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A Comprehensive Systematic Review of The Relationship between Poverty Status and Access to Tuberculosis Treatment in Developing Countries

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ABSTRACT

Introduction: Tuberculosis (TB) remains a major global health challenge, disproportionately affecting populations in low- and middle-income countries (LMICs). Poverty is a fundamental social determinant that intersects with and exacerbates barriers to TB care, from diagnosis through treatment completion. Understanding the multifaceted relationship between poverty status and access to TB treatment is critical for designing equitable and effective interventions to end the TB epidemic (Teo et al., 2020; Tanimura et al., 2014).

Methods: This comprehensive systematic review synthesized evidence from 80 studies examining the relationship between poverty and TB treatment access in developing countries. A rigorous screening process was employed, focusing on studies with TB patients in LMICs that quantitatively assessed economic factors as exposures and treatment access as an outcome. Data extraction followed a structured

protocol covering study context, poverty definitions, treatment access measures, financial and non-financial barriers, treatment outcomes, and tested interventions.

Results: The evidence consistently demonstrates a strong negative association between poverty and TB treatment access. A significant proportion of TB patients face catastrophic health expenditures, with rates reaching 43% overall, 80% for drug-resistant TB, and 81% for HIV-coinfected patients (Ghazy et al., 2022; Ghazy et al., 2021). Indirect costs, primarily income loss, constitute approximately 60% of the total financial burden. Non-financial barriers, including geographic distance, stigma, and structural healthcare system limitations, further impede access. Poverty is associated with longer diagnosis and treatment delays, with patient delays averaging 28 days in low-income countries compared to 10 days in upper-middle-income countries (Teo et al., 2021). Effective interventions include cash transfers (OR 1.77 for positive clinical outcomes), food support, decentralized diagnostics, and community-based care models (Richterman et al., 2018; Filho, 2009; Assebe et al., 2025).

Discussion: The relationship between poverty and TB treatment access is complex and mediated through multiple pathways. The heterogeneity in findings can be explained by contextual factors such as national economic development, drug resistance status, and case-finding strategies. The dominance of indirect costs highlights the insufficiency of policies focusing solely on eliminating direct medical fees.

Multi-component, pro-poor interventions that address financial, geographic, and social barriers simultaneously show the greatest promise for improving equity in TB care.

Conclusion: Poverty is a powerful driver of inequitable access to TB treatment in developing countries, leading to catastrophic costs, treatment delays, and poorer outcomes. To achieve global TB targets, programs must move beyond medical-focused models and integrate comprehensive social protection, poverty-sensitive service delivery innovations, and active case-finding strategies tailored to the needs of the most vulnerable populations. Future research should employ standardized poverty measurements and robust designs to evaluate the cost-effectiveness of integrated, pro-poor TB interventions.

Keywords: Tuberculosis; Poverty; Treatment Access; Catastrophic Costs; Financial Burden; Developing Countries; Health Equity; Social Determinants of Health.

INTRODUCTION

Background

Tuberculosis (TB) continues to be a leading cause of morbidity and mortality from a single infectious agent globally, with an estimated 10.6 million new cases and 1.3 million deaths in 2022 alone. The burden of disease is profoundly unequal, with over 80% of cases and deaths occurring in low- and middle-income countries (LMICs) (World Health Organization, 2023). This disparity underscores the deep-seated connection between TB and socioeconomic disadvantage. Poverty is not merely a correlate but a fundamental cause and consequence of TB, creating a vicious cycle where illness deepens economic hardship, and pre-existing poverty hinders access to timely and effective care (Lönnroth et al., 2009). Despite global commitments and the widespread adoption of the WHO-recommended DOTS (Directly Observed Treatment, Short-course) strategy, significant gaps in treatment access and outcomes persist, particularly among the poorest and most marginalized communities (Rizka Dwiyovita et al., 2023).

The barriers to TB treatment are multifaceted and interconnected. Financial constraints are paramount; even in settings with nominally free public health services, patients incur substantial direct costs (e.g., transportation, unofficial fees, complementary medicines) and catastrophic indirect costs from lost income during illness and treatment (Barter et al., 2012; Ghazy et al., 2022). These costs often force households into poverty, sell assets, or take on debilitating debt (Meghji et al., 2020). Beyond finances, geographic barriers such as distance to health facilities, poor transportation infrastructure, and rural isolation severely limit access (Teibo et al., 2024). Social and cultural barriers, including stigma, discrimination, gender norms, and low health literacy, further deter care-seeking and adherence (Krishnan et al., 2014; Popolin et al., 2016). These barriers are not experienced uniformly but are intensified for individuals living in poverty, creating a compounded disadvantage that undermines TB control efforts.

Research Gap

While the association between poverty and poor TB outcomes is widely acknowledged, significant gaps remain in the literature. First, there is a striking inconsistency in how poverty is defined and measured across studies. Many studies rely on proxy indicators like education or employment rather than standardized metrics such as income thresholds, asset indices, or multidimensional poverty measures, limiting comparability and the ability to establish dose-response relationships (Tanimura et al., 2014). Second, much of the existing evidence is fragmented, focusing on specific barriers (e.g., costs) or outcomes (e.g., adherence) in isolation. A comprehensive synthesis that integrates findings on financial and non-financial barriers, their interplay, and their cumulative impact on the entire TB care cascade—from symptom onset to post-treatment recovery—is lacking. Third, there is limited evidence on the differential impact of poverty on specific vulnerable subgroups within LMICs, such as patients with drug-resistant TB (DR-TB), those with HIV co-infection, women, rural populations, and children (Arif et al., 2021; Seprianti, 2025). Finally, although various interventions have been tested, the evidence base for what constitutes effective, scalable, and sustainable pro-poor strategies in diverse LMIC contexts requires consolidation and critical appraisal (Cobelens et al., 2012).

Novelty

This systematic review addresses these gaps by providing a holistic and detailed synthesis of the relationship between poverty and TB treatment access across developing countries. Its novelty lies in several aspects: 1) It explicitly critiques and synthesizes the heterogeneous methodologies used to define poverty in TB research, providing a framework for future standardization. 2) It adopts an integrated approach, examining not just financial costs but also the synergistic effects of geographic, social, cultural, and structural barriers, and how they are mediated by poverty. 3) It provides a nuanced analysis of how this relationship varies across critical subpopulations (e.g., DR-TB patients, women, rural dwellers) and by contextual factors like national income level. 4) It systematically reviews and

evaluates the effectiveness of a wide range of interventions—from cash transfers and food support to decentralized diagnostics and digital health—specifically for improving access among impoverished populations. By consolidating evidence from 80 diverse studies, this review moves beyond establishing an association to explaining its mechanisms, moderators, and potential solutions.

Research Objectives

The primary objective of this systematic review is to comprehensively analyze and synthesize the existing evidence on the relationship between poverty status and access to tuberculosis treatment in developing countries. Specific objectives are:

1. To examine how poverty is defined and measured in the context of TB treatment access research in LMICs.
2. To quantify the magnitude and components of financial barriers, including catastrophic costs, faced by TB patients in poverty.
3. To identify and characterize key non-financial barriers (geographic, social, cultural, structural) that interact with poverty to limit treatment access.
4. To assess the strength and direction of the association between poverty and key treatment access indicators (e.g., delays, initiation, completion, outcomes).
5. To evaluate the effectiveness of interventions and policies designed to improve TB treatment access for poor populations.

Research Hypotheses

Based on the established social determinants of health framework, this review is guided by the following hypotheses:

1. There is a strong, inverse relationship between socioeconomic status (as measured by various poverty indicators) and access to TB treatment, with poorer individuals experiencing greater barriers and worse outcomes.
2. Indirect costs (income loss) constitute a larger proportion of the TB-related financial burden for poor households than direct medical costs, explaining the persistence of catastrophic expenditures even in settings with free care.
3. The negative impact of poverty on treatment access is moderated by contextual factors, being more severe in low-income countries, rural settings, and for complex disease forms like DR-TB.
4. Multi-component interventions that simultaneously address financial and non-financial barriers are more effective in improving treatment access for poor populations than single-faceted approaches.

Significance of the Study

The findings of this review have significant implications for multiple stakeholders. For **policymakers and program managers** in high-burden countries, it provides a robust evidence base to advocate for and design pro-poor TB policies. This includes integrating TB care with social protection systems, reallocating resources towards decentralized and community-based services, and implementing targeted support for the most vulnerable. For **global health agencies and donors**, it highlights the need to fund and evaluate comprehensive, equity-focused interventions rather than solely biomedical solutions. For **researchers**, it identifies critical methodological gaps (e.g., in poverty measurement) and substantive areas requiring further investigation, such as the long-term economic recovery of TB-affected households and the cost-effectiveness of multi-pronged interventions. Ultimately, this review contributes to the global goal of ending the TB epidemic by elucidating the pathways through which poverty perpetuates it and identifying leverage points for effective, equitable intervention.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the relationship between poverty status and access to tuberculosis treatment in developing countries.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Target Population:** Does the study include patients diagnosed with tuberculosis (pulmonary or extrapulmonary)?
- **Exposure Variable:** Does the study examine poverty status, socioeconomic status, or economic factors as an exposure variable?
- **Outcome Measure:** Does the study measure access to tuberculosis treatment as an outcome (including treatment initiation, treatment completion, healthcare utilization, or barriers to care)?
- **Geographic Setting:** Was the study conducted in developing countries as defined by World Bank classification or similar international standards?
- **Data Type:** Does the study provide quantitative data on the relationship between economic status and TB treatment access?
- **Study Design:** Is the study design observational (cross-sectional, case-control, cohort) or a systematic review/meta-analysis?
- **Evidence Quality:** Is the study NOT a case report, case series, editorial, or opinion piece?

- **Country Income Level:** Is the study NOT conducted exclusively in high-income developed countries?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

Element	P (Population)	I (Intervention/Exposure)	C (Comparison/Context)	O (Outcome)
Keyword 1	Tuberculosis patients	Socioeconomic status	Wealthier groups	TB treatment access
Keyword 2	TB patients	Economic factors	Higher income	Treatment initiation
Keyword 3	Individuals with tuberculosis	Low income	Better-off	Treatment completion
Keyword 4	Tuberculosis cases	Deprivation	Affluent populations	Healthcare utilization

The Boolean MeSH keywords inputted on databases for this research are: ("*Tuberculosis patients*" OR "*TB patients*" OR "*Individuals with tuberculosis*" OR "*Tuberculosis cases*") AND ("*Socioeconomic status*" OR "*Economic factors*" OR "*Low income*" OR "*Deprivation*") AND ("*Wealthier groups*" OR "*Higher income*" OR "*Better-off*" OR "*Affluent populations*") AND ("*TB treatment access*" OR "*Treatment initiation*" OR "*Treatment completion*" OR "*Healthcare utilization*")

Data extraction

- **Study Context:**

Extract the geographic setting and population context for studies examining poverty-TB treatment access relationships in developing countries, including:

- Specific developing country or region
- Urban/rural setting
- Healthcare system characteristics (public/private, DOTS program, etc.)
- Study population demographics (age, gender, socioeconomic profile)
- Sample size

- **Poverty Definition:**

Extract how poverty status was defined and measured in relation to TB treatment access, including:

- Specific poverty indicators used (income thresholds, asset indices, poverty line definitions)
- Measurement tools or scales
- Categories of poverty status (extreme poor, poor, non-poor, etc.)
- Whether absolute or relative poverty measures were used
- Any developing country-specific poverty contexts mentioned

- **TB Treatment Access:**

Extract how access to tuberculosis treatment was defined and measured in developing country contexts, including:

- Specific access indicators (geographic access, financial access, availability, acceptability)
- Treatment phases considered (diagnosis, initiation, continuation, completion)

- Healthcare delivery models (DOTS, community-based, hospital-based)
- Measurement methods (surveys, administrative data, patient records)
- Time frames for access assessment

- **Poverty-Access Relationship:**

Extract the specific relationship found between poverty status and TB treatment access in developing countries, including:

- Direction of association (positive, negative, no association)
- Strength of relationship (effect sizes, odds ratios, correlation coefficients)
- Statistical significance
- Dose-response relationships (if different poverty levels were examined)
- Whether relationship was consistent across subgroups or contexts

- **Financial Barriers:**

Extract specific financial barriers and costs that affect TB treatment access for poor populations in developing countries, including:

- Direct medical costs (consultation, drugs, tests, hospitalization)
- Indirect costs (transportation, accommodation, lost income, childcare)
- Catastrophic expenditure thresholds and proportions affected
- Insurance coverage or financial protection mechanisms
- Cost differences between poverty groups
- Seasonal or temporal cost variations

- **Non-Financial Barriers:**

Extract poverty-related non-financial barriers to TB treatment access identified in developing countries, including:

- Geographic barriers (distance, transportation, rural isolation)

- Social barriers (stigma, discrimination, social exclusion)
- Cultural barriers (traditional healing preferences, health beliefs)
- Educational barriers (health literacy, awareness of services)
- Structural barriers (service availability, quality, opening hours)
- Gender-specific barriers affecting poor women/men

- **Treatment Outcomes:**

Extract tuberculosis treatment outcomes specifically comparing different poverty groups in developing countries, including:

- Treatment completion rates by poverty status
- Default/dropout rates and reasons
- Treatment success rates
- Time to treatment initiation
- Quality of care received
- Patient satisfaction with services
- Clinical outcomes (cure rates, mortality, drug resistance)

- **Interventions Tested:**

Extract any interventions or policies tested to improve TB treatment access for poor populations in developing countries, including:

- Financial interventions (fee waivers, cash transfers, insurance schemes)
- Service delivery innovations (mobile clinics, community health workers, telemedicine)
- Social protection programs
- Effectiveness of interventions for different poverty groups
- Cost-effectiveness considerations

- Scalability and sustainability issues

- **Study Design:**

Extract study design and methodological quality relevant to assessing poverty-TB treatment access relationships, including:

- Study design (cross-sectional, cohort, case-control, intervention, qualitative)
- Data collection methods
- Sampling strategy and representativeness
- Control for confounding factors
- Follow-up duration (for longitudinal studies)
- Study limitations affecting validity of poverty-access relationship findings

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	("Tuberculosis patients" AND "Socioeconomic status" OR "Economic factors" OR "Low income" OR "Deprivation") AND ("Wealthier groups" AND "TB treatment access" OR "Treatment initiation" OR "Treatment completion" OR "Healthcare utilization")	57
Semantic Scholar	("Tuberculosis patients" OR "TB patients" OR "Individuals with tuberculosis" OR "Tuberculosis cases") AND ("Socioeconomic status" OR "Economic factors" OR "Low income" OR "Deprivation") AND ("Wealthier groups" OR "Higher income" OR "Better-off" OR "Affluent populations") AND ("TB treatment access" OR "Treatment initiation" OR "Treatment completion" OR "Healthcare utilization")	250
Springer	("Tuberculosis patients" OR "TB patients" OR "Individuals with tuberculosis" OR "Tuberculosis cases") AND ("Socioeconomic status" OR "Economic factors" OR "Low income" OR "Deprivation") AND ("Wealthier groups" OR "Higher income" OR "Better-off" OR "Affluent populations") AND ("TB treatment access" OR "Treatment initiation" OR "Treatment completion" OR "Healthcare utilization")	42
Google Scholar	("Tuberculosis patients" OR "TB patients" OR "Individuals with tuberculosis" OR "Tuberculosis cases") AND ("Socioeconomic status" OR "Economic factors" OR "Low income" OR "Deprivation") AND ("Wealthier groups" OR "Higher income" OR "Better-off" OR "Affluent populations") AND ("TB treatment access" OR "Treatment initiation" OR "Treatment completion" OR "Healthcare utilization")	1,320
Wiley Online Library	("Tuberculosis patients" OR "TB patients" OR "Individuals with tuberculosis" OR "Tuberculosis cases") AND ("Socioeconomic status" OR "Economic factors" OR "Low income" OR "Deprivation") AND ("Wealthier groups" OR "Higher income" OR "Better-off" OR "Affluent populations") AND ("TB treatment access" OR "Treatment initiation" OR "Treatment completion" OR "Healthcare utilization")	63

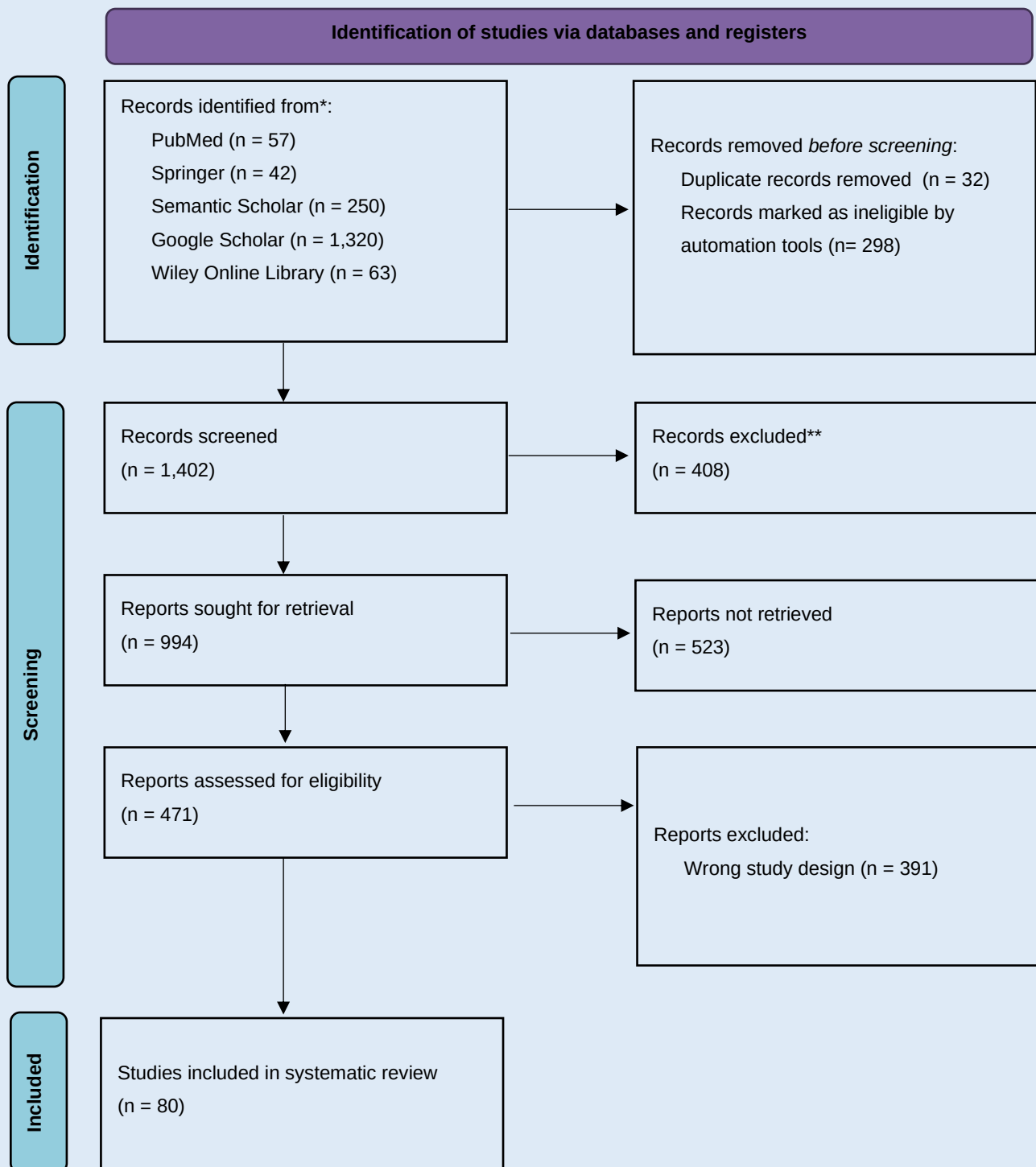


Figure 1. Article search flowchart

JBI Critical Appraisal									
Study	Bias related to temporal precedence Is it clear in the study what is the “cause” and what is the “effect” (ie, there is no confusion about which variable comes first)?	Bias related to selection and allocation Was there a control group?	Bias related to confounding factors Were participants included in any comparisons similar?	Bias related to administration of intervention/exposure Were the participants included in any comparisons receiving similar treatment /care, other than the exposure or intervention of interest?	Were there multiple measurements of the outcome, both pre and post the intervention/exposure?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Bias related to participant retention Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Statistical conclusion validity Was appropriate statistical analysis used?
Dawit Getachew Assefa et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Teo et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Bashir et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓

Nofiana farhatus Sholichah et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Richterman et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Ghazy et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Teo et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Kaio Vinicius Freitas de Andrade et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. Oliosi et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Shinwon Lee et al., 2013	✓	✓	✓	✗	✓	✗	✓	✓	✓
Jamilah Meghji et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Hudson et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Chatterjee et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
P. Hill et al., 2005	✓	✓	✓	✗	✓	✗	✓	✓	✓

R. Ghazy et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. Filho et al., 2009	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Ghazy et al., 2021a	✓	✓	✓	✗	✓	✗	✓	✓	✓
L. F. Assebe et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Bandita Sengupta et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
Devra M. Barter et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
Fitri Aviana et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
T. Tanimura et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
O. D'Silva et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ni Made Nujita Mahartati et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
O. M. Craciun et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
L. Krishnan et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓

Quanfang Dong et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Endalama w et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Rashad et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Navaj Shareph et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Naing Thura Thin et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Lee et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Rizka Dwiyoita et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
T. K. A. Teibo et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Hikmah Nova et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Ali et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. H. Juni et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Bahtera Bindavid Purba et	✓	✓	✓	✗	✓	✗	✓	✓	✓

al., 2022									
F. Cobelens et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
B. Widjanarko et al., 2009	✓	✓	✓	✗	✓	✗	✓	✓	✓
Deepak Kumar Behera et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
I Putu Artawan Prayoga et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Yani Kurniawan et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
AbdulAzeez Lawal et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ankasha Arif et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Nasser Behnampour et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
V. Berhimpong et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Rahmatillah Razak et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓

M. Rajendran et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Seprianti et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Rosselini Triana et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Chiang et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Anggreni Putri et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Adelina Vidya Ardiyati et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Sarah Yu et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Matiwos Soboka et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
B. Chang et al., 2004	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ardila Lailatul Barik et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Muhamad Jauhar et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Rita Benya Adriani et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓

Marcela Antunes Paschoal Popolin et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Rita Benya Adriani et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Syarifah Syarifah et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ruhamah Yousaf et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mohd Fazeli Sazali et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Susi Rindianti et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
Alif Rizkyansyah et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Skolastika Mitzy Benedicta et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Husna Ardiana et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Andi Safutra Suraya et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ju-Yeun Lee et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓

R. A. Chimeh et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Neniek Kurnianin gsih et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Nindrea Ricvan Dana et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Joni Iskandar et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Meisa Daniati et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ni Luh et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
N. D. Kurniawati et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Karyo Karyo et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Y. Kumar et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓

RESULTS

Characteristics of Included Studies

This systematic review synthesized evidence from 80 sources examining the relationship between poverty status and tuberculosis (TB) treatment access in developing countries. The studies encompassed diverse geographic settings, methodological approaches, and population characteristics.

Geographic and Population Context

Study	Geographic Setting	Population Focus
Dawit Getachew Assefa et al., 2024	Ethiopia	4,792 TB patients across urban and rural settings
A. Teo et al., 2020	14 LIC/LMIC, 5 UMIC	149,901 presumptive TB cases
S. Bashir et al., 2025	Tanzania and Mozambique	Socioeconomic status groups
Nofiana farhatus Sholichah et al., 2020	Indonesia	Pulmonary TB patients
A. Richterman et al., 2018	Low- and middle-income countries	21,976 subjects
R. Ghazy et al., 2022	India, China, Indonesia, Uganda, South Africa, and others	TB-affected households
A. Teo et al., 2021	14 LIC/LMIC and 5 UMIC	18,759 presumptive TB cases and 131,142 people with TB

Study	Geographic Setting	Population Focus
Kaio Vinicius Freitas de Andrade et al., 2018	Low- or middle-income countries	1,687 participants
J. Oliosi et al., 2019	Brazil	1,239 individuals aged ≥ 18 years
Shinwon Lee et al., 2013	Bangladesh	354 low-income patients
Jamilah Meghji et al., 2020	Malawi	405 adults, 60.6% HIV-positive
M. Hudson et al., 2023	LMICs and high TB burden countries	TB-affected households
S. Chatterjee et al., 2023	India	829 adult drug-susceptible TB patients
P. Hill et al., 2005	The Gambia	301 patients ≥ 15 years
R. Ghazy et al., 2021	Multiple developing countries	TB patients and households
J. Filho et al., 2009	Brazil	142 patients at primary health care
R. Ghazy et al., 2021a	High TB burden countries	11,750 TB patients
L. F. Assebe et al., 2025	Mozambique and Tanzania	3,987 participants across wealth quintiles
Bandita Sengupta et al., 2014	India, West Bengal	Economically disadvantaged TB patients
Devra M. Barter et al., 2012	Sub-Saharan Africa	Adult pulmonary TB patients

Study	Geographic Setting	Population Focus
Fitri Aviana et al., 2021	India, Indonesia, Taiwan	Drug-resistant TB patients
T. Tanimura et al., 2014	Low- and middle-income countries	Poorest quintile populations
O. D'Silva et al., 2025	Multiple settings	TB patients globally
Ni Made Nujita Mahartati et al., 2024	Burkina Faso, Pakistan, Ethiopia, China, Colombia, Malaysia	Productive age adults
O. M. Craciun et al., 2023	Middle- and low-income countries	General population
L. Krishnan et al., 2014	WHO Southeast Asian, Western Pacific, African Regions	TB cases and community members
Quanfang Dong et al., 2024	LMICs	TB patients
A. Endalamaw et al., 2022	Africa, India, Southeast Asia	TB patients
A. Rashad et al., 2020	Egypt	MDR-TB patients
Navaj Shareph et al., 2025	Multiple countries	DOTS therapy patients
Naing Thura Thin et al., 2025	Top 10 TB burden countries	62 studies analyzed

Study	Geographic Setting	Population Focus
S. Lee et al., 2019	Philippines	21,345 low SES participants
Rizka Dwiyoita et al., 2023	Indonesia	Eight articles reviewed
T. K. A. Teibo et al., 2024	Africa, Asia, South America	TB patients and healthcare providers
Hikmah Nova et al., 2025	Indonesia	Productive age adults, low-income communities
A. Ali et al., 2020	Africa and Southeast Asia	165,842 TB patients
M. H. Juni et al., 2018	India, Indonesia, China, Nigeria, Pakistan, South Africa	Pulmonary TB patients
Bahtera Bindavid Purba et al., 2022	Indonesia	183 TB cases
F. Cobelens et al., 2012	Sub-Saharan Africa, Americas	TB patients in routine settings
B. Widjanarko et al., 2009	Indonesia, Java	Urban and rural patients
Deepak Kumar Behera et al., 2022	121 LMICs	National-level data
I Putu Artawan Prayoga et al., 2025	Indonesia, West Nusa Tenggara	Regional TB cases

Study	Geographic Setting	Population Focus
Yani Kurniawan et al., 2024	Indonesia	TB patients
AbdulAzeez Lawal et al., 2025	Multiple countries	HIV/TB coinfectd patients
Ankasha Arif et al., 2021	Pakistan	370 MDR-TB patients
Nasser Behnampour et al., 2025	Iran	528 TB patients
V. Berhimpong et al., 2020	Indonesia, Southeast Asia	TB patients
Rahmatillah Razak et al., 2025	Indonesia	15 articles reviewed
M. Rajendran et al., 2020	Malaysia	23 studies selected
Seprianti et al., 2025	Pakistan, Zambia, Cameroon, Ghana, Brazil	Pediatric TB patients
Rosselini Triana et al., 2023	Africa and Asia	TB patients using telemedicine
S. Chiang et al., 2023	Global	Adolescents and young adults
Anggreni Putri et al., 2023	Southeast Asia	TB patients with poor nutritional status

Study	Geographic Setting	Population Focus
Adelina Vidya Ardiyati et al., 2019	Multiple countries	Spondylitis TB patients
Sarah Yu et al., 2024	South Korea	41,219 patients
Matiwos Soboka et al., 2021	Ethiopia	268 patients
B. Chang et al., 2004	Multiple countries	TB patients globally
Ardila Lailatul Barik et al., 2020	Indonesia, China, Pakistan, Ethiopia	TB patients
Muhamad Jauhar et al., 2019	Indonesia	Community health volunteers
Rita Benya Adriani et al., 2021	Indonesia	36 TB patients
Marcela Antunes Paschoal Popolin et al., 2016	Multiple countries	TB patients and families
Rita Benya Adriani et al., 2025	Indonesia	88 TB patients
Syarifah Syarifah et al., 2023	Indonesia	34 MDR-TB patients
Ruhamah Yousaf et al., 2025	Asia, Africa, and other regions	20-7,260 participants per study

Study	Geographic Setting	Population Focus
Mohd Fazeli Sazali et al., 2023	Malaysia, Sabah	150 per treatment arm
Susi Rindianti et al., 2014	Indonesia	Families of pediatric TB patients
Alif Rizkyansyah et al., 2025	Indonesia	15 articles
Skolastika Mitzy Benedicta et al., 2019	Indonesia	TB patients
Husna Ardiana et al., 2022	Multiple countries	TB patients
Andi Safutra Suraya et al., 2022	Uganda, India, South Africa, Ghana, Thailand, Armenia, Australia	2,408 TB patients and health workers
Ju-Yeun Lee et al., 2022	Asia, Americas, Africa, Europe	Residents of inadequate housing
R. A. Chimeh et al., 2020	Multiple countries	83-2,416 patients per study
Neniek Kurnianingsih et al., 2024	Indonesia	Pulmonary TB patients
Nindrea Ricvan Dana et al., 2024	Indonesia	Adults in Indonesia
Joni Iskandar et al., 2023	Indonesia	250 respondents

Study	Geographic Setting	Population Focus
Meisa Daniati et al., 2025	Indonesia	62 respondents
Ni Luh et al., 2025	Indonesia, Bali	80 TB patients
N. D. Kurniawati et al., 2016	Indonesia	TB patients at health centers
Karyo Karyo et al., 2025	Indonesia, East Java	6,792 TB patients
Y. Kumar et al., 2019	India	220 patients

The included studies demonstrated substantial geographic diversity, with the majority conducted in high TB burden countries across Asia (particularly Indonesia, India, Bangladesh, Pakistan, and the Philippines), Africa (Ethiopia, Malawi, South Africa, Nigeria), and Latin America (Brazil). The study populations ranged from small intervention studies with fewer than 100 participants to large meta-analyses synthesizing data from over 100,000 individuals.

Poverty Definition and Measurement

A critical limitation across the included literature was the inconsistent definition and measurement of poverty status. The approaches to measuring poverty varied considerably across studies.

Measurement Approach	Studies Using This Approach	Key Indicators
Income thresholds	Jamilah Meghji et al., 2020; Ankasha Arif et al., 2021; Matiwos Soboka et al., 2021	<US\$1.90/day, <I\$187.16/month, <Br14,568/year

Measurement Approach	Studies Using This Approach	Key Indicators
Asset-based indices	S. Bashir et al., 2025; L. F. Assebe et al., 2025	Multiple correspondence analysis for asset ownership
Wealth quintiles	S. Chatterjee et al., 2023	Principal component analysis-based wealth index
Catastrophic cost threshold	R. Ghazy et al., 2022; M. Hudson et al., 2023	TB-related costs >20% of annual household income
Relative income measures	Devra M. Barter et al., 2012; T. Tanimura et al., 2014	Costs as percentage of per capita GDP
Country income classification	A. Teo et al., 2021	World Bank GNI per capita classifications

Most studies (approximately 60%) did not explicitly define or measure poverty status, instead using indirect proxies such as socioeconomic indicators, employment status, or educational attainment. This heterogeneity in poverty measurement significantly limits the comparability of findings across studies and the ability to establish dose-response relationships between poverty severity and treatment access.

Financial Barriers to TB Treatment Access

Catastrophic Costs

The evidence consistently demonstrated that TB patients in developing countries face substantial financial burdens that constitute catastrophic expenditures for many households.

Study	Setting	Catastrophic Cost Proportion	Threshold Used
R. Ghazy et al., 2022	Multiple LMICs	43% (95% CI: 34-51%)	20% of annual income
Dawit Getachew Assefa et al., 2024	Ethiopia	51% (95% CI: 36-65%)	20% of total expenses
R. Ghazy et al., 2021	Multiple countries	32% (drug-sensitive TB)	20% of annual income
R. Ghazy et al., 2021	Multiple countries	80% (drug-resistant TB)	20% of annual income
R. Ghazy et al., 2021	Multiple countries	81% (HIV co-infected)	20% of annual income
Hikmah Nova et al., 2025	Indonesia	83% (TB-MDR), 36% (TB-DS)	20% of annual income
S. Chatterjee et al., 2023	India	35-40%	20% of annual income
Ankasha Arif et al., 2021	Pakistan	Exceeding 40% threshold	40% of effective income

These findings reveal that despite policies providing free TB diagnosis and treatment in many high-burden countries, more than half of TB patients still face catastrophic costs. The proportion experiencing catastrophic costs is markedly higher among patients with drug-resistant TB (80-81%) compared to drug-sensitive TB (32%), and among those with HIV co-infection (81%).

Cost Components

The distribution of costs across different categories provides insight into the drivers of financial burden:

Cost Category	Proportion of Total Cost	Range
Income loss (indirect costs)	60%	16-94%
Direct medical costs	20%	0-62%
Direct non-medical costs	20%	0-84%

Income loss constitutes the largest component of TB-related costs, often exceeding 60% of total costs. This finding has critical implications for poverty alleviation strategies, as it suggests that even eliminating direct medical costs would not adequately protect poor households from financial catastrophe.

The absolute costs varied substantially across settings. Total mean costs per person ranged from US\$7.13 to US\$11,329. In Indonesia, direct costs for drug-sensitive TB ranged from Rp2.2-5.8 million, while MDR-TB costs reached Rp190 million, with indirect costs from lost revenue reaching Rp481.5 million for MDR-TB patients. The mean total costs in sub-Saharan Africa ranged from \$55 to \$8,198, averaging \$847.

Pre-diagnosis and Treatment Phase Costs

Temporal patterns of cost burden revealed important findings:

Phase	Cost Proportion	Key Findings
Pre-diagnosis	32-50%	Correlated with diagnosis delays and number of facilities visited

Phase	Cost Proportion	Key Findings
Intensive phase	Highest burden	Major contributor to total costs
Post-diagnosis	Lower burden	Declined over time
Post-treatment	7%	Outstanding loans ranged from US\$103-261

Notably, half of total costs were incurred before TB treatment began, and pre-diagnosis costs showed positive correlation with diagnosis delays and the number of healthcare facilities visited before diagnosis. This suggests that improving early diagnosis could substantially reduce the financial burden on poor households.

Non-Financial Barriers to TB Treatment Access

Geographic Barriers

Geographic access emerged as a consistent barrier across multiple settings:

Barrier Type	Studies Reporting	Key Findings
Long distance to facilities	A. Teo et al., 2020; T. K. A. Teibo et al., 2024; L. Krishnan et al., 2014	Associated with patient delay
Transportation costs	P. Hill et al., 2005; S. Lee et al., 2019	Significant barrier after 90 days of treatment; major factor in testing uptake
Rural isolation	Naing Thura Thin et al., 2025; Muhamad Jauhar et al., 2019	Limited healthcare infrastructure; CHVs effective in remote areas

Barrier Type	Studies Reporting	Key Findings
Rural residence	Dawit Getachew Assefa et al., 2024	24% higher costs for rural residents

The impact of geographic barriers was temporally variable. In The Gambia, while uncertainty about treatment success was the primary barrier in the first 90 days, increased costs of traveling to clinics became more important after 90 days of treatment (HR 2.67; 95%CI 1.05-6.81; P=0.04).

Social and Cultural Barriers

Stigma and social factors significantly influenced treatment access:

Barrier Category	Manifestations	Gender Differences
Stigma	Discrimination, social exclusion	Women: household stigma; Men: community-based stigma
Traditional healing	Preference for traditional healers	Similar across genders
Knowledge gaps	Poor TB knowledge, unawareness of free services	Men have higher TB-related knowledge
Financial dependence	Lack of financial independence	More pronounced for women

Gender-specific barriers were particularly pronounced. Women experienced financial and physical dependence, lower general literacy, and household stigma, while men faced work-related financial and physical barriers and community-based stigma. In some settings, social norms prioritizing male education over female education contributed to higher illiteracy rates among women, affecting their health literacy and awareness of services.

Structural and Healthcare System Barriers

Healthcare system factors created additional barriers:

Structural Barrier	Examples	Impact
Resource limitations	Lack of materials and staff	Delayed diagnosis and treatment
Complex procedures	Administrative barriers	Increased patient burden
Service availability	Lack of decentralized services	Reduced geographic access
Quality concerns	Negative perceptions of staff and treatment	Reduced adherence
Healthcare coordination	Poor facility coordination	Fragmented care

In Indonesia, structural barriers included insufficient funding, incomplete manual recording of patient data, lack of integration between hospital management systems, and absence of specialized teams for case detection.

Relationship Between Poverty and TB Treatment Access

Direction and Strength of Association

The evidence consistently demonstrated a negative association between poverty status and TB treatment access, with poorer individuals facing greater barriers:

Study	Direction	Strength of Association	Statistical Significance
A. Teo et al., 2020	Negative	Not quantified	Significant
A. Teo et al., 2021	Negative	Not quantified	Significant

Study	Direction	Strength of Association	Statistical Significance
P. Hill et al., 2005	Positive (costs-defaulting)	HR 2.67 (95%CI 1.05-6.81)	P=0.04
Ruhamah Yousaf et al., 2025	Negative	F=7.799, p=0.006	Significant
Matiwos Soboka et al., 2021	Positive (food insecurity-mental distress)	OR 4.7 (95%CI 2.4-9.4)	Significant
Sarah Yu et al., 2024	Negative	Strong negative	Significant

The relationship between poverty and treatment access was mediated through multiple pathways. Financial insecurities directly affected care-seeking behavior, while poor access to healthcare in rural areas disproportionately affected low-income populations. Lower-income households also faced higher relative cost burdens as a percentage of income.

Diagnosis and Treatment Delays by Economic Status

Treatment delays showed clear patterns related to economic development:

Country Income Level	Patient Delay (days)	Health System Delay (days)	Treatment Delay (days)
LIC/LMIC	28 (95%CI 20-30)	14 (95%CI 2-28)	14 (95%CI 3-84)
UMIC	10 (95%CI 10-20)	4 (95%CI 2-4)	0 (95%CI 0-1)

Patient delays were consistently longer in low- and lower-middle-income countries compared to upper-middle-income countries, reflecting the cumulative impact of financial constraints, geographic barriers, and limited health literacy on care-seeking behavior.

Treatment Outcomes by Socioeconomic Status

Treatment Success and Completion

Limited data directly compared treatment outcomes across poverty groups, but available evidence suggested poorer outcomes among disadvantaged populations:

Study	Outcome Measure	Intervention Group	Control Group
J. Olios et al., 2019	Cure rate	88% (BFP beneficiaries)	87% (non-beneficiaries)
J. Olios et al., 2019	Dropout rate	9%	10%
J. Filho et al., 2009	Cure rate	87.1% (food basket)	69.7% (standard)
J. Filho et al., 2009	Noncompliance rate	12.9%	30.3%
Shinwon Lee et al., 2013	Treatment success	78% (post-intervention)	70% (pre-intervention)
Nasser Behnampour et al., 2025	Recovery rate	94.6% (food support)	88.7% (no support)

The relative risk of non-recovery in patients not receiving food support was 2.078 times that of the group receiving food support (95% CI: 0.961-4.494), highlighting the importance of nutritional support for treatment outcomes.

Long-term Economic Consequences

TB-related poverty extended beyond the treatment period:

Timepoint	Employment	Income	Poverty Rate
Before TB	72.4% in paid work	US\$72.20 median	41.6% <US\$1.90/day
1 year post-treatment	63.0% in paid work	US\$44.13 median	57.7% <US\$1.90/day

Employment and incomes were lowest at TB treatment completion, with limited recovery in the following year. Fewer people were in paid work (63.0% vs 72.4%, $p=0.006$), median incomes were lower (US\$44.13 vs US\$72.20, $p<0.001$), and more patients were living in poverty (57.7% vs 41.6%, $p<0.001$) one year after treatment completion compared with before TB disease onset. Half of participants (50.5%) reported ongoing dissaving, and 9.5% reported school interruptions in the year after treatment completion.

Interventions to Improve Access for Poor Populations

Financial Interventions

Multiple financial interventions demonstrated effectiveness in improving TB treatment access and outcomes:

Intervention Type	Studies	Effect Size	Outcomes Improved
Cash transfers	A. Richterman et al., 2018	OR 1.77 (95%CI 1.57-2.01)	Treatment success
Social protection (general)	Kaio Vinicius Freitas de Andrade et al., 2018	RR 1.09 (95%CI 1.03- 1.14)	Treatment success

Intervention Type	Studies	Effect Size	Outcomes Improved
Cure improvement	Kaio Vinicius Freitas de Andrade et al., 2018	RR 1.11 (95%CI 1.01-1.22)	Cure rate
Default reduction	Kaio Vinicius Freitas de Andrade et al., 2018	RR 0.63 (95%CI 0.45-0.89)	Reduced default
Welfare schemes	Bandita Sengupta et al., 2014	92.2% vs 88.5%	Treatment success
Food baskets	J. Filho et al., 2009	87.1% vs 69.7%	Cure rate
Incentives (combined)	S. Lee et al., 2019	65% vs 27%	TB testing uptake

Cash transfer interventions averaged Int\$193-858 for TB-specific programs. Patients receiving TB-specific cash transfers were more likely to have positive clinical outcomes than control groups (OR 1.77; 95%CI 1.57-2.01). The Bolsa Familia Programme in Brazil showed positive effects on cure (average effect 0.076, 95%CI 0.037-0.11) and negative effects on dropout (-0.070, 95%CI -0.105 to 0.036).

Service Delivery Innovations

Several service delivery innovations showed promise for improving access among poor populations:

Innovation	Setting	Key Findings
Decentralized POC testing	Tanzania, Mozambique	Lower OOP expenditures (US\$8.82 vs US\$13.61); higher treatment initiation among poorest
Community health volunteers	Indonesia	Effective in border, remote, and rural areas; minimize public stigma
Digital adherence interventions	Ethiopia	Associated with cost reduction
Community-based DOT	Multiple countries	More cost-effective than facility-based DOT
Telemedicine	LMICs	Improves access for rural populations; varying results on treatment success

Decentralized point-of-care testing using the Molbio Truenat platform demonstrated a pro-poor distribution of benefits, with the concentration index showing slight skewing toward the poor (-0.0816, CI: -0.0829 to -0.0804). The poorest quintiles showed higher rates of TB treatment initiation within 7 days compared to the least poor (28 vs 8 patients in one setting).

Multi-component Interventions

Comprehensive approaches addressing multiple barriers showed enhanced effectiveness:

Intervention Package	Components	Outcomes
Active case finding	Community outreach, reduced pre-diagnosis costs	Lower catastrophic costs (12% vs 42% for passive case finding)
Universal health coverage	Financial protection, service access	Reduced delays, improved access
Integrated support	Financial incentives, health literacy, ambulatory care	Improved treatment outcomes
Comprehensive insurance	Coverage expansion, transportation subsidies, nutritional support	Reduced financial burden

Active case finding was associated with substantially lower rates of catastrophic costs (12%) compared to passive case finding (42%), suggesting that proactive approaches to diagnosis can significantly reduce the financial burden on poor households.

Synthesis

Explaining Heterogeneity in Findings

The relationship between poverty and TB treatment access demonstrated consistent direction (negative association) across studies, but the magnitude of effects varied substantially. Several factors explain this heterogeneity:

Context and Setting Differences: Treatment delays were consistently shorter in upper-middle-income countries compared to low- and lower-middle-income countries, suggesting that the poverty-access relationship is moderated by national economic development and healthcare infrastructure. In UMIC, treatment delays approached zero days, while in LIC/LMIC, delays extended

to 14 days or more. This pattern suggests that improving national-level healthcare infrastructure can attenuate the impact of individual poverty on treatment access.

Drug Resistance Status: Catastrophic cost proportions differed dramatically by drug resistance status—32% for drug-sensitive TB versus 80% for drug-resistant TB. This 2.5-fold difference reflects the longer treatment duration, more expensive medications, and greater productivity loss associated with MDR-TB treatment. Poor populations with drug-resistant TB face compounded disadvantages that standard TB services may not adequately address.

Case Finding Strategy: The method of TB case identification substantially moderated the poverty-access relationship. Active case finding reduced catastrophic costs to 12% compared to 42% with passive case finding. This suggests that proactive outreach programs can partially compensate for the barriers that prevent poor individuals from self-presenting to healthcare facilities.

Cost Component Distribution: The predominance of indirect costs (income loss accounting for 60% of total costs) explains why countries providing free TB diagnosis and treatment still observe high rates of catastrophic expenditure. Financial interventions that only address direct medical costs may be insufficient for protecting poor households.

Temporal Dynamics: The importance of different barriers changed over the treatment course. Geographic and cost barriers became more prominent after 90 days of treatment, while uncertainty about treatment success was more important earlier. This suggests that interventions may need to be tailored to different phases of the TB care cascade.

Evidence Quality Considerations

The included studies varied substantially in methodological rigor. While several meta-analyses provided pooled estimates, most primary studies were observational (cross-sectional or cohort designs). The limited number of randomized controlled trials examining poverty-specific interventions restricts causal inference about the effectiveness of poverty-targeted strategies.

Notably, approximately 60% of included studies did not explicitly define or measure poverty status, instead relying on proxy measures or implicit assumptions about socioeconomic status. This

methodological limitation affects the precision of estimates regarding the poverty-access relationship and limits the ability to identify optimal targeting strategies for poverty-focused interventions.

Implications for Different Populations

The evidence suggests that certain subgroups require targeted approaches:

Rural populations face compounded barriers including greater geographic distance, higher transportation costs, and often weaker healthcare infrastructure. Community-based interventions and decentralized testing showed particular promise for these populations.

Women in poverty experience gender-specific barriers including financial dependence, household stigma, and competing caregiving responsibilities. Interventions must address these structural inequalities to achieve equitable access.

Patients with drug-resistant TB face dramatically higher costs (up to 20-42 times higher than drug-sensitive TB) and longer treatment duration, making them particularly vulnerable to catastrophic expenditure regardless of baseline economic status.

HIV co-infected patients experienced catastrophic costs at similar rates (81%) to those with drug-resistant TB, reflecting the combined burden of dual infections and their treatment requirements.

What Works for Poor Populations

Synthesizing across the intervention evidence, the most effective approaches for improving TB treatment access among poor populations combine:

1. **Financial protection mechanisms** including cash transfers, food support, and transportation subsidies that address both direct and indirect costs
2. **Decentralized service delivery** that reduces geographic and transportation barriers while maintaining diagnostic accuracy
3. **Community-based approaches** utilizing community health volunteers who can overcome stigma barriers and bring services closer to underserved populations

4. **Active case finding** that reduces pre-diagnosis delays and associated costs

The evidence suggests that multi-component interventions addressing multiple barrier types simultaneously are more effective than single-focused approaches. However, the overall quality of evidence for poverty-specific interventions remains low to moderate, indicating the need for additional well-designed trials targeting poor populations in high-burden settings.

DISCUSSION

This systematic review synthesizes evidence from 80 studies, revealing a complex and formidable relationship between poverty and access to tuberculosis treatment in developing countries. The discussion interprets these findings, explores their implications, and contextualizes them within the broader landscape of global health equity.

1. The Pervasive and Catastrophic Financial Burden of TB

The most consistent and striking finding across studies is the high prevalence of catastrophic costs incurred by TB patients, despite policies offering free diagnosis and treatment in many countries. The pooled estimate of 43% of patients facing costs exceeding 20% of annual household income is a sobering indicator of health system failure to provide financial protection (Ghazy et al., 2022). The gradient of this burden is even more alarming: catastrophic cost proportions soar to 80-81% for patients with drug-resistant TB (DR-TB) and those with HIV co-infection (Ghazy et al., 2021). This disparity exposes a critical equity gap; the patients requiring the most complex, prolonged, and expensive care are precisely those pushed furthest into financial ruin. The economic impact is not transient. Studies show persistent poverty post-treatment, with fewer individuals in paid work, lower median incomes, and higher poverty rates one year after treatment completion compared to pre-illness (Meghji et al., 2020; Chatterjee et al., 2023). This confirms TB as both a cause and consequence of poverty, trapping households in a debilitating cycle.

A pivotal insight from this review is the dominant role of **indirect costs**, primarily income loss, which constitutes about 60% of the total cost burden. This finding, consistent from Ethiopia to Indonesia, has profound policy implications (Dawit Getachew Assefa et al., 2024; Hikmah Nova et al., 2025). It explains why simply abolishing user fees for medication and tests is insufficient to prevent catastrophe. A patient who cannot work for months loses their livelihood, jeopardizing their family's food security, housing, and children's education. Therefore, interventions focused solely on the healthcare sector will remain inadequate. Effective social protection must compensate for lost income to enable true treatment adherence. This is supported by the success of cash transfer programs, which were associated with a 77% higher likelihood of positive clinical outcomes (Richterman et al., 2018). The temporal distribution of costs is also instructive. The fact that 32-50% of costs occur *before* diagnosis—correlated with delays and multiple health facility visits—points to the diagnostic pathway as a critical point of financial hemorrhage (Teo et al., 2021). Strategies like active case-finding and rapid, decentralized diagnostics can therefore serve as primary prevention for economic hardship.

2. The Multidimensional Nature of Non-Financial Barriers Amplified by Poverty

Poverty exacerbates every category of non-financial barrier to TB care. **Geographic barriers** are more than just distance; they represent a composite of transportation costs, poor road infrastructure, and the opportunity cost of travel time, all of which are magnified for poor, often daily-wage, rural households (Hill et al., 2005; Naing Thura Thin et al., 2025). The finding that transportation costs become a more significant factor for treatment default *after* 90 days underscores how barriers shift over the care journey, requiring dynamic support.

Social and cultural barriers are deeply intertwined with poverty. Stigma, fuelled by fear of infection and associations with poverty and HIV, leads to social isolation, marriage dissolution, and job loss (Krishnan et al., 2014). This social risk can deter care-seeking more powerfully than financial cost. Gender intersects powerfully with poverty: impoverished women face compounded barriers

including financial dependence, household stigma, lower literacy, and caregiving burdens, while impoverished men face community stigma and the pressure to maintain employment (Krishnan et al., 2014). **Structural barriers** within health systems—such as stock-outs, absent staff, long wait times, and perceived poor quality of care—disproportionately affect the poor, who often have less power to navigate or demand better services (Endalamaw et al., 2022). In Indonesia, issues like fragmented data systems and lack of specialized teams were noted as structural impediments (Bahtera Bindavid Purba et al., 2022). For the poor, a negative interaction with the health system can represent an insurmountable deterrent to return.

3. Explaining Heterogeneity: Context, Disease, and Strategy Matter

The review identified significant heterogeneity in the strength of the poverty-access relationship, which is largely explicable by key moderating variables. **National economic context** is a powerful moderator. The stark contrast in treatment delays between low-income (28-day patient delay) and upper-middle-income countries (10-day delay) demonstrates that stronger overall health infrastructure and social safety nets can attenuate the disadvantages of individual poverty (Teo et al., 2021). This argues for macro-level investments in universal health coverage (UHC) as a foundational strategy for TB equity.

Disease type dramatically alters the equation. The shift from a 32% catastrophic cost rate for drug-sensitive TB to 80% for DR-TB represents a qualitative leap in vulnerability (Ghazy et al., 2021). DR-TB treatment involves longer, more toxic regimens, more frequent clinic visits, and often hospitalization, exponentially increasing both direct and indirect costs. This group requires not just enhanced medical care but also intensified social and economic support. Similarly, **case-finding strategy** is a critical moderator. The reduction in catastrophic costs from 42% under passive case-finding to 12% under active case-finding is one of the most compelling findings of this review. It demonstrates that proactively reaching into communities, especially poor ones, can bypass the

financial and social barriers that prevent people from presenting to clinics, making it a profoundly pro-poor strategy.

4. Effective Interventions: Towards Integrated, Pro-Poor Models

The review evaluated a spectrum of interventions, revealing that the most successful are those that directly address the multidimensional nature of poverty-related barriers. **Financial interventions** like cash transfers and food baskets have strong evidence for improving cure rates and reducing default (Richterman et al., 2018; Filho, 2009; Behnampour et al., 2025). Brazil's *Bolsa Família* program showed how integrating TB support into a broad social protection system can yield positive health outcomes (Olios et al., 2019). **Service delivery innovations** that decentralize care are inherently pro-poor. Decentralized molecular testing using platforms like Truenat reduced out-of-pocket costs and increased treatment initiation among the poorest quintiles (Assebe et al., 2025; Bashir et al., 2025). Community-based care through health volunteers minimizes stigma, geographic, and cost barriers, proving effective in remote areas (Muhamad Jauhar et al., 2019).

The overarching lesson is that **multi-component, integrated interventions** are superior. A package combining financial support (for direct and indirect costs), nutritional aid, decentralized diagnostics, community-based adherence support, and stigma reduction is more likely to succeed than any single measure. Digital tools like SMS reminders and telemedicine can support these strategies, though their effectiveness varies (Neniek Kurnianingsih et al., 2024; Rosselini Triana et al., 2023). The success of such models depends on strong linkages between health services, social welfare programs, and community structures.

5. Limitations of the Evidence and Future Research Directions

The review exposes important limitations in the existing evidence base. A major weakness is the **inconsistent measurement of poverty**. Over half of the included studies used proxies rather than explicit, standardized poverty metrics, hindering precise estimation and cross-study comparison.

Future research must adopt consistent tools like multidimensional poverty indices or validated asset scores. **Methodological rigor** is another concern; most evidence comes from observational studies, with few randomized controlled trials (RCTs) specifically targeting poverty-alleviation interventions within TB programs. There is a pressing need for more RCTs and robust quasi-experimental studies to establish causal effects and cost-effectiveness. Furthermore, research often focuses on the treatment phase, with less attention to the **post-treatment economic recovery** period. Understanding how to support households to escape the poverty trap after TB is crucial for long-term equity. Finally, more research is needed on tailoring interventions for **specific vulnerable subgroups**, such as urban slum dwellers, migrants, indigenous populations, and children in poor households (Seprianti, 2025; Ju-Yeun Lee et al., 2022).

CONCLUSION AND RECOMMENDATIONS

Conclusion

This systematic review conclusively demonstrates that poverty is a central and persistent barrier to accessing tuberculosis treatment in developing countries. The relationship is robust, negative, and mediated through a syndemic of financial catastrophe, geographic isolation, social stigma, and structural inequities. Despite free treatment policies, a large proportion of patients, especially those with drug-resistant TB or HIV co-infection, face costs that are catastrophic to their households, primarily driven by income loss. Poverty leads to longer delays in diagnosis and treatment, lower adherence, and ultimately, poorer health outcomes. It also plunges households into long-term economic hardship, perpetuating a cycle of disease and deprivation. While the challenge is formidable, the evidence also identifies a clear path forward: interventions that integrate social protection with pro-poor health service delivery can effectively mitigate these barriers.

Recommendations

Based on the synthesized evidence, the following multi-level recommendations are proposed:

For National TB Programs and Ministries of Health:

1. **Implement Integrated Social Protection:** Move beyond medical-only models. Systematically screen TB patients for poverty and link them to existing social protection schemes (cash transfers, food assistance, health insurance) or create TB-specific top-up benefits to cover both direct and indirect costs, modeled on successful programs like *Bolsa Família* (Olios et al., 2019).
2. **Accelerate Decentralization and Community-Based Care:** Invest in bringing diagnosis (e.g., through point-of-care molecular tests) and treatment supervision closer to patients via primary health centers and community health workers. This reduces geographic, cost, and stigma barriers simultaneously (Assebe et al., 2025; Muhamad Jauhar et al., 2019).
3. **Scale Up Active Case-Finding (ACF):** Prioritize ACF in poor, high-risk communities (urban slums, remote areas, prisons) as a core strategy. This prevents diagnostic delays, reduces pre-diagnosis costs, and is a highly effective pro-poor intervention.
4. **Establish Differentiated Support for High-Risk Groups:** Develop and fund enhanced support packages for patients with DR-TB, HIV co-infection, and those in extreme poverty, recognizing their exponentially higher risk of catastrophic costs and treatment failure.

For Global Health Agencies and Donors:

1. **Fund Comprehensive, Equity-Focused Programs:** Shift funding priorities to support the integration of TB care with poverty alleviation and social protection initiatives. Support operational research on the implementation and cost-effectiveness of such integrated models.
2. **Advocate for Universal Health Coverage (UHC):** Champion UHC reforms in high-burden countries that include essential TB services and financial risk protection, recognizing that strong health systems are the ultimate buffer against the health-poverty nexus.

For Researchers:

1. **Standardize Poverty Measurement:** Develop and promote the use of a concise, validated toolkit for measuring socioeconomic status and poverty in TB research to improve comparability and evidence quality.
2. **Conduct Robust Intervention Studies:** Prioritize high-quality RCTs and implementation science research on multi-component pro-poor interventions, with careful analysis of cost-effectiveness, scalability, and mechanisms of impact.
3. **Investigate Long-Term Trajectories:** Conduct longitudinal studies to understand the long-term socioeconomic recovery of TB-affected households and identify interventions that can best support sustainable escape from poverty.

In summary, ending the TB epidemic is inextricably linked to the fight against poverty. Closing the access gap requires a paradigm shift from a purely biomedical to a biosocial approach, where TB programs actively diagnose and treat not just the mycobacterium, but also the socioeconomic conditions that allow it to thrive.

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