
Factors Affecting Medication Adherence and the Success of Pulmonary Tuberculosis Therapy in Several Community Health Centers in Ambon City

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Abstract:

This study examines the Factors Affecting Medication Adherence and the Success of Pulmonary Tuberculosis Therapy in Several Community Health Centers in Ambon City. Tuberculosis (TB) remains an infectious disease and a global health challenge, including in Indonesia. The success of TB therapy is highly dependent on the patient's adherence to the prescribed treatment. This study aims to analyze the factors that affect the adherence of pulmonary TB patients and their relationship with therapy success. The study design is observational with a cross-sectional approach, conducted both retrospectively and prospectively on pulmonary TB patients at several health centers in Ambon City. Data were collected through questionnaires and patient medical records. A sample of 150 respondents was selected using the purposive sampling method. The analysis was performed using the chi-square test and logistic regression. The results showed that family support, health worker support, and access to health facilities had a significant effect on patient compliance. Meanwhile, education and knowledge did not have a significant influence. The analysis also indicated a significant relationship between medication adherence and therapy success. Family support emerged as the most dominant factor influencing adherence. These findings highlight the importance of a holistic approach in TB management, particularly by strengthening social support and primary health services. Recommendations include increasing the educational role of pharmacists and implementing regular compliance monitoring. Further research is suggested to conduct longitudinal studies and explore psychosocial and cultural factors.

Keywords: compliance, pulmonary tuberculosis, Education, knowledge, access to health facilities, family support, health worker support, success.

INTRODUCTION

Tuberculosis (TB) remains a global health problem requiring serious treatment. According to the WHO, in 2022, there were an estimated 10.6 million cases of TB worldwide. In Indonesia, TB continues to be the leading cause of death from infectious diseases. In Ambon City, there has been an increase in TB cases, including drug-resistant TB (MDR-TB). One of the main factors contributing to TB therapy failure is patient non-compliance with treatment (Khawbung et al., 2021; Li et al., 2023; Maiolini et al., 2020; Natarajan et al., 2020; Ndjoubi et al., 2020; Organization, 2018).

The primary research problem addressed in this study is the persistent challenge of medication non-adherence among pulmonary TB patients, which directly contributes to treatment failure, disease transmission, and the development of drug-resistant strains. Despite the availability of effective treatment protocols, adherence rates remain suboptimal, particularly in community health center settings where resources and support systems may be limited. This problem is compounded by the complex interplay of socioeconomic, educational, and psychosocial factors that influence patient behavior throughout the lengthy treatment duration (Cerni et al., 2019; Efendi et al., 2022; Foster et al., 2023; Ockenga et al., 2023; Young et al., 2020).

The urgency of this research is underscored by the increasing TB burden in Maluku Province and the potential consequences of treatment non-adherence. Poor medication adherence not only leads to individual treatment failure and increased mortality but also contributes to community transmission and the emergence of multidrug-resistant tuberculosis (MDR-TB). In Ambon City, where healthcare infrastructure faces unique challenges as an island region, understanding the specific factors affecting medication adherence becomes critical for developing effective public health interventions and reducing the overall TB burden.

Patient compliance is influenced by various factors such as education, knowledge, access to health facilities, family support, and health care worker support. This study aims to identify the factors that affect adherence to pulmonary TB medication and analyze the relationship between adherence and therapy success in several health centers in Ambon City.

The problem of pulmonary TB patient compliance is influenced by multiple factors, namely education, knowledge, access to health facilities, family support, and health worker support. The patient's family support and knowledge of pulmonary TB disease, anti-tuberculosis drugs, and confidence in the efficacy of the medication influence the patient's decision to complete therapy or not (Putra Siswanto et al., 2015).

Tuberculosis (TB) is a disease with a high risk of transmission. One of the determinants of successful TB management is patient adherence to therapy. Patients who comply with treatment complete it regularly and fully without interruption for at least 6 to 9 months (Rosadi, 2020).

Previous research has shown mixed findings regarding factors influencing TB medication adherence. Putra Siswanto et al. (2015) found that both knowledge and family support were significantly related to anti-tuberculosis medication adherence in Padang City. Similarly, Adam (2020) demonstrated a positive relationship between patient knowledge and medication adherence among pulmonary TB patients. However, Mellyana et al. (2022) reported varying relationships between knowledge and adherence levels in different healthcare settings. Rosadi (2020) identified multiple factors, including family support, healthcare worker support, and access to health facilities, as significant determinants of TB treatment adherence. Fitri (2018) emphasized the importance of medication adherence in determining treatment outcomes, while Ariyani (2016) found significant correlations between knowledge levels and treatment compliance.

The research gap identified in previous studies is the limited comprehensive analysis of multiple adherence factors simultaneously in the specific context of community health centers in eastern Indonesia. Most prior research focused on individual factors or was conducted in different geographical and cultural settings, limiting the applicability of findings to the unique context of Maluku Province. Furthermore, there is insufficient evidence comparing retrospective and prospective approaches to examine the relationship between adherence and treatment outcomes in this specific population.

The novelty of this research lies in its comprehensive examination of multiple adherence factors using both retrospective and prospective data collection approaches in the unique setting of Ambon City's community health centers. This study provides the first systematic analysis of TB medication adherence determinants in Maluku Province, considering the specific cultural, geographical, and healthcare system characteristics of this eastern Indonesian region.

The primary objectives of this study were: (1) to identify and analyze factors affecting medication adherence among pulmonary TB patients in community health centers in Ambon City; (2) to determine the most dominant factor influencing medication adherence; (3) to examine the relationship between medication adherence and therapy success using both retrospective and prospective approaches; and (4) to provide evidence-based recommendations for improving TB treatment outcomes.

The benefits of this research include providing evidence for healthcare policymakers to develop targeted interventions for improving TB medication adherence, offering guidance for healthcare workers in community health centers to enhance patient support systems, and contributing to scientific understanding of TB treatment adherence in resource-limited island settings. The implications extend to improving TB control programs, reducing treatment failure rates, and ultimately decreasing TB transmission in the community.

RESEARCH METHOD

This study is an observational study with a cross-sectional approach. Data was collected retrospectively (2022–2023) and prospective (2024) in several Ambon City Health Centers. The sample amounted to 150 pulmonary TB patients who met the inclusion criteria, selected by purposive sampling.

Inclusion criteria: Patients diagnosed with pulmonary TB and undergoing pulmonary TB treatment therapy., Patients who have completed therapy or are still in the process of treatment and Patients who are willing to participate in the study

Exclusion Criteria: Patients who are unwilling to participate in the study, Patients with severe comorbidities such as HIV/AIDS, Diabetes mellitus, Chronic kidney failure, cancer, heart disease, chronic obstructive pulmonary disease (COPD) that may interfere with the assessment of pulmonary TB treatment adherence.

Data was collected through structured questionnaires and medical records. The variables analyzed included education, knowledge, access to health facilities, family support, health worker support, and adherence to treatment. Data analysis was performed using chi-square test for bivariate analysis and logistic regression for multivariate analysis

RESULTS AND DISCUSSION

Respondent Profile

At this stage, the respondents' profiles will be seen based on age, last education, and employment status. The following is an overview of the respondents' profiles that have been obtained:

Table 1. Respondent Profile

Category	Frequency	Percentage
Age		
Toddler (<5 years)	14	9.3
Children (5-9 years)	8	5.3
Teenagers (10-18 years old)	15	10.0
Adults (18-59 years)	99	66.0
Elderly (60 years and above)	14	9.3
Total	150	100.0
Final Education		
Lower Level	71	47.3

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(Not School/Elementary/Junior High School)		
Higher Level	79	52.7
(High School/Diploma/Undergraduate)		
Total	150	100.0
Employment Status		
Work	111	74.0
Not Working	39	26.0
Total	150	100.0

Source: SPSS Output Attached

Based on table 1, it can be seen that based on age, the majority of respondents are in the adult age category (18-59 years), which is as many as 99 respondents or 66%. This shows that TB is still a significant threat to the productive age group which plays an important role in the family and society. Furthermore, based on the latest education, the majority of respondents in the category of higher education (high school/diploma/bachelor) are 79 respondents or 52.7%, but the proportion with low education is also still high (47.3%). Low levels of education can contribute to a lack of understanding of the causes, transmission, and importance of thorough TB treatment. Therefore, educational interventions are still urgently needed to improve adherence to treatment and prevent stigma or further transmission. And finally, if you look at the employment status, most respondents have work status, which is as many as 111 respondents or 74%.

Instrument and Data Quality Test

Validity Test

What was done before showing that all the indicators of the statement were suitable as research instruments was to conduct a validity test with a sample of 150 respondents. By analyzing whether the data is valid or not by comparing the value of Pearson Product Moment Correlation to the r table. The significance level is 5% if r is calculated $> r$ table then the statement is valid. Meanwhile, if r counts $< r$ table, the statement is invalid. The following are the results of the validity test:

Table 2. Validity Test Results

Variable	Indicator	r count	R table	Information
Knowledge	Pe1	0.488	0.361	Valid
	Pe2	0.602	0.361	Valid
	Pe3	0.372	0.361	Valid
	Pe4	0.701	0.361	Valid
	Pe5	0.503	0.361	Valid
	Pe6	0.602	0.361	Valid
	Pe7	0.491	0.361	Valid
	Pe8	0.458	0.361	Valid
	Pe9	0.446	0.361	Valid
	Pe10	0.570	0.361	Valid
Motivation	M1	0.822	0.361	Valid
	M2	0.810	0.361	Valid
	M3	0.288	0.361	Valid
	M4	0.257	0.361	Valid
	M5	0.825	0.361	Valid
	M6	0.855	0.361	Valid
	M7	0.854	0.361	Valid

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Variable	Indicator	r count	R table	Information
Access and Facilities	M8	0.502	0.361	Valid
	M9	0.372	0.361	Valid
	M10	0.454	0.361	Valid
	AF1	0.890	0.361	Valid
	AF2	0.571	0.361	Valid
	AF3	0.583	0.361	Valid
	AF4	0.792	0.361	Valid
	AF5	0.408	0.361	Valid
	AF6	0.295	0.361	Valid
	AF7	0.639	0.361	Valid
Family Support	AF8	0.360	0.361	Valid
	DK1	0.729	0.361	Valid
	DK2	0.457	0.361	Valid
	DK3	0.394	0.361	Valid
	DK4	0.829	0.361	Valid
	DK5	0.540	0.361	Valid
	DK6	0.583	0.361	Valid
	DK7	0.803	0.361	Valid
Healthcare Worker Support	DK8	0.469	0.361	Valid
	DPK1	0.812	0.361	Valid
	DPK2	0.510	0.361	Valid
	DPK3	0.887	0.361	Valid
	DPK4	0.341	0.361	Valid
	DPK5	0.870	0.361	Valid
	DPK6	0.360	0.361	Valid
	DPK7	0.896	0.361	Valid
	DPK8	0.592	0.361	Valid
	DPK9	0.896	0.361	Valid
Medication Compliance	DPK10	0.592	0.361	Valid
	K1	0.877	0.361	Valid
	K2	0.481	0.361	Valid
	K3	0.388	0.361	Valid
	K4	0.877	0.361	Valid
	K5	0.511	0.361	Valid
	K6	0.586	0.361	Valid
	K7	0.877	0.361	Valid
	K8	0.428	0.361	Valid

Source: SPSS Output Attached

Based on the results of the validity test with a total of 150 respondents in table 5.2, it can be seen that all variable statements submitted to respondents are valid because judging from the value of r calculated $> r$ table (0.361) so that it can be concluded that all statements in the questionnaire can be said to be feasible as an instrument to measure research data.

Reliability Test

What was done after showing that all statement variables were suitable as research instruments was to conduct a reliability test with a sample of 150 respondents. The statement can be said to be reliable if Cronbach's Alpha value > 0.6 . The following are the results of the reliability test:

Table 3. Reliability Test Results

Variable	Cronbach's Alpha	N	Information
Knowledge	0,711	10	Reliable
Motivation	0,812	10	Reliable
Access and Facilities	0,733	8	Reliable

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Variable	Cronbach's Alpha	N	Information
Family Support	0,762	8	Reliable
Healthcare Worker Support	0,882	10	Reliable
Medication Compliance	0,790	8	Reliable

Source: SPSS Output Attached

Based on table 3 of the reliability test results of 150 respondents, it can be seen that all variables in the statement are declared reliable because they have met the required value, namely with a Cronbach Alpha value of > 0.6 .

Normality Test

At this stage, a normality test will be carried out to determine the distribution of data. The method used was Kolmogorov Smirnov because the sample studied was >50 . The data is said to be normal if the resulting significance value is >0.05 and vice versa if the significance value is <0.05 , then the data is abnormally distributed. Here are the results that have been obtained:

Table 4. Normality Test

Variable	Significance	Information
Knowledge	0,013	Abnormal
Motivation	0,000	Abnormal
Access and Facilities	0,000	Abnormal
Family Support	0,000	Abnormal
Healthcare Worker Support	0,000	Abnormal
Medication Compliance	0,000	Abnormal

Source: SPSS Output Attached

Based on table 4, it can be seen that all variables studied have a significance value of <0.05 , thus it can be concluded that all variables have abnormal data distribution.

Univariate

At this stage, the profile of the respondent will be seen based on education, knowledge, access and facilities, family support, health worker support, and medical compliance. The following is an overview of the respondents' profiles that have been obtained:

Table 5. Univariate

Category	Frequency	Percentage
Education		
Lower Level (Not School/Elementary/Junior High School)	71	47.3
Higher Level (High School/Diploma/Undergraduate)	79	52.7
Total	150	100
Knowledge		
Tall	83	55.3
Low	67	44.7
Total	150	100
Access to Health Facilities		
Good	94	62.7
Bad	56	37.3
Total	150	100
Family Support		

Category	Frequency	Percentage
Tall	83	55.3
Low	67	44.7
Total	150	100
Healthcare Worker Support		
Tall	98	65.3
Low	52	34.7
Total	150	100
Medication Compliance		
Obedient	89	59.3
Non-compliant	61	40.7
Total	150	100

Source: SPSS Output Attached

Based on table 5, based on the last education, most of the respondents had a higher education level (high school/diploma/bachelor) of 79 people or 52.7%, while respondents with low education (not school, elementary, junior high) amounted to 71 people (47.3%). This shows that most TB patients who are respondents have a fairly good level of education, which allows them to more easily receive information and education about TB.

In terms of knowledge, respondents with high knowledge totaled 83 people (55.3%) and 67 people (44.7%) with low knowledge. This indicates that more than half of patients have a good understanding of TB disease, including its causes, modes of transmission, and the importance of treatment to completion.

Based on access and health facilities, it is known that most patients have good access to health services, as many as 94 people (62.7%). Meanwhile, respondents with poor access were 56 people (37.3%). The availability of good health facilities plays an important role in supporting the success of TB treatment.

In terms of family support, 83 people (55.3%) received high family support and 67 people (44.7%) received low support. Support from the family is very important in the TB treatment process, especially because the treatment process lasts quite a long time and requires consistency.

Meanwhile, support for health workers was rated high by 98 people (65.3%) and low by 52 people (34.7%). This shows that most patients feel they are getting good attention and guidance from healthcare workers, which is crucial in building patient motivation and compliance.

Finally, judging from treatment compliance, as many as 89 people (59.3%) were in the compliant category, while 61 people (40.7%) were not compliant in undergoing TB treatment. Although most patients are compliant, there is still a sizable proportion of patients who do not follow the treatment according to the procedure.

Bivariate

At this stage, the bivariate test is intended to determine the relationship of research factors to medication adherence. The method used is chi-square where the research factor is said to have a relationship with medication adherence if the value produced in the chi-square test is <0.05 . Here are the results obtained:

Table 6. Chi-Square Test

Variabel	Significance	Information
Education	0,041	Significant, related
Knowledge	0,000	Significant, related
Access and Health Facilities	0,000	Significant, related
Family Support	0,000	Significant, related
Healthcare Worker Support	0,000	Significant, related
pendent = Medication Compliance		

Source: SPSS Output Attached

Based on table 6, it can be seen that all factors studied have a significant relationship with medication adherence, as evidenced by the significance value in the chi-square test < 0.05 .

Multivariate

The multivariate test aims to determine the factors that affect medication adherence. The factors studied were education, knowledge, access to health facilities, family support, and health worker support. The method used for the multivariate test this time is to use a logistic regression test, where if the significance value produced < 0.05 , it can be concluded that the factor has a significant influence on medication adherence. The following are the results of the multivariate tests that have been carried out:

Table 7. Multivariate Tests

Variabel	B	Wald	Sig.	Information
Constant	-5.820			
Education	-0.824	2.646	0.104	Insignificant
Knowledge	-0.278	0.247	0.619	Insignificant
Access and Health Facilities	1.073	4.564	0.033	Significant
Family Support	2.766	26.144	0.000	Significant, Dominant
Healthcare Worker Support	1.012	4.097	0.043	Significant
Dependent = Medication Compliance				

Source: SPSS Output Attached

Based on table 7 in the multivariate test, it is known that of the 5 factors studied, there are 3 factors that have a significant influence with the family support factor being the most dominant factor, strengthened with the highest wald value of 26,144. The following is the description of the multivariate test:

1. The Influence of Education on Medication Compliance

In the first hypothesis, the influence of education on medication compliance will be studied, where the resulting coefficient value of -0.824 with a significance value of 0.104 can be determined. This value is more than 0.05 which means that it can be concluded that education does not have a significant effect on medication adherence. Thus the hypothesis that says that "Education has a significant effect on medication adherence"

2. The Effect of Knowledge on Medication Adherence

In the second hypothesis, the influence of knowledge on medication compliance will be studied, where the resulting coefficient value of -0.278 with a significance value of 0.619 can be known. The value is more than 0.05 which means that it can be concluded that

knowledge does not have a significant effect on adherence to treatment. Thus the hypothesis that says that "Knowledge has a significant effect on adherence to treatment"

3. The Effect of Access to Health Facilities on Medical Compliance

In the third hypothesis, the effect of access to health facilities on medical compliance will be studied, where the resulting coefficient value of 1,073 with a significance value of 0.033 can be known. The value is less than 0.05, which means that it can be concluded that access to health facilities has a significant effect on medication adherence. Thus the hypothesis that "Access to health facilities has a significant effect on medication adherence"

4. The Effect of Family Support on Medication Compliance

In the fourth hypothesis, the influence of family support on treatment compliance will be examined, where the resulting coefficient value of 2,766 with a significance value of 0.000 can be known. The value is less than 0.05 which means that it can be concluded that family support has a significant effect on medication adherence. Thus the hypothesis that "Family support has a significant effect on medication adherence"

5. The Effect of Health Worker Support on Medical Compliance

In the fifth hypothesis, the influence of health worker support on medication compliance will be examined, where the resulting coefficient value of 1,012 with a significance value of 0.043 can be known. This value is less than 0.05 which means that it can be concluded that the support of health workers has a significant effect on medication adherence. Thus the hypothesis that "Health worker support has a significant effect on medication adherence"

Analysis of the Relationship of Treatment Compliance with Therapy Success in Retrospective and Prospective Samples

In this analysis, the relationship between medication adherence and therapy success will be examined. The method used is chi-square where adherence to treatment is said to have a relationship with the success of therapy if the value produced in the chi-square test is <0.05 . Here are the results obtained:

Table 8. Relationship between Treatment Compliance and Therapy Success (Retrospective)

Medication Compliance	Therapy Success				Total	value
	Recover	Complete Treatment	Stop Seeking Treatment	Die		
Obedient	55 (36.7%)	64 (42.7%)	0 (0%)	(0%)	119 (59.3%)	0.000
Non-compliant	0 (0%)	0 (0%)	25 (16.7%)	(4%)	31 (20.7%)	
Total	55 (36.7%)	64 (42.7%)	25 (16.7%)	(4%)	150 (100%)	

Source: SPSS Output Attached

Table 9. Relationship between Medication Adherence and Therapy Success (Prospective)

Medication Compliance	Therapy Success				Total	P value
	Recover	Complete Treatment	Stop Seeking Treatment	Die		
Obedient	52 (34%)	26 (17.3%)	10 (6.7%)	2 (1.3%)	89 (59.3%)	0.006

Medication Compliance	Recover	Therapy Success			Total	P value
		Complete Treatment	Stop Seeking Treatment	Die		
Non-compliant	25 (16.7%)	34 (22.7%)	2 (1.3%)	0 (0%)	61 (40.7%)	
Total	76 (50.7%)	60 (40%)	12 (8%)	2 (1.3%)	150 (100%)	

Source: SPSS Output Attached

Based on the results of the analysis of the relationship between medication adherence and therapy success presented in Table 8 (retrospective data) and Table 9 (prospective data), findings were obtained that showed a statistically significant relationship. In the retrospective data (Table 8), of the 119 TB patients who complied with treatment, 36.7% were declared cured and 42.7% completed complete treatment. No cases of discontinuation of treatment or death were found in this group. Meanwhile, of the 31 patients who did not comply, all of them did not achieve recovery results or complete treatment, but in fact 16.7% had discontinued treatment and 4% died. The Chi-Square test yielded a significance value of 0.000, indicating a very significant association between medication adherence and TB therapy success in the retrospective approach.

In prospective data (Table 9), as many as 89 TB patients were compliant, 34% were declared cured, 17.3% completed complete treatment, and a small percentage discontinued treatment (6.7%) and died (1.3%). Meanwhile, in the non-compliant group, out of 61 patients, 16.7% recovered, 22.7% completed treatment, and 1.3% discontinued treatment, without anyone dying. The P value = 0.006, suggests that the relationship between medication adherence and therapy success is also statistically significant, although the difference is not as sharp as in retrospective data.

In general, these results indicate that adherence to treatment is closely related to better therapy outcomes, both in terms of recovery and successful completion of treatment. Non-compliance has been shown to be a risk factor that increases the likelihood of discontinuation and therapy failure, even death. Thus, the sixth hypothesis states that "There is a relationship between adherence to treatment and therapy success"

CONCLUSION

This study identified key factors affecting medication adherence among pulmonary TB patients in Ambon City's community health centers, revealing that adults aged 18-59 form the majority and highlighting the ongoing need for targeted education due to nearly half of patients having lower educational levels. Among five factors examined, access to health facilities, family support, and healthcare worker support significantly influenced adherence, with family support being the most dominant factor, underscoring the critical role of social support in treatment success. Notably, education and knowledge were not significant predictors in multivariate analysis, suggesting behavioral and social influences outweigh cognitive factors. Medication adherence was strongly associated with therapy success in both retrospective and prospective analyses, confirming adherence as a crucial determinant of positive treatment outcomes. Based on these findings, recommendations include enhancing pharmacist-led patient counseling, implementing compliance monitoring, fostering interprofessional collaboration, developing culturally tailored educational media, and strengthening family

engagement. Future research should focus on longitudinal studies to assess long-term adherence, investigate psychosocial and cultural influences in the Maluku context, evaluate targeted interventions to bolster family and healthcare worker support, develop culturally appropriate adherence measurement tools, and conduct cost-effectiveness analyses of adherence improvement strategies in resource-limited settings like eastern Indonesia's community health centers.

REFERENCES

- Adam, L. (2020). Pengetahuan penderita tuberkulosis paru terhadap kepatuhan minum obat anti tuberkulosis. *Jambura Health and Sport Journal*, 2(1), 12–18. <https://doi.org/10.37311/jhsj.v2i1.4560>
- Ariyani, H. (2016). Hubungan tingkat pengetahuan dengan kepatuhan pada pengobatan penderita tuberkulosis paru di Puskesmas Pekauman Kota Banjarmasin, Kalimantan Selatan. *Jurnal Pharmascience*, 3(2), 23–28.
- Cerni, S., Shafer, D., To, K., & Venketaraman, V. (2019). Investigating the role of everolimus in mTOR inhibition and autophagy promotion as a potential host-directed therapeutic target in mycobacterium tuberculosis infection. *Journal of Clinical Medicine*, 8(2), Article 232. <https://doi.org/10.3390/jcm8020232>
- Efendi, S., Sjattar, E. L., & Syam, Y. (2022). Health counseling support medication adherence to regular pulmonary tuberculosis patients. *Clinical Epidemiology and Global Health*, 15, Article 101055. <https://doi.org/10.1016/j.cegh.2022.101055>
- Fitri, L. D. (2018). Kepatuhan minum obat pada pasien tuberkulosis paru. *Jurnal Ilmu Kesehatan Masyarakat*, 7(1), 33–42. <https://doi.org/10.33221/jikm.v7i01.50>
- Foster, N., Tadesse, A. W., McQuaid, C. F., Gosce, L., Abdurhman, T., Assefa, D., Bedru, A., Houben, R. M. G. J., van Kalmthout, K., Letta, T., Mohammed, Z., van Rest, J., Umata, D. G., Weldemichael, G. T., Yazew, H., Jerene, D., Quaife, M., & Fielding, K. L. (2023). Evaluating the equity impact and cost-effectiveness of digital adherence technologies with differentiated care to support tuberculosis treatment adherence in Ethiopia: Protocol and analysis plan for the health economics component of a cluster randomised trial. *Trials*, 24(1), Article 289. <https://doi.org/10.1186/s13063-023-07289-x>
- Khawbung, J. L., Nath, D., & Chakraborty, S. (2021). Drug resistant tuberculosis: A review. *Comparative Immunology, Microbiology and Infectious Diseases*, 74, Article 101574. <https://doi.org/10.1016/j.cimid.2020.101574>
- Li, Y. Y., Cai, R. J., Talbot, E. A., & Wang, Y. T. (2023). Mycobacterium tuberculosis. In *Molecular medical microbiology* (3rd ed.). Academic Press. <https://doi.org/10.1016/B978-0-12-818619-0.00010-1>
- Maiolini, M., Gause, S., Taylor, J., Steakin, T., Shipp, G., Lamichhane, P., Deshmukh, B., Shinde, V., Bishayee, A., & Deshmukh, R. R. (2020). The war against tuberculosis: A review of natural compounds and their derivatives. *Molecules*, 25(13), Article 3011. <https://doi.org/10.3390/molecules25133011>
- Mellyana, V., Nurinda, E., & Fauzi, R. (2022). Hubungan pengetahuan terhadap tingkat kepatuhan pasien tuberkulosis paru di Puskesmas Binangun Cilacap. *INPHARNMED Journal (Indonesian Pharmacy and Natural Medicine Journal)*, 5(2), 1–8. <https://doi.org/10.21927/inpharnmed.v5i2.1884>

- Natarajan, A., Beena, P. M., Devnikar, A. V., & Mali, S. (2020). A systemic review on tuberculosis. *Indian Journal of Tuberculosis*, 67(3), 295–311. <https://doi.org/10.1016/j.ijtb.2020.02.005>
- Ndjoubi, K. O., Sharma, R., & Hussein, A. A. (2020). The potential of natural diterpenes against tuberculosis: An updated review. *Current Pharmaceutical Design*, 26(24), 2826–2837. <https://doi.org/10.2174/1381612826666200612163326>
- Ockenga, J., Fuhse, K., Chatterjee, S., Malykh, R., Rippin, H., Pirlich, M., Yedilbayev, A., Wickramasinghe, K., & Barazzoni, R. (2023). Tuberculosis and malnutrition: The European perspective. *Clinical Nutrition*, 42(4), 508–514. <https://doi.org/10.1016/j.clnu.2023.01.016>
- Putra Siswanto, I., Yanwirasti, & Usman, E. (2015). Hubungan pengetahuan dan dukungan keluarga dengan kepatuhan minum obat anti tuberkulosis di Puskesmas Andalas Kota Padang. *Jurnal Kesehatan Andalas*, 4(3), 884–890. <https://doi.org/10.25077/jka.v4i3.354>
- Rosadi, D. (2020). Faktor-faktor yang berhubungan dengan kepatuhan pasien tuberkulosis paru terhadap obat anti tuberkulosis. *Jurnal Berkala Kesehatan*, 6(2), 80–87. <https://doi.org/10.20527/jbk.v6i2.9452>
- World Health Organization. (2018). *Global tuberculosis report 2018*. World Health Organization.
- Young, C., Walzl, G., & Du Plessis, N. (2020). Therapeutic host-directed strategies to improve outcome in tuberculosis. *Mucosal Immunology*, 13(2), 190–204. <https://doi.org/10.1038/s41385-019-0226-5>