Journal of Public Health and Pharmacy
2775-4952 (Online - Elektronik)
Review Articles Open Access

Evaluation and Study of the Cost of Illness of Tuberculosis in Indonesia: A Systematic Review

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ARTICLE INFO

Manuscript Received: 10 Nov, 2024
Revised: 23 Mar, 2025
Accepted: 16 Apr, 2025
Date of publication: 05 Dec, 2025
Volume: 6
Issue: 1
DOI: 10.56338/jphp.v6i1.6854

KEYWORDS

Cost of Illness;
Disease Burden;
TB

ABSTRACT

Introduction: Tuberculosis (TB) remains a significant public health challenge in Indonesia, ranking among the highest global TB burden countries. The financial burden of TB is substantial, encompassing direct medical costs, indirect income losses, and catastrophic household expenditures. Although systematic reviews on TB-related cost-of-illness (COI) have been conducted in various settings, this study aims to fill critical gaps in Indonesian TB financial data, provide comparative regional insights, and offer actionable policy recommendations.
Methods: This study used the Systematic Review (SR) method on articles relevant to: COI, disease cost evaluation, or therapy costs for tuberculosis. Articles are examined in English or Indonesian; obtain full text through several search engines such as: PUBMED, Science Direct, Google Scholar, and SCOPUS; research coverage in Indonesia; and in an unlimited time frame.
Results: A total of 11 eligible articles were obtained based on inclusion and exclusion criteria. The direct cost of TB-DS ranges from Rp2.2-5.8 million, while TB-MDR reaches Rp190 million. Indirect costs due to loss of revenue reached Rp481.5 million for MDR-TB. Catastrophic costs occurred in 83% of TB-MDR households and 36% of TB-DS, exceeding 20% of annual income. Most patients were men of productive age (18-45 years), with 82.33% losing their jobs during treatment. These findings highlight the need for strategic interventions to reduce the economic impact of TB.
Conclusions: The impact of moderate financial burdens and other medical aspects on institutions and individuals is caused by tuberculosis. Further research should be conducted related to this study to obtain a larger estimate.

Publisher: Pusat Pengembangan Teknologi Informasi dan Jurnal Universitas Muhammadiyah Palu

INTRODUCTION

TB remains a critical public health issue in Indonesia, which ranks as the third-highest TB burden country in the world (1). The disease, caused by *Mycobacterium tuberculosis,* is transmitted through the air when people with TB cough, sneeze, or speak; hence the TB bacteria are inhaled by others. The main risk factors contribute to its high prevalence, including direct exposure to TB patients, smoking habits, alcohol consumption, poor nutritional status, and diseases such as diabetes (2). Over the past three years, Indonesia has reported a large number of TB cases. In 2021, the incidence rate was 354 per 100,000 people, which translates to about 824,000 new cases (3). In 2022, the number of TB cases reported was around 393,323 (3). In 2023, the incidence is still high, with an estimated 301 cases per 100,000 people (3). Those conditions impact financial consequences of people with TB.

The cost of TB disease in Indonesia includes direct and indirect costs (4). Direct costs include medical expenses such as diagnostics, medication, and hospitalization (4). Indirect costs mainly involve productivity losses due to illness and premature death. A study estimates that the total annual cost of tuberculosis in Indonesia is around USD 6.9 billion, with productivity losses from premature death accounting for the largest share of that cost (5).

Despite implementing *Universal Health Coverage* (UHC) in 2014, TB patients in Indonesia still face high costs of their own (4). This is especially true for those who initially seek treatment from private healthcare providers, leading to higher pre-diagnosis costs and more frequent visits. Fragmented healthcare systems and preference for private healthcare providers contribute to these high costs.

The economic consequences of TB extend beyond individual patients to entire households and communities. TB negatively impacts productivity and household income, increasing the risk of poverty, social stigma, and discrimination (6). Based on the latest national TB patient cost survey data from who, almost half of TB-affected households must allocate more than 20% of their income to medical expenses. The global target to reduce the number of TB patients and households facing *catastrophic costs* due to TB to zero by 2020 has not been achieved (7). TB prevention and control requires a comprehensive and systematic approach, including early detection, appropriate treatment, and measures to reduce various risk factors. TB also has considerable economic and social consequences (8,9).

Efforts to reduce the economic burden of TB in Indonesia include strengthening the participation of the public and private sectors in health services, increasing access to diagnostics and treatment, and increasing the efficiency of the National Tuberculosis Management Program (PTN). International initiatives, such as World Bank funding to support the TB response in Indonesia, aim to address these challenges by improving the coverage, quality, and efficiency of TB care (1). The purpose of this study is to identify multifaceted approaches in managing the cost of TB disease in Indonesia, including policy reform, improvement of health service delivery, and strengthening financial support to reduce the economic impact on patients and the health care system. This study aims to provide a comprehensive evaluation of the financial burden of TB in Indonesia, identify key healthcare policy gaps, and propose evidence-based solutions, including improved healthcare financing models and social protection mechanisms.

This study differentiates itself from prior (10) systematic reviews by addressing specific gaps in Indonesian healthcare policy, providing a comparative regional analysis within Southeast Asia, and proposing actionable financial solutions that align with Indonesia's unique healthcare landscape. Unlike previous reviews, this study integrates a policy-focused approach, offering insights into cost-reduction strategies that could be implemented at both national and regional levels.

METHOD

Search Strategy

This systematic review (SR) was conducted to comprehensively evaluate the economic burden of tuberculosis (TB) in Indonesia, particularly focusing on direct and indirect costs, income loss, and catastrophic health expenditures (CHE). To ensure transparency and reproducibility in the study selection process, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were followed. The literature search was performed across four major academic databases: Google Scholar, PubMed, ScienceDirect, and Scopus, covering studies published between 2010 and 2024. The search strategy was developed using a combination of Medical Subject Heading (MeSH) terms and text keywords to maximize the retrieval of relevant literature. The MeSH terms included "cost of illness," "cost analysis," "direct medical cost," and "economic burden," while the text keywords incorporated "burden of disease," "cost of treatment," "tuberculosis," and "Indonesia." These keywords

were combined using Boolean operators (AND, OR) to refine the search and ensure the inclusion of relevant studies related to TB-associated costs in Indonesia.

Inclusion and Exclusion Criteria

The SR method begins with the Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) approach consisting of 5 steps: 1) defining literature topics/inclusion criteria, 2) defining sources of information, 3) selecting literature, 4) collecting data, 5) preparing summaries of research results. The study selection process was based on predefined inclusion and exclusion criteria to ensure the relevance and quality of the reviewed articles.

The search results showed 970 selected articles until 11 articles were obtained for review. The inclusion criteria of the article include: 1) studies focusing on the economic burden of TB in Indonesia, and 2) Indonesia is included in the scope of study, 3) Peer-reviewed articles in English or Indonesian, and 4) the full text can be legally downloaded. The article exclusion criteria include: 1) research lacking COI analysis, 2) research older than 2010, and 3) non-peer-reviewed materials including commentaries, editorials, and grey literature that lack empirical evidence. This criterion is applied in the hope that this study is relevant because it is sourced from the latest literature (2010-2024) and is comparative because it contains an analysis of one type of disease (tuberculosis) and in Indonesia (showing the same legal and policy coverage).

Filtering and Data Extraction

The selection of articles followed the PRISMA 2020 guidelines, beginning with the identification of 969 articles across the four databases. After removing 64 duplicate entries, a total of 905 articles remained for further screening. These articles were reviewed based on title and abstract relevance, leading to the 610 excluded studies that did not meet the inclusion criteria, specifically country of evidence in Indonesia and relevance to this study. The remaining 295 articles were further assessed for eligibility, by eliminated in total of 285 articles that did not meet the inclusion criterion as shown in Fig 1. After a detailed review, a total of 11 studies were selected for inclusion in the final systematic review. To ensure objectivity and reliability, the screening and selection process was independently conducted by three researchers. One researcher performed data extraction which were checked by the second reviewer independently. The third reviewer adjudicated to avoid discrepancy, and this reviewer decision was considered final. Any disagreements regarding the inclusion of studies were resolved through discussion until a consensus was reached, ensuring a rigorous and unbiased selection process.

Once the final set of studies was identified, data extraction was conducted systematically. Key information collected from each study included study characteristics such as author, year, location, and sample size; economic outcomes such as direct medical costs, indirect costs, and catastrophic health expenditures; and study methodologies, including cross-sectional, cohort, and cost-analysis approaches. The data extraction process was independently performed by two researchers to minimize bias and ensure accuracy in reporting economic data.

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Standardization of Costs

To allow for comparability across studies, all cost estimates were standardized and adjusted using a two-step conversion process. First, all financial values were converted to Indonesian Rupiah (IDR) for the year 2024 using the Consumer Price Index (CPI) to account for inflation. Second, to enable international comparisons, cost data were converted from IDR to USD using the 2024 Purchasing Power Parity (PPP) exchange rate. This approach ensures cross-country comparability, particularly with Vietnam, India, and the Philippines, which have similar healthcare systems and TB burdens. These standardization methods ensure that all cost estimates reflect 2024 values and allow for meaningful financial comparisons across different settings, improving the applicability of findings for global health policy discussions.

Overall, the methodology employed in this systematic review adheres to PRISMA guidelines, ensuring a rigorous and transparent selection process. The inclusion of multiple researchers in the screening and data extraction process enhances the validity and reliability of the study. Furthermore, the use of standardized cost adjustments through CPI and PPP allows for a better comparison of economic burdens across different settings. The findings from this review are expected to provide valuable insights into the financial impact of TB in Indonesia and inform potential policy interventions.

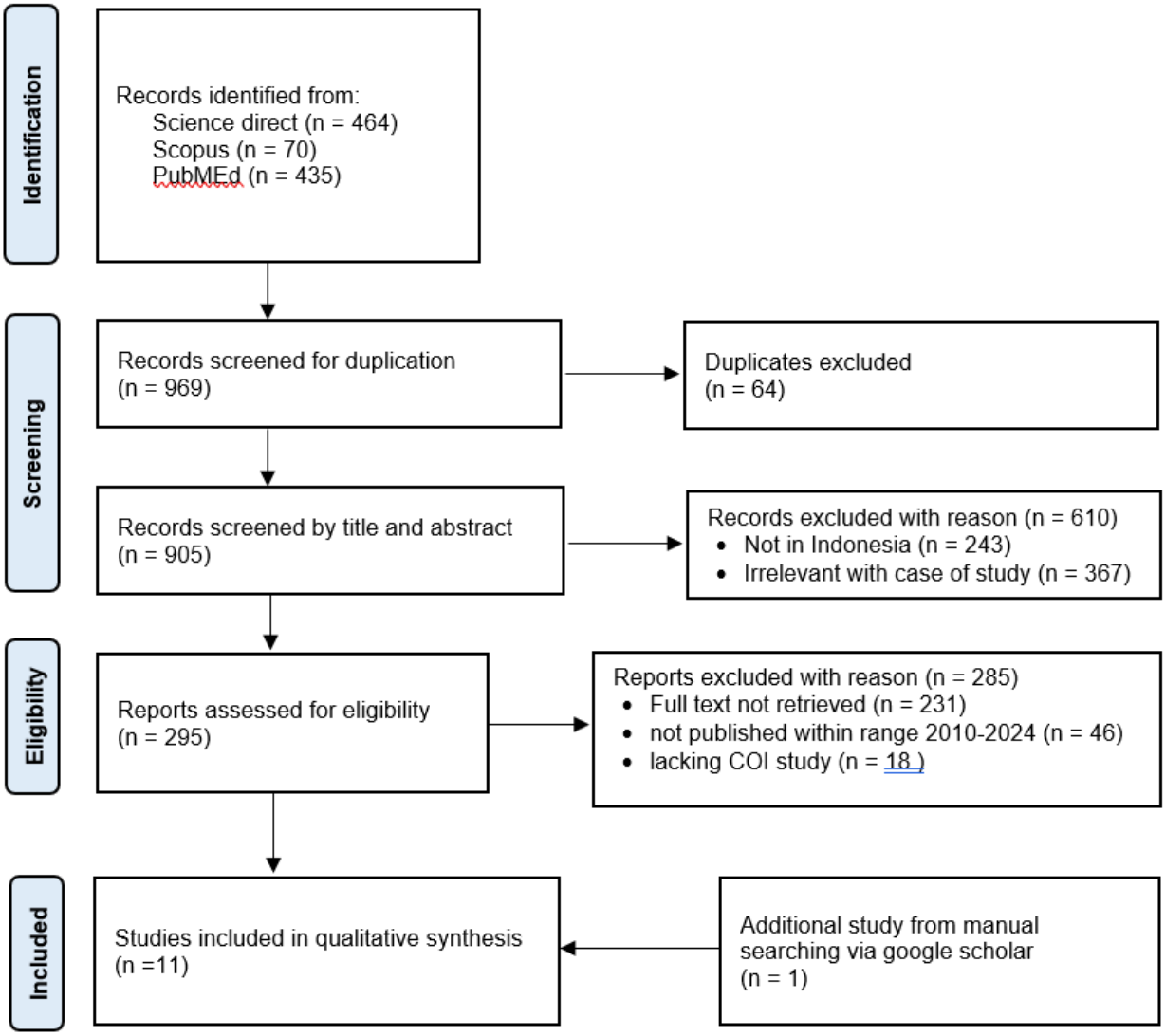

Figure 1. PRISMA Flow-Chart

RESULTS

There are two stages of analysis performed. In the first stage, a characteristic analysis of 11 articles for related data collection was carried out: number of samples, location, database sources, time frame, research design, and writing perspective. The analysis in the first stage is the discussion of Table 1. The second stage was followed by data analysis extracted from 11 articles. This second stage is shown in Table 2. The last stage written in Table 3 is the financial analysis of the existing cases.

Table 1. Article Characteristics

Author(s)	City	Type	Sample Size	Data Source	Time Horizon	Study Design	Perspective
(Mahendradhata et al., 2010)	JOG	TBC BTA positive	Private practice doctors suspects Hospital: 10,878 suspec	Secondary sources: records of hospitals, health centers, and private doctors	May 2004-April 2005	CS, IS, and longitudinal follow-up	H
(van den Hof et al., 2016)	JKT, SOL	TB, MDR-TB	MDR-TB: 143 patients TB: 118 patients	Primary sources: structured interviews, and	-	CS	PX

Author(s)	City	Type	Sample Size	Data Source	Time Horizon	Study Design	Perspective
				secondary sources: databases.			
(Collins et al., 2017)	Various Cities in Indonesia	MDR TB, DS-TB	TB: 1,017,378 active cases	Secondary sources: records from MHO, Gadjah Mada University, and the Indonesian Tuberculosis Prevalence Survey	2013-2015	*Decision Tree*	PX
(Fuady A. et al., 2018)	JKT, TAS, DEP	TB, MDR	TB: 282 patients MDR-TB: 64 patients	Primary Source: Structured interviews	July-September 2016	SCS	PX
(Wulan, 2018)	BKL	TB	71 patients	Primary sources: Interviews and questionnaires	January 2013-June 2014	CS	PX
(Fuady A. et al., 2019)	JKT, TAS, DEP	TB, MDR	TB: 282 patients MDR-TB: 64 patients	Primary Source: Structured interviews	July-September 2016	SCS	PX
(Sari et al., 2020)	JKT	TB.	42 patients	Primary sources: face-to-face interviews, and secondary sources: medical records.	January to April 2018	CS	S
(McAllister et al., 2020)	BDG	TB, DS-TB, MDR-TB	469 patients	Primary sources: Interviews	January – March 2019	CS	S
(Iskandar et al., 2023)	Various cities in Indonesia (mostly in Java and Sumatra)	TB	DS-TB: 1,426,548 cases	Secondary sources: records taken from the Tuberculosis Information System (SITB, Indonesian National Tuberculosis Information System)	January 2017 to December 2019	*Multi-year* CS	H
(Idrus et al., 2024)	BEK	TB	239 TB patients (200 with TB, 39 with HIV/TB)	Primary sources: from the *voluntary and testing* (VCT) survey and Paru Regional Hospital in Bekasi City	January to March 2018	CS	PX
Saragih et al. (2024).	MED	TB, DS-TB	1,000,000 patients	Secondary sources: Impact of Medan budget, Ministry of Health Guidelines, and other sources [SITT (2018), BPJS-K sample dataset (2015-2018), and WHO Report]	2015-2018	P	PY

JOG, Jogjakarta; JKT, Jakarta; TAS, Tasikmalaya; DEP, Depok; BKL, Bengkulu; SOL, Solo; BEK, Bekasi; MED, Medan; BDG, Bandung; CS, Cross Sectional; IS, Intervention Study; P, Prospective; SCS, Stratified Cluster Sampling; H, Hospital; PY, Payer; PX, Patients; S, Society.

Based on Table 1, there are several cities that are the sample of the analysis. Major cities such as Jakarta, Bandung, and Medan have the dominant number of TB cases (10). This trend is expected as these cities have a higher population density compared to smaller towns, leading to a greater disease burden. However, despite the higher case numbers, access to healthcare facilities tends to be more convenient in urban areas. This is supported by in-depth studies that highlight the relatively better availability of TB healthcare services in these cities, which may mitigate some of the financial and social burdens of TB treatment.

In this study, in-depth learning was conducted with 7 out of 11 studies using a cross-sectional method. This method shows a comprehensive view of several types of TB case treatment costs. However, to further strengthen the findings, prospective studies should be included to assess long-term TB-related costs and socio-economic impacts. A prospective study approach would allow researchers to predict future financial burdens, treatment adherence, and productivity loss over time. This study needs to be balanced with in-depth research with prospective methods to obtain and predict the long-term outcome of TB cases and the socio-economic aspects affected (11). Coupled with the intervention study method, several aspects of TB treatment and the costs obtained can be compared (12). *Stratified cluster sampling* from the literature was studied by clarifying the population in several groups according to certain criteria to clarify socio-economic aspects, facilitating regional and demographic analysis of patients affected by TB. By clarifying patient groups based on income levels, geographic distribution, and healthcare access, the study offers a more nuanced perspective on how different communities experience the economic burden of TB.

Beyond methodological considerations, a perspective analysis was also conducted. From the payer's perspective, the financial burden of TB is determined by how treatment costs are covered—whether through BPJS (Indonesia's national health insurance), private insurance, or out-of-pocket payments. The extent of insurance coverage significantly influences the patient's ability to afford the remaining costs, shaping their financial resilience against catastrophic healthcare expenses (11). From the patient's perspective, it was found that access to services affected the patient's recovery and had an impact on work performance (15). For example, in Solo and Bengkulu, because it is a developing city, access to services is more difficult and limited than in big cities. From a social aspect, how these affected patients can affect the economic burden they bear and extend to the surrounding community (16). In urban settings, where employment is often tied to daily wage labor or private sector jobs, TB-related productivity losses have a more immediate and severe impact. In contrast, in smaller towns or rural areas, where livelihoods may be based on subsistence farming or informal employment, the economic burden may be less pronounced but still significant. The social aspect of TB's financial burden is also influenced by family dynamics and support networks. In large cities, TB patients often face stigma that may reduce their employment opportunities, whereas in smaller communities, extended family support may partially mitigate financial hardships.

From the general aspects written in Table.1 and the previous analysis of the study design and perspective, it is necessary to gain deeper insights such as sample demographics and details of types of TB health care providers and care as shown in Table.2. Study locations in Table.1 such as urban cities and rural areas the effects in terms of TB effects on socioeconomic aspects would be better explained if demographic and socioeconomic trends were obtained and observed. The sample size as shown in Table.1 also affects the resilience of the findings in Table.2, providing a broader analysis of patient income and employment that will result in a more comprehensive evaluation of the effects of TB on socio-economic aspects. In addition to the study's enriching location and sample size in terms of demographic and socioeconomic analysis, the study provides better described arrangements and health care in Table.2 in terms of direct (such as consultation fees, medications, and diagnostic tests) and indirect costs (such as lost wages and transportation expenses) in Table.3. The integration of these findings across Tables 1, 2, and 3 highlights the importance of a holistic approach to TB financial burden analysis. Therefore, this study demonstrates the contextual framework provided by Table 1 in understanding the sample, study design, and perspectives that lead to the socio-economic and clinical impacts detailed in Table 2 and cost analysis in Table 3.

Table 2. Data Extracted from Articles

Study	Hospital type	Gender	Age (years)	(Economic Condition)	Duration (months)	Length of stay, days	TB complication	Treatment
(Mahendradhata et al., 2010)	Private Doctors, Public Hospitals, Private Hospitals	-	-	-	-	-	Pleural effusion, meningitis, lung damage, etc.	Public-private standard TB partnerships: directly observed treatment, short course (DOTS)
(van den Hof et al., 2016)	General Hospital,	Male: 52.9% Female: 46.1%	21-29: 23.8%	**Occupation TB:** Formal: 52.0%	**TB.** 2-3 4-5	90	Lung damage, organ impact,	MDR-TB: First-line drug fails, second-line drug

Study	Hospital type	Gender	Age (years)	(Economic Condition)	Duration (months)	Length of stay, days	TB complication	Treatment
	Satellite Clinic		30-39: 27.2% 40-49: 25.3% >49: 23.7%	Informal: 48.0% **MDR-TB:** Formal: 74.0% Informal: 26.0%	**TB.** 2-3 8, 12	MDR-TB: 195	meningitis, heart problems	(e.g., fluoroquinolones)
(Collins et al., 2017)	Certified Public and Private Hospitals, Certified Private Clinics	-	All samples were aged between 15-60	Assuming all samples work at a monthly minimum wage of $209 (equivalent to Rp 5.07 million, 2024)	TB: 1 MDR-TB: 2-3	-	-	-
(Wulan, 2018)	Public Hospital	Male: 53.5% Female: 46.5%	17-43: 46.5% >43: 53.5%	**Work** Informal: 87.3% Formal: 12.7% **Income** High: 40.9% Low: 59.1%	INT: 2 CON: 4	-	-	DOTS, first-line TB drugs, nutritional support
(Fuady A. et al., 2018)	Public Hospitals, Private Hospitals, Community Health Centers	**TB.** Male: 55.0% Female:45.0 % **MDR-TB**: Male: 48.0% Female: 52.0%	**TB.** 40-49 41-64: 44% >64: 8% **MDR-TB** 18-40: 53% 41-64: 45% >64: 2%	**Income** **TB** High: 38.0% Low: 62.0% **MDR-TB** High: 64.0% Low: 36.0%	**TB.** INT: 2 CON: 4 **MDR-TB.** INT: 3 CON: 5	-	Lung problems, systemic effects, heart problems, etc.	Standard TB drugs (isoniazid, rifampicin), Second-line TB drugs (kanamycin, cycloserine), supplements, food
(Fuady A. et al., 2019)	Public Hospitals, Private Hospitals, Community Health Centers	-	All patients > 18 years old	**Income** **Before TB** Income: 71.0% No-income: 29.0% **After TB** Income: 48.18% No-Income: 51.72%	18-24	DS-TB:120-270 MDR-TB: 50-180	Lung damage, meningitis, joint and bone pain, organ damage	Standard TB drugs (isoniazid, rifampicin), Second-line TB drugs (kanamycin, cycloserine), supplements, food
(Sari et al., 2020)	Army Hospital	-	>18	**Occupation** Private: 19.0% Government: 11.9% Entrepreneur: 11.9% Military/Police: 4.8% Unemployment: 52.4%	-	-	High Cholestrol	Anti-TB drugs, Other drugs, Sputum tests, Radiology and pathology tests, Other laboratory tests
(McAllister et al., 2020)	Public hospitals, private hospitals, community health	Men: 57.0% Women: 43.0%	18-29: 30.4% 30-30: 32.6% 40-49: 15.9%	**Occupation** Part-time/full-time: 60.6% Other: 39.4% Income Low: 33.0%	Active: 6-12 Latent: 3-9	TB: varied DS-TB: 20-60 MDR-	diabetes, gastritis, asthma, heart disease	Anti-TB, antibiotics, other drugs, diagnostic tests (sputum microscopy and

Study	Hospital type	Gender	Age (years)	(Economic Condition)	Duration (months)	Length of stay, days	TB complication	Treatment
	centers, and private practice doctors		>50: 20.1%	Medium – High: 67.0%		TB: 50-180		chest X-ray), hospitalization
(Iskandar et al., 2023)	Public hospitals, private hospitals, community health centers and private practitioners	Male: 58.0% Female: 42.0%	<15 >15:90% average: 39	-	5.46-5.66	-	lung complications, hepatitis, visual impairment, peripheral neuropathy	Other Standard TB Drug and Treatment Regimens
(Idrus et al., 2024)	Public hospital	Male: 58.5% Female: 41.3%	18-34: 50% 35 - 50 80%: 20%	**Occupation** Working: 56.7% Unemployment: 21.1% Housewife: 18.1% **Income** No income: 41.5% Low income: 25.4% Mid-high: 33.1%	TB: 3-4 TB/HIV: 5	-	HIV-TB, Pulmonary TB, extra pulmonary TB, both	Standard TB treatment, access to treatment issues
Saragih et al. (2024).	Public hospitals, private hospitals	Not specifically mentioned, but TB affects more adults aged 25-44 years	Not specifically mentioned, but TB affects more adults aged 25-44 years	Assortment	-	TB: varied DS-TB: 20-60 MDR-TB: 50-180	-	First-line drugs, second-line drugs (e.g., fluoroquinolones), diagnostics: GeneXpert, microscopy, chest X-ray, tests: glucose, HIV, etc.

CHC, community health centers (puskesmas); INT, intensive; CON, continuation; DS, Drug-Sensitive; MDR, Multi Drug Resistant;

The management of TB varies greatly depending on the type of hospital, the demographic profile of the patient, and the severity of the disease, such as whether the disease involves drug resistance or concomitant diseases such as HIV (17). This study provides a broad overview of TB treatment across healthcare settings, patient populations, and countries, highlighting differences in hospital type, treatment regimen, and patient experience.

According to this study, TB treatment involved public hospitals, private hospitals, and private practice doctors. For example Fuady A *et al* (2018) and McAllister *et al* (2020) show how public hospitals play an important role in dealing with standard TB cases, especially in low-income countries like Indonesia (13,18). Private clinics and hospitals complement the public health system by providing diagnostic and pretreatment services. In some regions, partnerships between the public and private sectors help reduce the burden of care effectively, particularly in places where public health infrastructure is inadequate to handle the burden on patients (12,18). These hospitals focus on providing standard first-line drug care for TB, in addition to the necessary diagnostic services. The role of private practitioners and their engagement with public health programs is critical in improving access to care in underserved areas (12). Table 2 highlights the healthcare settings where TB and MDR-TB patients receive treatment, with a significant proportion seeking care at public hospitals. This reflects Indonesia's policy of integrating TB services into

government-funded hospitals and primary healthcare centers. The National Action Plan for TB Control emphasizes strengthening Puskesmas as frontline providers, ensuring that even remote populations can access diagnostic and treatment services (5). However, some patients still prefer private hospitals and clinics, possibly due to shorter waiting times or perceived better quality of care. Harmonizing public and private TB treatment standards is crucial to prevent discrepancies, such as the expansion of Temukan, Obati, Sampai Sembuh – Find, Treat, Cure TB (TOSS-TB) to all types of healthcare, a government-led initiative, aims to increase TB detection and ensure treatment completion (7).

Demographic data across studies highlighted varying age distributions and sex ratios, depending on the type of TB being treated. 57% of patients were male, and 43% were female, with an average age of 38 years (12). Similarly, in Idrus *et al* (2024) highlights the gender distribution of 48% males and 52% females, with an average age of 34 years (17). These findings confirm that TB and MDR-TB primarily affect productive-age adults (21–49 years), particularly 21–29 (23.8%) and 30–39 (27.2%), aligning with Indonesia's workforce, where most are in formal and informal employment. The impact of TB on this age group is particularly concerning, as prolonged treatment and recovery periods can lead to income loss, financial insecurity, and reduced productivity (18). Indonesia's Jaminan Kesehatan Nasional (JKN), a universal health coverage (UHC) program under BPJS Kesehatan, covers TB treatment for both drug-sensitive and drug-resistant cases. However, indirect costs such as transportation, lost wages, and nutritional support remain significant burdens for patients.

In line with the previous analysis Low-income communities, informal workers, and rural populations are the most affected by TB, especially MDR-TB, due to financial constraints, job insecurity, and limited healthcare access. For example, 62% of TB-DS patients and 36% of MDR-TB patients fall into the low-income category Fuady A *et al* (2018) and 87.3% of patients are in the Wulan (2018) vulnerable informal sector due to lack of access to health benefits or sick leave provided by employers (13,15). This evidence is reinforced by several aspects such as: low-income patients are more susceptible to income disorders, long work absences due to treatment duration (normal TB ranges from 1-4 months while MDR-TB ranges from 8-12 months), and loss of productivity which has an impact on huge financial losses with more affected MDR-TB patients (13). The extended treatment duration for MDR-TB (up to 12 months) significantly affects patients' economic stability. While the Indonesian government provides free anti-TB drugs through its DOTS strategy, the financial burden of MDR-TB treatment is exacerbated by high out-of-pocket expenses, especially for those outside the BPJS system. Patients who cannot afford frequent hospital visits or who experience job loss due to their condition may abandon treatment, leading to higher mortality rates and continued disease spread (7). To address this, Indonesia has introduced PMDT (Programmatic Management of Drug-Resistant TB), which integrates decentralized MDR-TB treatment into primary healthcare centers (Puskesmas) and referral hospitals (5). Despite these efforts, challenges remain in ensuring timely diagnosis and continuous drug availability, especially in rural areas.

Based on Table 1 and Table 2, urban areas such as Jakarta and Bandung are reported to have more medical facilities and are more advanced compared to rural areas. Due to the large number of medical facilities, patients have better access in urban areas. Meanwhile, based on the care provided, health facilities in urban areas are known to have higher costs than urban areas which will be detailed in Table 3.

Table 3. Analysis of TB Costs in Indonesia

Study	Year	City	Cost	Initial Direct Cost (IDR)	Adjusted Direct Cost (2024 IDR)	Indirect Cost (IDR)	TOTAL COST	Incidence of Catastrophic Costs (%)	Other Details
(Mahendradhata et al., 2010)	2010	JOG	I/D	PPS Referral: $52.30 Direct public health center: $18.81	PPs Referral: 810,650 Direct public health center: 291,555	PPs referral: 475,075 Direct public health center: 231,570	PPs Reference: 1,285,725 Direct health center: 523,125	-	Exploration of additional cost-effectiveness
(van den Hof et al., 2016)	2016	various cities	I/D	$133	2,118,740	573,494	2,690,000	38-92% reported loss of income, 26-76%	Treatment success rates vary widely Total cost is

Study	Year	City	Cost	Initial Direct Cost (IDR)	Adjusted Direct Cost (2024 IDR)	Indirect Cost (IDR)	TOTAL COST	Incidence of Catastrophic Costs (%)	Other Details
								reported loss of job	equivalent to income of 9.3-24.9 months
(Collins et al., 2017)	2017	various cities	I/D	DST-TB: $278.6 MDR-TB: $11,964	DS-TB: 4,438,204 MDR-TB: 190,591,080	DS-TB: >100 million MDR-TB: >200 million	DS-TB: 141,294,000 MDR-TB: 409,279,350	This fee exceeds 20% of the average annual fee	It is assumed that patients aged 15-60 years are productive
(Fuady A. et al., 2018)	2018	JKT, TAS, DEP	I/D	1,828,515	2,180,486	481.5 million	Varies	36% for TB, 83% for MDR-TB	High indirect costs, job loss
(Wulan, 2018)	2018	BKL	I/D	2,125,200	2,535,405	5,812,000	8,347,405	Affected up to 51% of households	Significant impact of job loss
(Fuady A. et al., 2019)	2019	JKT, TAS, DEP	I/D	1,828,515	2,180,486	481.5 million	Varies	-	Financial support reduces disaster costs
(McAllister et al., 2020)	2020	BDG	I/D	$20.79-$71.25	311,850-1,068,750	981,450-10,359,900	1,926,900-8,260,650	-	-
(Sari et al., 2020)	2020	JKT	Direct (Medical)	5,499,656	5,843,658	-	5,843,658	26.5% more than 20% of household income	DOT is more cost-effective than SAT
(Iskandar et al., 2023)	2023	various cities	D (Medical)	$40 - $41	606,150	-	606,150	The cost of TB treatment can trap people into poverty	The economic burden of tuberculosis patients who are susceptible to drugs
(Idrus et al., 2024)	2024	BEK	D (Medical, TB-HIV)	TB: $24.2 TB/HIV: $56.2	TB: 375,100 TB/HIV: 871,100	-	TB: 375,100 TB/HIV: 871,100	-	Higher Out-of-pocket costs for TB/HIV
Saragih et al. (2024).	2024	MED	I/D	3,515,800	3,515,800	-	3,515,800	*Out-of-pocket* exceeds 20% annual income	Strategic purchases to reduce costs

JOG, Jogjakarta; JKT, Jakarta; TAS, Tasikmalaya; DEP, Depok; BKL, Bengkulu; SOL, Solo; BEK, Bekasi; MED, Medan; BDG, Bandung; CS, Cross Sectional; IS, Intervention Study; P, Prospective; SCS, Stratified Cluster Sampling; H, Hospital; PY, Payer; PX, Patients; S, Society.

DISCUSSION

Table 3 provides an in-depth analysis of the cost of TB illness (COI) in Indonesia, emphasizing the direct medical costs, indirect costs, income loss, and catastrophic expenditures faced by TB and MDR-TB patients. When correlated with the findings from Table 1 and Table 2, the data illustrate that TB's financial burden varies significantly based on disease severity, demographic factors, hospital type, and healthcare accessibility. A deeper examination of

these economic impacts and potential interventions is necessary to mitigate TB-related financial hardship in Indonesia.

Variability in Cost Estimates

One of the main sources of variation in cost estimates is the difference in research design and methodology. Studies using a cross-sectional approach often report lower cost estimates as they capture only a snapshot of patient expenses at a given time, failing to consider the long-term economic burden. In contrast, cohort studies and cost-projection models tend to yield higher estimates since they follow patients over extended treatment periods and account for cumulative expenses, including treatment failures, relapse, and long-term productivity loss (13). The inclusion or exclusion of hidden costs, such as informal caregiving expenses and productivity loss for family members, further amplifies the discrepancies between studies.

Another major factor affecting cost variations across studies is the source of healthcare financing and institutional setting. In Indonesia, BPJS Kesehatan (the national health insurance scheme) covers a significant portion of TB treatment costs in public healthcare facilities, leading to lower reported direct medical costs in studies conducted within government hospitals. However, studies focusing on patients treated in private hospitals or those seeking care outside the BPJS system report significantly higher out-of-pocket expenditures (18).Additionally, patients in rural areas often face higher indirect costs due to transportation expenses and lost income associated with long-distance travel for treatment, which is less evident in urban-centric studies (12).

Furthermore, the year of study publication and inflation adjustments also contribute to the observed variations in cost estimates. Older studies may not account for inflation, currency depreciation, or changes in TB treatment protocols, resulting in underestimated costs compared to more recent analyses. In this systematic review, all cost estimates have been adjusted for inflation and converted to 2024 values using the Consumer Price Index (CPI) to ensure comparability. The use of Purchasing Power Parity (PPP) adjustments further enhances international comparisons, allowing cross-country cost assessments that are less influenced by local currency fluctuations (21).

Cost of TB Illness Analysis

Based on Table 3, TB, especially MDR-TB, the financial burden of TB in Indonesia is significant, affecting individuals, households, and the national economy. The COI for TB includes various components, such as direct medical costs, direct non-medical costs, and indirect costs. Direct medical costs include consultations, diagnostic tests, medications, and hospital stays, while direct non-medical costs cover transportation, food, and accommodation for patients traveling to healthcare facilities. Indirect costs arise due to lost productivity, prolonged work absences, and, in severe cases, premature mortality. These financial burdens vary based on the type of TB infection, with MDR-TB and TB-HIV co-infections presenting significantly higher costs compared to DS-TB. Although the government provides free drugs, some patients still have to pay medical expenses at non-governmental Health facilities or for TB complications (19). However, as emphasized by Fuady A *et al* (2018), indirect costs, especially those associated with loss of income due to inability to work, are also very burdensome (13). The high rate of patients losing their jobs (82.33%) shows a significant economic impact on the patient's family (19).

One key factor that exacerbates direct non-medical costs for TB patients is Indonesia's adoption of the DOTS strategy, which requires frequent visits to healthcare facilities to receive medication under direct supervision. While DOTS is essential for ensuring treatment adherence and reducing drug resistance, it also increases economic hardship for patients, particularly those living in rural areas or those who lack stable employment. Table 3 highlights that transportation expenses alone can reach IDR 50,000–500,000 per month, depending on the patient's location. Over the six-month standard treatment duration for DS-TB, transportation costs can accumulate to IDR 3–6 million, while for MDR-TB patients undergoing 12–24 months of treatment, total transportation expenses can exceed IDR 12 million. These additional financial burdens are often not covered by BPJS Kesehatan, forcing many patients to rely on personal savings, loans, or family support to continue treatment. Although the government provides free TB drugs through DOTS, some patients still incur out-of-pocket medical expenses for additional diagnostics, hospitalization, or managing TB complications (13). Furthermore, DOTS disproportionately impacts informal workers, who lack paid sick leave and must sacrifice daily income to attend weekly or biweekly medical visits. Studies have shown that 82.33% of TB patients experience job loss due to treatment-related work absences, highlighting a significant

economic impact on families (13). In Jakarta, the direct cost for TB treatment is estimated at IDR 1,828,515, and if adjusted for inflation until 2024, the amount will be IDR 2,180,486. This is coupled with an indirect cost of IDR 481.5 million, primarily due to income loss (13). This trend is observed nationwide, particularly in low-income households, where 36% of TB-affected families and 83% of MDR-TB-affected families face catastrophic health expenditures (13).

In Indonesia, the treatment of DS-TB is primarily covered by government programs, with BPJS Kesehatan (Indonesia's National Health Insurance) covering most medical expenses. However, patients still incur additional costs related to transportation, nutritional supplements, and work absences. Table 3 shows that direct medical costs for DS-TB range from IDR 291,555 for primary care in public health centers to significantly higher amounts in hospitals. The financial impact extends beyond medical expenses, as indirect costs related to lost wages and reduced productivity due to prolonged treatment (typically six months) can be substantial. This burden is particularly severe for low-income and informal workers, who often lack paid sick leave or employer-supported healthcare benefits (25). Studies indicate that in many low- and middle-income countries, DS-TB patients face catastrophic costs exceeding 20% of their household income, which aligns with findings in Indonesia (20,21). DOTS exacerbates financial instability for informal workers, who do not have paid sick leave and must take frequent absences from work for routine health center visits. This issue is particularly severe among low-income workers in the informal sector, as they lack job security and employer-supported healthcare benefits. Studies indicate that in many low- and middle-income countries, DS-TB patients face catastrophic costs exceeding 20% of their household income, a pattern that aligns with Indonesia's findings (20).

MDR-TB imposes a considerably higher financial burden due to its longer treatment duration, second-line drug costs, and increased hospitalization rates. The direct medical costs for MDR-TB treatment can reach IDR 190 million per patient, making it nearly ten times more expensive than DS-TB treatment (26). Additionally, MDR-TB patients suffer from high indirect costs, with average income losses of IDR 481.5 million per patient, as seen in Table 3. The extended treatment period, which lasts 12 to 24 months, further contributes to financial instability, leading to job losses, increased debt, and household impoverishment. Alarmingly, 83% of MDR-TB patients in Indonesia experience catastrophic health expenditures, meaning their treatment costs exceed 20% of their household income. Similar patterns are seen in other high-burden TB countries, where MDR-TB patients face significantly higher economic strain compared to DS-TB patients (20). Under DOTS, MDR-TB patients must visit healthcare facilities for direct supervision throughout their treatment course, which lasts 12 to 24 months. This further amplifies lost income, travel expenses, and time away from work.

Patients co-infected with TB and HIV face even greater financial difficulties due to the need for lifelong antiretroviral therapy (ART) alongside TB treatment. The total median costs for TB-HIV co-infected patients are estimated at INR 7,355 (approximately US$108), which is higher than for TB-only patients (27). The dual burden of managing both conditions results in higher direct medical costs and prolonged indirect costs, including absenteeism and productivity loss. TB-HIV patients also require more frequent medical visits, additional diagnostic tests, and specialized treatment, increasing their financial strain. Many TB-HIV patients belong to economically vulnerable groups, including low-income, unemployed, or informal workers, making the cost of treatment an even greater challenge. Strengthening financial protection mechanisms and social support programs for TB-HIV patients is crucial to improving treatment adherence and outcomes.

A study by Tanimura *et al* (2014), also emphasizes global variability in TB costs, with direct medical costs ranging from $55 to $8,198 depending on the region. These costs highlight gaps in healthcare infrastructure globally, with richer countries having better access to diagnostic and treatment services, while poorer countries struggle to provide even basic care (20). The wide range of costs shows how complicated TB treatment can be when medical access is limited or when patients face long travel times for diagnosis and treatment. MDR-TB poses higher socio-economic costs and challenges compared to drug-susceptible TB. As highlighted by Van den Hof et al (2016), MDR-TB cases in Indonesia, Ethiopia, and Kazakhstan incur significantly higher costs, especially related to the duration of treatment and the need for more intensive medical interventions (21). The cost of TB-MDR treatment in Indonesia, for example, is $169 USD per patient, a Van den Hof et al (2016) figure that if adjusted for inflation in 2024, will increase (21). The study, along with Van den Hof et al (2016), underscores how MDR-TB patients often undergo long treatment times, which exacerbates the economic burden on individual healthcare systems and households (21).

Indonesia's TB-related financial burden is comparable to that of India, the Philippines, and Vietnam, which have similar healthcare structures and TB control programs. In India, TB patients lose approximately 40% of their annual income due to direct and indirect costs, and catastrophic costs affect 30% to 61% of TB households (28). The Philippines' national TB patient cost survey found that indirect costs often exceed direct medical costs, with transportation and lost wages forming the largest financial burdens for patients (29). In Vietnam, research indicates that TB-related catastrophic health expenditures primarily affect low-income populations, exacerbating economic inequalities (30). These countries have attempted to reduce the economic impact of TB through targeted financial support mechanisms, such as government-subsidized transport, workplace-based screening programs, and cash transfer schemes for affected families.

Demographics and Cost of Illness

TB poses a significant economic burden on individuals, households, and communities, with its impact strongly related to economic conditions and demographic characteristics. Economic inequality plays an important role in exacerbating TB's financial pressures. Low-income households are disproportionately affected, as seen in the study where 62% of drug-sensitive TB (DS-TB) patients and 36% of multidrug-resistant TB (MDR-TB) patients were included in the low-income group (13). These households face enormous health expenditure, with 83% of MDR-TB households and 36% of DS-TB households spending more than 20% of their annual income on medical expenses (13,14). Informal workers, who do not have job security, sick leave, or access to employer-sponsored health insurance, are particularly vulnerable. In Bengkulu, for example, 87.3% of TB patients work in the informal sector, making them more vulnerable to loss of income and financial instability during treatment (15).

The economic impact of TB is most pronounced among adults of working age (18-45 years), who make up most TB patients. This demographic group, who are often the breadwinners for their families, experience significant productivity losses due to the long duration of treatment, which ranges from 2-4 months for TB-DS to 8-12 months for MDR-TB. Post-diagnosis, the income of affected households decreased dramatically, as evidenced by Fuady A *et al* (2019), where members with income decreased from 71% before diagnosis to 48.18% after diagnosis (14). Older adults (50+ years), despite facing higher medical complications, are less economically active and therefore experience lower overall economic impact. Children and adolescents, although less frequently affected, impose indirect costs on their families due to caregiving responsibilities and the long-term care requirements they require.

Inequality between regions further exacerbates the economic burden of TB. Urban areas such as Jakarta and Bandung incur higher direct costs due to the availability of advanced health services, but these areas also benefit from better financial support systems, such as BPJS-K(Indonesian National Health Insurance) (10,17). In contrast, rural areas such as Bengkulu face higher indirect costs, as patients often travel long distances to access health facilities, exacerbating income losses and impaired productivity. These challenges are even greater for low-income groups and informal workers in these regions (11,15).

Loss of Income and Catastrophic Costs

One of the significant challenges in this study was the high cost of catastrophic —where TB treatment costs exceed 20% of a household's annual income. This phenomenon is especially seen in low-income areas, as seen in a Wulan (2018) study in Bengkulu, Indonesia (15). The study reported that the family incurred a total cost of Rp 12,970,900, mainly due to job loss and transportation costs (15). This not only affects patients but also causes a tiered effect on family income, with many households forced to change their consumption patterns and take out loans to cover costs. Low socioeconomic status plays an important role in the high burden of tuberculosis. These include overcrowded households and the use of natural building materials, all of which contribute to the spread of disease. Unhygienic living environment and population density increase the risk of transmission of *Mycobacterium tuberculosis* bacteria through the air and increase the chance of spreading the disease through droplets (22). Similarly, it Fuady A *et al* (2018) shows that loss of income is one of the main contributors to the overall financial burden faced by TB patients in Jakarta, where many households are already living in poverty (13).

The incidence of catastrophic costs is striking, with 83% of households with MDR-TB in Indonesia experiencing financial difficulties (13). These figures indicate the need for targeted social protection programmes and financial support mechanisms, which can aid households most affected by TB. However, despite efforts such as the Indonesian National Health Insurance (JKN) Scheme, McAllister *et al* (2020) noted, the costs to patients remain

high, especially for pretreatment costs (18). Reinforcement action against *catastrophic cost* 55.67% of patients were forced to sell assets such as property to meet economic needs. Many families receive assistance from the government (68.33%) or extended family (78%) to cope with the economic impact (19). This catastrophic *cost* demonstrates that TB can trigger sustained poverty in patients and their families, especially without adequate social support.

The Role of Strategic Intervention

TB remains a significant financial burden for individuals and households, as evidenced in Table 1, Table 2, and Table 3. The high costs associated with direct medical care, indirect income loss, and catastrophic health expenditures necessitate targeted interventions to alleviate the economic strain on patients, particularly those suffering from MDR-TB and TB-HIV co-infections (13,15). Addressing these challenges requires financial protection mechanisms, decentralization of TB services, workplace support, DOTS reform, and increased funding. Indonesia has implemented key programs, including JKN (National Health Insurance), PMDT (Programmatic Management of Drug-Resistant TB), and TOSS-TB (Find, Treat, Cure TB), to improve treatment access and financial protection.

One critical strategy to reduce the financial burden of TB is strengthening BPJS Kesehatan coverage. Although the Indonesian National Health Insurance scheme covers TB medications, patients still bear significant out-of-pocket costs, particularly for transportation, nutritional needs, and income loss due to prolonged treatment (20). As Table 3 highlights, indirect costs remain a significant component of total TB-related expenses, especially for low-income households. Expanding BPJS Kesehatan to include transportation subsidies, nutritional support, and income protection for informal workers could significantly ease this burden (21). Similar measures have been adopted in Vietnam and India, where targeted financial support mechanisms have been integrated into national TB programs to improve patient retention in treatment (18).

Beyond financial protection, decentralizing MDR-TB treatment can help reduce indirect costs, particularly travel expenses and work absences (25). Table 2 indicates that patients in rural areas face greater financial hardship due to the need to travel to distant healthcare centers. The implementation of MDR-TB treatment at Puskesmas (primary healthcare centers) and community clinics could allow patients to access care locally, reducing both transportation costs and productivity losses (13,14). PMDT, Indonesia's decentralized MDR-TB treatment initiative, integrates TB care into Puskesmas (primary healthcare centers) and referral hospitals, improving accessibility and affordability (5). A similar approach has been successfully implemented in the Philippines, where community-based MDR-TB treatment reduced total patient costs by 30% (20,28). Additionally, the expansion of telemedicine and digital adherence monitoring (DAM) can reduce the need for frequent in-person visits, which is particularly beneficial for MDR-TB patients undergoing prolonged treatment courses of 12–24 months (21).

Given that TB disproportionately affects working-age individuals (21–49 years old), workplace-based interventions are also necessary. Table 3 shows that 82.33% of TB patients experience job loss due to extended absences for treatment, exacerbating financial distress (21). Countries such as Vietnam have introduced employer-supported TB care, allowing patients to receive treatment without risking job security (18,27). Indonesia could adopt similar measures, including paid sick leave policies for TB patients and workplace-based screening programs. Encouraging employers to integrate TB treatment into occupational health services would ensure greater retention in treatment and minimize productivity losses.

Another essential intervention is reforming the DOTS strategy to mitigate its financial burden on patients. While DOTS ensures treatment adherence and reduces drug resistance, it also raises indirect costs, particularly transportation expenses and lost wages due to frequent clinic visits (20). As seen in Table 3, transportation costs for TB patients can reach IDR 500,000 per month, accumulating to IDR 12 million over a two-year MDR-TB treatment (13,14). Countries like India have successfully adopted Community-Based DOTS (CB-DOTS), where healthcare workers visit patients instead of requiring frequent facility visits (21,28). Indonesia could implement CB-DOTS in rural areas, reducing both travel expenses and work absences while maintaining high adherence rates. Similarly, telemedicine-based DOTS could replace some in-person visits, allowing patients to receive virtual supervision for medication adherence. Indonesia's TOSS-TB program (Temukan, Obati, Sampai Sembuh – Find, Treat, Cure TB) follows a similar approach by enhancing early detection and community-based treatment, yet implementation gaps remain. Strengthening TOSS-TB by integrating telemedicine and home-based care could reduce non-medical costs while improving adherence.

Finally, securing increased funding from both government and international organizations is essential to sustaining these interventions. The Indonesian government's current TB budget remains insufficient, with many patients still experiencing catastrophic health expenditures despite BPJS Kesehatan (18). Expanding government subsidies for non-medical TB expenses and strengthening public-private partnerships can improve long-term sustainability. Additionally, international organizations such as the WHO and the Global Fund have supported TB financial relief programs in India, the Philippines, and Vietnam, offering potential funding avenues for Indonesia (20)

CONCLUSION

The cost of tuberculosis (TB) treatment in Indonesia shows significant variation, influenced by geographical location, type of TB, and complexity of treatment. In urban areas such as Jakarta, the direct cost of drug-sensitive TB (DS-TB) treatment can reach Rp 2,180,486 per case, while in Bekasi, patients with HIV (TB/HIV) co-infection have to spend up to Rp 871,100 per month. For cases of MDR-TB (drug-resistant TB), the cost of treatment is very high, which is up to Rp 190,591,080 per patient. On the other hand, indirect costs, such as lost revenue due to the duration of treatment, are very burdensome for patients. For example, families of MDR-TB patients in Jakarta suffered an average loss of up to IDR 481.5 million due to lost productivity. This economic burden pushed 83% of MDR-TB households and 36% of DS-TB households into the category of *catastrophic costs,* where spending on treatment exceeded 20% of their annual income. Demographically, TB most significantly affects the productive age group (18-45 years), who are often the primary breadwinners in households. The long duration of treatment, 2-4 months for TB-DS and 8-12 months for MDR-TB, caused large productivity losses, thus exacerbating the economic impact on the patient's family. Informal sector workers, who do not have financial protection such as insurance or sick leave, are in a very vulnerable position. A total of 62% of TB-DS patients and 36% of MDR-TB patients came from low-income households while in rural areas such as Bengkulu, 87.3% of TB patients worked in the informal sector, exacerbating financial instability during treatment. Geographical inequality is also evident. Large cities such as Jakarta, Bekasi, and Medan have high direct medical costs due to more advanced health facilities. However, access to health services in these cities is relatively easier than in rural areas, such as Bengkulu, where patients often have to travel long distances to get treatment. This increases in indirect costs, including transportation and lost revenue, which overall exacerbate financial burdens. The economic impact of TB in Indonesia is complex and multifaceted. This burden is heaviest felt by vulnerable groups, such as informal sector workers and low-income households, especially those living in rural areas. To address these economic challenges, targeted financial and healthcare interventions are necessary. Expanding BPJS Kesehatan to cover transportation subsidies, nutritional support, and income protection could significantly reduce patient costs. Decentralizing MDR-TB treatment to Puskesmas and community clinics, as seen in Vietnam and the Philippines, would minimize travel-related expenses. Additionally, employer-supported TB programs and workplace-based screening could help prevent job loss and improve adherence to treatment. Reforming the DOTS strategy, by introducing telemedicine-based supervision (TOSS-TB) and community-based DOTS (CB-DOTS), would further lower indirect costs and enhance treatment retention. Lastly, increased government funding is essential to strengthen TB financial relief programs, ensuring that vulnerable populations receive adequate care without facing financial devastation.

AUTHOR'S CONTRIBUTION STATEMENT

All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

CONFLICTS OF INTEREST

No conflicts of Interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

ChatGPT was used solely to support clarity, structure, and language refinement during manuscript drafting. All AI-assisted suggestions were reviewed, verified, and revised by the authors to ensure conceptual accuracy and originality. The authors assume full responsibility for the final content of the manuscript.

SOURCE OF FUNDING

This research is independent and does not receive financial support from any party.

ACKNOWLEDMENTS

The authors would like to thank all parties who have provided support for this research, including those who contributed to data collection and analysis, even though they do not meet the criteria to be recognized as authors.

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