
LITERATURE REVIEW: MEDICATION COMPLIANCE IN TUBERCULOSIS PATIENTS

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ABSTRACT

Tuberculosis (TB) remains one of the leading global health challenges, with a high incidence of infection, widespread drug resistance, and significant morbidity, especially in low- and middle-income countries. Despite advancements in diagnostic tools, treatment regimens, and global policy support, adherence to TB medication remains a critical issue. This study aims to examine the factors influencing medication adherence among TB patients and assess the effectiveness of interventions designed to improve compliance. The research utilizes a literature review methodology, analyzing secondary data obtained from 15 journals and articles published between 2019 and 2024. The findings indicate that knowledge, family support, and healthcare access are key in improving TB treatment adherence. Integrating community-based interventions and educational programs has positively enhanced patient compliance. Additionally, addressing socio-economic factors such as poverty and inadequate healthcare access is essential in reducing TB incidence and preventing drug-resistant strains. The study emphasizes the importance of continuous monitoring, patient education, and support to ensure effective TB control and treatment. The results contribute to the development of targeted strategies for improving TB treatment adherence, particularly in regions with high TB burden.

Keywords: Tuberculosis; Medication Adherence; Treatment Compliance; Drug-Resistant TB; Patient Education; Global Health

INTRODUCTION

Tuberculosis (TB) is a preventable and usually curable disease (Roberts et al., 2022). However, by 2023, TB may again be the leading cause of death in the world due to a single infectious agent, after 3 years of being replaced by coronavirus disease (COVID-19) and causing nearly twice as many deaths as HIV/AIDS. More than 10 million people continue to fall ill with TB each year, and the number has been steadily increasing since 2021. Urgent action is needed to end the global TB epidemic by 2030. (Global tuberculosis report, 2024) According to the 2023 global tuberculosis report, geographically, the most tuberculosis cases are in Southeast Asia (45%), Africa (24%), the Western Pacific (17%), the Eastern Mediterranean (8.6%), the Americas (3.2%), and Europe (2.1%). Up to 56% of tuberculosis cases in the world are found in 5 countries, namely India (26%), Indonesia (10%), China (6.8%), the Philippines (6.8%), and the United States (10%), Pakistan (6.3%), Nigeria (4.6%), Bangladesh (3.5%), and the Democratic Republic of Congo (3.1%). Based on this data, Indonesia occupies the second position in the world with the highest number of tuberculosis cases (Global tuberculosis report, 2024). Tuberculosis (TB) is still a health problem in Indonesia and the world. Based on the WHO Global TB Report 2022, Indonesia occupies the

second position after India, and is followed by China in third place with 969,000 cases and 144,000 deaths.

Indonesia itself is ranked third (8%) as the country that contributes to the number of Tuberculosis (TB) cases in the world after India and China. It is estimated that every year there are 1,020,000 cases of Tuberculosis (TB) in Indonesia, but only about 446,732 cases of Tuberculosis have been reported, and 2.5% have died[3]. In the annual Tuberculosis report for 2020, Tuberculosis is among the top 10 causes of death in the world, and one of them is in Indonesia, at 843,000, with treatment success of around 85%, with 32% of cases unreported. In 2023, Tuberculosis cases in Indonesia increased by 2,000 from the previous year to 845,000 cases, with the total success percentage decreasing by about 2% from before. There are 11,463 cases of drug-resistant tuberculosis (TB RO), 70,341 tuberculosis cases in children, and 12,015 HIV-positive tuberculosis cases (Ministry of Health of the Republic of Indonesia, 2022). Indonesia is committed to reducing the incidence of TB to 65/100,000 population by 2030. Efforts to control TB in Indonesia in 2020-2024 accelerate Indonesia's efforts to achieve TB elimination by 2030 and end the tuberculosis epidemic by 2050. The Tuberculosis control strategy in Indonesia in 2020-2024 is implemented to achieve the target of reducing the incidence of TB from 319/100,000 population in 2017, to 190/100,000 population, and also reducing the death rate due to TB from 42/100,000 population in 2017, to 37/100,000 population by 2024 (RI, 2020)

Failure and non-compliance of tuberculosis patients in carrying out treatment is one of the causes of Multidrug-Resistant TB (MDR-TB). Internationally, Indonesia is ranked eighth among 27 countries with the highest number of Multidrug-Resistant TB (MDR-TB) cases worldwide. The cure rate for MDR-TB is only about 50%, while also carrying the risk of direct transmission of resistant germs or primary resistance. This means that a person who has never been exposed to TB before can immediately experience MDR-TB after being infected with MDR-TB. One of the problems in TB treatment is treatment adherence, based on the success rate of TB treatment has decreased by 6% from 89% in 2010 to 82% since 2020 (Yunitasari Akbar, I.B., & Nurmeliani, R., 2023). Based on data from patient medication adherence to consuming OAT, 68% was obtained in 2022. Meanwhile, according to the Ministry of Health of the Republic of Indonesia (2022), the (Health, 2023) sets a standard for treatment success at 90% (Chairani Utami et al., 2023). The urgency of drug adherence research for tuberculosis patients is still very important to continue to be researched because it is still a global health problem with a high incidence and mortality rate, especially in Indonesia. Low medication adherence, due to long duration of therapy and lack of patient education, can lead to treatment failure, drug resistance (MDR-TB/XDR-TB), and worsen the spread of the disease. In addition, non-compliance increases the economic and social burden on patients, so more effective intervention strategies are needed. This research is relevant to support the achievement of the 2030 SDG target in ending the TB epidemic and to assist in evaluating and strengthening health policies, such as the DOTS program, for sustainable TB control. This literature review aims to analyze some of the research conducted on tuberculosis cases globally, starting from the incidence of prevalence and geographical distribution.

Tuberculosis (TB) continues to be a major global health problem, with high incidence rates and significant morbidity, particularly in countries like Indonesia. Despite being a preventable and treatable disease, TB remains the second leading cause of death from an infectious agent worldwide. A key challenge in TB management is patient non-compliance with medication regimens, which leads to treatment failure, the development of drug-resistant strains, and increased transmission. The increasing incidence of Multi-Drug-Resistant (MDR-

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TB) further complicates treatment strategies. There is an urgent need to improve medication adherence among TB patients to reduce the incidence of drug-resistant TB and improve treatment outcomes.

The urgency of this research is highlighted by the growing global TB crisis, particularly in Indonesia, where TB is a leading cause of death. With the rise in drug-resistant TB and the associated challenges in treatment, improving patient adherence to TB medication is critical. This research aims to address the barriers to medication adherence and identify effective strategies to enhance compliance, thereby contributing to TB control efforts and improving patient outcomes. Understanding the factors that affect adherence will aid in reducing the spread of TB and the incidence of MDR-TB.

Previous research by Suryana & Nurhayati (2021) examined the role of family support in medication adherence among TB patients, showing that good family support significantly improved adherence. Similarly, Kusmiyani et al. (2024) explored the relationship between patient knowledge and adherence, finding that a better understanding of the disease leads to higher compliance with treatment regimens. Another study by Yunitasari et al. (2023) highlighted the impact of patient education on adherence, suggesting that improved health literacy is crucial in enhancing medication adherence among TB patients.

While previous studies have explored various factors influencing medication adherence in TB patients, limited research exists on the combined effects of knowledge, social support, and healthcare access on adherence, particularly in the context of MDR-TB. This study aims to fill this gap by evaluating these interconnected factors and proposing targeted interventions to improve medication adherence, thereby reducing the incidence of drug-resistant TB.

This study introduces a novel approach by combining multiple factors—knowledge, family support, and healthcare access—to analyze their collective impact on medication adherence in TB patients. Unlike previous studies that focus on individual factors, this research takes a more holistic view, offering a comprehensive analysis of the barriers to adherence and providing actionable recommendations for improving treatment success.

The primary objective of this research is to analyze the factors influencing medication adherence in TB patients, with a focus on the role of patient knowledge, family support, and healthcare access. The study also aims to propose effective strategies to improve adherence and contribute to the global efforts to combat TB.

This research will provide valuable insights into the factors that influence medication adherence in TB patients, offering practical recommendations for healthcare providers and policymakers. By improving adherence, the study aims to contribute to better treatment outcomes, reduced transmission of TB, and a decrease in the incidence of drug-resistant TB. Additionally, the findings can support the development of more effective TB control strategies and interventions.

METHOD

This study uses secondary data from a literature review with a prism method, starting from determining the topic of research, searching for relevant references, grouping, and analyzing to summarize. The reference criteria to be reviewed are articles or journals published in the last 5 years (2019-2024) obtained through several databases, namely PubMed, Science Direct, and Google Scholar. Articles or journals with published criteria in full with the keywords tuberculosis", "TB compliance", "taking TB medicine", "TB treatment", "TB patients", and "prevalence" using a combination of "or" and "and". Next is the screening of the title, abstract, method, and research results used in the article. Articles are sorted based on

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predefined inclusion and exclusion criteria. The inclusion criteria in this study are (1) all articles related to TB compliance, taking TB medication, Challenges and Prevention related to Medication Compliance for Tuberculosis patients, and (2) full access and full papers are available. The exclusion criteria are (1) articles in the form of reports, essays, dissertations, and literature reviews; (2) Articles that are not available in their entirety or are incomplete. Based on the search results from several databases, 20 articles were found that fit the criteria and will be further analyzed in this literature review.

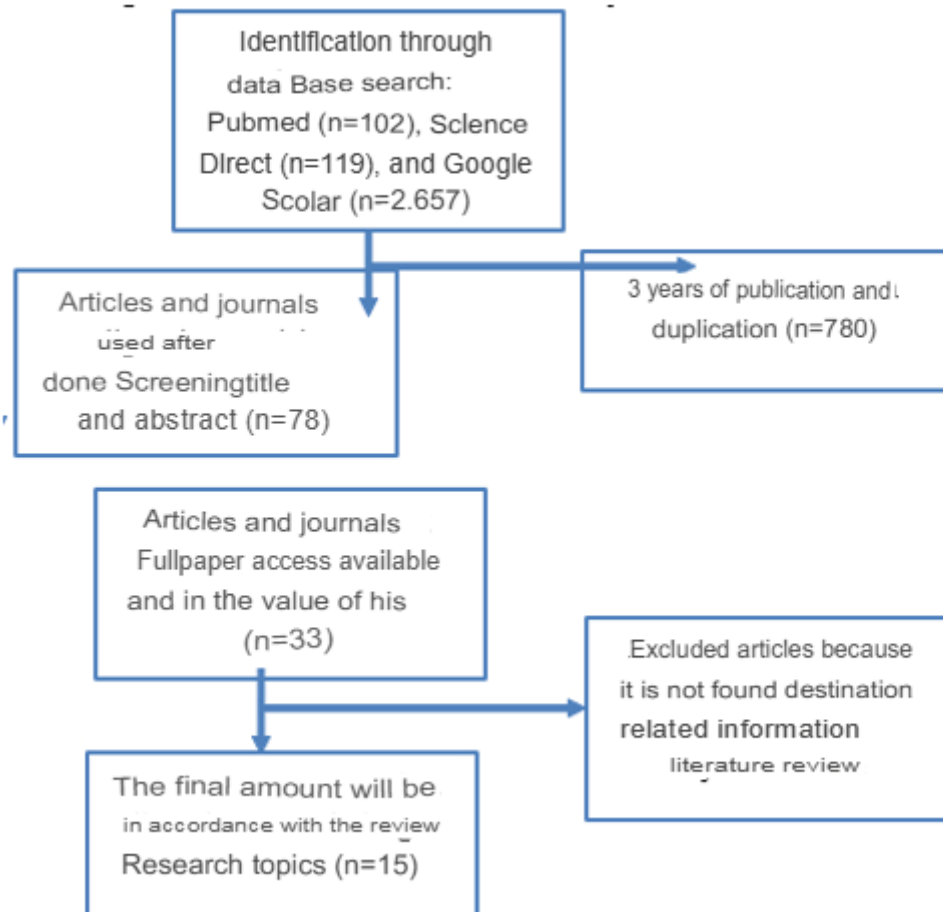


Figure 1. Prism Flow Diagram

RESULTS AND DISCUSSION

The results of the online journal search were obtained from as many as 15 journals about tuberculosis. Then the grouping of journal topics was carried out in the form of medication adherence (3 journals), TB incidence (1 journal), TB prevalence (1 journal), geographical distribution of TB (1 journal), determinants and risk factors of TB (3 journals), TB spread pattern (2 journals), TB control and prevention (2 journals), challenges and development of TB (2 journals).

Table 1. Research Title

Researchers	Research Title	Research methods	Result
Idawaty Siregar , Parluhutan Siagian , Elmeida Effendy (2019)	Dukungan Keluarga meningkatkan Kepatuhan Minum Obat pada Penderita Tuberkulosis Paru di Kabupaten Tapanuli Utara	Observational analysis with a cross-sectional design	The results showed that of the 58 patients with good family support, almost all (98.3%) also had good medication adherence. Two patients with low-income family support all had poor medication adherence (100%). The Fisher exact test showed a significant relationship between family support and medication adherence (p=0.002).
Siti Nur Hasina, Arum Rahmawati, Imamatul Faizah, Ratna Yunita Sari, Riska Rohmawati (2023)	Hubungan Tingkat Pengetahuan Dengan Kepatuhan Minum Obat Anti Tuberkulosis (Oat) Pada Pasien Tuberkulosis Paru	Correlational Analysis With Cross-Sectional Design	There is a relationship between knowledge level and medication compliance. So, self-care-based health promotion activities are needed to overcome TB patients' non-compliance, increase compliance with treatment programs, and improve the health of pulmonary tuberculosis patients.
Lusiane Adam (2020)	Pengetahuan Penderita Tuberkulosis Paru Terhadap Kepatuhan Minum Obat Anti Tuberkulosis	Cross-sectional Study Approach	Tuberculosis patients in the East City Health Center Work Area are mostly sufficient and lacking. This is due to the educational background of the sufferers, most of whom are high school students who do not understand the importance of taking anti-tuberculosis drugs until they are finished, so that no disease resistance causes other problems that have more serious impacts.
<i>Berly Afilla Christy, Ressi Susanti, Nurmainah (2022)</i>	Hubungan Tingkat Kepatuhan Minum Obat Pasien Tuberkulosis Terhadap Efek Samping Obat Anti Tuberkulosis (Oat)	Observational With Cross-Sectional Study Design	There is a significant relationship between the side effects of OAT and medication adherence in pulmonary tuberculosis patients at the Sungai Betung District Health Center, Bengkayang

			Regency.
Linda, Ony Rachmawati (2020)	Tingkat Kepatuhan Penggunaan Obat Anti Tuberkulosis Pada Pasien Di Puskesmas Tombulilato Kabupaten Bone Bolango	<i>Quantitative with Quasi-experimental design</i>	Compliance with the use of anti-tuberculosis drugs in patients at the Tombulilato Health Center, Bone Raya District, Bone Bolango Regency, can be concluded that the level of compliance of pulmonary tuberculosis patients at the Tombulilato Health Center is included in the compliant category, with a percentage of 86.8%.
Maulan Agung Nugroho, Kumboyono, Setyoadi (2023)	Analisa Kepatuhan Minum Obat Anti Tuberculosis: Perbandingan Penggunaan Layanan Pesan Singkat Dengan Pengawas Minum Obat	The post-test only control group design was used in the TB patient population	There is no significant difference between the compliance of respondents who received SMS services and respondents who received PMO services to monitor medication intake only.
Sinta Ratna Dewi, Leony Yola Shalsabila1, Nur Fitriah1, Widya Rahmah (2022)	Hubungan Efikasi Diri Dengan Kepatuhan Minum Obat Pasien Tb Paru Di Rumah Sakit Dirgahayu Samarinda	Descriptive cross-sectional	Pulmonary Tuberculosis patients at Dirgahayu Hospital Samarinda are mostly of productive age (26-35 years), 53.8%, and mostly male, 60%. Most of the education is college graduates/bachelors, 46.3%, and most are self-employed, 47%.
Rusman, Sarinah Basri K (2019)	Faktor Yang Mempengaruhi Penderita TB Paru Terhadap Kepatuhan Minum Obat Anti Tuberkulosis Di Puskesmas Jatisawit Indramayu	Descriptive analytics with a cross-sectional approach	There is no relationship between education and adherence to taking OAT (p-Value 0.082, p > 0.05), There is a relationship between knowledge and adherence to taking OAT (p-Value 0.012, p < 0.05), There is a relationship between attitude and adherence to taking OAT (p-Value 0.040, p < 0.05).
Annisa Novita Sary, Riva Nadia Putri, Nina Marini (2024)	Faktor-Faktor Kepatuhan Minum Obat Anti Tuberculosis Pada Penderita Tb Paru	Cross-sectional study design	It was found that there was a relationship between the level of knowledge and family support with compliance in taking anti-tuberculosis drugs (OAT) in TB patients in the Ujung Gading Health Center Work

			Area, West Pasaman Regency. It is hoped that the community will increase public knowledge about TB disease and activate the participation of individuals, families, and communities in the TB disease control program.
Fauzan Adima, Merita Arini (2024)	The Influence Of Healthcare Workers' Social Support On Compliance To Medication In Multi-Drug Resistant Tuberculosis Patients At The Regional General Hospital Of Dr. Saiful Anwar	Quantitative research methodology, specifically using a cross-sectional study design.	The respondents' gender was mostly male at 60.26%, while the age of the respondents was mostly 45–64 years (43.59%), and the education level of the respondents was mostly high school graduates at 38.47%. The instrumental support variable is the variable that has the most influence on treatment compliance in MDR-TB patients (Sig. < 0.005).
Sari Widiya Dewi (2022)	Tuberculosis Control Efforts by Increasing Compliance in Taking Anti-Tuberculosis Drugs	This scientific study was written using a literature review approach	There are 5 journals used, 2 of which use efforts made by both individuals and groups to increase the self-confidence of tuberculosis sufferers, thereby increasing their compliance with medication regularly. Patient compliance is highly demanded in undergoing long-term treatment, and it is important to know the patient's attitude and behavior towards the treatment program that has been given by health workers.
Ni Nyoman Aldina, Raden Bagus Bambang Hermanto, Dafrosia Darmi Manggasa (2020)	Hubungan Konseling dengan Kepatuhan Minum Obat Anti Tuberkulosis Pasien Tuberkulosis di Kabupaten Poso	The research design is a cross-sectional study	Counseling in patients with pulmonary tuberculosis is good (80.5%) and less (19.5%). Compliance in taking medication is compliant (70.7%) and not compliant (29.3%). Patients who received good counseling and were compliant in taking medication were 78.8%, and those who were not compliant were 21.2%. Patients who received less counseling and

			were compliant in taking medication were 37.5%, and those who were not compliant were not compliant. The results of the statistical analysis showed a p-value = 0.034.
Sidita Dachi, Rahmat Alyakin Dachi, Mido Ester J. Sitorus, Donal Nababan, Frida Lina Tarigan (2024)	Faktor Yang Berhubungan Dengan Kepatuhan minum Obat Anti Tuberkulosis (Oat) Pada Pasien Tb Paru di wilayah kerja puskesmas lahomi kecamatan lahomi kabupaten Nias Barat	Mixed methods research method	There is no relationship between knowledge and adherence to taking Anti-Tuberculosis Drugs (OAT) in Pulmonary TB patients in the Work Area of Lahomi Health Center, Lahomi District, West Nias Regency. There is a relationship between motivation and adherence to taking Anti-Tuberculosis Drugs (OAT) in Pulmonary TB patients in the Work Area of Lahomi Health Center, Lahomi District, West Nias Regency. There is no relationship between access to health facilities and adherence to Anti-Tuberculosis Drugs (OAT) in Pulmonary TB patients in the Work Area of Lahomi Health Center, Lahomi District, West Nias Regency.
Herdiman, Dian Rahman, Linlin Lindayani (2020)	Picture Of Drinking Compliance In TB Patients In The Cimaung District Community Health Center Area	Descriptive Analytical	A total of 54 patients (54%) were compliant, 40 patients (40%) were less compliant, and 6 patients (6%) were not compliant with taking anti-tuberculosis medication.
Anita Dyah Listyarini ¹ , Dwi Mey Heristiana (2021)	Relationship Between Knowledge And Attitude Of Pulmonary Tb Patients Towards Compliance In Taking Anti-Tuberculosis Drugs At The Rsi Nu Demak Polyclinic	Correlation with cross-sectional design	The highest level of knowledge was in the moderate category, with 25 respondents (65.8%), and the lowest was in the good category, with 4 respondents (10.5%). The highest level of medication compliance was in the moderate category, with 21 (55.3%), and the lowest was low compliance, with 5 respondents (13.2%).

Discussion

Compliance or adherence is the level at which a patient carries out the treatment methods and behaviors recommended by their doctor or others. In undergoing long-term treatment, patient compliance is required to know the patient's attitude and behavior towards the treatment program that health workers have provided (Suryana & Nurhayati, N., 2021). Treatment success in TB patients depends on the patient's compliance and support from the family. If there is no effort from oneself or motivation from the family that lacks support to complete treatment, it will affect the patient's compliance with consuming medication (Kusmiyani O. T., 2024).

According to Pratiwi (2025), the patient's compliance or level of compliance in following the treatment plan that the doctor has determined is very important. The TB treatment regimen requires regular use of medications over a set period. If the patient does not follow the treatment properly, drug resistance may develop, or the treatment may become less effective. It is important to remember that TB treatment requires discipline, patience, and cooperation between patients, medical personnel, and the community to achieve optimal recovery. These factors must be considered to improve the recovery of pulmonary TB patients.

WHO noted that in 2021, there were a total of 10.6 million cases of tuberculosis in 2021 the world, or an increase of 600,000 compared to the previous year, 2020, where it is suspected that there were around 10 million people infected with tuberculosis. Furthermore, there are 6.4 million (60.3%) patients out of the total who, according to records, receive treatment, and 4.2 million (39.7%) others are unsuccessful in their reports/diagnoses (Mujahidah Silalahi et al., 2023). Based on the latest report (WHO, 2020) published in the Global Tuberculosis Report 2023, the prevalence of pulmonary tuberculosis (pulmonary TB) around the world shows that TB remains a significant global health threat. In 2022, there were an estimated 10.6 million new cases of TB, with a worldwide incidence rate of around 134 cases per 100,000 population. The death toll from TB is estimated at 1.6 million, including 187,000 deaths in people living with HIV (Ezzah El, 2024). The Geographic Information System is one of the computer-based mapping systems that is useful for collecting, storing, displaying and correlating spatial data from geographical phenomena for analysis whose results are used by stakeholders (Zain, 2020), with the existence of the Geographic Information System (GIS), we can map and analyze the spread of TB to help in better decision-making in handling this disease. Environmental cleanliness also affects the spread of this virus, such as houses with poor ventilation.

GIS allows us to combine geographic data with epidemiological data to produce maps that show the distribution of TB cases in different regions. This mapping not only helps identify areas with high cases but can also help understand environmental factors that may contribute to the spread of the disease. As a powerful analytical tool, GIS also allows the identification of trends and patterns of spread over time, which is important for the planning of appropriate health interventions (Anzari & Wibowo, 2025). According to Pralambang & Setiawan (2021) the incidence of tuberculosis can be caused by TB history factors in the family. If one family member is exposed to TB, other family members will likely be infected. TB transmission in the family occurs due to frequent direct contact with TB patients who live in the same house. According to research (Handayani et al., 2024), the factors that affect the incidence of pulmonary TB are divided into host factors (sufferers), environment, and agents (*Mycobacterium tuberculosis* germ). Research conducted by Duarte said there are TB incidence factors, both associated with the sufferer and environmental factors. Early

identification of these risk factors can be applied to increase the level of vigilance of health workers, identify TB patients early, and enable more effective treatment.

Research conducted by Fransiska (2019) shows that knowledge, age, smoking, and housing density are risk factors for tuberculosis incidence, and statistically, there is a meaningful relationship. The BCG vaccine, or *Bacillus Calmette-Guérin*, is the only vaccine used to fight and prevent TB. The BCG vaccine contains a weak form of the bacterium *Mycobacterium Bovis*. The effectiveness of BCG vaccines in preventing TB in adults and infants varies widely, with progress ranging from 0% to 80% (average 50%). This variation can occur due to geographical location, age of vaccine recipients, vaccine doses, nutritional status of vaccine recipients, and the environment of vaccine recipients (Putri I. D. M., 2024). Several researchers model the spread of TB disease with the SVIR model where there are inhibiting factors, namely the administration of vaccines, namely research conducted by Nugroho (2023) with the title "Analysis and Simulation of Parameters of the Susceptible Vaccinated Infected Recovered (SVIR) Model in the Spread of Tuberculosis in Indonesia", (Tilahun G. T., 2020) with the title "Stochastic model of tuberculosis with vaccination of newborns", (Kelemu Mengistu A., 2019) with the title "Modeling the Effects of Vaccination and Treatment on Tuberculosis Transmission Dynamics", and Egonmwan and Okuonghae (Egonmwan A. O., 2019) with the title "Mathematical analysis of a tuberculosis model with imperfect vaccine". These studies assume that the effectiveness of the BCG vaccine is less than perfect, so vaccinated individuals can still contract infections. In addition, research by (Tilahun G. T., 2020) modeled the lack of effectiveness of vaccines against TB transmission.

The study illustrates that the chance of disease transmission in vaccinated individuals is smaller than in vulnerable individuals who are not vaccinated. Some of these researchers conducted TB transmission modeling that only paid attention to inhibiting factors with the administration of vaccines without paying attention to incidence factors, or the occurrence of transmission due to contact with infected individuals to uninfected individuals. The policy implementation theory developed by Van Meter and Van Horn is a comprehensive framework for analyzing the effectiveness of public policies, including in the context of health. This theory focuses on six main variables affecting policy implementation: policy standards and objectives, resources, communication between organizations, characteristics of implementing agents, the disposition of policy implementers, and social, economic, and political environmental conditions. This approach provides a framework for systematic analysis to evaluate barriers and opportunities in the implementation of health policies, including in the early detection of tuberculosis (TB). One of the main challenges in the treatment of abdominal TB is the difficulty in diagnosis. Unlike pulmonary TB, which can be easily diagnosed through sputum examination and radiological imaging, abdominal TB often has nonspecific symptoms, such as abdominal pain, prolonged fever, weight loss, and indigestion (Sari Desty Gusti & Resultanti, 2022). These symptoms often resemble other conditions such as Crohn's disease, ulcerative colitis, or abdominal malignancies, which leads to delays in diagnosis and treatment. In addition, available diagnostic methods, such as microbiological and histopathological examinations, are often of low sensitivity, requiring a multidisciplinary approach to establishing a diagnosis.

CONCLUSION

Tuberculosis (TB) remains one of the most pressing global health challenges, exacerbated by several interrelated factors, including high incidence rates, increasing drug resistance, and its strong association with HIV. The disease is further complicated by social

determinants such as poverty, inadequate healthcare access, and poor living conditions. TB disproportionately affects marginalized populations, making it a critical issue for public health systems, particularly in low- and middle-income countries. Despite these ongoing challenges, significant advancements have been made in the fight against TB. Innovations in diagnostics, such as the introduction of the GeneXpert platform, have significantly improved detection, especially for drug-resistant strains. The development of new medications, such as bedaquiline, and shorter, more effective treatment regimens offers promising options for patients with multidrug-resistant tuberculosis (MDR-TB). Moreover, the integration of TB and HIV services has streamlined care for co-infected patients, enhancing both TB and HIV treatment outcomes. Policy frameworks like the WHO's End TB Strategy 2035 provide a clear path forward, aiming to reduce TB incidence and mortality, ultimately leading to the disease's elimination by 2035. However, achieving these ambitious goals requires a holistic, multi-pronged approach that includes increasing financial investments, leveraging technology, fostering cross-sector collaboration, and empowering communities to address the underlying social determinants of health.

In light of these developments, further research is necessary to identify effective strategies for overcoming barriers to TB treatment adherence, especially in resource-limited settings. Future studies should explore the integration of digital health technologies, such as mobile health applications, to improve patient engagement and treatment monitoring. Additionally, there is a need for deeper investigation into the socio-economic and cultural factors that influence TB treatment adherence and health-seeking behavior. Research should also focus on evaluating the long-term sustainability of TB control programs, particularly in regions with high TB burden, to ensure that advancements in diagnostics and treatment reach those who need them most. Expanding research into personalized treatment regimens and community-based interventions will be crucial in addressing the remaining gaps in TB elimination efforts.

REFERENCES

- Anzari, Y., & Wibowo, S. (2025). Sistem Informasi Geografis Pemetaan Penyebaran TBC di Provinsi Jambi Tahun 2022. *Technologica*, 4(1), 44–52.
- Chairani Utami, P. R., Indrayati, S., Almurdi, A., & Rahmayana, R. C. (2023). Perbedaan Hasil Pemeriksaan Mikroskopis BTA Pada Pasien TB Paru Sebelum dan Sesudah Pengobatan Fixed-Dose Combination (FDC) Fase Intensif. *Jurnal Kesehatan Perintis*, 10(1), 68–73.
- Egonmwan A. O., & O. D. (2019). Mathematical analysis of a tuberculosis model with imperfect vaccine. *International Journal of Biomathematics*, 12(7), 1–30.
- Ezzah El, D. (2024). Asuhan Keperawatan Pasien Yang Mengalami Tuberkuosis Paru Dengan Bersihan Jalan Napas Tidak Efektif Di Rumah Sakit Pasar Rebo Jakarta Timur. *Doctoral dissertation, Universitas Mohammad Husni Thamrin*.
- Fransiska M, H. E. (2019). Faktor Resiko Kejadian Tuberculosis. *J Kesehat*, 10(3), 252–260.
- Global tuberculosis report, 2024. (2024). *Global tuberculosis report 2024*.
- Health, O. W. (2023). Global Tuberculosis Report 2023. *Geneva: WHO*. <https://www.who.int>
- Kelemu Mengistu A., & W. P. J. (2019). Modeling the Effects of Vaccination and Treatment on Tuberculosis Transmission Dynamics. *Journal of Applied Mathematics*.
- Kusmiyani O. T., H. H. & R. K. (2024). Analisis Faktor yang Berhubungan dengan Kepatuhan Minum Obat Anti Tuberkulosis pada Pasien TB Paru di Puskesmas Samuda dan Bapinang Kotawaringin Timur. *Jurnal Surya Medika (JSM)*, 10(1), 139–151.
- Mujahidah Silalahi, M. K., Prestisia, R. P., & Djubaidah, S. Z. (2023). Hubungan Tingkat

- Pengetahuan dan Sikap Pasien Tuberkulosis Dengan Perilaku Pencegahan Penularan Penyakit Tuberkulosis Paru di Poli Paru. *Jurnal Ilmiah Kesehatan*, 15(1), 130–136. <https://doi.org/https://doi.org/10.37012/jik.v15i1.1103>
- Nugroho A. A., A. A. M. Y. A. & T. A. (2023). Analisis dan Simulasi Parameter Model Susceptible Vaccinated Infected Recovered (SVIR) pada Penyebaran Tuberkulosis di Indonesia. *JURNAL INTEGRASI SAINS DAN QUR'AN (JISQu)*, 2(1), 114–120.
- Pralambang, S. D., & Setiawan, S. (2021). Faktor risiko kejadian tuberkulosis di Indonesia. *Jurnal Biostatistik, Kependudukan, Dan Informatika Kesehatan*, 2(1), 5.
- Pratiwi D. D., & S. I. (2025). Tingkat Kepatuhan Minum Obat Anti Tuberkulosis (OAT) Berhubungan Terhadap Kesembuhan Pasien Tuberkulosis Paru Di Rumah Sakit Umum Daerah Rokan Hulu. *JURNAL PANDU HUSADA*, 6(3), 11–20.
- Putri I. D. M., & A. A. (2024). Model Penyebaran Tuberculosis Dengan Pengurangan Waktu Kontak Dan Vaksinasi. *MATHunesa: Jurnal Ilmiah Matematika*, 12(2), 311–321.
- RI, K. (2020). Tuberculosis. Pusat Data dan Informasi. *Kementerian Kesehatan Republik Indonesia*.
- Roberts, C. A., Davies, P. D. O., Blevins, K. E., & Stone, A. C. (2022). Preventable and curable, but still a global problem: Tuberculosis from an evolutionary perspective. *Palaeopathology and evolutionary medicine*, 179–203.
- Sari Desty Gusti, R. I., & Resultanti, R. (2022). Abses Iliopsoas Akibat Tuberkulosis: Sebuah Laporan Kasus. *Jurnal Penyakit Dalam Indonesia*, 11(3), 7.
- Suryana & Nurhayati, N., I. (2021). Hubungan Antara Peran Pengawas Menelan Obat (PMO) Terhadap Kepatuhan Minum Obat Penderita TB Paru. *Indonesian Journal of Nursing Sciences and Practice*, 4(2), 93–98.
- Tilahun G. T., B. M. T. & G. Z. (2020). Stochastic model of tuberculosis with vaccination of newborns. *Advances in Difference Equations*, 1, 658.
- Yunitasari Akbar, I. B., & Nurmeliiani, R., R. (2023). Korelasi Kinerja Pengawas Menelan Obat dengan Kepatuhan Minum Obat Pasien Tuberkulosis Paru. *Bandung Conference Series: Medical Science*, 3(1), 19–24.



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