

Characteristics of Multidrug-Resistant Tuberculosis (MDR-TB) Patients; Correlation Study with BPALM Regimen at RSUD Dr. Moewardi Surakarta

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ABSTRACT

Background: Tuberculosis (TB) remains a major infectious disease caused by *Mycobacterium tuberculosis*, with the emergence of Multidrug-Resistant Tuberculosis (MDR-TB) posing a significant global public health challenge. Indonesia is among the high-burden MDR-TB countries. The introduction of the BPALM regimen has improved treatment outcomes; however, real-world evidence regarding its effectiveness and association with patient characteristics in referral hospitals remains limited. **Objective:** This study aimed to analyze the characteristics of MDR-TB patients and examine their correlation with treatment outcomes of the BPALM regimen at RSUD Dr. Moewardi Surakarta. **Methods:** A quantitative observational study with a cross-sectional design was conducted using medical record data. A total of 90 patients were selected from 885 MDR-TB cases using the Slovin formula. Independent variables included sociodemographic and clinical characteristics such as age, gender, nutritional status, smoking history, MDR status, previous treatment history, TB drug resistance status, comorbidities, and HIV status. The dependent variable was treatment success. Data were analyzed using Chi-Square test with a significance level of 95% ($\alpha=0.05$). **Results:** The majority of patients were aged 25–44 years, male, had normal nutritional status, a history of smoking, and were relapsed cases. The treatment success rate with the BPALM regimen reached 71.1%. Bivariate analysis showed a significant association between treatment success and gender ($p=0.003$), nutritional status ($p=0.016$), smoking history ($p=0.011$), MDR status ($p=0.008$), previous treatment history ($p<0.001$), and TB-RO status ($p<0.001$). Multivariate analysis showed that only TB-RO status was significantly associated with treatment success ($OR=6.463$; $95\%CI=1.610-25.947$; $p=0.008$).

Keywords : BPALM; Chi-Square; MDR-TB; patient characteristics; treatment outcome.

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INTRODUCTION

Tuberculosis (TB) remains one of the most common infectious diseases with high morbidity and mortality rates worldwide. According to the World Health Organization (WHO), TB continues to be a major global health problem, with millions of new cases and deaths reported annually, despite the availability of effective diagnostic and therapeutic strategies (WHO, 2024). The emergence of multidrug-resistant tuberculosis (MDR-TB), defined as tuberculosis resistant to at least isoniazid and rifampicin, the two most effective first-line anti-tuberculosis drugs, has further complicated disease control efforts because MDR-TB requires longer treatment duration, higher costs, and is associated with increased risks of adverse events and treatment failure (WHO, 2024; Dheda et al., 2021).

Indonesia is among the countries with the highest burden of TB and MDR-TB globally, making the management of MDR-TB cases a major priority within national tuberculosis control programs (WHO, 2024). The complexity of MDR-TB treatment has encouraged the development of shorter and more effective therapeutic approaches. One of the latest therapeutic innovations recommended by WHO is the BPALM regimen, consisting of Bedaquiline, Pretomanid, Linezolid, and Moxifloxacin, which has demonstrated improved treatment

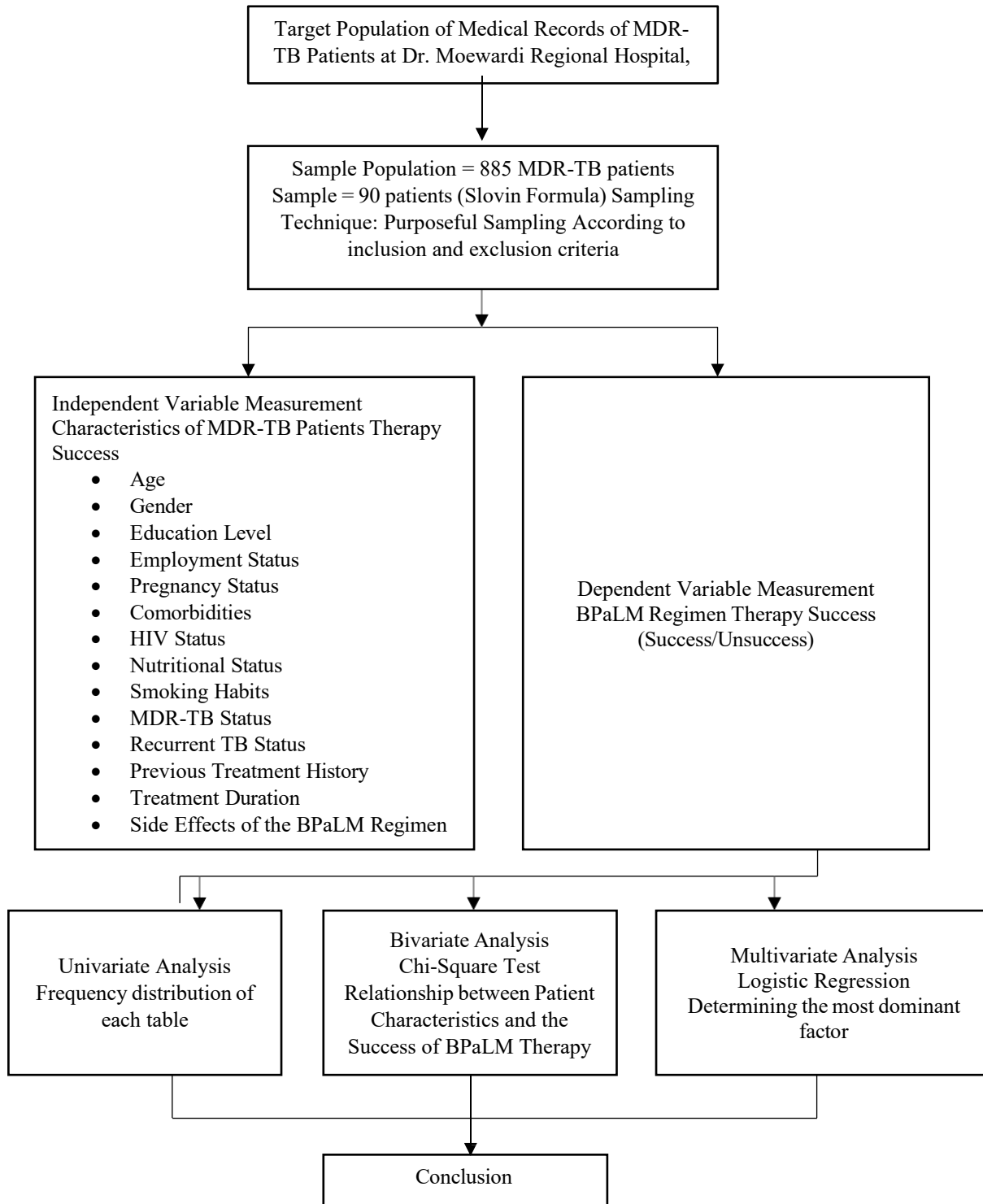
outcomes with a shorter duration compared with conventional MDR-TB regimens (WHO, 2022). The Nix-TB and ZeNix clinical trials showed that regimens containing bedaquiline, pretomanid, and linezolid achieved high rates of treatment success among patients with drug-resistant TB, supporting their inclusion in global MDR-TB treatment recommendations (Conradie et al., 2020; Conradie et al., 2022).

However, evidence regarding the effectiveness and real-world implementation of the BPaLM regimen in routine clinical practice, particularly in referral hospitals in Indonesia, remains limited. Previous studies have mainly focused on clinical trial outcomes, programmatic preparedness, and implementation challenges of new MDR-TB treatment regimens, while evidence evaluating the association between patient sociodemographic and clinical characteristics and treatment success using the BPaLM regimen remains insufficient (Ahmad et al., 2023). Patient-related factors, including age, sex, nutritional status, history of previous tuberculosis treatment, comorbidities, and baseline disease characteristics, may influence treatment response and clinical outcomes among MDR-TB patients (Pradipta et al., 2018; Dheda et al., 2021).

Furthermore, specific data describing the relationship between the characteristics of MDR-TB patients and the success of BPaLM regimen therapy at Dr. Moewardi Regional General Hospital, Surakarta, as one of the major referral hospitals in Central Java, are still unavailable. Evaluation of treatment outcomes in local clinical settings is essential to determine the effectiveness of this regimen and identify patient factors associated with successful therapy. Therefore, this study was conducted to analyze the characteristics of MDR-TB patients and determine the relationship between these characteristics and the success of BPaLM regimen therapy. The results of this study are expected to provide evidence for evaluating BPaLM implementation and contribute to improving the quality of MDR-TB care and treatment success in Indonesia.

METHODS

This study is an observational quantitative study with a cross-sectional design using secondary data from medical records of Multidrug-Resistant Tuberculosis (MDR-TB) patients at Dr. Moewardi Regional General Hospital, Surakarta. The study sample was selected using a purposive sampling technique based on predetermined inclusion and exclusion criteria. Independent variables include patient characteristics, such as age, gender, nutritional status, smoking history, previous TB treatment history, drug resistance status, comorbidities, and HIV status, while the dependent variable is the success of treatment using the BPaLM regimen. Data analysis was performed univariately to describe the characteristics of respondents, bivariate using the Chi-square test to assess the relationship between variables, and multivariate using logistic regression to identify the factors that most influence the success of therapy, with a significance level of $p < 0.05$.



RESULTS

Patient characteristics in this study included age, gender, education level, employment status, comorbidities, HIV status, nutritional status, smoking habits, previous treatment history, treatment duration, side effects of the BPALM regimen, and therapy success. The data obtained were then analyzed univariately to determine the frequency distribution of each study variable.

The bivariate analysis aimed to determine the relationship between patient characteristics, including age, gender, education level, employment status, comorbidities, HIV status, nutritional status, smoking habits, previous treatment history, treatment duration, and side effects of the BPALM regimen.

Characteristics	healed (n=64)	Not cured (n=26)	X ²	p-value
Age				
Teenagers: 15 - 24 years	5 (71,4%)	2 (28,6%)	0,336	0,953
Adults: 25 - 44 years	34 (72,3%)	13 (27,7%)		
Late Adulthood: 45 - 64 years	22 (70,9%)	9 (29,1%)		
Old (>65 tahun)	3 (60%)	2 (40%)		
Gender				
Man	39 (57,1%)	24 (38%)	8,664	0,003
Woman	25 (92,5%)	2 (7,4%)		
Education Status				
No School	1 (100%)	0 (0,0%)	2,064	0,724
elementary school	11 (78,5)	3 (21,4%)		
Junior high school	12 (60%)	8 (40%)		
Senior High School	35 (72,9%)	13 (27,1%)		
diploma or bachelor's degree	5 (71,4%)	2 (28,6%)		
Employment Status				
Work	58 (70,7%)	24 (29,3%)	0,065	0,799
Not successful	6 (75%)	2 (25%)		
Pregnancy Status				
Pregnant	2 (100%)	0 (0,0%)	0,831	0,362
Not Pregnant	62 (70,4%)	26 (29,6%)		
Comorbidities				
Comorbidities	22 (64,7%)	12 (35,3%)	1,091	0,296
No Comorbidities	42 (75%)	14 (25%)		
HIV status				
HIV Positive	15 (60%)	10 (40%)	2,080	0,149
HIV Negative	49 (75,3%)	16 (24,7%)		
Nutritional Status (IMT)				
Underweight (<18.5)	14 (53,8%)	12 (46,1%)	8,323	0,016
Normal (18.5–24.9)	50 (79,4%)	13 (20,6%)		
Overweight: (>25)	0 (0,0%)	1 (100%)		
Smoking Status				
Smoking	36 (62,1%)	22 (37,9%)	6,492	0,011
No Smoking	28 (87,5%)	4 (12,5%)		
MDR Status				
MDR	35 (61,4%)	22 (38,6%)	7,131	0,008
Non MDR	29 (87,8%)	4 (12,2%)		
BPALM				
Using	34 (65,4%)	18 (34,6%)	1,966	0,161
Not Using	30 (78,9%)	8 (21,1%)		
Patient Category				
category I	26 (86,7%)	4 (13,3%)	5,966	0,051
category II	37 (62,7%)	22 (37,3%)		
category III	1 (100%)	0 (0,0%)		
Side effects				
Side Effects	60 (69,8%)	26 (30,2%)	1,701	0,192
Not Side Effects	4 (100%)	0 (0,0%)		
Treatment Duration				
Standard: (6 months)	20 (83,3%)	4 (16,7%)	2,380	0,123
Extended: (>7-9 months)	44 (66,7%)	22 (33,3%)		

Previous Medical History				
New cases	25 (83,3%)	5 (16,7%)		
Relapse cases	39 (72,2%)	15 (27,8%)	16,983	0,000
Stop medication	0 (0,0%)	6 (100%)		
Status TB-S0				
Yes, sensitive to drugs	3 (100%)	0 (0,0%)	1,261	0,262
No, sensitive to drugs	61 (70,1%)	26 (29,9%)		
TB-RO (Resistance) Status				
Yes, drug resistant	19 (48,7%)	20 (51,3%)	16,800	0,000
No, drug resistant	45 (88,2%)	6 (11,8%)		

Source: processed data, 2026

Variables	Coefficient (B)	p-value	OR (95% CI)
Gender	1,710	0,286	5,529 (0,239-127,668)
Nutritional status	-	0,478	-
Smoking Status	0,859	0,503	2,362 (0,191-29,209)
MDR Status	2,242	0,109	11,286 (0,584-218,247)
Previous Medical History	-	0,446	-
TB-RO	1,866	0,008	6,463 (1,610-25,947)

Source: processed data, 2026

Multivariate analysis using binary logistic regression showed that drug-resistant TB status was the only variable significantly associated with the success of BPALM regimen therapy after controlling for other variables ($p=0.008$; $OR=6.463$; $95\% CI=1.610-25.947$). These results indicate that drug resistance status is the most dominant independent factor influencing the success of therapy in MDR-TB patients. Clinically, drug resistance patterns significantly determine the effectiveness of BPALM regimens, therefore, Drug Susceptibility Testing (DST) before initiating therapy is a crucial step to ensure the regimen matches the patient's resistance pattern. These findings align with research by Soeroto et al., 2021, which states that the success of MDR-TB treatment is strongly influenced by drug resistance test results and the selection of the appropriate regimen.

DISCUSSION

The bivariate analysis aimed to determine the relationship between patient characteristics, including age, gender, education level, employment status, comorbidities, HIV status, nutritional status, smoking habits, previous treatment history, treatment duration, and side effects of the BPALM regimen.

a. Relationship between Patient Characteristics Based on Age and BPALM Success

Based on the Chi-Square test, the p-value was 0.953 ($p>0.05$), thus concluding that there was no significant relationship between age and the success of the BPALM regimen in MDR-TB patients. This finding indicates that the chance of therapy success is relatively equal across all age groups, so age is not a primary factor determining treatment outcomes. Although advanced age is theoretically associated with decreased immune function and increased comorbidities, the success of MDR-TB therapy is more influenced by other factors such as medication adherence, previous treatment history, nutritional status, and the presence of comorbidities. The results of this study align with those of (Azmiardi1, 2024), which reported that age was not significantly associated with treatment outcomes in patients on short-course regimens for MDR-TB ($p 0.052$), while gender and employment status significantly influenced treatment success. Furthermore, research (Gurumurthy, 2025) also

showed that clinical conditions, particularly diabetes mellitus, significantly influenced MDR-TB treatment success compared to demographic characteristics such as age. Furthermore, recent research on MDR-TB outcomes indicates that the use of short-course oral regimens such as BPaLM can provide good treatment success across various age groups due to their strong bactericidal potential and shorter treatment duration than older regimens. The WHO recommends a 6-month BPaLM regimen as the primary choice for eligible MDR/RR-TB patients because it can replace the 18–24-month long regimen. Therefore, age was not a primary factor determining the success of BPaLM therapy in this study.

b. Relationship between Patient Characteristics Based on Gender and BPaLM Success

The results of the bivariate analysis using the Chi-Square test indicate that gender is significantly associated with BPaLM therapy success ($p=0.003$), with a higher proportion of successful treatment outcomes found in male patients. Although men are known to have a higher risk of developing MDR-TB due to smoking, high mobility, and greater environmental exposure to *Mycobacterium tuberculosis*, research (Sutrisna et al., 2022) suggests that the high success rate of treatment in men in this study is likely influenced by the predominance of patients of productive age who are in good physical condition and have healthy immune systems, enabling them to optimally undergo therapy. However, research (Soeroto et al., 2021) explains that MDR-TB treatment outcomes are more influenced by treatment factors such as adherence, monitoring for side effects, and selecting the right regimen. The use of shorter BPALM regimens can improve treatment adherence, so that therapy success is determined not only by patient risk factors but also by medication adherence, nutritional status, family support, and the effectiveness of the BPaLM regimen.

c. Relationship between Patient Characteristics Based on Educational Status and BPaLM Success

Based on the Chi-Square test, the p -value was 0.953 ($p>0.05$), thus concluding that there is no significant association between age and the success of BPALM regimen treatment in MDR-TB patients. This finding indicates that the chance of therapy success is relatively equal across all age groups, so age is not a major factor determining treatment outcomes. Although advanced age is theoretically associated with decreased immune function and increased comorbidities, the success of MDR-TB therapy is more influenced by other factors such as medication adherence, previous treatment history, nutritional status, and the presence of comorbidities. The results of this study are consistent with those of Azmiardi1, 2024, which reported that age was not significantly associated with treatment outcomes in patients with short-term MDR-TB regimens ($p\ 0.052$), while gender and employment status significantly influenced therapy success. Furthermore, research by Gurumurthy (2025) also showed that clinical conditions, particularly diabetes mellitus, significantly impacted MDR-TB treatment success compared to demographic characteristics such as age.

d. Relationship between Patient Characteristics Based on Employment Status and BPaLM Success

Based on the results of the Chi-Square test, employment status was not significantly associated with the success of BPaLM regimen treatment in MDR-TB patients ($p>0.05$). This result indicates that both employed and unemployed patients have a relatively equal chance of achieving treatment success. Therapy success is more influenced by clinical factors, such as treatment adherence, nutritional status, clinical condition, and previous treatment history, than by employment status. This study's findings align with those of Soeroto et al., 2021, who reported that in MDR-TB patients undergoing the BPaLM/BPaL

regimen, treatment success is more influenced by medication adherence and improved nutritional status than by sociodemographic characteristics. This finding is also supported by Wibowo et al., 2021, who stated that MDR-TB treatment outcomes are more influenced by clinical factors, while employment status did not show a significant relationship with treatment success. Therefore, employment status is not a primary factor determining the success of BPALM regimen therapy in MDR-TB patients.

e. Relationship between Patient Characteristics Based on Pregnancy Status and BPALM Success

Chi-square test results showed no significant association between pregnancy status and the success of MDR-TB therapy with the BPALM regimen ($p > 0.05$), indicating that pregnancy status did not significantly impact treatment outcomes. This finding aligns with WHO (2024), which states that MDR-TB treatment in special groups, such as pregnant women, can still be administered with effective regimens, with appropriate adjustments and clinical monitoring. Therefore, pregnancy status is not a primary determinant of treatment success. Furthermore, literature on the BPALM regimen also indicates that this therapy is highly effective and can be used in various groups of MDR/RR-TB patients with appropriate medical supervision. Although pregnancy is a special condition that requires close monitoring, the BPALM regimen can still provide good treatment outcomes in a variety of patient conditions as long as optimal clinical supervision is maintained. Therefore, there is no statistically significant association between pregnancy status and treatment success, suggesting that clinical factors and treatment adherence are more dominant in determining MDR-TB outcomes. However, research on MDR-TB therapy during pregnancy shows that pregnant patients can still achieve treatment success if they receive an appropriate regimen and optimal clinical monitoring. A systematic review and meta-analysis by Alene et al., 2026, of 275 pregnant patients with MDR-TB, showed that the success rate of MDR-TB treatment during pregnancy reached approximately 72.5%, indicating that pregnancy does not always lead to treatment failure when treatment is administered appropriately.

Nevertheless, the use of the BPALM regimen during pregnancy remains a matter of special concern, particularly due to limited data on the fetal safety of pretomanid. The WHO recommends the BPALM regimen (bedaquiline, pretomanid, linezolid, and moxifloxacin) as the regimen of choice for patients with MDR/RR-TB who meet the criteria. However, this regimen is not yet routinely recommended for pregnant and breastfeeding women due to limited data on the safety of pretomanid.

f. Relationship between Patient Characteristics Based on Comorbid Status and BPALM Success

Based on the results of the Chi-Square test, a p-value of 0.296 ($p > 0.05$) was obtained, thus concluding that there was no significant relationship between comorbid status and the success of the BPALM regimen in MDR-TB patients. This result indicates that the presence of comorbidities did not directly affect therapy success in this study. This is likely because most comorbidities were well managed during MDR-TB treatment, thus not significantly impacting therapy outcomes. However, these results should be interpreted with caution because the types of comorbidities in the study were not analyzed separately. Various studies have shown that the influence of comorbidities on treatment success can vary depending on the type of comorbidity. (Xu et al., 2023) reported that MDR-TB patients with diabetes mellitus had a higher risk of experiencing unsuccessful treatment outcomes than patients without diabetes. Therefore, although in this study comorbid status was not significantly associated with therapeutic success, management of comorbidities remains important to maintain the patient's clinical condition during the BPALM regimen.

g. Relationship between Patient Characteristics Based on HIV Status and BPaLM Success

Based on the results of the Chi-Square test, a p-value of 0.149 ($p > 0.05$) was obtained, thus concluding that there was no significant relationship between HIV status and the success of the BPaLM regimen in MDR-TB patients. This result indicates that HIV status was not a direct factor in determining therapy success in this study. This is likely due to the fact that HIV patients received antiretroviral (ARV) therapy and optimal clinical monitoring during MDR-TB treatment, which allowed for successful therapy. Furthermore, the relatively small number of HIV-positive patients in the study limited their impact on the statistical analysis. This finding aligns with a study (Hadaynal, 2025), which also reported that HIV status was not significantly associated with MDR-TB treatment outcomes after taking other clinical factors into account.

Furthermore, research (Soeroto et al., 2021) on the use of bedaquiline-based regimens in MDR-TB patients in Indonesia showed that therapy success was more influenced by factors such as treatment adherence, baseline clinical condition, nutritional status, and ability to complete therapy than by HIV status alone. The BPaLM regimen has the advantage of being administered orally for a shorter duration than conventional MDR-TB regimens. This shorter duration of therapy can improve patient adherence and reduce the risk of premature discontinuation of treatment. This is especially advantageous for patients with HIV, who face more complex therapy.

h. Relationship between Patient Characteristics Based on Nutritional Status and BPaLM Success

Based on the results of the bivariate analysis using the Chi-Square test, a p-value of 0.016 ($p < 0.05$) was obtained, indicating a significant relationship between nutritional status and the success of BPaLM therapy in MDR-TB patients. Patients with normal nutritional status tend to have a higher chance of therapy success than those with poor nutritional status. Good nutritional status can enhance the immune response, accelerate the healing process, and increase tolerance to drug side effects during treatment. The results of this study align with those of (Siraj, 2025), which reported that MDR-TB patients with good nutritional status had higher treatment success rates than those with undernutrition or overnutrition. Therefore, monitoring and improving nutritional status should be an essential part of MDR-TB patient management. These results also align with those of (Xu *et al.*, 2023), which reported that nutritional status is a factor associated with MDR-TB treatment outcomes. Malnourished patients are at higher risk of treatment failure due to impaired immune responses and possible delays in clinical improvement.

i. Relationship between Patient Characteristics Based on Smoking Status and BPaLM Success

Based on the results of a bivariate analysis using the chi-square test, a p-value of 0.011 ($p < 0.05$) was obtained, indicating a significant relationship between smoking status and the success of BPaLM therapy in MDR-TB patients. This result indicates that non-smoking patients tend to have a higher chance of successful therapy than smoking patients.

The results showed that patients with a history of smoking had a higher proportion of successful therapy compared to non-smoking patients. This finding differs from studies that suggest smoking is associated with poorer MDR-TB treatment outcomes. (Romo et al., 2025) reported that treatment success rates in MDR-TB patients who smoked were lower than in non-smoking patients. This difference in results is likely influenced by patient characteristics. Despite having a history of smoking, the majority of patients who successfully recovered were male and in good enough health to complete treatment.

Furthermore, the success of MDR-TB therapy is not solely determined by smoking status but is also influenced by other factors such as medication adherence, good nutritional status, family support, and the effectiveness of the BPaLM regimen used.

Research (Wang et al., 2021) shows that TB patients with a history of smoking have a higher risk of experiencing unfavorable treatment outcomes compared to non-smokers. This is associated with impaired local lung immunity, increased inflammation, and the possibility of delayed sputum culture conversion.

However, the results of this study indicate a significant association between smoking status and the success of BPaLM therapy, but the direction of the relationship requires further analysis. In this study, the majority of patients were men of productive age who also had a high proportion of smokers. This condition may cause smoking status to be a variable related to other patient characteristics (confounding factors) such as gender, occupation, and environmental exposure.

j. Relationship between Patient Characteristics Based on MDR Status and BPaLM Success

The chi-square test results obtained a p-value of 0.008 ($p < 0.05$), indicating a significant relationship between MDR status and BPaLM therapy success. These results suggest that a patient's level of drug resistance can influence treatment success. Patients with more complex resistance generally face greater treatment challenges than those with lower resistance. However, the use of a more effective BPaLM regimen with a shorter treatment duration can increase the chances of therapy success in drug-resistant TB patients. These results align with those of Soeroto et al., 2021 and Nyang et al., 2023, which reported that the BPaLM/BPaL regimen provided a high treatment success rate in MDR/RR-TB patients. Therefore, therapy success is influenced not only by MDR status but also by treatment adherence, nutritional status, and the patient's clinical condition during therapy.

These results align with research showing that bedaquiline, pretomanid, and linezolid-based regimens can provide high therapeutic efficacy in drug-resistant TB patients. The study reported treatment efficacy rates of over 80%, indicating that BPaLM-based regimens can be an effective alternative for MDR-TB patients with resistance to first-line drugs.

k. Relationship between Patient Characteristics and BPaLM Regimen Use

Based on the results of the Chi-Square test, a p-value of 0.161 ($P > 0.05$) was obtained, concluding that there was no significant relationship between BPaLM regimen use and treatment success in MDR-TB patients. This result is likely due to the fact that nearly all patients in the study received the same treatment regimen, so there was insufficient variation to demonstrate a statistical relationship. In other words, the BPaLM regimen was not a differentiating factor in therapy success in this study. Treatment success was more influenced by other factors, such as nutritional status, prior treatment history, patient compliance, and monitoring during therapy. This finding aligns with guidelines (Saefurrohim, 2025), which state that the success of a BPaLM regimen is not solely determined by the type of regimen but also by appropriate patient selection, treatment adherence, side effect management, and ongoing clinical monitoring.

In this study, therapy success was more likely influenced by individual patient characteristics than by the type of regimen used, as all patients received the same BPaLM therapy. Factors such as nutritional status, previous treatment history, drug resistance level, HIV status, side effects, and patient compliance during therapy can influence treatment outcomes. Research (Soeroto et al., 2021) on the use of bedaquiline-based regimens in MDR-TB patients in Indonesia showed that therapy success is not solely determined by regimen selection but also influenced by the patient's clinical condition at the time of

initiation of therapy, previous treatment history, and the patient's ability to complete treatment. Patients with more stable clinical conditions and good therapy monitoring tend to have more optimal treatment outcomes.

l. Relationship of Patient Characteristics Based on Patient Category with BPaLM Success

The chi-square test results yielded a p-value of 0.051 ($P > 0.05$), indicating no significant association between patient category (Category 1, Category 2, and Category 3) and the success of MDR-TB therapy using the BPaLM regimen ($p > 0.05$). Although descriptively, the majority of patients were in Category 2 (65.6%) with previous treatment history, this did not significantly impact therapy outcomes. This indicates that treatment success is more influenced by other factors such as medication adherence, clinical condition during treatment, nutritional status, and medication than by the patient's treatment history. These results align with research (Soeroto et al., 2021), which reported that medication adherence and improved nutritional status were the most influential factors in the success of MDR-TB therapy using the BPaLM regimen, while prior treatment history did not significantly influence treatment outcomes. Furthermore, (Ardiansa, 2024) also emphasized that the success of MDR/RR-TB therapy is more determined by medication adherence and effective regimen use than by patient characteristics and treatment history. Therefore, the results of this study confirm that patient category is not the primary factor determining the success of MDR-TB therapy using the BPaLM regimen.

m. Relationship between Patient Characteristics Based on Side Effects and BPaLM Success

The chi-square test results obtained a p-value of 0.192 ($p > 0.05$), indicating no significant relationship between the occurrence of side effects and the success of MDR-TB therapy. Therefore, side effects cannot be considered a factor directly influencing treatment outcomes. This indicates that although side effects are common, most are mild to moderate and can be managed through appropriate monitoring and management, allowing patients to continue therapy until completion. This finding aligns with research (Soeroto et al., 2026), which reported that more than 80% of patients on the BPaLM regimen experienced side effects, but most did not result in discontinuation of therapy or treatment failure. The success of therapy is more influenced by medication adherence and clinical supervision than by the presence of side effects.

n. Relationship between Patient Characteristics Based on Treatment Duration and BPaLM Success

Based on the results of a bivariate Chi-Square test, a p-value of 0.123 ($p > 0.05$) was obtained, indicating no significant relationship between treatment duration and the success of MDR-TB therapy using the BPaLM regimen ($p > 0.05$). This indicates that differences in treatment duration, whether 6 months or longer, do not significantly affect therapy outcomes. This finding aligns with research (Soeroto et al., 2026), which explains that the BPaLM regimen is an effective short-term therapy for MDR/RR-TB. However, in practice, treatment duration can vary due to differences in clinical response in each patient, so it does not always directly influence therapy success. Furthermore, (Soeroto et al., 2021) stated that the success of MDR-TB therapy is more influenced by medication adherence and the patient's clinical condition than by treatment duration, so therapy duration is not the primary factor determining treatment outcomes. Thus, the results of this study indicate that although most patients underwent treatment for more than 6 months, there was no statistically significant relationship between treatment duration and the success of MDR-TB therapy.

using the BPaLM regimen. Therefore, patient adherence and clinical condition play a greater role in determining therapy outcomes.

o. Relationship between Patient Characteristics Based on Previous Treatment History and BPaLM Success

The chi-square test yielded a p-value of 0.000 ($p < 0.05$), indicating a significant relationship between previous treatment history and BPaLM therapy success. These results suggest that a patient's TB treatment history can influence the success of current treatment. Patients who have experienced treatment failure, discontinuation, or incomplete treatment are at higher risk of developing drug resistance. However, the use of the more effective BPaLM regimen with a shorter treatment duration can increase the chance of cure, even in patients with a history of previous treatment. Therefore, therapy success is influenced not only by treatment history but also by patient adherence to therapy, nutritional status, clinical condition, and proper treatment monitoring. This finding aligns with research by Soeroto et al., 2021 and Bartekay et al., 2025, which states that prior treatment history is a factor associated with treatment outcomes in MDR-TB patients.

p. Relationship of Patient Characteristics Based on Tuberculosis Drug Sensitivity with BPaLM Success

The chi-square test results showed a p-value of 0.262 ($p > 0.05$), indicating no significant association between TB-SO status and the success of MDR-TB therapy using the BPaLM regimen ($p > 0.05$). This means that drug sensitivity status at initial diagnosis does not significantly influence treatment outcomes. Therapy success is more influenced by other factors such as medication adherence, the patient's clinical condition, nutritional status, and management of side effects. This can be explained by the BPaLM regimen being an effective MDR-TB therapy that continues to produce good results even if the patient has an initial resistance status, as long as treatment is carried out regularly and monitored. This finding is in line with (WHO, 2024) which states that the success of MDR/RR-TB therapy is determined more by adherence and access to effective regimens than by initial sensitivity status.

q. Relationship between Patient Characteristics Based on Tuberculosis Drug Resistance and BPaLM Success

The Chi-square test results obtained a p-value of 0.000 ($p < 0.05$), indicating a significant relationship between TB-RO status and therapy success. Patients without drug resistance have a higher treatment success rate than TB-RO patients because the causative agent is still sensitive to the therapy, resulting in a more optimal healing process. Conversely, drug resistance can complicate treatment and increase the risk of therapy failure. These results align with research by Rossato (2024) and Sridharan (2025), which indicates that drug resistance is a factor that can influence treatment success, although the use of the BPaLM regimen can improve therapy outcomes in drug-resistant TB patients.

Multivariate analysis using binary logistic regression showed that drug-resistant TB status was the only variable significantly associated with the success of BPaLM regimen therapy after controlling for other variables ($p = 0.008$; OR=6.463; 95% CI=1.610-25.947). These results indicate that drug resistance status is the most dominant independent factor influencing the success of therapy in MDR-TB patients. Clinically, drug resistance patterns significantly determine the effectiveness of BPaLM regimens, therefore, Drug Susceptibility Testing (DST) before initiating therapy is a crucial step to ensure the regimen matches the patient's resistance pattern. These findings align with research by Soeroto et al., 2021, which

states that the success of MDR-TB treatment is strongly influenced by drug resistance test results and the selection of the appropriate regimen.

In contrast, the variables gender, nutritional status, smoking status, MDR status, and previous treatment history no longer showed a significant association in the multivariate analysis ($p > 0.05$). This indicates that the associations found in the bivariate analysis are likely influenced by confounding factors, making these variables not independent predictors of therapy success. Furthermore, the large standard error values and wide confidence intervals for several variables indicate model instability, likely due to the limited sample size and skewed data distribution (Schuster et al., 2021). Therefore, the analysis results should be interpreted with caution.

CONCLUSION

Based on the research results, it can be concluded that there is a relationship between patient characteristics and treatment success using the BPaLM regimen in MDR-TB patients at Dr. Moewardi Regional Hospital, Surakarta. The variables of gender, nutritional status, smoking history, MDR status, previous TB treatment history, and TB drug resistance status were significantly associated with treatment success. Based on multivariate analysis, TB drug resistance status was the most influential factor in the success of BPaLM regimen therapy. These results indicate that identifying patient characteristics early in treatment is crucial to support the success of MDR-TB therapy.

This study has several limitations, including its retrospective design using medical record data, which relies on the completeness and accuracy of data recording. Furthermore, the study was conducted in only one hospital with a limited sample size, so the results cannot be generalized to the entire population of MDR-TB patients in Indonesia.

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Conflicts of Interest

The authors declare that there are no conflicts of interest in the conduct or preparation of this study. This research was conducted independently without influence from any party that could have influenced the study design, data collection, analysis, and interpretation, the writing of the manuscript, or the decision to publish the results. This research also received no external funding. Therefore, the funders had no role in the study design, data collection, analysis, or interpretation, the writing of the manuscript, or the decision to publish the results.

REFERENCES

1. Adhanty, S. (2023). *Kepatuhan Pengobatan pada Pasien Tuberkulosis dan Faktor-Kepatuhan Pengobatan pada Pasien Tuberkulosis dan Faktor- Faktor yang Mempengaruhinya : Tinjauan Sistematis*. 7(1). <https://doi.org/10.7454/epidkes.v7i1.6571>
2. Aisyah, W. O. N., Sabilu, Y., & Azim, L. O. L. (2024). Faktor risiko Multidrug Resistant Tuberculosis (MDR-TB) di Kota Kendari Tahun 2024. *Indonesian Journal of Health Science*, 4(6s), 917–928. <https://doi.org/10.54957/ijhs.v4i6s.1278>
3. Andili, A. A. (2025). *Analisis Faktor Risiko Kejadian Multidrug Resistant Tuberculosis*

- (MDR-TB) Di RSUD Kota Makassar. 15, 899–912.
4. Ardana. (2025). Gambaran Karakteristik Pada Penderita TB MDR Di Rumah Sakit Khusus Paru Provinsi Sumatera Utara. *An-Nadaa: Jurnal Kesehatan Masyarakat (e-Journal)*, 12(1), 134–140.
 5. Ardiansa. (2024). Faktor Faktor Yang mempengaruhi terjadinya penyakit paru paru Tuberkulosis pada kelompok usia produktif. *Jurnal Penelitian Kesehatan Global Indonesia Volume*, 6, 215–226. <https://e-journals2.unmul.ac.id>
 6. Assyifa, A. Z. (2025). Prevalensi Dan Karakteristik Pasien Tuberkulosis Multidrug-Resistant Di Klinik Utama Dr. H. a. Rotinsulu Cianjur Periode 2019-2023. *Medika Kartika Jurnal Kedokteran Dan Kesehatan*, Volume 8 No 0, 35–46. <https://doi.org/10.35990/mk.v8n0.p35-46>
 7. Ayulia, D., Sandi, D., Maulida, I., & Isnani, N. (2025). *Karakteristik Pasien TB Resisten Obat di Kalimantan Selatan : Studi Korelasi terhadap Kesiapan Implementasi Regimen BPaL / M*. 09(02), 247–258.
 8. Chasanah, K. F., Trinawati, I., & Istiono, W. (2022). *Risk Factor Identification of Multi-Drug Resistant Tuberculosis Kurnia*. 20–24.
 9. Francesca. (2020). Treatment of Highly Drug-Resistant Pulmonary Tuberculosis. *New England Journal of Medicine*, 382(10), 893–902. <https://doi.org/10.1056/nejmoa1901814>
 10. Geroda, P., Suhermi, S., & Fradilla, F. (2020). Pengaruh Faktor Klinis Dan Keteraturan Minum Obat Dengan Terjadinya TB MDR di Wilayah Kerja Puskesmas Kecamatan Pasar Rebo Jakarta Timur. *Jurnal Ilmiah Kesehatan*, 12(1), 16–29. <https://doi.org/10.37012/jik.v12i1.115>
 11. Gurumurthy. (2025). *pengobatan pada penderita diabetes dan tuberkulosis resisten multidrug MDR TB terdaftar dalam uji klinis STREAM.pdf*. April, 1–13.
 12. Kasaeva, D. T. A. G. D. T. (2025). *Global Tuberculosis Report*.
 13. Kemenkes. (2024). *Petunjuk Teknis Penatalaksanaan Tuberkulosis Resistan Obat di Indonesia*.
 14. Malahayati. (2025). *Faktor-faktor Yang Berhubungan Dengan Kejadian Multidrug Resistant Tuberculosis (MDR-TB) Di RSUD Dr.H.Abdul Moeloek Provinsi Lampung*. 7, 1128–1144.
 15. Nikmawati, S. (2024). *Gambaran Pasien Tuberkulosis Multidrug Resistance (TB-MDR) yang Menjalani Pengobatan di RSUD M . Natsir Selama Periode Tahun 2021-2024*.
 16. Nugraha, O. (2024). *Machine Translated by Google Perspektif Machine Translated by Google*. 17(April), 335–337. <https://doi.org/10.4103/apjtm.apjtm>
 17. Raka, G., Samudra, S. A., Vidiari Juhanna, I., Wahyuni, N., Made, I., & Dinata, K. (2024). Artikel Asli Karakteristik pasien tuberkulosis paru dengan multidrug-resistance di Rumah Sakit Pusat Dr. Kariadi Semarang tahun 2021-2022. *Fakultas Kedokteran Universitas Udayana | Medicina*, 55(1), 26–29. <https://doi.org/10.15562/medicina.v55i1.1292>
 18. Rossato. (2024). *Machine Translated by Google tuberkulosis resisten multidrug atau rifampisin : tinjauan sistematis*. 50(6), 1–9.
 19. Rossato, D., Fonseca, F., Carvalho, J., Bernando, W., Maria, M., & Dalcolmo, P. (2024). *and moxifloxacin (BPaLM) for multidrug- or rifampin-resistant tuberculosis : a systematic review*. 50(6), 1–9.
 20. Silva1, D. R. (2024). *Bedaquiline pretomanid linezolid dan moxifloxacin BPaLM untuk*

- tuberkulosis resisten multidrug atau rifampisin tinjauan sistematis. 50(6), 1–9.*
21. Simorangkir, L., Ginting, F., Rupang, E. R., & Sinaga, S. P. (2022). *Gambaran Faktor Penyebab Multidrug-Resistent Tuberkulosis (Mdr-Tb) di RSUP Haji Adam Malik Medan Tahun 2022. 7(1), 59–73.*
 22. Siraj. (2025). *Dampak malnutrisi dan faktor-faktor terkait terhadap hasil pengobatan tuberkulosis resisten multidrug / rifampisin pada pasien yang dirawat di Rumah Sakit Alert dan Rumah Sakit Spesialis St . Peter , Addis Ababa , Ethiopia : studi tindak lanjut.*
 23. Soeroto, A. Y., Pratiwi, C., Santoso, P., & Lestari, B. W. (2021). *Factors affecting outcome of longer regimen multidrug-resistant tuberculosis treatment in West Java Indonesia: A retrospective cohort study. 16(2 February), 1–13.*
<https://doi.org/10.1371/journal.pone.0246284>
 24. Soeroto, A. Y., Purwiga, A., Suryadinata, H., Alisjahbana, B., Makmun, A., & Supriatna, Y. A. (2026). *Faktor faktor yang Memprediksi Keberhasilan Pengobatan dengan Rejimen BPaLM Baru pada Individu dengan Tuberkulosis Resisten Obat PengaDari Indonesia. April, 1–13.*
 25. Sutrisna, M., Rahmadani, E., Studi, P., & Keperawatan, I. (2022). *Hubungan Usia dan Jenis Kelamin dengan TB MDR. 1(4), 370–376.*
<https://doi.org/10.54259/sehatrakyat.v1i4.1168>
 26. WHO. (2020). Meeting report of the WHO expert consultation on the definition of extensively drug-resistant tuberculosis. In *Wold Health Organization* (Issue October).
<https://www.who.int/publications/i/item/meeting-report-of-the-who-expert-consultation-on-the-definition-of-extensively-drug-resistant-tuberculosis>
 27. WHO. (2023). Global Tuberculosis Report. In *January: Vol. t/malaria/* (Issue March).
 28. WHO. (2024). *Global tuberculosis report 2024.*
 29. WHO. (2025). *WHO consolidated guidelines on tuberculosis.*