PALUWALA: Jurnal Ilmu Kesehatan
Special Issue (GICHS 2025) Pages 194-200
https://ejournal.airlangga.org/index.php/ghj
E-ISSN 3090-0239

Kepatuhan Pasien dan Efek Samping Obat Antituberkulosis: Studi Cross-Sectional di Wilayah Gorontalo

Patient Adherence and Adverse Effects Of Antituberculosis Drugs: A Cross-Sectional Study in the Gorontalo Region

Madania[1,2], Mohamad Reski Manno[2]
[1]Faculty of Pharmacy, Hasanuddin Univesity, Indonesia (Doctoral Student)
[2]Department of Pharmacy, Faculty of Sport and Health, Gorontalo State University

✉ Corresponding author: *madania.tulsyahra@ung.ac.id*

Article info

Article history:
Received: 25 Agustus 2025
Revised: 1 September 2025
Accepted: 29 September 2025
Online: 29 September 2025

*Corresponding author
Madania, Department of Pharmacy, Faculty of Sport and Health, Gorontalo State University
E-Mail: *madania.tulsyara@ung.ac.id*

Abstrak

Tuberkulosis (TB) masih menjadi tantangan kesehatan masyarakat global, terutama di Indonesia, yang menempati peringkat ketiga negara dengan beban TB tertinggi di dunia. Penelitian ini bertujuan untuk menggambarkan kepatuhan pasien dan insidensi efek samping obat anti-TB (OAT) di wilayah Gorontalo. Desain potong lintang digunakan dengan melibatkan 259 pasien TB dari 11 puskesmas yang menjalani pengobatan Kategori I dan II. Data dikumpulkan menggunakan observasi langsung, Skala Kepatuhan Obat Morisky (MMAS-8), dan laporan mandiri pasien tentang reaksi obat yang merugikan. Hasil penelitian menunjukkan bahwa 82,24% pasien menunjukkan kepatuhan yang tinggi, meskipun lebih dari 30% mengalami efek samping seperti malaise, mual, sakit kepala, dan pusing. Mayoritas pasien berjenis kelamin perempuan, berusia produktif, berpendidikan menengah, dan bekerja di sektor informal. Meskipun efek samping cukup tinggi, efektivitas strategi DOTS dan dukungan sosial yang kuat tampaknya berkontribusi terhadap kepatuhan yang tinggi. Temuan ini menyoroti pentingnya edukasi, pemantauan efek samping, dan pendekatan berbasis komunitas untuk meningkatkan luaran pengobatan TB.

Kata Kunci: *Tuberkulosis_Kepatuhan Minum Obat_Reaksi Obat yang Tidak Diinginkan_Gorontalo.*

Abstract

Tuberculosis (TB) remains a global public health challenge, especially in Indonesia, which ranks third among countries with the highest TB burden worldwide. This study aims to describe patient adherence and the incidence of adverse effects from anti-TB drugs (ATDs) in the Gorontalo region. A cross-sectional design was employed involving 259 TB patients from 11 primary health centers undergoing Category I and II treatment. Data were collected using direct observation, the Morisky Medication Adherence Scale (MMAS-8), and patient self-reports of adverse drug reactions. The results showed that 82.24% of patients demonstrated high adherence, although more than 30% experienced side effects such as malaise, nausea, headache, and dizziness. The majority of patients were female, of productive age, had secondary-level education, and worked in informal sectors. Despite the prevalence of side effects, the effectiveness of the DOTS strategy and strong social support appeared to contribute to high adherence. These findings highlight the importance of education, side-effect monitoring, and community-based approaches to improve TB treatment outcomes.

Keywords: *Tuberculosis_Medication Adherence_Adverse Drug Reactions_Gorontalo.*

BACKGROUND

Tuberculosis (TB) remains one of the leading causes of illness and death from infectious diseases worldwide. In 2022, it was estimated that there were 10.6 million TB cases globally, with Indonesia ranking third in TB burden after India and China (World Health Organization [WHO], 2023). Although first-line TB therapies are widely available and clinically effective, treatment success is highly dependent on patient adherence to the long and rigorous therapeutic regimen, particularly in developing countries (Tola et al., 2015).

Adherence to TB treatment is a critical determinant of therapeutic success and disease transmission control. Non-adherence not only contributes to higher relapse and treatment failure rates but also increases the risk of drug resistance (multidrug-resistant TB/MDR-TB) and the economic burden on health services (Becerra et al., 2019).

Several factors influence patient adherence, including sociodemographic characteristics, disease knowledge, family support, and clinical variables such as adverse drug reactions to anti-TB medications (Ghosh et al., 2020).

Adverse effects of TB treatment—such as nausea, vomiting, joint pain, skin rash, and hepatotoxicity—are commonly reported and constitute a major source of discomfort that often leads to treatment discontinuation (Schnippel et al., 2017). A meta-analysis conducted by Mekonnen et al. (2021) revealed that patients experiencing adverse drug reactions were 2.8 times more likely to be non-adherent to treatment compared to those who did not experience such effects.

Considering the critical role of adherence in treatment success and the real challenge posed by drug-related side effects, this study aims to explore the incidence of adverse effects and the level of treatment adherence among TB patients in the Gorontalo region. This investigation is expected to contribute to a more patient-centered approach in TB treatment and strengthen the local implementation of the DOTS (Directly Observed Treatment Short-course) strategy.

METHODS

This study employed a descriptive-analytic design with a cross-sectional approach, aiming to explore the incidence of adverse effects and treatment adherence among tuberculosis (TB) patients in the Gorontalo region. Data were collected from primary healthcare centers (Puskesmas) located in the administrative areas of Gorontalo City, Gorontalo Regency, Bone Bolango Regency, and Boalemo Regency. The primary data source comprised TB patients undergoing Category I and II treatment protocols according to the DOTS (Directly Observed Treatment Short-course) strategy across 11 Puskesmas.

Primary data were systematically obtained from each Puskesmas, focusing on two main variables:

1. Patient adherence to anti-TB therapy, measured using standard instruments such as the Morisky Medication Adherence Scale (MMAS-8) and direct observation by healthcare workers.
2. Adverse drug reactions (ADRs) reported by patients during the course of TB treatment.

Data were analyzed descriptively to illustrate the frequency distribution of adherence levels and the types of adverse effects experienced. Narrative synthesis was conducted to provide an integrated depiction of patient adherence and drug-related side effects.

All included studies had received prior ethical approval from their respective educational institutions. Data collection was conducted with informed consent and assurance of patient confidentiality. In this secondary analysis, data were reprocessed without any personally identifiable information, adhering to ethical standards for secondary research.

RESULTS AND DISCUSSION

Characteristics of TB Patients

1. Characteristics Based on Gender

Table 1. Gender Distribution of TB Respondents

Gender	Frequency	Percentage
Male	122	47.10%
Female	137	52.90%
Total	259	100%

Table 1 shows that the majority of respondents were female, totaling 137 individuals (52.90%), while male respondents amounted to 122 individuals (47.10%). Although this percentage difference may appear small, the predominance of female patients warrants attention from sociocultural, physiological, and epidemiological perspectives. Women, particularly those in rural areas or with dominant domestic roles, tend to interact more frequently with primary healthcare services due to their responsibilities in reproduction and family health. A study from Indonesia based on the Demographic and Health Survey (IDHS 2017) and the SITT database found that women were more dominant (approximately 83%) in initiating care-seeking behavior through community-based and primary health facilities, compared to men—even though they comprised only 45% of the TB cases recorded in the national system (Dare et al., 2017). This discrepancy is attributed to women's domestic roles and their engagement with local primary healthcare systems.

In many communities, women bear a dual burden as caregivers and supplemental income earners. This condition increases their exposure to active TB through interactions in informal work environments, densely populated settlements, and multigenerational households. Moreover, poor nutritional status due to unequal access to food also contributes to women's vulnerability to TB (Gupta et al., 2021). A review in Pulmonology (2018) highlights that biological differences, particularly in hormones and immune system responses, result in distinct clinical outcomes and TB progression between men and women. These factors explain why women in certain age groups are more likely to develop active TB, even though the overall prevalence remains higher among men (Yang & Krishnan, 2018).

The dominance of women among TB patients in Gorontalo reflects an intersectional issue—blending biological, social, economic, and cultural factors. This finding aligns with global literature, which suggests that the increase in female

Special Issue (GICHS 2025) Pages 194-200
https://ejournal.airlangga.org/index.php/ghj
E-ISSN 3090-0239

representation in TB treatment data does not solely indicate higher incidence, but also reflects women's involvement in healthcare systems, social perceptions of disease, and more structured case-reporting mechanisms among female populations.

2. Characteristics Based on Age

Table 2. Age of TB Respondents

Age Group	Frequency	Percentage
≤ 20 years	21	8.11%
20–35 years	93	35.91%
36–50 years	84	32.43%
> 50 years	61	23.55%
Total	259	100%

Based on the data in Table 2, the age distribution of TB patients in Gorontalo shows that the most common age group falls within the 20–35 year range, totaling 93 individuals (35.91%), followed by those aged 36–50 years with 84 individuals (32.43%). Patients over the age of 50 accounted for 61 individuals (23.55%), while those under 20 years old represented the smallest group, with only 21 individuals (8.11%). This distribution illustrates that TB most frequently occurs among individuals in the productive age group.

The 20–50 age group is considered the productive age during which individuals are generally active both socially and economically. This increases the frequency of interactions in external environments, including workplaces and public transportation, thereby heightening the risk of TB transmission. According to the World Health Organization (WHO), individuals of productive age are at greater risk of active TB due to higher exposure to infectious TB cases (WHO, 2023). People in this age group often experience occupational stress, fatigue, and unhealthy lifestyles, such as smoking or alcohol consumption, which can weaken the immune system and increase the risk of latent TB activation. A study by Marais et al. (2020) revealed that oxidative stress and depression among the productive age group are positively correlated with the development of active TB, particularly in developing countries. Most TB patients aged 20–50 come from lower-middle socioeconomic backgrounds and live in densely populated housing with poor ventilation. These conditions facilitate the transmission of Mycobacterium tuberculosis among household members or within crowded communities (Wingfield et al., 2014).

The younger age group (<20 years) and the elderly (>50 years) are often underdiagnosed in a timely manner. In children and adolescents, TB symptoms tend to be less specific, whereas in the elderly, comorbidities frequently obscure the diagnosis. This leads to underreporting of TB in these two age groups, even though the actual incidence may be higher (Gie, 2019).

3. Characteristics Based on Educational Level

Table 3. Educational Level of TB Respondents

Education Level	Frequency	Percentage
Elementary School	32	12.36%
Junior High School	90	34.75%
Senior High School	98	37.84%
Diploma/Bachelor (D3/S1)	25	9.65%
No Schooling	14	5.41%
Total	259	100%

Table 3 shows that out of a total of 259 tuberculosis (TB) respondents in the Gorontalo region, the majority had completed senior high school (37.84%) and junior high school (34.75%). This indicates that over 70% of respondents came from the secondary education group. Respondents with only elementary education amounted to 32 individuals (12.36%), while those with no formal education totaled 14 individuals (5.41%). Only a small portion had higher education (associate or undergraduate degree), comprising 25 individuals (9.65%).

Educational level plays a vital role in shaping public health knowledge and behavior. Individuals with low education tend to have limited understanding of TB transmission, early symptoms, and the importance of completing treatment. A study by Hoa et al. (2011) indicated that low health literacy is closely linked to delays in TB diagnosis and treatment in developing countries. Health information access inequality frequently occurs among low-educated populations, particularly in remote areas or regions with limited healthcare infrastructure. These groups are less likely to receive health education through print, digital media, or formal health campaigns (Van den Hof et al., 2016). This contributes to the high TB burden among individuals with junior and senior high school education, reflecting the average education level in the study area. Those with higher education (D3/S1) tend to exhibit more proactive health-seeking behavior and greater awareness of TB screening. Thus, although fewer in number, this group is more likely to receive prompt treatment and achieve higher recovery rates (Chang et al., 2014).

Most TB patients in Gorontalo come from lower-middle educational backgrounds. This finding is consistent with literature emphasizing education as a key social determinant in the control of infectious diseases. Community-based educational interventions are strongly recommended to enhance health awareness and improve TB treatment adherence among high-risk groups.

4. Characteristics Based on Occupation

Table 4. Occupation of TB Respondents

Occupation	Frequency	Percentage
Housewife	72	27.8%
Farmer	51	19.69%
Merchant	39	15.06%
Student	28	10.81%
Laborer	21	8.11%
Civil Servant (ASN)	17	6.57%
Entrepreneur	12	4.63%
Unemployed	10	3.86%
Others	9	3.47%
Total	259	100%

Table 4 presents the occupational distribution of 259 TB patients analyzed from 11 undergraduate theses. The data indicate that the majority of patients were housewives (27.8%), followed by farmers (19.7%) and traders (15.1%). Meanwhile, other occupational groups such as students, laborers, civil servants, entrepreneurs, and the unemployed had lower proportions, each below 11%.

The high number of TB patients among housewives suggests that TB transmission is not limited to active workplaces but also occurs in domestic settings. Women in this role often have limited access to health information, healthcare services, and early detection. A study by Huaman et al. (2019) found that women working in the informal sector or those unemployed are more vulnerable to TB infection due to the dual role of caregiving and economic constraints.

A total of 51 respondents (19.7%) worked as farmers and 39 (15.1%) as traders. These occupations are at high risk due to poor environmental exposure, inadequate nutrition, and limited access to primary healthcare services. This is consistent with research by Oga-Omenka et al. (2020), which found that informal sector workers such as farmers and traders have a higher prevalence of TB compared to formal sector workers due to income instability and limited health insurance coverage.

These findings have significant implications for the development of community-based TB intervention strategies. Education and early detection programs should target households, agricultural communities, and informal work environments. Primary healthcare services must strengthen active screening among these vulnerable occupational groups to improve early detection and expedite treatment.

Tuberculosis Patient Compliance

Table 5. Treatment Adherence Level

Adherence	Frequency	Percentage
High	213	82.24%
Moderate	42	16.22%
Low	4	1.54%
Total	259	100.00%

Table 5 shows that out of a total of 259 tuberculosis (TB) patients in Gorontalo, the majority demonstrated a high level of treatment adherence, with 213 individuals (82.24%) categorized as highly adherent. A total of 42 patients (16.22%) had a moderate adherence level, while only 4 individuals (1.54%) were classified as having low adherence. These findings indicate that most patients have been following treatment guidelines appropriately, although a small proportion still requires closer attention.

One of the main factors influencing patient adherence to TB therapy is the occurrence of adverse drug reactions (ADRs) such as nausea, vomiting, itching, and joint pain. Research by Djochie et al. (2023) reported that ADRs to first-line anti-TB drugs significantly reduce adherence, with risk factors including female gender, older age, HIV status, and alcohol use. Similarly, a study in South Africa by Tzelios et al. (2025) found that patients who experienced moderate to severe ADRs—especially those with HIV or substance use—were more likely to skip doses and showed lower overall adherence. However, Sant'Anna et al. (2023) found that despite over 78% of patients experiencing ADRs, their perception of the benefits of treatment was a strong motivator in maintaining full adherence.

The presence of social support from family and healthcare providers plays a crucial role in maintaining patient motivation to remain adherent. The WHO (2023) reports that community-based interventions, directly observed

therapy (DOT), and ongoing counseling significantly improve adherence, especially in developing countries with a high TB burden.

Patients' understanding of the importance of completing therapy also significantly affects adherence. A study by Gebremariam et al. (2016) concluded that patients with good knowledge of the consequences of incomplete TB treatment were more likely to adhere to their therapy compared to those with limited understanding.

Side Effects of TB Treatment

Table 6. Frequency Distribution of Anti-Tuberculosis Drug Side Effects

Type of Side Effect	Experienced Side Effect (n)	Experienced Side Effect (%)	Did Not Experience Side Effect (n)	Did Not Experience Side Effect (%)
Nausea	85	32.8%	174	67.2%
Vomiting	60	23.2%	199	76.8%
Anorexia	52	20.1%	207	79.9%
Abdominal Pain	64	24.7%	195	75.3%
Red-colored Urine	69	26.6%	190	73.4%
Constipation	31	12.0%	228	88.0%
Numbness	56	21.6%	203	78.4%
Drowsiness	70	27.0%	189	73.0%
Fever	58	22.4%	201	77.6%
Headache	78	30.1%	181	69.9%
Malaise	92	35.5%	167	64.5%
Itching	40	15.4%	219	84.6%
Joint Pain	49	18.9%	210	81.1%
Dizziness	74	28.6%	185	71.4%

Table 6 presents the frequency distribution of side effects experienced by 259 TB patients during their treatment with anti-tuberculosis drugs. The data show that several side effects are quite commonly reported, potentially influencing patient adherence to long-term therapy.

The most frequently reported side effects were malaise (35.5%), nausea (32.8%), headache (30.1%), and dizziness (28.6%). These symptoms represent systemic reactions commonly associated with first-line anti-TB drugs such as isoniazid and rifampicin, which exert mild hepatotoxic and neurotoxic effects. A study by Tola et al. (2021) also found that malaise and nausea were the most common complaints and were directly related to the discomfort experienced by patients during long-term TB therapy. In contrast, less common effects such as constipation (12.0%), itching (15.4%), and joint pain (18.9%) were reported less frequently. Nonetheless, these symptoms may still lead patients to reduce or discontinue medication, especially if not accompanied by proper education from healthcare providers. Kigozi et al. (2017) emphasized that even mild side effects can significantly impact treatment outcomes if not managed early on.

The emergence of these side effects calls for stronger patient monitoring systems and supportive interventions such as symptomatic treatment and counseling. Patient education becomes crucial to help them understand that some side effects are temporary and should not be a reason to stop treatment. The most frequently experienced side effects include malaise, nausea, headache, and dizziness. Early recognition of side effects and strengthening of medical and psychosocial support are vital for maintaining treatment continuity and ensuring TB therapy success.

The majority of TB patients were female (52.9%) and in the productive age group of 20–50 years (68.3%). This group was also dominated by individuals with secondary education (junior and senior high school) and informal occupations such as housewives, farmers, and traders. These characteristics reflect a social condition structurally vulnerable to delayed diagnosis and reduced quality of TB care due to limited access to healthcare, low health literacy, and economic pressures. Previous studies have confirmed that women and individuals with lower educational backgrounds often face more barriers in TB treatment, ranging from stigma to a lack of social and economic support.

Although the overall adherence rate among patients was high (82.24%), data revealed that over 30% experienced side effects such as malaise, nausea, headache, and dizziness—all of which have the potential to reduce comfort and motivation to complete therapy. These symptoms are commonly associated with the use of isoniazid, rifampicin, and ethambutol in standard TB regimens. Mekonnen et al. (2021) reported that patients who experienced side effects were nearly three times more likely to be non-adherent to TB treatment. However, in the context of Gorontalo, the ability to maintain a high adherence rate is likely influenced by the implementation of the DOTS (Directly Observed Treatment Short-course) strategy in primary health centers, health education from healthcare workers, and strong social pressure within the community to ensure TB recovery. Effective social support, direct observation, and strong communication

between healthcare providers and patients serve as protective factors against non-adherence even in the face of bothersome side effects.

CONCLUSION

This study reveals that despite most TB patients in Gorontalo experiencing side effects from anti-TB drugs, adherence to treatment remains high. This reflects the success of educational interventions and treatment monitoring at the primary care level, as well as the critical role of social support in sustaining treatment continuity.

RECOMMENDATIONS

Based on the findings, healthcare providers are encouraged to enhance education on anti-TB drug side effects and emphasize the importance of adherence from the beginning of therapy. The DOTS program should be strengthened through personalized approaches and family support, particularly for vulnerable groups such as women and informal workers. Community-based accompaniment is also essential to sustain therapy and prevent treatment dropout.

ACKNOWLEDGEMENTS

The authors express sincere gratitude to all individuals who contributed to this research. Special thanks are extended to the Health Office and primary healthcare staff in the Gorontalo region for their support and access to TB patient data. Appreciation is also directed to the TB patients who willingly participated and shared valuable insights for the advancement of knowledge and health services.

REFERENCES

Becerra, M. C., Swaminathan, S., & Harausz, E. P. (2019). Death or survival from tuberculosis: How can we improve outcomes?. *International Journal of Infectious Diseases*, 80, 6–8. https://doi.org/10.1016/j.ijid.2018.12.005

Chang, S. H., & Cataldo, J. K. (2014). A systematic review of global cultural variations in knowledge, attitudes and health responses to tuberculosis stigma. *International Journal of Tuberculosis and Lung Disease*, 18(2), 168–173. https://doi.org/10.5588/ijtld.13.0181

Dale, K., Tay, E., Trauer, J. M., Trevan, P., & Denholm, J. M. (2017). Gender differences in tuberculosis diagnosis, treatment and outcomes in Victoria, Australia, 2002–2015. *International Journal of Tuberculosis and Lung Disease*, 21(12), 1264–1271. https://doi.org/10.5588/ijtld.17.0338

Djochie, R. D. A., Anto, B. P., & Opare Addo, M. N. A. (2023). Determinants of adverse reactions to first-line antitubercular medicines: a prospective cohort study. *Journal of Pharmaceutical Policy and Practice, 16, Article 70.* https://doi.org/10.1186/s40545-023-00577-6

Gebremariam, M. K., Bjune, G. A., & Frich, J. C. (2016). Barriers and facilitators of adherence to TB treatment in patients on concomitant TB and HIV treatment: a qualitative study. *BMC Public Health*, 16(1), 1-10. https://doi.org/10.1186/s12889-016-2923-8

Ghosh, S., Choudhury, S., & Dey, S. (2020). Treatment adherence and its barriers among tuberculosis patients in India: A narrative review. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, 21, 100213. https://doi.org/10.1016/j.jctube.2020.100213

Gie, R. P. (2019). Diagnostic challenges in childhood tuberculosis. *Paediatric Respiratory Reviews*, 29, 37–42. https://doi.org/10.1016/j.prrv.2018.10.004

Gupta, A., Kinikar, A., Valvi, C., Bhosale, R., Gupte, N., Bharadwaj, R., ... & Bollinger, R. C. (2021). Nutritional status of HIV-infected children and TB co-infection in India: a cohort study. *BMC Infectious Diseases*, 21, 1035. https://doi.org/10.1186/s12879-021-06693-4

Hoa, N. P., Chuc, N. T. K., & Thorson, A. (2011). Knowledge, attitudes, and practices about tuberculosis and choice of communication channels in a rural community in Vietnam. *Health Policy*, 98(2-3), 146–152. https://doi.org/10.1016/j.healthpol.2010.06.015

Huaman, M. A., Henson, D. E., Ticona, E., Sterling, T. R., & Garvy, B. A. (2019). Tuberculosis and gender-based differences: Understanding the role of woman as caregivers and patients. *PLoS ONE*, 14(5), e0216369. https://doi.org/10.1371/journal.pone.0216369

Kigozi, N. G., Heunis, J. C., Engelbrecht, M. C., Janse van Rensburg, A. P., & van Rensburg, H. C. J. (2017). Tuberculosis patients' reasons for non-adherence to anti-TB treatment in the Free State Province of South Africa. *South African Journal of Infectious Diseases*, 32(4), 127–132. https://doi.org/10.4102/sajid.v32i4.116

Marais, B. J., et al. (2020). Tuberculosis comorbidity with communicable and non-communicable diseases. *European Respiratory Journal*, 56(1), 2001328.

Mekonnen, H. S., Azagew, A. W., & Wubneh, C. A. (2021). Prevalence and associated factors of non-adherence to anti-tuberculosis treatment in Ethiopia: A systematic review and meta-analysis. *Tropical Medicine and Health*, 49(1), 1–12. https://doi.org/10.1186/s41182-021-00310-z

Neyrolles, O., & Quintana-Murci, L. (2009). Sexual inequality in tuberculosis. *PLoS Medicine*, 6(12), e1000199. https://doi.org/10.1371/journal.pmed.1000199

Oga-Omenka, C., Ogbuabor, D. C., & Uzochukwu, B. S. (2020). Socioeconomic determinants of tuberculosis prevalence in sub-Saharan Africa: Evidence from Nigeria. *BMC Public Health*, 20(1), 1258. https://doi.org/10.1186/s12889-020-09347-w

Sant'Anna, F. M., Araújo Pereira, M., Schmaltz, C. A. S., Arriaga, M. B., Andrade, B. B., & Rolla, V. C. (2023). Impact of adverse drug reactions on the outcomes of tuberculosis treatment. *PLOS ONE*, 18(2), e0269765. https://doi.org/10.1371/journal.pone.0269765

Schnippel, K., Firnhaber, C., Berhanu, R., Page-Shipp, L., Sinanovic, E., & Long, L. (2017). Adverse drug reactions during second-line TB treatment in South Africa: a prospective cohort study. *BMC Infectious Diseases*, 17(1), 593. https://doi.org/10.1186/s12879-017-2685-2

Tola, H. H., Shojaeizadeh, D., Garmaroudi, G., Tol, A., & Yekaninejad, M. S. (2021). Psychological and educational intervention to improve tuberculosis treatment adherence in Ethiopia based on Health Belief Model: A cluster randomized control trial. *PloS one*, 11(5), e0155147. https://doi.org/10.1371/journal.pone.0155147

Tola, H. H., Tol, A., Shojaeizadeh, D., & Garmaroudi, G. (2015). Tuberculosis treatment non-adherence and lost to follow-up among TB patients with or without HIV in developing countries: a systematic review. *Iranian Journal of Public Health*, 44(1), 1–11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4441931/

Tzelios, C. A., Malatesta, S., Carney, T., White, L. F., Weber, S. E., Thomson, S., … & Farhat, M. R. (2025). Patient determinants and effects on adherence of adverse drug reactions to tuberculosis treatment: a prospective cohort analysis. *Clinical Infectious Diseases*, ciae642. https://doi.org/10.1093/cid/ciae642

Van den Hof, S., Najlis, C. A., Bloss, E., & Straetemans, M. (2016). A systematic review on the role of education in TB awareness and access to diagnosis and treatment. *International Journal of Tuberculosis and Lung Disease*, 20(9), 1129–1139.

Wingfield, T., et al. (2014). The economic effects of supporting tuberculosis-affected households in Peru. *European Respiratory Journal*, 43(3), 901–904.

World Health Organization. (2023). *Global Tuberculosis Report* 2023.

Yang, W.-t., & Krishnan, L. (2022). Gender-related barriers and delays in accessing tuberculosis diagnostic and treatment services: A systematic review. *BMC Public Health*, 22, 14419. https://doi.org/10.1186/s12889-022-14419-8