008). Most evidence suggests that funding for the health system, particularly domestic government health spending, is essential to maintaining disease control (Dheda *et al.*, 2022). Prior research shows that higher government healthcare spending and better disease surveillance are linked to improved health outcomes and economic growth (Anwar *et al.*, 2023). Economic development is promoted, and case detection and treatment are improved by performance-based strategies that tie resources to results (Xu *et al.*, 2024). Ecological analyses clarify the relationship between TB incidence and control indicators and population-level factors (World Health Organization, 2014). Enhancing detection rates and lowering the burden of disease have also been demonstrated benefits of community-based screening (Fox *et al.*, 2013; Ahmad Khan *et al.*, 2017). Effective identification of cases and successful treatment lead to a decrease in tuberculosis spread (Ayabina *et al.*, 2021; Menzies *et al.*, 2024). Many Researchers suggest that enhanced detection may lead to higher reported rates or may struggle in poorly functioning systems (Amare, Alene and Ambaw, 2025). From the above literature, the following hypothesis (H) is constructed.

**H2a:** Case Detection reduces tuberculosis rates.

**H2b:** Treatment Success reduces tuberculosis rates.

According to historical and modern accounts, systematic urban health initiatives and sanitation advancements were essential to the long-term control of tuberculosis (Holloway-Kew and Henneberg, 2023). Population-based interventions and domestic health spending must be in line with surveillance indicators to direct focused public health responses by empirical data (Boccia *et al.*, 2011). Better sanitation and access to energy lower the chances of catching infectious diseases (Sharma Waddington *et al.*, 2023). Having good infrastructure makes people less at risk of tuberculosis in rapidly developing areas like ASEAN (Fahdhienie *et al.*, 2024). From the above literature, the following hypothesis (H) is formulated.

**H3a:** Improved sanitation access reduces tuberculosis incidence.

**H3b:** Greater electricity coverage reduces tuberculosis incidence.

To account for underlying demographic features that can affect tuberculosis incidence independently of the study's primary explanatory factors, Population Total (PT) and Urban Population (UP) were added to the empirical model as control variables. The model can account for cross-national differences in population size, which have an impact on both the total number of reported cases and the scope of public health demands, by incorporating PT. Similarly, UP measures the level of urbanisation, a crucial contextual feature that influences the dynamics of tuberculosis transmission through mobility patterns, population density, and unequal access to

medical care (Kwan *et al.*, 2018). By separating the impacts of infrastructural conditions, health financing, and surveillance performance, these demographic controls increase the accuracy and robustness of the calculated connections (Lu *et al.*, 2017). In line with econometric practice in public health and development research, PT and UP were not connected to formal hypotheses because they are merely adjustment factors rather than theoretical constructs developed from the literature. Based on the above literature, the following hypothesis (H) is constructed.

**H4a:** Higher population size increases tuberculosis incidence.

**H4b:** Higher levels of urbanisation increase tuberculosis incidence.

Important conceptual and empirical discussions continue in the literature despite these developments. The question of whether higher case detection rates necessarily signal better surveillance effectiveness or instead point to inherent flaws in the way the health system operates is still being debated. Similarly, the relationship between government health spending and tuberculosis outcomes remains unclear in several contexts, as institutional performance, governance frameworks, and equitable resource allocation are often key factors. There is also a glaring void in the regional literature: prior research typically examines infrastructure determinants, health system features, and surveillance variables independently, resulting in fragmented views (Blanchet *et al.*, 2017). In the context of ASEAN, where structural disparities and surveillance discrepancies persist, even fewer studies incorporate these factors into a cohesive analytical framework (WHO, 2019; Ferreira *et al.*, 2023). By creating a surveillance-driven, multi-indicator model that concurrently looks at case detection, treatment success, health financing trends, sanitation availability, and power coverage across nine ASEAN nations, this study fills in these gaps. The study expands current discussions and offers a comprehensive knowledge of the structural and system-level determinants of tuberculosis by including these variables in a comparative regional framework. This all-encompassing strategy provides region-specific insights that help bolster surveillance systems, promote fairer resource allocation, and guide evidence-based TB control policies throughout ASEAN.

### 3. Methods

#### 3.1 Data Description

This study utilised secondary panel data covering 9 ASEAN countries from 2000 to 2021. The World Bank's World Development Indicators (WDI) provided secondary data for the dataset's compilation. Countries were classified by income group according to the World Bank: lower-middle-income economies (Cambodia, Lao PDR, Philippines, Viet Nam), upper-middle-income economies (Indonesia, Malaysia, Thailand), and high-income economies (Brunei Darussalam, Singapore). In total, the dataset comprised 9 ASEAN countries × 22 years = 198 country-year observations. Because the study used secondary national-level data, no individual respondents or field sampling were required.

The implied "sampling formula" is therefore a balanced panel construction, where all available annual observations for each country are included. The variables, units, and data sources are summarised in Table 1. Although economic growth isn't directly included as a variable in this model, it is conceptually reflected through the health system and infrastructure indicators such as government health expenditure, out-of-pocket spending, sanitation, and electricity coverage that represent key components of national development capacity (World Bank, 2023; Anand & Ravallion, 2022). These factors together act as a substitute for economic development and how it affects tuberculosis results in the ASEAN nations.

Table 1. Descriptive of variables

| Variable | Definition                                                                        | Unit of Measurement | Source              |
|----------|-----------------------------------------------------------------------------------|---------------------|---------------------|
| TBSINCD  | Incidence of tuberculosis (per 100,000 people).                                   | People              | World Bank Database |
| TBSCDR   | Tuberculosis case detection rate (% , all forms).                                 | %                   | World Bank Database |
| TBSTSR   | Tuberculosis treatment success rate (% of new cases)                              | %                   | World Bank Database |
| DGGHE    | Domestic general government health expenditure (% of current health expenditure). | %                   | World Bank Database |
| PT       | Population, total                                                                 | People              | World Bank Database |
| UP       | Urban population (% of total population).                                         | %                   | World Bank Database |
| PUBSS    | People using at least basic sanitation services (% of population).                | %                   | World Bank Database |
| OPE      | Out-of-pocket expenditure (% of current health expenditure).                      | %                   | World Bank Database |
| AE       | Access to electricity (% of population).                                          | %                   | World Bank Database |

### 3.2 Methods

The study examined the relationship between tuberculosis incidence and economic, infrastructural, and surveillance indicators using a panel regression framework. Figure 1 below presents the conceptual framework guiding this study. The model hypothesises that tuberculosis incidence is influenced by four dimensions: (i) health financing (government expenditure and out-of-pocket expenditure), (ii) surveillance (case detection and treatment success rates), (iii) infrastructure (sanitation and electricity access) and (iv) Population (Total Population and Urban Population). The model studied concepts are illustrated in Figure 1.

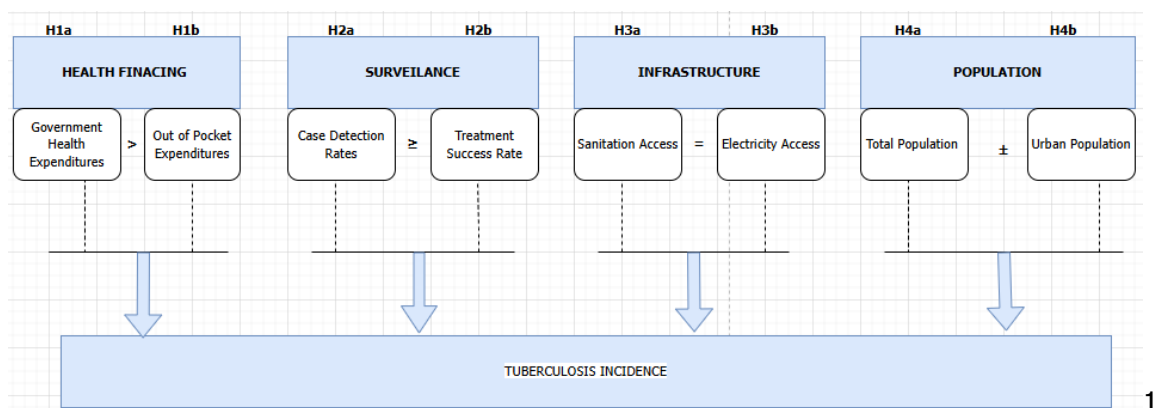


Figure1. Research Framework

The choice of models has been made based on various diagnostic tests, the most recent of which is the Hausman test, which helps to determine whether a fixed or random effects model produces consistent estimates. The relationship between the dependent and independent variables is represented by the collected linear regression model, which is described as follows:

$$TBSINCD_{it} = \beta_0 + \beta_1 TBSCDR_{it} + \beta_2 TBSTSR_{it} + \beta_3 DGGHE_{it} + \beta_4 PT_{it} + \beta_5 UP_{it} + \beta_6 PUBSS_{it} + \beta_7 OPE_{it} + \beta_8 AE_{it} + \varepsilon_{it}$$

Where  $TBSINCD_{it}$  denotes the tuberculosis incidence rate in country  $i$  at time  $t$ ,  $TBSCDR$ ,  $TBSTSR$ ,  $DGGHE$ ,  $PT$ ,  $UP$ ,  $PUBSS$ ,  $OPE$ , and  $AE$  represent the explanatory variables as previously described.  $\beta_0$  is the constant term,  $\beta_1$  to  $\beta_8$  are the estimated coefficients, and  $\varepsilon_{it}$  represents the error term. All estimators were conducted using STATA 17.0 Software.

#### 4. Results

Following descriptive statistics, correlation diagnostics, and multicollinearity evaluations, the results are arranged methodically. Inferential findings from OLS, Fixed Effects (FE), Random Effects (RE), the Hausman specification test and Augmented Dickey-Fuller (ADF) are then presented.

Table 2. Descriptive Statistics

| Variable | Obs | Mean     | Std. Dev. | Min    | Max       |
|----------|-----|----------|-----------|--------|-----------|
| TBSINCD  | 198 | 239.157  | 168.344   | 34     | 590       |
| TBSCDR   | 198 | 58.015   | 23.714    | 11     | 88        |
| TBSTSR   | 198 | 83.253   | 8.694     | 45     | 96        |
| DGGHE    | 198 | 46.12    | 21.298    | 15.532 | 95.142    |
| PT       | 198 | 61785259 | 75018992  | 326424 | 2.768e+08 |
| UP       | 198 | 51.863   | 24.372    | 18.586 | 100       |
| PUBSS    | 198 | 75.416   | 22.053    | 10.186 | 100       |
| OPE      | 198 | 37.619   | 15.8      | 4.858  | 68.741    |
| AE       | 198 | 87.457   | 21.103    | 9.5    | 100       |

The average incidence of tuberculosis (TBSINCD) was 239.16 cases per 100,000 population (min 34; max 590), reflecting a significant public health challenge. The rate of detecting cases (58.02%) does not meet the WHO standard, whereas the success rate of treatment (83.25%) indicates that case management is effective after patients are identified. Government spending on health made up 46.12% of all expenditures, while substantial out-of-pocket payments reached 37.62%, highlighting the existing disparities in funding.

Table 3. Correlation Matrix of TB-related Indicators Across 9 ASEAN Countries 2000-2021

| Variables      | (1)     | (2)    | (3)    | (4)    | (5) PT | (6) UP | (7)    | (8) OPE | (9)   |
|----------------|---------|--------|--------|--------|--------|--------|--------|---------|-------|
|                | TBSINCD | TBSCDR | TBSTSR | DGGHE  |        |        | PUBSS  |         | AE    |
| (1)<br>TBSINCD | 1.000   |        |        |        |        |        |        |         |       |
| (2)<br>TBSCDR  | -0.718  | 1.000  |        |        |        |        |        |         |       |
| (3)<br>TBSTSR  | 0.558   | -0.505 | 1.000  |        |        |        |        |         |       |
| (4)<br>DGGHE   | -0.566  | 0.516  | -0.635 | 1.000  |        |        |        |         |       |
| (5) PT         | 0.419   | -0.457 | 0.269  | -0.158 | 1.000  |        |        |         |       |
| (6) UP         | -0.657  | 0.743  | -0.603 | 0.460  | -0.190 | 1.000  |        |         |       |
| (7)<br>PUBSS   | -0.684  | 0.659  | -0.541 | 0.613  | -0.129 | 0.727  | 1.000  |         |       |
| (8) OPE        | 0.608   | -0.441 | 0.538  | -0.924 | 0.185  | -0.378 | -0.554 | 1.000   |       |
| (9) AE         | -0.589  | 0.454  | -0.401 | 0.570  | 0.185  | 0.595  | 0.847  | -0.509  | 1.000 |

Indicators regarding infrastructure showed differences, as sanitation coverage stood at 75.42%, while access to electricity reached 87.46%, indicating gaps in living standards and infrastructure that are important for TB risk factors. The distribution of the population was balanced between urban areas, comprising 51.86%, and rural areas, which made up the remainder. Together, these findings emphasise ongoing shortages in monitoring, disparities in health funding, and inconsistent growth in infrastructure, all of which continue to be vital factors influencing tuberculosis outcomes.

The incidence of tuberculosis (TBSINCD) is highly and negatively related to case detection (−0.718), sanitation (−0.684), access to electricity (−0.589), and urban populations (−0.657). This reinforces the importance of monitoring and infrastructure in alleviating the burden of disease. In contrast, there is a positive correlation with treatment success rate (0.558), out-of-pocket expenses (0.608), and total population (0.419), underscoring structural and financial weaknesses. The significant negative relationship between government health expenditure and OPE (−0.924) demonstrates financial imbalances. In summary, the matrix reinforces the study's hypotheses by demonstrating that enhanced detection, government spending, and infrastructure are associated with a reduced incidence of tuberculosis (TB).

Table 4. Hausman specification test

| Relationship          | Coef.   |
|-----------------------|---------|
| Chi-square test value | 181.119 |
| P-value               | 0.0000  |

The Chi-square statistic ( $\chi^2 = 181.12$ ,  $p < 0.001$ ) rejects the null hypothesis, indicating that the Fixed Effects estimator is favoured over Random Effects. This confirms the strength of the FE model by considering unobserved, time-invariant attributes of countries

Table 5. The Fixed Effect Model

| TBSINCD            | Coef.   | St.Err. | t-value  | p-value              | [95% Interval] | Sig     | Support for Hypothesis |     |
|--------------------|---------|---------|----------|----------------------|----------------|---------|------------------------|-----|
| TBSCDR             | -.421   | .153    | -2.75    | .007                 | -.723          | -.119   | ***                    | Yes |
| TBSTSR             | .135    | .251    | 0.54     | .591                 | -.36           | .63     |                        | No  |
| DGGHE              | .793    | .283    | 2.80     | .006                 | .235           | 1.352   | ***                    | No  |
| PT                 | 0       | 0       | 6.37     | 0                    | 0              | 0       | ***                    | Yes |
| UP                 | -1.76   | .494    | -3.56    | 0                    | -2.734         | -.785   | ***                    | Yes |
| PUBSS              | -2.029  | .27     | -7.51    | 0                    | -2.561         | -1.496  | ***                    | Yes |
| OPE                | .103    | .252    | 0.41     | .684                 | -.394          | .599    |                        | No  |
| AE                 | -1.497  | .214    | -6.99    | 0                    | -1.919         | -1.074  | ***                    | Yes |
| Constant           | 498.686 | 30.773  | 16.21    | 0                    | 437.966        | 559.405 | ***                    |     |
| Mean dependent var |         |         | 239.157  | SD dependent var     |                |         | 168.344                |     |
| R-squared          |         |         | 0.879    | Number of obs        |                |         | 198                    |     |
| F-test             |         |         | 164.008  | Prob > F             |                |         | 0.000                  |     |
| Akaike crit. (AIC) |         |         | 1642.042 | Bayesian crit. (BIC) |                |         | 1671.636               |     |

\*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

TB incidence (TBSINCD) decreases by improved case detection (TBSCDR;  $\beta = -0.421$ ,  $p < 0.01$ ), better sanitation (PUBSS;  $\beta = -2.029$ ,  $p < 0.01$ ), greater electricity access (AE;  $\beta = -1.497$ ,  $p < 0.01$ ), and higher urbanisation (UP;  $\beta = -1.76$ ,  $p < 0.01$ ), all supporting their respective hypotheses. Total population (PT;  $\beta \approx 0.000$ ,  $p < 0.01$ ) also remains a significant demographic factor. Conversely, government health spending (DGGHE;  $\beta = 0.793$ ,  $p < 0.01$ ) shows a positive association with TB incidence, opposite to the expected negative relationship.

Thus, support for this hypothesis is "No", suggesting that although spending increases, it may not yet translate into effective TB control due to inefficient allocation, delayed program effects, or spending concentrated on non-preventive areas. Treatment success (TBSTSR;  $\beta = 0.135$ ,  $p = 0.591$ ) and out-of-pocket expenditure (OPE;  $\beta = 0.103$ ,  $p = 0.684$ ) remain insignificant. The model fits strongly ( $R^2 = 0.879$ ; F-test  $p < 0.001$ ). The results underscore the necessity of increasing government health funding, enhancing TB detection frameworks, and

allocating resources to sanitation and electricity infrastructure as practical approaches to lower TB incidence in areas with high burden. Therefore, all significant interpretations and policy implications are based on the results of the FE estimation.

Table 6. Augmented Dickey-Fuller (ADF)

| Variables | Test with None I(0) level | Test with None at I(1) level | Order of integration |
|-----------|---------------------------|------------------------------|----------------------|
| TBSINCD   | 0.0000                    | 0.0000                       | I(0)                 |
| TBSCDR    | 0.9455                    | 0.0021                       | I(1)                 |
| TBSTSR    | 0.0000                    | 0.0000                       | I(0)                 |
| DGGHE     | 0.0375                    | 0.0000                       | I(0)                 |
| PT        | 0.0000                    | 0.0000                       | I(0)                 |
| UP        | 0.0000                    | 0.0000                       | I(0)                 |
| PUBSS     | 0.0000                    | 0.0000                       | I(0)                 |
| OPE       | 0.1188                    | 0.0000                       | I(1)                 |
| AE        | 0.5160                    | 0.0080                       | I(1)                 |

The results show that most variables, such as TB incidence (TBSINCD), treatment success (TBSTSR), government health expenditure (DGGHE), population size (PT), urbanisation (UP), and sanitation access (PUBSS), are stationary at level I(0). Conversely, case detection (TBSCDR), out-of-pocket expenditure (OPE), and electricity access (AE) are stationary only after first differencing, thus signifying I(1) processes. The presence of both I(0) and I(1) variables eliminates the possibility of spurious regressions and supports the use of panel estimation techniques that can manage mixed integration levels. Concerning the hypotheses of the study, the stability of TB incidence and vital financing variables (H1) indicates their quick reaction to policy measures, while the I(1) characteristic of case detection shows the ongoing adjustment necessary to enhance surveillance systems (H2). In the same way, the mixed integration order among infrastructure variables like sanitation and electricity (H3) indicates that although certain factors influence TB outcomes right away, others take longer periods to show a significant effect. These findings suggest that TB control strategies should harmonise short-term policy tools, like funding and detection, with long-term structural investments in infrastructure, guaranteeing both immediate effects and lasting enhancements in public health.

Table 7. Descriptive Averages of TB-related Indicators by Country (2000–2021).

| COUNTRY     | TBS.INCD | TBS.CDR | TBS.TSR | DGGHE | PT          | UP    | PUBSS | OPE   | AE    |
|-------------|----------|---------|---------|-------|-------------|-------|-------|-------|-------|
| Cambodia    | 428.41   | 54.14   | 93.14   | 20.51 | 14648293.41 | 20.93 | 40.22 | 58.22 | 43.86 |
| Lao PDR     | 224.27   | 33.77   | 86.95   | 28.01 | 6400502.05  | 30.16 | 56.91 | 43.44 | 71.8  |
| Philippines | 548.41   | 38.59   | 86.77   | 35.12 | 97142313.41 | 46.12 | 72.38 | 51.04 | 86.16 |
| Viet Nam    | 229.73   | 49.27   | 91.59   | 41.24 | 87837998.68 | 30.93 | 70.27 | 37.85 | 96.01 |
| Indonesia   | 341.5    | 36.45   | 86.86   | 37.17 | 247567892.3 | 49.96 | 63.11 | 45.12 | 93.42 |
| Malaysia    | 81       | 84.09   | 73.91   | 52.44 | 28806050.27 | 70.65 | 94.73 | 34.99 | 99.35 |
| Thailand    | 189.18   | 51.82   | 79.27   | 69.84 | 68299374.55 | 42.97 | 95.64 | 17.25 | 96.51 |
| Brunei      | 67.14    | 87      | 71.82   | 89.67 | 392909.36   | 75.05 | 85.49 | 10.33 | 100   |
| Darussalam  |          |         |         |       |             |       |       |       |       |
| Singapore   | 42.77    | 87      | 78.95   | 41.09 | 4971996.95  |       | 100   | 40.33 | 100   |

Population (H4) are I(0), indicating that total and urban population exert immediate and consistent demographic pressure on TB incidence across countries. Table 7 above presents the descriptive averages of key tuberculosis-related health and socioeconomic indicators across 9 ASEAN countries over the period 2000–2021. Below are key comparative insights across the

three income clusters.

#### 4.1 Low- and Middle-Income Economies

Cambodia (428.41 per 100,000) and the Philippines (548.41 per 100,000) have the highest rates of incidence. This situation is exacerbated by inadequate case detection (54.14% and 38.59%), substantial out-of-pocket costs (58.22% and 51.04%), and major deficiencies in infrastructure, particularly regarding sanitation (40.22% and 72.38%) and electricity (43.86% and 86.16%). Lao PDR (224.27 per 100,000) faces comparable challenges, with very low detection (33.77%) and limited financing. By contrast, Viet Nam (229.73 per 100,000) demonstrates increased resilience by attaining effective treatment results (91.59%) and sustaining reliable infrastructure with sanitation at 70.27% and electricity access at 96.01%, in addition to a moderate rate of incidence.

#### 4.2 Upper Middle-Income Economies

Indonesia continues to experience a significant incidence of disease (341.50 per 100,000) and insufficient detection (36.45%), despite notable advancements in its infrastructure, with sanitation coverage at 63.11% and electricity access at 93.42%. In comparison, Malaysia (81.00 per 100,000) and Thailand (189.18 per 100,000) exhibit a lower rate of disease occurrence and possess better monitoring systems (84.09% and 51.82%). In a nutshell, they fail in providing effective treatment, with success rates of only 73.91% and 79.27%, highlighting deficiencies in patient follow-up care.

#### 4.3 High-Income Economies

Brunei Darussalam (67.14 per 100,000) and Singapore (42.77 per 100,000) have the lowest rates of incidence. This is due to their universal access to electricity (100% in both), comprehensive sanitation services (85.49% and 100%), and effective detection systems (87% each). Nonetheless, both indicate lower success rates in treatment (71.82% and 78.95%), highlighting difficulties in maintaining ongoing care.

However, the above Descriptive Averages of TB results indicate that lower-middle-income nations are still the most at risk for TB, whereas upper- and high-income countries have improved their control measures but still encounter inefficiencies in their programs. The evidence highlights that, in addition to income levels, effective monitoring, fair funding, and investment in infrastructure are crucial in determining tuberculosis outcomes throughout the 9 ASEAN countries.

### 5. Discussion

#### 5.1 Health Financing and TB Incidence

The findings reveal that government health spending (DGGHE) contradicts the hypothesis (H1a), showing a positive instead of a negative relationship with TB incidence, while out-of-pocket expenditure (OPE) remains insignificant, thus not supporting H1b. These results are not in line with prior evidence suggesting that higher government spending reduces TB burden (Pradipta *et al.*, 2018; Malakoane *et al.*, 2020). This divergence may indicate inefficiencies in fund utilisation or delayed impacts of health investments. Due to differences in community involvement and health system reach, DOTS implementation success differs greatly between urban and rural populations (Singh and Ramamohan, 2020). Cross-country comparisons affirm that investment in urban health and sanitation infrastructure corresponds with lower TB incidence (Költringer *et al.*, 2023a). Countries with higher public health investment consistently show improved TB detection and treatment success (Malakoane *et al.*, 2020). To ensure that a TB response can adjust to the evolving social, economic, and epidemiological environment, it is imperative to invest in system flexibility (Nisha Ahamed, Anita Khilall, and Patricia Woods, 2017).



Strategic advancements in regulatory frameworks, workforce development, and governance structures are essential for long-term TB elimination efforts (Li *et al.*, 2015; Ogbuabor and Onwujekwe, 2019).

The first steps toward a stable and adaptable health system include improving the infrastructure of medical facilities, growing and educating human resources, and integrating accountability into TB policy (Heidi Behm *et al.*, 2024). Clear policies, intersectoral leadership, and coordinated strategic planning involving the public and private sectors are the cornerstones of strong TB control initiatives (Madhukar Pai and Zelalem Temesgen, 2018; Cole *et al.*, 2020). It is important to reframe TB treatment and surveillance as vital instruments for human growth rather than just as medical procedures (Jakubowiak *et al.*, 2001; Fuady, Hutnamon, *et al.*, 2024). The unexpected positive correlation between government health spending and TB incidence can be explained by the possibility that higher spending does not necessarily result in successful community-level interventions (Mcintyre, Meheus and Røttingen, 2017).

Public health funds are frequently directed into administrative, hospital-based, or curative services rather than early identification, preventive outreach, or bolstering surveillance networks in several ASEAN contexts (Adima and Arini, 2025). Therefore, rather than being a proactive investment that can lower transmission, increased spending might be a reaction to the growing TB burden (Faeni, 2023). Despite apparent gains in overall health spending, the impact of government investment might be weakened by inefficiencies in allocation, governance restrictions, and uneven implementation across regions, limiting its ability to deliver immediate reductions in TB incidence (Dussault and Dubois, 2003).

## 5.2 Case Detection and Treatment Success

The findings show that the case detection rate (TBSCDR) supports the hypothesis (H2a), as higher detection significantly reduces TB incidence, whereas the treatment success rate (TBSTSR) does not support H2b due to its insignificant effect. This partially aligns with prior studies indicating that robust surveillance and active case finding improve TB control (Jia *et al.*, 2008; Fuady, 2023). Though other research also highlights that weak follow-up systems can limit treatment effectiveness (Amare, Alene and Ambaw, 2025). Technology adoption across the health system improves the reach and effectiveness of TB programs (Nisha Ahamed, Anita Khilall, and Patricia Woods, 2017). Diagnostic advancements, such as molecular testing, have also made it possible to detect TB more rapidly (Yang *et al.*, 2025). Enhancing laboratory infrastructure and diagnostic capabilities is essential for successful TB control, and utilising sophisticated molecular diagnostics, like GeneXpert MTB/RIF, improves the precision and speed of TB detection (Zeka, Tasbakan and Cavusoglu, 2011; Piatek *et al.*, 2013; Stevens *et al.*, 2017). Instruments for distinguishing tuberculosis (TB) from related illnesses like nontuberculous mycobacteria (NTM) can sometimes make surveillance and clinical treatment more difficult (Gopalaswamy *et al.*, 2020).

Increasing laboratory capacity with these technologies guarantees more accurate diagnostics, improving patient outcomes and producing more trustworthy public health data (Olmsted *et al.*, 2010; Robbiati *et al.*, 2022; Solanki *et al.*, 2024). Access to suitable medication regimens is necessary for managing multidrug-resistant TB (Olawade *et al.*, 2024; Adima and Arini, 2025). Improved adherence and better overall health outcomes are largely dependent on addressing side effects, providing psychosocial support, and customising care to meet the needs of each patient (Zelalem Temesgen, 2011; Munteanu *et al.*, 2025). Treatment success alone does not account for the larger systemic and surveillance issues within the health system, which is a major reason why the treatment success rate (TBSTSR) is not considerably lower than TB incidence (Johnston, Cooper and Menzies, 2022). Due to underreporting, delayed diagnosis, and restricted access to basic healthcare, patients in several ASEAN nations frequently start treatment

later than expected (Satyanarayana *et al.*, 2020a). Because of this, significant transmission from undiagnosed or untreated cases persists in the community, even if those who finish treatment have positive results (Reaser *et al.*, 2021). Only those enrolled in national TB programs are usually included in treatment success statistics, which do not account for follow-up losses, migrating populations, or individuals receiving care outside of the official healthcare system (Liu *et al.*, 2024a). The observable link between treatment success and population-level TB decrease is weakened by these measurement gaps, which explains why TBSTSR seems statistically insignificant despite program performance that appears to be favourable.

The above results show that lower TB incidence is primarily driven by better sanitation, electricity access, case detection, and urbanisation, confirming the structural nature of transmission. For example, similar trends in Sub-Saharan Africa link improved living conditions to reduced TB burden (Xie *et al.*, 2025). The unexpected positive link between government health spending and TB incidence likely reflects reactive investment in high-burden contexts and improved detection through stronger reporting systems (Liu *et al.*, 2020). To enhance TB control, health expenditure should shift from reactive to preventive approaches, focusing on sanitation, early detection, and primary care access (Fuady, Anindhita, *et al.*, 2024; Saragih *et al.*, 2024). Strengthening governance to ensure timely, targeted investment will improve the long-term efficiency and sustainability of ASEAN TB programs (Liu *et al.*, 2024c).

### 5.3 Sanitation and Electricity Access

The findings confirm that both sanitation access (PUBSS) and electricity access (AE) significantly and negatively affect TB incidence, supporting H3a and H3b. These results are consistent with prior research emphasising that improved living standards and infrastructure reduce infectious disease risk (Sharma Waddington *et al.*, 2023; Fahdhienie *et al.*, 2024). Social responsibility and community involvement must be the cornerstones of any effective TB control plan (Chavez-Rimache, Ugarte-Gil and Brunette, 2023; MacPherson *et al.*, 2024). Building trust and ensuring coordinated action against tuberculosis requires educating communities, cultivating alliances with neighbourhood organisations (Nitta, Davidson and Hsu, 2003; Kumah, 2025). Addressing the broader social determinants of TB is equally crucial, and factors such as poverty, malnutrition, inadequate housing, and limited access to care must be tackled through coordinated efforts that align with the Sustainable Development Goals (Wingfield, 2016; Bernal *et al.*, 2020; Satyanarayana *et al.*, 2020b). Multi-ministerial collaboration and the integration of social protection measures into TB programs are necessary (WHO, 2019; Ferreira *et al.*, 2023).

Although access to electricity and sanitation strongly supports H3a and H3b, the treatment success rate (TBSTSR) does not show a significant impact on TB reduction because structural and environmental improvements have a greater impact on transmission than treatment results alone (Robbiati *et al.*, 2022). Even when treatment is effective for enrolled individuals, community-level transmission is maintained by ongoing exposure in packed dwellings, inadequate ventilation, poor sanitation, and unpredictable electricity factors common in diverse ASEAN contexts (Jennifer Frances Dela, 2025). Treatment success reflects the outcomes of individuals who are already engaged in the health system, but exposure risks for the broader community are defined by access to energy and sanitation (Alshamsan *et al.*, 2010). Because of this mismatch, therapeutic effectiveness, although clinically substantial, does not immediately lead to population-wide incidence reductions when upstream environmental variables are ignored (Ryan *et al.*, 2020). As a result, TBSTSR is statistically insignificant in comparison to more reliable structural variables like power coverage and cleanliness.

#### 5.4 Population Trends and Urbanisation

The findings complement H4a and H4b by showing that both urbanisation (UP) and population expansion (PT) significantly lower TB incidence. These results imply that when combined with improved infrastructure, increased access to health services, and increased surveillance coverage, urbanisation and population growth may improve TB outcomes. According to earlier research, population growth can improve the allocation of health resources, strengthen public health networks, and raise the density of healthcare workers in developing nations (Akash *et al.*, 2023; Sriram *et al.*, 2024). Most research indicates that urban regions have greater access to healthcare, better sanitation, and more sophisticated diagnostic capabilities; urbanisation exhibits a similar protective impact (Chen *et al.*, 2022; Adane *et al.*, 2024).

Increased urban density also makes it easier to integrate community-based interventions, expand the reach of TB screening programs, and expedite referral processes (Singh and Ramamohan, 2020). The advantages of urbanisation are greatest in areas where health services successfully control population mobility and slum overpopulation is uncommon (Janlert, 2009). Increased use of healthcare services in growing and urbanising areas, enhanced monitoring networks, and better health infrastructure may all contribute to the substantial negative correlation between PT and UP (Nguyen *et al.*, 2024). Together, these factors minimise the spread of tuberculosis by improving case discovery, reducing diagnostic delays, and promoting early treatment initiation (Johnston, Cooper and Menzies, 2022). Therefore, by changing the environment in which public health services function, population increase, and urbanisation become structural determinants that indirectly influence TB outcomes.

Overall, these findings align with the integrated model that emphasises the combined role of surveillance, infrastructure, and social protection in TB reduction (Költringer *et al.*, 2023b). Reducing the incidence of tuberculosis and enhancing treatment results requires the effective management of comorbidities like HIV, diabetes, and chronic respiratory conditions (Dzinamarira, Imran and Muvunyi, 2022). These illnesses make it more difficult to diagnose and treat active TB, in addition to raising the risk of getting it (Kraef *et al.*, 2021). In a nutshell, an integrated strategy that makes use of institutional governance, health system reforms, advanced diagnostics, and active community involvement is needed to control tuberculosis (Calderon *et al.*, 2022; Dzinamarira, Imran and Muvunyi, 2022). The WHO guidelines and practical innovations offer actionable pathways, with theories that provide the conceptual underpinning to create a thorough, moral, and long-term plan for lowering the worldwide TB burden (David A. Warrell *et al.*, 2003; Crofton, 2009; Dye, 2015; *Management of Tuberculosis*. Fourth Edition, 2021). Tuberculosis (TB) is a socio-structural condition rather than just a clinical illness, and is also a biological phenomenon that is exacerbated by public health fragmentation (Wingfield, 2016; Marchese *et al.*, 2022).

#### 6. Conclusion

To effectively reduce the cases of tuberculosis and the costs associated with it, nations need to concentrate on building solid systems for monitoring the disease, providing fair funding for healthcare services, particularly in regions where TB rates are high and resources are scarce. Linking TB monitoring to broader health system advancements and social support programs is essential to achieve lasting health improvements and economic stability. The previous findings above show that with better sanitation, electricity access, and case detection, TB incidence across ASEAN countries can be substantially lower. The positive link between government health spending and TB incidence likely reflects reactive funding, underscoring the need to redirect resources toward prevention, infrastructure, and early detection. To ensure that no population is left behind in the global fight against tuberculosis, harmonised strategies that combine public health priorities with economic development will be necessary for sustainable progress toward

the End TB targets and the Sustainable Development Goals that cover it. In summary, combining efficient surveillance, fair financing, and socioeconomic progress is essential for sustained TB control in ASEAN and beyond.

## 7. Implication of research

This research emphasises that tuberculosis presents both a health risk and an economic issue. By connecting monitoring measures, such as case finding, treatment success rates, hygiene, access to electricity, population size, urban population, and health funding, to TB rates in 9 ASEAN nations, it is evident that proper monitoring and fair investments are vital for mitigating the disease's impact and promoting steady economic progress. The results indicate that lowering out-of-pocket health costs, enhancing sanitation and electricity systems, addressing pressures from rapid population growth, and increasing government spending on health are key methods for controlling TB within ASEAN regions. Model estimates suggest that the variables for this research, when combined, could collectively reduce TB incidence within ASEAN regions. Population dynamics also play a critical role, as densely populated and rapidly urbanising areas benefit the most from improved surveillance and infrastructure investments. Each 1% improvement in these areas contributes to measurable declines in TB cases. The positive link with health spending likely reflects reactive investment in high-burden areas rather than a true rise in cases. These findings assist the worldwide community by providing helpful policy ideas that correspond with the Sustainable Development Goals, stressing the importance of combining health, demographic planning, and development efforts to significantly reduce TB cases and boost economic security around the world.

## 8. Limitations of the study and future research

This research depends on secondary information from the World Bank and monitoring databases. These sources may not be completely accurate due to issues such as underreporting, variations in diagnostic methods, and differences in the capacities of health systems across countries. The analysis relied on broad indicators, which may not account for specific factors such as patient compliance, social stigma, other health issues, or variations in local health programs. In addition, the study examines relationships rather than causality, limiting the ability to clearly identify direct links between tuberculosis rates and socioeconomic factors. Future studies should include gathering original data, conducting specific case studies for each country, and applying advanced analytical techniques such as spatial analysis or machine learning to offer deeper insights. Longitudinal studies that consider comorbidities such as HIV and diabetes, as well as the impact of emerging technologies like molecular testing and digital health tools, would enhance understanding and support more targeted interventions. Future research could also integrate health economics with behavioural and political perspectives to explore how sociocultural factors and policy preferences influence health outcomes and system efficiency.

### Authors' contributions and responsibilities

Mohamed Sesay: data analysis, interpretation, methodology, and drafted the manuscript, Hariyono Hariyono, Wahyu Aditama Putra Mukti Wibawa, Hijrah Saputra: conceptualization, Methodological support, data validation and literature support, Abdul Rhoda Sankoh: provided critical feedback and revisions.

### Competing interests

There are no potential conflicts of interest reported by the authors.

### Data availability statement



The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ORCID

Mohamed Sesay <https://orcid.org/0009-0004-3911-0597>

Hariyono Hariyono <https://orcid.org/0009-0009-2509-0018>

Wahyu Aditama Putra Mukti Wibawa <https://orcid.org/0000-0002-3961-0709>

Hijrah Saputra <https://orcid.org/0000-0002-5082-4046>

Abdul Rhoda Sankoh <https://orcid.org/0009-0008-4520-4820>

## References

Adima, F. and Arini, M. (2025) 'The influence of healthcare workers' social support on compliance to medication in multi drug resistant tuberculosis patients at the Regional General Hospital of Dr. Saiful Anwar', *Clinical Epidemiology and Global Health*, 31, p. 101890. doi: 10.1016/j.cegh.2024.101890.

Ahmad Khan, F. *et al.* (2017) 'Effectiveness and safety of standardised shorter regimens for multidrug-resistant tuberculosis: individual patient data and aggregate data meta-analyses', *European Respiratory Journal*, 50(1), p. 1700061. doi: 10.1183/13993003.00061-2017.

Alshamsan, R. *et al.* (2010) 'Impact of pay for performance on inequalities in health care: systematic review', *Journal of Health Services Research & Policy*, 15(3), pp. 178–184. doi: 10.1258/jhsrp.2010.009113.

Amare, D., Alene, K. A. and Ambaw, F. (2025) 'Effect of integrating traditional and modern healthcare systems on tuberculosis case detection in Ethiopia: a cluster randomised controlled study', *Infectious Diseases of Poverty*, 14(1), p. 16. doi: 10.1186/s40249-024-01270-9.

Anwar, A. *et al.* (2023) 'Government health expenditures and health outcome nexus: a study on OECD countries', *Frontiers in Public Health*, 11, p. 1123759. doi: 10.3389/fpubh.2023.1123759.

Ardhana, S. and Dariatno Sihaloho, E. (2025) 'Investigating the Role of Health Expenditure on Tuberculosis Incidence in Indonesia', *Economics Development Analysis Journal*, 13(4). doi: 10.15294/edaj. v13i4.21080.

Ayabina, D. V. *et al.* (2021) 'The impact of active case finding on transmission dynamics of tuberculosis: A modelling study', *PLOS ONE*. Edited by M. L. Ndeffo Mbah, 16(11), p. e0257242. doi: 10.1371/journal.pone.0257242.

Bernal, O. *et al.* (2020) 'Determinantes sociales y meta de tuberculosis en los Objetivos de Desarrollo Sostenible en las Américas'. doi: <https://doi.org/10.26633/RPSP.2020.153>.

Bhatia, V. *et al.* (2023) 'Ending TB in South-East Asia: flagship priority and response transformation', *The Lancet Regional Health - Southeast Asia*, 18, p. 100301. doi: 10.1016/j.lansea.2023.100301.

Bio, R. B. *et al.* (2024) 'Economic burden and coping mechanisms by tuberculosis treatment supporters: a mixed method approach from Bono Region, Ghana', *BMC Health Services Research*, 24(1), p. 148. doi: 10.1186/s12913-024-10611-1.

Blanchet, K. *et al.* (2017) 'Governance and Capacity to Manage Resilience of Health Systems: Towards a New Conceptual Framework', *International Journal of Health Policy and Management*, 6(8), pp. 431–435. doi: 10.15171/ijhpm.2017.36.

Boccia, D. *et al.* (2011) 'Cash transfer and microfinance interventions for tuberculosis control: review of the impact evidence and policy implications', *The International Journal of Tuberculosis and Lung Disease*, 15(6), pp. 37–49. doi: 10.5588/ijtld.10.0438.

Brown, J. *et al.* (2015) 'Health status and quality of life in tuberculosis', *International Journal of Infectious Diseases*, 32, pp. 68–75. doi: 10.1016/j.ijid.2014.12.045.

Bui, V. L. *et al.* (2025) 'Impact of Case Detection and COVID-19-Related Disruptions on Tuberculosis in Vietnam: A Modelling Analysis'. *Infectious Diseases (except HIV/AIDS)*. doi: 10.1101/2025.02.27.25323053.

Calderon, J. S. *et al.* (2022) 'Innovating tuberculosis prevention to achieve universal health coverage in the Philippines', *The Lancet Regional Health - Western Pacific*, 29, p. 100609. doi: 10.1016/j.lanwpc.2022.100609.

Chavez-Rimache, L., Ugarte-Gil, C. and Brunette, M. J. (2023) 'The community as an active part in the implementation of interventions for the prevention and care of tuberculosis: A scoping review', *PLOS Global Public Health*. Edited by L. Gao, 3(12), p. e0001482. doi: 10.1371/journal.pgph.0001482.

Cole, B. *et al.* (2020) 'Essential Components of a Public Health Tuberculosis Prevention, Control, and Elimination Program: Recommendations of the Advisory Council for the Elimination of Tuberculosis and the National Tuberculosis Controllers Association', *MMWR. Recommendations and Reports*, 69(7), pp. 1–27. doi: 10.15585/mmwr.rr6907a1.

Crofton, J. (2009). *Crofton's clinical tuberculosis*. Third edition. Edited by H.L. Rieder *et al*, Oxford; Macmillan. Available at: [https://tbrieder.org/publications/books\\_english/crofton\\_clinical.pdf](https://tbrieder.org/publications/books_english/crofton_clinical.pdf).

David A. Warrell *et al.* (2003) *Oxford Textbook of Medicine*. 4th edition. Available at [https://www.bjanaesthesia.org/article/S0007-0912\(17\)37541-4/fulltext](https://www.bjanaesthesia.org/article/S0007-0912(17)37541-4/fulltext).

De La Rua-Domenech, R. *et al.* (2006) 'Ante mortem diagnosis of tuberculosis in cattle: A review of the tuberculin tests,  $\gamma$ -interferon assay and other ancillary diagnostic techniques', *Research in Veterinary Science*, 81(2), pp. 190–210. doi: 10.1016/j.rvsc.2005.11.005.

De Lombaerde, P. *et al.* (2024) 'Strategic responses of regional economic organizations to the Chinese Belt and Road Initiative: the cases of ASEAN, EAEU, and EU', *Asia Pacific Business Review*, 30(2), pp. 399–419. doi: 10.1080/13602381.2022.2093526.

Dean, A. S. *et al.* (2022) '25 years of surveillance of drug-resistant tuberculosis: achievements, challenges, and way forward', *The Lancet Infectious Diseases*, 22(7), pp. e191–e196. doi: 10.1016/S1473-3099(21)00808-2.

Dheda, K. *et al.* (2022) 'The intersecting pandemics of tuberculosis and COVID-19: population-level and patient-level impact, clinical presentation, and corrective interventions', *The Lancet Respiratory Medicine*, 10(6), pp. 603–622. doi: 10.1016/S2213-2600(22)00092-3.

Dodd, P. J. *et al.* (2014) 'Burden of childhood tuberculosis in 22 high-burden countries: a mathematical modelling study', *The Lancet Global Health*, 2(8), pp. e453–e459. doi: 10.1016/S2214-109X (14)70245-1.

Doulla, B. E. (2021) 'Creating an Effective Routine Surveillance System for Drug-Resistant Tuberculosis Among Previously Treated Patients in Tanzania by'. A cross-sectional study of stakeholders' perceptions. *PLOS ONE*, 14(2), p.e0212421. <https://doi.org/10.1371/journal.pone.0212421>

Dussault, G. and Dubois, C.-A. (2003) 'Human resources for health policies: a critical component in health policies', *Human Resources for Health*, 1(1), p. 1. doi: 10.1186/1478-4491-1-1.

Dye, C. (2015) *The Population Biology of Tuberculosis*. 1st edn. Princeton University Press. doi: 10.23943/princeton/9780691154626.001.0001.

Dzinamarira, T., Imran, M. and Muvunyi, C. M. (2022) 'The Management of Infectious Diseases in Comorbidity with Tuberculosis', *Medicina*, 58(10), p. 1406. doi: 10.3390/medicina58101406.

Faeni, D. P. (2023) 'SERVQUAL measures: Indonesian government healthcare (BPJS) from a human resource perspective', *Journal of Infrastructure, Policy and Development*, 8(2). doi: 10.24294/jipd. v8i2.2271.

Fahdhienie, F. *et al.* (2024) 'Risk factors of pulmonary tuberculosis in Indonesia: A case-control study in a high disease prevalence region', *Narra J*, 4(2), p. e943. doi: 10.52225/narra. v4i2.943.

Ferreira, M. R. L. *et al.* (2023) 'Social protection as a right of people affected by tuberculosis: a scoping review and conceptual framework', *Infectious Diseases of Poverty*, 12(1), p. 103. doi: 10.1186/s40249-023-01157-1.

Fløe, A. *et al.* (2018) 'Comorbidities, mortality and causes of death among patients with tuberculosis in Denmark 1998–2010: a nationwide, register-based case–control study', *Thorax*, 73(1), pp. 70–77. doi: 10.1136/thoraxjnl-2016-209240.

Fox, G. J. *et al.* (2013) 'Contact investigation for tuberculosis: a systematic review and meta-analysis', *European Respiratory Journal*, 41(1), pp. 140–156. doi: 10.1183/09031936.00070812.

Fuady, A. (2023) 'Estimating tuberculosis burden: national reporting systems', *The Lancet Global Health*, 11(1), pp. e14–e15. doi: 10.1016/S2214-109X(22)00473-9.

Fuady, A., Hutnamon, T., *et al.* (2024) 'Achieving universal social protection for people with tuberculosis', *The Lancet Public Health*, 9(5), pp. e339–e344. doi: 10.1016/S2468-2667(24)00046-X.

Fuady, A., Anindhita, M., *et al.* (2024) 'Bridging the gap: financing health promotion and disease prevention in Indonesia', *Health Research Policy and Systems*, 22(1), p. 146. doi: 10.1186/s12961-024-01206-7.

Gandy, M. and Zumla, A. (2002) 'The resurgence of disease: social and historical perspectives on the "new" tuberculosis'. [https://doi.org/10.1016/s0277-9536\(01\)00176-9](https://doi.org/10.1016/s0277-9536(01)00176-9)

Garrido-Cardenas, J. A. et al. (2020) 'Global tuberculosis research and its prospects', *Tuberculosis*, 121, p. 101917. doi: 10.1016/j.tube.2020.101917.

Gopalaswamy, R. et al. (2020) 'Of tuberculosis and non-tuberculous mycobacterial infections – a comparative analysis of epidemiology, diagnosis and treatment', *Journal of Biomedical Science*, 27(1), p. 74. doi: 10.1186/s12929-020-00667-6.

Harling, G., Ehrlich, R. and Myer, L. (2008) 'The social epidemiology of tuberculosis in South Africa: A multilevel analysis', *Social Science & Medicine*, 66(2), pp. 492–505. doi: 10.1016/j.socscimed.2007.08.026.

Heidi Behm et al. (2024) *Tuberculosis Infection Control*. 2ND EDITION. Available at: <https://www.currytbcenter.ucsf.edu/products/view/tuberculosis-infection-control-practical-manual-preventing-tb>.

Hogan, A. B. et al. (2020) 'Potential impact of the COVID-19 pandemic on HIV, tuberculosis, and malaria in low-income and middle-income countries: a modelling study', *The Lancet Global Health*, 8(9), pp. e1132–e1141. doi: 10.1016/S2214-109X(20)30288-6.

Holloway-Kew, K. L. and Henneberg, M. (2023) 'Dynamics of tuberculosis infection in various populations during the 19th and 20th century: The impact of conservative and pharmaceutical treatments', *Tuberculosis*, 143, p. 102389. doi: 10.1016/j.tube.2023.102389.

Hong, C.-Y. et al. (2023) 'Time-trend analysis of tuberculosis diagnosis in Shenzhen, China between 2011 and 2020', *Frontiers in Public Health*, 11, p. 1059433. doi: 10.3389/fpubh.2023.1059433.

Huda, M. H. et al. (2024) 'A meta-analysis of technology-based interventions on treatment adherence and treatment success among TBC patients', *PLOS ONE*. Edited by M. F. Umer, 19(12), p. e0312001. doi: 10.1371/journal.pone.0312001.

Iskandar, D. et al. (2023) 'Clinical and economic burden of drug-susceptible tuberculosis in Indonesia: national trends 2017–19', *The Lancet Global Health*, 11(1), pp. e117–e125. doi: 10.1016/S2214-109X(22)00455-7.

Jakubowiah, W. et al. (2001) 'TB Manual National Tuberculosis Programme Guidelines'. Warsaw: Ministry of Health of Poland. Available at <https://iris.who.int/bitstream/handle/10665/107401/WHO-EURO-2001-8583-48355-71790-eng.pdf>.

Janlert, U. (2009) 'Economic crisis, unemployment and public health', *Scandinavian Journal of Public Health*, 37(8), pp. 783–784. doi: 10.1177/1403494809351070.

Jennifer Frances Dela (2025) 'Tuberculosis in the ASEAN Region'. Available at: <https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2024/tb-disease-burden/1-1-tb-incidence?>



Jeyashree, K. *et al.* (2024) 'Cost of TB care and equity in distribution of catastrophic TB care costs across income quintiles in India', *Global Health Research and Policy*, 9(1), p. 51. doi: 10.1186/s41256-024-00392-9.

Jia, Z.-W. *et al.* (2008) 'Spatial Analysis of Tuberculosis Cases in Migrants and Permanent Residents, Beijing, 2000–2006', *Emerging Infectious Diseases*, 14(9), pp. 1413–1419. doi: 10.3201/1409.071543.

Johnston, J. C., Cooper, R. and Menzies, D. (2022) 'Chapter 5: Treatment of tuberculosis disease', *Canadian Journal of Respiratory, Critical Care, and Sleep Medicine*, 6(sup1), pp. 66–76. doi: 10.1080/24745332.2022.2036504.

Khaing, M. N. T. *et al.* (2024) 'Out-of-pocket payment and catastrophic health expenditure of tuberculosis patients in accessing care at public-private mix clinics in Myanmar, 2022', *Infectious Diseases of Poverty*, 13(1), p. 81. doi: 10.1186/s40249-024-01248-7.

Kim, M.K., Bhattacharya, Jayanta and Bhattacharya, Joydeep (2024) 'Is income inequality linked to infectious disease prevalence? A hypothesis-generating study using tuberculosis', *Social Science & Medicine*, 345, p. 116639. doi: 10.1016/j.socscimed.2024.116639.

Kirigia, J. M. and Muthuri, R. D. K. (2016) 'Productivity losses associated with tuberculosis deaths in the World Health Organization African region', *Infectious Diseases of Poverty*, 5(1), p. 43. doi: 10.1186/s40249-016-0138-5.

Költringer, F. A. *et al.* (2023a) 'The social determinants of national tuberculosis incidence rates in 116 countries: a longitudinal ecological study between 2005–2015', *BMC Public Health*, 23(1), p. 337. doi: 10.1186/s12889-023-15213-w.

Kraef, C. *et al.* (2021) 'Delayed diagnosis of tuberculosis in persons living with HIV in Eastern Europe: associated factors and effect on mortality—a multicentre prospective cohort study', *BMC Infectious Diseases*, 21(1), p. 1038. doi: 10.1186/s12879-021-06745-w.

Kumah, A. (2025) 'Building community networks and engagement for effective TB case management', *Frontiers in Public Health*, 13, p. 1576875. doi: 10.3389/fpubh.2025.1576875.

Kwan, A. *et al.* (2018) 'Variations in the quality of tuberculosis care in urban India: A cross-sectional, standardized patient study in two cities', *PLOS Medicine*. Edited by C. Evans, 15(9), p. e1002653. doi: 10.1371/journal.pmed.1002653.

Law, I. *et al.* (2015) 'The first national tuberculosis prevalence survey of Lao PDR (2010–2011)', *Tropical Medicine & International Health*, 20(9), pp. 1146–1154. doi: 10.1111/tmi.12536.

Ledesma, J. R. *et al.* (2024) 'Global, regional, and national age-specific progress towards the 2020 milestones of the WHO End TB Strategy: a systematic analysis for the Global Burden of Disease Study 2021', *The Lancet Infectious Diseases*, 24(7), pp. 698–725. doi: 10.1016/S1473-3099(24)00007-0.

Lee, A. *et al.* (2007) 'Improving Health and Building Human Capital Through an Effective Primary Care System', *Journal of Urban Health*, 84(S1), pp. 75–85. doi: 10.1007/s11524-007-9175-5.

Li, G. *et al.* (2015) 'Decision Models for Workforce and Technology Planning in Services', *Service Science*, 7(1), pp. 29–47. doi: 10.1287/serv.2015.0094.

Lim, M. Y. *et al.* (2023) 'Health financing challenges in Southeast Asian countries for universal health coverage: a systematic review', *Archives of Public Health*, 81(1), p. 148. doi: 10.1186/s13690-023-01159-3.

Lim, V. W. *et al.* (2021) 'Cross-sectional study of prevalence and risk factors, and a cost-effectiveness evaluation of screening and preventive treatment strategies for latent tuberculosis among migrants in Singapore', *BMJ Open*, 11(7), p. e050629. doi: 10.1136/bmjopen-2021-050629.

Liu, J. *et al.* (2020) 'How investment in public health has impacted the prevalence of tuberculosis in China: A study of provincial variations between 2005 and 2015', *The International Journal of Health Planning and Management*, 35(6), pp. 1546–1558. doi: 10.1002/hpm.3034.

Liu, Y. *et al.* (2024a) 'Health system efficiency and equity in ASEAN: an empirical investigation', *Cost Effectiveness and Resource Allocation*, 22(1), p. 86. doi: 10.1186/s12962-024-00588-3.

Lu, Y. *et al.* (eds) (2017) *Handbook of Global Tuberculosis Control: Practices and Challenges*. Boston, MA: Springer US. doi: 10.1007/978-1-4939-6667-7.

MacPherson, P. *et al.* (2024) 'Community-based active-case finding for tuberculosis: navigating a complex minefield', *BMC Global and Public Health*, 2(1), p. 9. doi: 10.1186/s44263-024-00042-9.

Madhukar Pai and Zelalem Temesgen (2018) 'Quality of Tuberculosis care'. doi: doi: 10.1016/j.jctube.2018.12.001.

Malakoane, B. *et al.* (2020) 'Public health system challenges in the Free State, South Africa: a situation appraisal to inform health system strengthening', *BMC Health Services Research*, 20(1), p. 58. doi: 10.1186/s12913-019-4862-y.

*Management of Tuberculosis*. Fourth Edition (2021). Malaysia: Malaysian Health Technology Assessment Section (MaHTAS) Medical Development Division, Ministry of Health Malaysia. Available at: <http://www.moh.gov.my> <http://www.acadmed.org.my>.

Marchese, V. *et al.* (2022) 'Fragmentation of Healthcare Services as a Possible Determinant of the Low Completion for the Tuberculosis Cascade of Prevention among Asylum Seekers: Results from a Prospective Study with Historical Comparison', *Pathogens*, 11(6), p. 613. doi: 10.3390/pathogens11060613.

Mcintyre, D., Meheus, F. and Røttingen, J.-A. (2017) 'What level of domestic government health expenditure should we aspire to for universal health coverage?', *Health Economics, Policy and Law*, 12(2), pp. 125–137. doi: 10.1017/S1744133116000414.

Menzies, N. A. *et al.* (2024) 'The long-term effects of domestic and international tuberculosis service improvements on tuberculosis trends within the USA: a mathematical modelling study', *The Lancet Public Health*, 9(8), pp. e573–e582. doi: 10.1016/S2468-2667(24)00150-6.



Mijiti, P. *et al.* (2016) 'Prevalence of pulmonary tuberculosis in western China in 2010–11: a population-based, cross-sectional survey', *The Lancet Global Health*, 4(7), pp. e485–e494. doi: 10.1016/S2214-109X(16)30074-2.

Mtetwa, H. N. *et al.* (2023) 'Exploring the role of wastewater-based epidemiology in understanding tuberculosis burdens in Africa', *Environmental Research*, 231, p. 115911. doi: 10.1016/j.envres.2023.115911.

Munteanu, I. *et al.* (2025) 'The Role of Psychosocial Interventions in Increasing Adherence to Tuberculosis Treatment in People Belonging to Socially Vulnerable Categories', *Applied Sciences*, 15(15), p. 8173. doi: 10.3390/app15158173.

Nahid, P. (2006) 'Advances in the Diagnosis and Treatment of Tuberculosis', *Proceedings of the American Thoracic Society*, 3(1), pp. 103–110. doi: 10.1513/pats.200511-119JH.

Nguyen, T.-A. *et al.* (2024) 'Population-wide active case finding as a strategy to end TB', *The Lancet Regional Health - Western Pacific*, 46, p. 101047. doi: 10.1016/j.lanwpc.2024.101047.

Nisha Ahamed, Anita Khilall, and Patricia Woods (2017). Tuberculosis Case Management: A *GUIDE FOR NURSES*. Available at: [globaltb.njms.rutgers.edu](http://globaltb.njms.rutgers.edu).

Nitta, A. T., Davidson, P. T. and Hsu, V. (2003) 'Tuberculosis Control Program Manual'. Los Angeles: Los Angeles County Department of Public Health. Available at: <https://publichealth.lacounty.gov/tb/tbmanual/tbmanual.pd>.

Nooy, A. D. *et al.* (2024) 'Trade-offs between clinical performance and test accessibility in tuberculosis diagnosis: a multi-country modelling approach for target product profile development', *The Lancet Global Health*, 12(7), pp. e1139–e1148. doi: 10.1016/S2214-109X(24)00178-5.

Nunn, A. J. *et al.* (2014) 'Evaluation of a standardised treatment regimen of anti-tuberculosis drugs for patients with multi-drug-resistant tuberculosis (STREAM): study protocol for a randomised controlled trial', *Trials*, 15(1), p. 353. doi: 10.1186/1745-6215-15-353.

Ogbuabor, D. C. and Onwujekwe, O. E. (2019) 'Governance of tuberculosis control programme in Nigeria', *Infectious Diseases of Poverty*, 8(1), p. 45. doi: 10.1186/s40249-019-0556-2.

Olawade, D. B. *et al.* (2024) 'Transforming multidrug-resistant tuberculosis care: The potentials of telemedicine in resource-limited settings', *Health Sciences Review*, 12, p. 100185. doi: 10.1016/j.hsr.2024.100185.

Olivares-Tirado, P. and Zanga, R. (2024) 'Waste in health care spending: A scoping review', *International Journal of Healthcare Management*, 17(2), pp. 330–342. doi: 10.1080/20479700.2023.2185580.

Olmsted, S. S. *et al.* (2010) 'Strengthening Laboratory Systems in Resource-Limited Settings', *American Journal of Clinical Pathology*, 134(3), pp. 374–380. doi: 10.1309/AJCPDQOSB7QR5GLR.

Pescarini, J. M. *et al.* (2017) 'Migration to middle-income countries and tuberculosis—global policies for global economies', *Globalization and Health*, 13(1), p. 15. doi: 10.1186/s12992-017-0236-6.

Piatek, A. S. *et al.* (2013) 'GeneXpert for TB diagnosis: planned and purposeful implementation', *Global Health: Science and Practice*, 1(1), pp. 18–23. doi: 10.9745/GHSP-D-12-00004.

Pradipta, I. S. *et al.* (2018) 'Risk factors of multidrug-resistant tuberculosis: A global systematic review and meta-analysis', *Journal of Infection*, 77(6), pp. 469–478. doi: 10.1016/j.jinf.2018.10.004.

Puiu, I.-A. and Bîlbîie, A. (2025) 'Measuring productivity in the healthcare sector: a bibliometric and content analysis', *Health Economics Review*, 15(1), p. 24. doi: 10.1186/s13561-025-00612-z.

Reaser, J. K. *et al.* (2021) 'Ecological countermeasures for preventing zoonotic disease outbreaks: when ecological restoration is a human health imperative', *Restoration Ecology*, 29(4), p. e13357. doi: 10.1111/rec.13357.

Reis, A. C. *et al.* (2021) 'Global trends of epidemiological research in livestock tuberculosis for the last four decades', *Transboundary and Emerging Diseases*, 68(2), pp. 333–346. doi: 10.1111/tbed.13763.

Robbiati, C. *et al.* (2022) 'Improving TB Surveillance and Patients' Quality of Care Through Improved Data Collection in Angola: Development of an Electronic Medical Record System in Two Health Facilities of Luanda', *Frontiers in Public Health*, 10, p. 745928. doi: 10.3389/fpubh.2022.745928.

Ryan, N. *et al.* (2020) 'Implementation of the therapeutic use of hydroxyurea for sickle cell disease management in resource-constrained settings: a systematic review of adoption, cost and acceptability', *BMJ Open*, 10(11), p. e038685. doi: 10.1136/bmjopen-2020-038685.

Sahu, S. *et al.* (2025) 'Overcoming the global tuberculosis crisis with urgent country-level political and financial action', *The Lancet Infectious Diseases*, 25(1), pp. 14–16. doi: 10.1016/S1473-3099(24)00748-5.

Saragih, S. *et al.* (2024) 'Estimating the budget impact of a Tuberculosis strategic purchasing pilot study in Medan, Indonesia (2018–2019)', *Health Economics Review*, 14(1), p. 44. doi: 10.1186/s13561-024-00518-2.

Satyanarayana, S. *et al.* (2020a) 'An Opportunity to END TB: Using the Sustainable Development Goals for Action on Socio-Economic Determinants of TB in High Burden Countries in WHO South-East Asia and the Western Pacific Regions', *Tropical Medicine and Infectious Disease*, 5(2), p. 101. doi: 10.3390/tropicalmed5020101.

Schmidt, T. *et al.* (2024) 'Expanding the Catalog of Patient and Caregiver Out-of-Pocket Costs: A Systematic Literature Review', *Population Health Management*, 27(1), pp. 70–83. doi: 10.1089/pop.2023.0238.



Schneider-Kamp, A. (2021) 'Health capital: toward a conceptual framework for understanding the construction of individual health', *Social Theory & Health*, 19(3), pp. 205–219. doi: 10.1057/s41285-020-00145-x.

Sharma Waddington, H. *et al.* (2023) 'Impact on childhood mortality of interventions to improve drinking water, sanitation, and hygiene (WASH) to households: Systematic review and meta-analysis', *PLOS Medicine*. Edited by J. Thorley, 20(4), p. e1004215. doi: 10.1371/journal.pmed.1004215.

Singh, H. and Ramamohan, V. (2020) 'A model-based investigation into urban-rural disparities in tuberculosis treatment outcomes under the Revised National Tuberculosis Control Programme in India', *PLOS ONE*. Edited by N. McCreesh, 15(2), p. e0228712. doi: 10.1371/journal.pone.0228712.

Solanki, P. *et al.* (2024) 'Improving the diagnosis of tuberculosis: old and new laboratory tools', *Expert Review of Molecular Diagnostics*, 24(6), pp. 487–496. doi: 10.1080/14737159.2024.2362165.

Spies, R. *et al.* (2024) 'Spatial Analysis of Drug-Susceptible and Multidrug-Resistant Cases of Tuberculosis, Ho Chi Minh City, Vietnam, 2020–2023', *Emerging Infectious Diseases*, 30(3). doi: 10.3201/eid3003.231309.

Stevens, W. S. *et al.* (2017) 'Impact of the GeneXpert MTB/RIF Technology on Tuberculosis Control'. doi: 10.1128 /microbiolspec. TBTB2-0040-2016.

Syafiq, N. J. M. *et al.* (2023) 'Latent tuberculosis infection in health-care workers in the government sector in Brunei Darussalam: A cross-sectional study', *Journal of Integrative Nursing*, 5(3), pp. 197–202. doi: 10.4103/jin.jin\_18\_23.

Teo, A. K. J. *et al.* (2020) 'Determinants of delayed diagnosis and treatment of tuberculosis in Cambodia: a mixed-methods study', *Infectious Diseases of Poverty*, 9(1), p. 49. doi: 10.1186/s40249-020-00665-8.

The Lancet Microbe (2024) 'Despite available tools, tuberculosis is the top killer again', *The Lancet Microbe*, 5(12), p. 101044. doi: 10.1016/j.lanmic.2024.101044.

Trisha Greenhalgh, Oxford textbook of medicine. Fourth edition. David A Warrell, Timothy M Cox, John D Firth, Edward J Benz Jr (eds). (4146 pages, £275.) Oxford University Press, 2003. ISBN 0-19-262922-0. *Family Practice*, Volume 20, Issue 4, August 2003, Page 499, <https://doi.org/10.1093/fampra/cm441>.

Tok, P.S.K. *et al.* (2020) 'Determinants of unsuccessful treatment outcomes and mortality among tuberculosis patients in Malaysia: A registry-based cohort study', *PLOS ONE*. Edited by H. S. Ehtesham, 15(4), p. e0231986. doi: 10.1371/journal.pone.0231986.

Tschirhart, N., Nosten, F. and Foster, A. M. (2016) 'Access to free or low-cost tuberculosis treatment for migrants and refugees along the Thailand-Myanmar border in Tak province, Thailand', *International Journal for Equity in Health*, 15(1), p. 100. doi: 10.1186/s12939-016-0391-z.

Vesga, J. F. *et al.* (2019) 'Assessing tuberculosis control priorities in high-burden settings: a modelling approach', *The Lancet Global Health*, 7(5), pp. e585–e595. doi: 10.1016/S2214-109X(19)30037-3.

Villar-Hernández, R. *et al.* (2023) 'Tuberculosis: current challenges and beyond', *Breathe*, 19(1), p. 220166. doi: 10.1183/20734735.0166-2022.

Vo, L. N. Q. *et al.* (2020) 'Evaluating the yield of systematic screening for tuberculosis among three priority groups in Ho Chi Minh City, Viet Nam', *Infectious Diseases of Poverty*, 9(1), p. 166. doi: 10.1186/s40249-020-00766-4.

WHO (2019) 'Multisectoral Accountability Framework To Accelerate Progress To End Tuberculosis By 2030'. Available at: (CC BY-NC-SA 3.0 IGO; <https://creativecommons.org/licenses/bync-sa/3.0/igo>).

Wingfield, T. (2016) 'Beyond pills and tests: addressing the social determinants of tuberculosis', 16. Beyond pills and tests: addressing the social determinants of tuberculosis. *Clinical Medicine*, 16(Supply 6), pp.s79–s91. Available at <https://doi.org/10.7861/clinmedicine.16-6-s79>.

Witter, S. *et al.* (2025) 'Political economy analysis of health financing reforms in times of crisis: findings from three case studies in south-east Asia', *International Journal for Equity in Health*, 24(1), p. 34. doi: 10.1186/s12939-025-02395-5.

World Health Organisation (2014). *Understanding and using tuberculosis data*. Geneva: World Health Organisation. Available at: <https://iris.who.int/handle/10665/129942> (Accessed: 13 April 2025).

World Health Organisation (2024) *Global Tuberculosis Report 2024*. 1st ed. Geneva: World Health Organisation. Available at: <https://www.who.int/publications/i/item/97892401015331>.

Wright, A. *et al.* (2009) 'Epidemiology of antituberculosis drug resistance 2002–07: an updated analysis of the Global Project on Anti-Tuberculosis Drug Resistance Surveillance', *The Lancet*, 373(9678), pp. 1861–1873. doi: 10.1016/S0140-6736(09)60331-7.

Xie, S. *et al.* (2025) 'Decadal trends and regional disparities in tuberculosis burden: a comprehensive analysis of global, African, and Southeast Asian data from the GBD 1990–2021', *Frontiers in Public Health*, 13, p. 1467509. doi: 10.3389/fpubh.2025.1467509.

Xu, P. *et al.* (2024) 'Impact of an innovative bundled payment to TB health care providers in China: an economic simulation analysis', *BMC Health Services Research*, 24(1), p. 577. doi: 10.1186/s12913-024-11034-8.

Yang, Z. *et al.* (2025) 'Recent progress in tuberculosis diagnosis: insights into blood-based biomarkers and emerging technologies', *Frontiers in Cellular and Infection Microbiology*, 15, p. 1567592. doi: 10.3389/fcimb.2025.1567592.

Youngkong, S. *et al.* (2024) 'Catastrophic costs incurred by tuberculosis affected households from Thailand's first national tuberculosis patient cost survey', *Scientific Reports*, 14(1), p. 11205. doi: 10.1038/s41598-024-56594-1.



Zannetos, S. *et al.* (2022) 'The economic burden of tuberculosis in Cyprus. A probabilistic cost of illness study.', *Epidemiology, Biostatistics, and Public Health*, 15(2). doi: 10.2427/12780.

Zeka, A. N., Tasbakan, S. and Cavusoglu, C. (2011) 'Evaluation of the GeneXpert MTB/RIF Assay for Rapid Diagnosis of Tuberculosis and Detection of Rifampin Resistance in Pulmonary and Extrapulmonary Specimens', *Journal of Clinical Microbiology*, 49(12), pp. 4138–4141. doi: 10.1128/JCM.05434-11.

Zelalem Temesgen, Z. (2011) *Mayo Clinic Infectious Diseases Board Review*. Cary: Oxford University Press USA - OSO (Mayo Clinic Scientific Press Ser). Available at: <https://global.oup.com/academic/product/mayo-clinic-infectious-diseases-board-review-9780199827626>.

Zhang, Q. *et al.* (2025) 'Providing financial protection in health for low-income populations: a comparison of health financing designs in East Asia', *International Journal for Equity in Health*, 24(1), p. 215. doi: 10.1186/s12939-025-02568-2.