Factors Influencing The Incidence of Loss To Follow-Up Treatment In Drug-Resistant Tuberculosis Patients

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Abstract.

Drug-resistant tuberculosis (DR-TB) represents a significant global health challenge with Indonesia ranking second highest for pulmonary TB cases. Treatment adherence in DR-TB patients is influenced by multiple interacting factors requiring systematic investigation to identify independent risk determinants. This descriptive analytical cross-sectional study assessed associations between independent variables and loss to follow-up treatment outcomes in DR-TB patients at Adam Malik Hospital, Medan, from May to November 2024. A purposive sampling strategy enrolled 104 bacteriologically confirmed DR-TB patients comprising 34 loss to follow-up cases and 70 treatment completers. Data collection utilized validated questionnaires assessing attitudes toward treatment, perceived social support, and healthcare service quality. Statistical analysis employed chi-squared testing for bivariate associations and multiple logistic regression for multivariate analysis with significance level p<0.05. Results demonstrated that 85.3% of loss to follow-up patients experienced low to moderate social support, 67.6% held poor treatment attitudes, and 64.7% perceived insufficient healthcare services. Bivariate analysis revealed significant associations between education (PR=4.13; p=0.023), attitudes (PR=6.04; p<0.001), social support (PR=14.50; p<0.001), and healthcare services (PR=5.72; p<0.001) with treatment discontinuation. Multivariate analysis identified three independent risk factors: low to moderate social support emerging as the predominant determinant (PR=14.01; 95% CI=4.26–46.02; p<0.001), followed by inadequate healthcare services (PR=3.33; 95% CI=1.18–9.43; p=0.023), while unemployment showed protective effect (PR=0.315; p=0.045). This investigation concludes that social support constitutes the principal modifiable risk factor for loss to follow-up treatment in DR-TB patients, necessitating implementation of family-based psychosocial interventions and quality healthcare service improvements to sustain treatment adherence during the challenging 20-month therapeutic regimen.

Keywords: *Adherence; Cure Treatment; Drug-Resistant Tuberculosis; Loss To Follow-Up and Social Support.*

I. INTRODUCTION

Tuberculosis (TB) remains one of the most significant infectious diseases contributing to global morbidity and mortality, with drug-resistant tuberculosis (DR-TB) representing an increasingly severe challenge to disease control efforts worldwide. Indonesia currently ranks as the second-highest burden country for pulmonary TB cases globally, following India, positioning it at the forefront of TB management challenges in the Southeast Asian region. The epidemiological data demonstrates the escalating severity of this public health crisis, as Indonesia reported 821,200 new TB cases in 2023, comprising 808,718 cases of drug-sensitive tuberculosis and 12,482 cases of drug-resistant tuberculosis, with men aged 15 years and above accounting for 57.8% of infected individuals and 8.2% of all infected persons being coinfected with HIV. The emergence and progression of DR-TB represents a critical threat to TB control programs, particularly when patients fail to maintain consistent treatment adherence throughout their therapeutic course. Treatment success rates for TB patients remain substantially below global targets, largely due to treatment dropout and loss to follow-up occurrences that undermine long-term management outcomes and facilitate further disease transmission within communities.Adherence to TB treatment, particularly in drug-resistant tuberculosis cases, constitutes a complex dynamic phenomenon influenced by multiple interacting factors spanning individual, social, and health system dimensions.

The treatment regimens for DR-TB are notably demanding, requiring prolonged therapy periods of at least 20 months compared to the conventional 6-month regimen for drug-susceptible TB, combined with frequent and often debilitating adverse effects that substantially diminish patients' quality of life and psychosocial well-being. This extended treatment duration, coupled with the rigorous requirements of

directly observed therapy (DOTS) implementation, creates substantial barriers to treatment continuation, particularly among vulnerable populations with limited socioeconomic resources and restricted access to healthcare facilities. The convergence of prolonged treatment duration, psychological burden from chronic disease management, and systemic healthcare limitations creates a critical situation wherein patients may abandon treatment prematurely, resulting in the development of extensively drug-resistant TB (XDR-TB), treatment failure, and increased mortality risk.

Research Problem

Loss to follow-up during TB treatment represents one of the most significant obstacles to achieving successful treatment outcomes and represents a major contributor to treatment failure and mortality among DR-TB patients. Previous investigations have identified that loss to follow-up can result in delayed sputum conversion, accelerated development of additional drug resistance, significantly prolonged treatment duration, and substantially elevated mortality rates, thereby undermining both individual patient outcomes and broader TB control efforts at the population level. Despite the existence of comprehensive national TB control strategies and decades of implementation of the Directly Observed Treatment Short-course (DOTS) strategy in Indonesia, the country continues to experience persistent challenges with underdiagnosis, substantial treatment dropouts, and the emergence of increasingly complex drug-resistant TB forms, particularly among vulnerable and marginalized populations with limited healthcare access.Contemporary epidemiological research demonstrates that multiple determinants contribute to treatment discontinuation in DR-TB patients, extending far beyond simple individual behavioral factors to encompass complex interactions between patient-level characteristics, psychosocial determinants, healthcare system factors, and broader socioeconomic circumstances.

Previous studies, particularly in African contexts, have identified that lack of family support, inadequate nutritional intake, and substantial distance to health facilities represent significant risk factors associated with loss to follow-up treatment in DR-TB populations. Moreover, recent evidence from Indonesia and other high-burden TB countries indicates that psychosocial factors including patient knowledge, attitudes toward treatment, treatment-related beliefs, and perceptions of healthcare service quality significantly influence treatment adherence outcomes, yet these psychosocial dimensions remain incompletely characterized in the specific context of DR-TB management in Indonesian healthcare settings.The complexity of factors influencing treatment adherence in DR-TB necessitates comprehensive investigation using multivariate analytical approaches to identify the independent associations between specific risk factors and loss to follow-up outcomes. Early identification of high-risk patients and understanding the relative importance of modifiable versus non-modifiable determinants are essential for designing targeted intervention strategies that can effectively address the most significant barriers to treatment continuation. Without systematic investigation of these multifactorial influences in local Indonesian contexts, healthcare providers and TB control programs lack the evidence-based insights necessary to implement context-specific interventions that can meaningfully improve treatment adherence and reduce loss to follow-up rates among DR-TB populations.

Research Objective and Significance

This study was conducted to determine the factors associated with loss to follow-up treatment in DR pulmonary TB patients at Adam Malik Hospital, Medan, with particular emphasis on identifying independent risk factors through multivariate statistical analysis. The research addresses an important public health gap by providing empirical evidence regarding the relative importance of sociodemographic, psychosocial, and healthcare system factors in predicting treatment discontinuation among DR-TB patients in an Indonesian tertiary care setting. The findings from this investigation contribute to the urgent need for early identification and risk stratification of DR-TB patients at heightened risk of treatment abandonment, thereby enabling healthcare providers to implement timely, targeted interventions designed to maintain treatment adherence and improve clinical outcomes. Furthermore, this research directly supports Indonesia's commitment to eliminate TB by 2030, as outlined in the End TB Strategy, by providing actionable evidence regarding modifiable risk factors that can inform the development and implementation of more effective, patient-centered DR-TB management protocols within resource-constrained healthcare settings.

II. METHODS

Study Design and Research Method

This study employed a quantitative research methodology with a descriptive analytical design utilizing a cross-sectional approach to assess the associations between independent variables and the incidence of loss to follow-up treatment in drug-resistant tuberculosis patients. The cross-sectional design represents one of the most practical approaches for investigating the prevalence of health outcomes and their determinants at a specific point in time, providing a snapshot of the population characteristics without manipulation of variables or intervention in the natural environment. As described by contemporary epidemiological frameworks, descriptive analytical cross-sectional studies characterize and measure the prevalence of health outcomes through systematic collection of data on existing cases within a defined population, while simultaneously examining relationships among multiple variables to establish preliminary evidence for associations between exposure factors and disease outcomes.

In the context of quantitative research methodology, this design enables researchers to conduct both univariate descriptive analysis to characterize the study population and multivariate analytical procedures to examine associations between predictor variables and the outcome of interest.The investigation was conducted at Adam Malik Hospital, Medan, Indonesia, one of the leading tertiary care facilities specializing in pulmonary and respiratory medicine. The study period extended from May 20, 2024, to November 1, 2024, following institutional review board approval obtained from the Faculty of Medicine, Universitas Sumatera Utara on May 7, 2024 (Approval No: 435/KEPK/USU/2024). The hospital setting was selected deliberately due to its comprehensive drug-resistant tuberculosis management program, established diagnostic capabilities for bacteriological confirmation of DR-TB cases, and accessibility to documented patient records spanning the 2020-2023 treatment period. This methodological approach aligns with standards established in quantitative research design literature, wherein the specification of study setting, duration, and ethical approval details constitute fundamental components of research transparency and reproducibility.

Population, Sampling Strategy, and Participant Selection

The study population consisted of adult patients aged 18 years and older who had received treatment for bacteriologically confirmed drug-resistant tuberculosis at Adam Malik Hospital between January 2020 and December 2023. The target population encompassed all individuals meeting the established inclusion criteria without geographic or socioeconomic restrictions. The study employed a purposive sampling strategy combined with non-probability sampling methodology to recruit research participants based on predefined criteria rather than random selection. Purposive sampling, also termed judgmental or expert sampling, involves deliberate selection of participants whose characteristics align with specific research objectives and eligibility requirements, making this approach particularly appropriate for studies investigating phenomena that require participants meeting particular clinical or behavioral criteria. The purposive sampling technique was supplemented with non-probability sampling methods to optimize recruitment efficiency while maintaining focus on participants with direct experience of the phenomenon under investigation.

The inclusion criteria specified that participants must be 18 years of age or older, have received a diagnosis of drug-resistant tuberculosis confirmed through bacteriological methods including sputum smear microscopy or culture testing, have initiated treatment at Adam Malik Hospital during the 2020-2023 periomaintaine completed sufficient duration of follow-up to be classified as either loss to follow-up or treatment completion status. Patients were categorized into two groups: the case group comprising 34 patients who experienced loss to follow-up from DR-TB treatment, and the control group consisting of 70 patients who completed their treatment regimens according to national tuberculosis control guidelines. The total sample comprised 104 DR-TB patients, calculated to provide adequate statistical power for detecting meaningful associations between predictor variables and the outcome of loss to follow-up treatment. This sample size determination reflects consideration of the prevalence of loss to follow-up in DR-TB populations, the number of independent variables to be assessed, and the statistical power required for detecting clinically meaningful associations.

Data Collection Instruments and Measurement Techniques

This study utilized validated questionnaires to assess three primary dimensions of interest: attitudes toward tuberculosis treatment, perceived social support, and perceptions of healthcare service quality. The questionnaire for measuring attitudes toward treatment was developed by Yuda and adapted from established behavioral research instruments, consisting of eight binary yes-no items with a maximum possible score of 8 and minimum score of 0. The instrument has demonstrated acceptable validity with a Pearson correlation coefficient value exceeding 0.444, indicating compliance with conventional validity thresholds. Regarding reliability assessment, the instrument yielded a Cronbach's alpha coefficient of 0.178, reflecting the specific item composition and dimensionality of the attitude construct being measured. Following established scoring conventions, participants were classified as possessing positive attitudes when their total questionnaire score exceeded 56 percent of the maximum possible score, while scores at or below this threshold were classified as negative or poor attitudes. This categorical classification reflects the dichotomous nature of treatment attitudes and enables clinically meaningful interpretation of the attitude variable within the context of TB treatment adherence.

The social support questionnaire was developed by Soedarsono and Pandini based on the Multidimensional Scale of Perceived Social Support (MSPSS) framework, which was originally developed by Zimet and adapted to the Indonesian language context. This instrument comprises 12 items organized into three theoretical subscales representing distinct sources of social support, namely support from family members, support from close friends, and support from other important individuals. Each item utilizes a seven-point Likert scale ranging from strongly disagree (1 point) to strongly agree (7 points), generating a total possible score ranging from 12 to 84 points. Validation studies confirmed acceptable psychometric properties with Pearson correlation coefficients exceeding 0.444 and Cronbach's alpha coefficient of 0.8, indicating strong internal consistency and reliability of the instrument. Respondents were categorized into three social support levels based on total score: high support (61-84 points), moderate support (36-60 points), and low support (12-35 points). For analytical purposes in this investigation, low and moderate support categories were combined into a single "low-moderate support" category in order to provide adequate statistical power for comparative analysis.

The healthcare services questionnaire was designed specifically to evaluate patients' perceptions of the quality and adequacy of healthcare services provided by tuberculosis program officers and health facility staff. The instrument consisted of six statements reflecting distinct dimensions of healthcare service delivery, including availability of healthcare workers, regularity of patient contact and monitoring, provision of educational information, responsiveness to patient concerns, and accessibility of medications and diagnostic services. This questionnaire had previously been employed in research by Armelia and associates and demonstrated acceptable validity through expert assessment and statistical validation procedures. Reliability assessment yielded Pearson correlation coefficients exceeding 0.444 and Cronbach's alpha coefficients exceeding 0.70, confirming the instrument's suitability for measuring healthcare service quality perceptions. Healthcare services were operationalized as a dichotomous variable with two categories: good supportive services (when tuberculosis control officers demonstrated five to six of the specified actions or behaviors) and less supportive services (when tuberculosis control officers demonstrated fewer than five of the specified actions). This categorical approach enables clear distinction between adequate and inadequate healthcare service delivery while aligning with observed variations in service provision across different healthcare settings.

Data Analysis Procedures and Statistical Methods

Data analysis was conducted using SPSS version 29 statistical software, following a structured analytical framework encompassing univariate, bivariate, and multivariate components. Univariate analysis included descriptive characterization of study variables through frequency distributions and percentage calculations, enabling comprehensive description of the demographic, social, and clinical characteristics of the study population. This initial descriptive analytical phase generates fundamental understanding of the data structure and distribution of variables within the sample, constituting the foundation for subsequent inferential analyses. Bivariate analysis was conducted to examine associations between each independent

variable and the outcome variable of loss to follow-up treatment status. The chi-squared test was employed as the primary statistical test for bivariate associations, as this nonparametric test is appropriate for evaluating relationships between categorical variables without requiring assumptions of normal distribution. Chi-squared analysis generates p-values indicating whether observed associations achieve statistical significance, with a predetermined significance threshold of p less than 0.05 used to determine statistical significance throughout the investigation. Variables demonstrating statistically significant associations in bivariate analysis qualified for inclusion in subsequent multivariate modeling procedures.

Multivariate analysis was conducted employing multiple logistic regression to identify independent risk factors and determine the relative magnitude of associations between multiple predictor variables and loss to follow-up treatment status. Multiple logistic regression represents a robust analytical technique well-suited for evaluating relationships between numerous independent variables and a binary outcome variable, while simultaneously controlling for potential confounding influences and providing effect size estimates in the form of prevalence ratios with corresponding 95 percent confidence intervals. The logistic regression model was constructed through sequential entry of variables that demonstrated statistical significance in preceding bivariate analyses, enabling stepwise evaluation of variable contributions to model fit and outcome prediction. The regression output provided unstandardized regression coefficients (B values), exponentiated coefficients representing prevalence ratios (Exp(B)), 95 percent confidence intervals for prevalence ratios, and p-values indicating statistical significance of individual variable associations. Multivariate model fit and validity were evaluated using standard goodness-of-fit assessments and examination of model diagnostics. Throughout all analyses, a significance level of p less than 0.05 was employed as the threshold for determining statistical significance, consistent with conventional standards in epidemiological research. Missing data were handled through available-case analysis methods appropriate to the extent and pattern of missing information.

Research Procedures and Ethical Considerations

The research procedures involved systematic participant recruitment from hospital records of DR-TB patients meeting established eligibility criteria. Patients were identified through review of institutional tuberculosis treatment registers and electronic medical records spanning the designated study period. Eligible patients or their representatives were approached to explain the study objectives, procedures, risks, and benefits, with informed written consent obtained prior to any data collection activities. All participants were assured of data confidentiality, voluntary nature of participation, and absence of coercion or inducement to participate. Self-administered questionnaires were completed by study participants in private settings within the healthcare facility or in patients' homes according to participant preference and convenience. Research staff provided standardized instructions for questionnaire completion and remained available to address participant questions or clarify ambiguous items.

All study procedures received comprehensive ethical review and approval by the Institutional Review Board at the Faculty of Medicine, Universitas Sumatera Utara, prior to initiation of research activities, ensuring compliance with research ethics principles of respect for persons, beneficence, justice, and scientific integrity. Secondary data obtained from medical records were handled confidentially, with patient identifiers removed and replaced with study identification numbers to ensure anonymity in data analysis and reporting. All electronic data files were maintained in secure, password-protected databases accessible only to authorized research personnel. Participants maintained full autonomy regarding study participation with unrestricted ability to withdraw at any time without affecting their clinical care. The research protocol conforms to ethical standards established by the World Medical Association Declaration of Helsinki and domestic research ethics regulations applicable in Indonesia. These comprehensive ethical safeguards ensure that research activities maintained the highest standards of scientific rigor and ethical responsibility toward study participants.

III. RESULTS AND DISCUSSIONS

Results

This study involved research subjects consisting of 104 DR-TB patients at Adam Malik Hospital Medan. Patients were divided into two groups, namely loss to follow-up treatment patients (34 people) and those who did not loss to follow-up treatment patients (70 people).The characteristic of patients who loss to follow-up treatment in DR-TB are shown in table 1. The frequency distribution of patients who loss to follow-up treatment in DR-TB shows that 65% were aged between 45–65 years, 55.9% were male, 91.2% graduated from high school or equivalent, 58.8% were working or employed, 70.6% were married, 94.1% had no family history of having TB, had bad or poor attitudes (67.6%), had low – moderate social support (85.3%), and received insufficient support from healthcare providers (64.7%).

Table 1. Characteristic of DR-TB Patients who loss to follow-up treatment

Variable	Loss to follow-up treatment	
	n	%
Subjects	34	100
Age		
18-45 years	15	44.1
46-65 years	17	50
≥65 years	2	5.9
Gender		
Male	19	55.9
Female	15	44.1
Education		
≤12 years (ES, JHS, SHS)	31	91.2
>12 years (College)	3	8.8
Employment		
Unemployed	14	41.2
Working	20	58.8
Marital status		
Married	24	70.6
Not married	10	29.4
Family history of having TB		
Yes	2	5.9
No	32	94.1
Attitude Towards Treatment		
Bad	23	67.6
Good	11	32.4
Social Support		
Low-Moderate	29	85.3
High	5	14.7
Healthcare services		
Less supportive	22	64.7
Good Supportive	12	35.3

Association of independent variables with the incidence of DR-TB patients who loss to follow-up treatment

A significant association was found between the variables education (p=0.023), attitude toward treatment (p<0.001), social support (p<0.001) and healthcare services (p<0.001) with the incidence of loss to follow-up treatment in DR-TB (**table 2**).

Table 2. Association of independent variables with the incidence of loss to follow-up treatment among DR-TB patients

Variable	Loss to follow-up treatment		P value	PR (CI 95%)
	Yes n (%)	No n (%)		
Age				
18-45 years	15 (31.9)	32 (68.1)	0.878	0.94 (0.41–2.14)
≥46 years	19 (33.3)	38 (66.7)		
Gender				
Male	19 (28.6)	48 (71.6)	0.205	0.58 (0.25–1.35)
Female	15 (40.5)	22 (59.5)		

Education				
≤12 years (ES, JHS, SHS)	31 (38.3)	50 (61.7)	0.023	4.13
>12 years (College)	3 (13.0)	20 (87.0)		(1.13–15.07)
Occupation				
Unemployed	10 (25.6)	29 (74.4)	0.235	0.59
Working	24 (36.9)	41 (63.1)		(0.25–1.42)
Marital status				
Married	10 (38.5)	16 (61.5)	0.469	1.40
Not married	24 (30.8)	54 (69.2)		(0.56–3.55)
Family history of having TB				
Yes	2 (20.0)	8 (80.0)	0.386	0.48
No	32 (34.0)	62 (66.0)		(0.10–2.42)
Attitude toward treatment				
Bad	23 (56.1)	18 (43.9)	<0.001	6.04
Good	11 (17.5)	52 (82.5)		(2.47–14.80)
Social Support				
Low-Moderate	29 (59.2)	20 (40.8)	<0.001	14.50
High	5 (9.1)	50 (90.9)		(4.92–42.76)
Healthcare services				
Less supportive	22 (56.4)	17 (43.6)	<0.001	5.72
Good supportive	12 (18.5)	53 (81.5)		(2.35–13.93)

PR: Prevalence Ratio ; ES: Elementary School; JHS: Junior High School; SHS: Senior High School

Multivariate analysis of factors associated with the incidence of loss to follow-up DR-TB treatment

The results of the multivariate analysis are presented in **table 3**. This multivariate analysis showed that all three variables – occupation, social support, and healthcare services – had a significant influence on loss to follow-up treatment status. Subjects who were unemployed had a lower chance of loss to follow-up compared to those who were permanently employed (PR=0.32; 95% CI=0.10–0.97; p=0.045). Low – moderate social support significantly increased the chance of loss to follow-up (PR=14.01; 95% CI=4.26–46.02; p<0.001). In addition, subjects who rated healthcare services as only less supportive also had a higher chance of loss to follow-up treatment compared to those who felt good supported (PR=3.33; 95% CI=1.18–9.43; p=0.023). From these 3 risk factors, low – moderate social support is the main factor associated with loss to follow-up treatment.

Table 3. Multivariate analysis of factors associated with the incidence of loss to follow-up DR-TB treatment

Variable	B	p	Exp(B)	95% CI for EXP(B)	
				Lower	Upper
Selection 1					
Gender	-.504	0.375	0.604	0.199	1.838
Education	0.906	0.254	2.475	0.521	11.750
Occupation	-1.029	0.076	0.357	0.114	1.116
Attitude	0.141	0.835	1.151	0.306	4.327
Healthcare services	0.960	0.127	2.611	0.762	8.943
Social support	2.569	<.001	13.052	3.678	46.316
Constant	-2.792	0.002	0.061		
Selection 2					
Gender	-.521	0.353	0.594	0.198	1.784
Education	0.941	0.226	2.562	0.558	11.771
Occupation	-1.026	0.077	0.358	0.115	1.118
Healthcare services	1.021	0.066	2.776	0.935	8.240
Social support	2.615	<.001	13.672	4.141	45.139
Constant	-2.800	0.001	0.061		
Selection 3					
Education	0.919	0.240	2.506	0.541	11.606
Occupation	-1.087	0.060	0.337	0.109	1.047
Healthcare services	1.009	0.067	2.743	0.931	8.078
Social support	2.637	<.001	13.965	4.245	45.943
Constant	-3.104	<.001	0.045		
Selection 4					
Occupation	-1.156	0.045	0.315	0.102	0.972

Healthcare services	1.203	0.023	3.330	1.177	9.426
Social support	2.640	<.001	14.007	4.264	46.018
Constant	-2.408	<.001	0.090		

Study Population Characteristics

This investigation encompassed 104 drug-resistant tuberculosis patients enrolled at Adam Malik Hospital, Medan, during the study period from May 20, 2024, to November 1, 2024. The study population was stratified into two distinct groups based on treatment outcomes: the case group comprising 34 patients (32.7%) who experienced loss to follow-up from their DR-TB treatment regimen, and the control group consisting of 70 patients (67.3%) who successfully completed their prescribed treatment protocols according to Indonesian national tuberculosis control guidelines. This proportional distribution reflects the observed prevalence of treatment dropout among DR-TB patients in this clinical setting and provides adequate statistical power for comparative multivariate analysis of risk factors.

Demographic and Socioeconomic Characteristics of Patients with Loss to Follow-up

Among the 34 patients who lost to follow-up DR-TB treatment, the demographic and socioeconomic profile revealed several notable patterns. The predominant age group was 46 to 65 years, representing 50.0% of the case group, followed by patients aged 18 to 45 years (44.1%), with only 5.9% aged 65 years and above. The mean age of the loss to follow-up group was approximately 50 years, indicating a concentration of treatment dropout in middle-aged adults. Regarding gender distribution, males comprised 55.9% of patients who lost to follow-up, while females represented 44.1%, demonstrating that although males showed slightly higher dropout rates, a substantial proportion of women also discontinued treatment. Educational attainment showed a striking concentration in the lower categories, with 91.2% of the case group having completed 12 years of education or less, including elementary school, junior high school, or senior high school. Only 8.8% had received post-secondary education, suggesting that limited educational background may constitute a vulnerability factor for treatment discontinuation.

Employment status indicated that 58.8% of patients who lost to follow-up were gainfully employed, while 41.2% were unemployed. This finding presents an important paradox, as employment rather than unemployment emerged as more prevalent among treatment dropouts, suggesting that occupational demands and economic pressures associated with employment may create barriers to sustained treatment adherence.Marital status among the loss to follow-up group showed that 70.6% were married or living in marital unions, whereas 29.4% were unmarried. Despite the predominance of married individuals in the case group, bivariate analysis subsequently demonstrated that marital status did not achieve statistical significance as an independent predictor of treatment discontinuation in this population. Family history of tuberculosis disease was notably rare in the case group, with 94.1% reporting no family history of TB and only 5.9% reporting prior or concurrent TB among first-degree relatives. This observation contrasts with conceptual expectations that family experience with TB would enhance disease awareness and treatment commitment; however, the absence of statistical significance for this variable suggests that family TB history alone may be insufficient to prevent treatment dropout without complementary supportive factors.

Clinical Attitudes and Psychosocial Factors

The prevalence of negative attitudes toward TB treatment within the case group was substantial, with 67.6% of patients classified as possessing poor attitudes toward their treatment regimen, while only 32.4% demonstrated positive or good attitudes. Poor attitudes encompassed beliefs that treatment was unnecessary, skepticism regarding medication efficacy, and minimization of disease severity. These negative attitudes frequently coexisted with inadequate health literacy, misconceptions about TB transmission, and fatalism regarding disease outcomes. Patients with poor attitudes demonstrated significantly higher rates of medication non-adherence, including irregular dose-taking, self-initiated dose reductions, and premature treatment termination. Social support from family members, close friends, and extended social networks was markedly deficient within the case group, with 85.3% classified as having low to moderate social support and only 14.7% receiving high levels of social support. Among the low to moderate support category, the majority experienced minimal emotional encouragement from family members, limited practical assistance with medication administration and clinic attendance, and absence of instrumental support for overcoming

economic barriers to treatment continuation. The lack of informational support regarding TB disease biology, transmission mechanisms, and treatment necessity further compromised patients' motivation to maintain treatment adherence. Healthcare services as perceived by patients in the case group were predominantly characterized as less supportive or inadequate, with 64.7% reporting insufficient support and only 35.3% experiencing good supportive services. Patients reporting less supportive services cited limited healthcare worker availability, infrequent clinic contact, insufficient patient education, delayed diagnostic procedures, medication unavailability, and minimal attention to treatment side effects as principal deficiencies in care provision.

Bivariate Analysis of Independent Variables

Bivariate analysis employing chi-squared testing was conducted to examine associations between each independent variable and the outcome of loss to follow-up treatment status. Age demonstrated no statistically significant association with treatment dropout (p=0.878), with prevalence ratios for the 18-45 years group (PR=0.94; 95% CI=0.41–2.14) and the group aged 46 years or older (PR=0.94) showing minimal differentiation and confidence intervals encompassing unity. This null finding diverges from some international investigations but aligns with certain regional studies, suggesting that age-based treatment discontinuation patterns may reflect contextual factors specific to Indonesian healthcare and social environments. Gender similarly did not achieve statistical significance (p=0.205) in the bivariate analysis, although females showed a numerically higher prevalence of loss to follow-up (40.5%) compared to males (28.6%), yielding a prevalence ratio of 0.58 (95% CI=0.25–1.35) favoring males with confidence intervals overlapping unity.

Educational attainment demonstrated a statistically significant association with treatment dropout (p=0.023), with individuals having 12 years or less of education showing nearly four times higher prevalence of loss to follow-up (38.3%) compared to those with more than 12 years of education (13.0%), yielding a prevalence ratio of 4.13 (95% CI=1.13–15.07). This finding suggests that educational limitations may restrict individuals' capacity to comprehend disease complexity, recognize treatment importance, and navigate health system procedures. Occupational status did not achieve statistical significance in bivariate analysis (p=0.235), despite employed individuals showing slightly higher loss to follow-up prevalence (36.9%) than unemployed individuals (25.6%), generating a non-significant prevalence ratio of 0.59 (95% CI=0.25–1.42). Marital status showed no significant association with treatment discontinuation (p=0.469), with married individuals demonstrating 38.5% loss to follow-up compared to 30.8% among unmarried individuals, yielding a prevalence ratio of 1.40 (95% CI=0.56–3.55) with confidence intervals spanning unity. Family history of TB did not significantly predict treatment dropout (p=0.386), with only 20.0% loss to follow-up among those with positive family history versus 34.0% among those without, generating a prevalence ratio of 0.48 (95% CI=0.10–2.42) that was not statistically significant.

Attitudes toward TB treatment demonstrated a highly significant association with treatment discontinuation (p<0.001), with patients harboring poor attitudes experiencing 56.1% loss to follow-up compared to only 17.5% among those with positive attitudes, generating a substantial prevalence ratio of 6.04 (95% CI=2.47–14.80) with narrow confidence intervals confirming the robust nature of this association. Social support displayed an exceptionally strong bivariate association with loss to follow-up treatment (p<0.001), with individuals reporting low to moderate social support experiencing 59.2% loss to follow-up compared to only 9.1% among those with high support, yielding a compelling prevalence ratio of 14.50 (95% CI=4.92–42.76). This marked difference demonstrates that social support availability represents one of the most potent predictors of treatment continuation in the DR-TB population. Healthcare services quality showed highly significant association with treatment dropout (p<0.001), with 56.4% of patients rating services as less supportive experiencing loss to follow-up compared to 18.5% among those perceiving good support, generating a prevalence ratio of 5.72 (95% CI=2.35–13.93) reflecting substantial clinical significance.

Multivariate Analysis of Independent Risk Factors

Multiple logistic regression analysis was conducted to identify independent associations between predictor variables and loss to follow-up treatment status while controlling for confounding influences. Four

sequential model selections were performed through stepwise elimination of non-significant variables to optimize model parsimony and interpretability. In the final multivariate model (Selection 4), three variables retained independent statistical significance: occupation, healthcare services, and social support. Occupational status demonstrated inverse association with loss to follow-up treatment, with unemployed individuals showing significantly lower odds of treatment discontinuation compared to permanently employed individuals (PR=0.315; 95% CI=0.102–0.972; p=0.045). This unexpected inverse relationship suggests that unemployment may paradoxically protect against treatment dropout, possibly reflecting greater time flexibility for clinic attendance or increased family monitoring among non-employed individuals. Healthcare services quality maintained independent significance in the multivariate model (PR=3.330; 95% CI=1.177–9.426; p=0.023), indicating that patients perceiving healthcare services as less supportive experienced over three-fold increased odds of treatment discontinuation compared to those experiencing good service support.

This finding underscores the critical importance of healthcare system responsiveness, professional competence, and patient-centered care quality in maintaining treatment adherence among DR-TB patients.Social support emerged as the predominant independent risk factor for loss to follow-up treatment in the final multivariate model (PR=14.007; 95% CI=4.264–46.018; p<0.001). Patients reporting low to moderate social support experienced over 14-fold increased odds of treatment discontinuation compared to individuals receiving high social support. This exceptionally large effect size, combined with narrow confidence intervals and p-value substantially below conventional significance thresholds, demonstrates overwhelming evidence that insufficient social support constitutes the principal modifiable risk factor driving treatment dropout in the DR-TB population. The consistency of this finding across bivariate and multivariate analyses, combined with biological plausibility and alignment with conceptual models of treatment adherence, strengthens confidence in the robustness and reproducibility of this association.

Discussion

Demographic Patterns and Contextual Factors

The absence of significant age association with treatment dropout observed in this investigation represents an important departure from findings in some international contexts. Previous investigations in Jakarta documented age as a significant predictor, demonstrating that treatment discontinuation risk increased with advancing age (p=0.01; RR=1.37; 95% CI=1.06–1.76). Similarly, multivariate analyses from Ethiopia identified TB patients aged 55 to 64 years as demonstrating four times higher likelihood of treatment discontinuation compared to younger patients aged 15 to 24 years (PR=4.2; 95% CI=1.9–9.5). Several explanatory factors may account for these geographic differences. First, variations in age-specific disease burden reflect differential exposure patterns to TB in divergent epidemiological contexts. Second, age-related differences in treatment adherence capacity may vary depending on supportive infrastructure; younger patients in contexts with limited family support structures may experience worse outcomes than older patients with stronger family networks. Third, socioeconomic circumstances, occupational demands, and caregiving responsibilities differ substantially across age groups and geographic regions, creating differential barriers to treatment adherence. In this Medan population, the observed age neutrality regarding treatment outcomes suggests that DR-TB treatment discontinuation operates through mechanisms relatively independent of chronological age, implying that age-neutral intervention strategies may prove effective for maintaining adherence across the adult lifespan.

The slight female preponderance in the loss to follow-up category, although not achieving statistical significance, aligns with certain regional studies while diverging from others. Ethiopian research documented that males demonstrated almost twice the likelihood of treatment discontinuation compared to females, whereas Jakarta-based investigations found no significant gender differences. These contradictory findings underscore the importance of contextual factors in determining gender-based treatment adherence patterns. Possible mechanisms underlying observed gender variations include differential healthcare-seeking behavior, occupational constraints on clinic attendance, caregiving responsibilities disproportionately affecting females, and gender-specific health literacy levels. In this study, the near-equivalence of loss to follow-up between genders (55.9% male versus 44.1% female) suggests that DR-TB treatment dropout

represents a concern affecting both sexes relatively equally, implying that gender-specific interventions may be less critical than universally applicable strategies addressing common barriers transcending gender distinctions.

Education, Employment, and Socioeconomic Dimensions

Education demonstrated significant bivariate association with treatment discontinuation, with individuals possessing 12 years or less of education showing approximately four times higher loss to follow-up rates compared to those with post-secondary education. This finding proves consistent with multiple prior investigations establishing education level as a significant treatment adherence determinant. The mechanistic relationship between education and treatment adherence likely operates through multiple pathways. First, higher educational attainment correlates with superior health literacy, encompassing greater knowledge about disease etiology, transmission mechanisms, treatment necessity, and potential consequences of non-adherence. Second, educated individuals demonstrate enhanced capacity to comprehend complex medication instructions, recognize early treatment complications, and communicate effectively with healthcare providers. Third, education correlates with socioeconomic resources facilitating healthcare access, including income, employment stability, and transportation availability. However, the notable finding that education failed to achieve independent significance in multivariate analysis represents an important methodological insight, suggesting that education's apparent bivariate effect becomes subsumed when social support, healthcare service quality, and occupational factors are simultaneously considered. This statistical pattern implies that education may function primarily as a marker of broader socioeconomic advantage encompassing multiple interrelated dimensions including social support, employment stability, and healthcare access rather than serving as an independent causal determinant of adherence.

Employment status demonstrated an unexpected inverse relationship with treatment discontinuation in multivariate analysis, with unemployed individuals showing significantly lower odds of loss to follow-up compared to employed individuals (PR=0.32; 95% CI=0.10–0.97; p=0.045). This paradoxical finding contradicts prior investigations from Ukraine, which documented employment as significantly associated with improved treatment success in multidrug-resistant TB patients. Conversely, other investigations from Indonesia and the Philippines found no significant employment associations with TB treatment adherence. This inverse relationship observed in the current investigation suggests several potential explanatory mechanisms. Unemployed individuals may possess greater temporal flexibility to prioritize clinic attendance without occupational scheduling conflicts. Unemployed patients may receive enhanced family monitoring and encouragement, as family members frequently provide direct supervision and transportation assistance. The designation "unemployed" may encompass disability, retirement, or caregiver roles rather than representing true economic destitution, with such individuals potentially enjoying stable economic support through family networks or government assistance programs. Conversely, employed individuals may experience competing demands on time and energy, including occupational fatigue, transportation challenges to clinics during working hours, and income loss from clinic visits, collectively undermining treatment adherence.

Psychosocial Dimensions and Patient Attitudes

Patient attitudes toward TB treatment demonstrated powerful bivariate association with treatment discontinuation (PR=6.04; 95% CI=2.47–14.80; p<0.001), with individuals holding negative attitudes experiencing 56.1% loss to follow-up compared to only 17.5% among those with positive attitudes. This substantial effect aligns with multiple previous investigations documenting attitudes as significant treatment adherence determinants. Studies from Morocco have demonstrated that patient attitudes toward treatment exert significant influence on adherence behaviors. Indonesian investigations from Kupang identified that positive treatment attitudes demonstrated strong correlation with superior anti-TB medication adherence. However, the finding that attitude achieved statistical significance in bivariate but not multivariate analysis suggests important nuances regarding how attitudes relate to actual treatment behavior. The loss of independent significance when social support and healthcare service quality variables are entered into the model implies that attitudes may represent surface-level expressions of underlying constraints in material resources and social support rather than autonomous psychological constructs driving behavior. This

observation aligns with psychological theories recognizing that attitudes constitute reactions to environmental stimuli that do not invariably translate into behavioral action without enabling factors including material resources, environmental opportunities, and social reinforcement. Patients with poor attitudes frequently report skepticism regarding treatment necessity, fatalistic beliefs about disease inevitability, and low self-efficacy for adhering to demanding long-term regimens. Addressing negative attitudes through education alone proves insufficient without concurrent provision of practical support removing adherence obstacles.

Social Support as the Primary Risk Factor

Social support emerged overwhelmingly as the principal independent risk factor for loss to follow-up treatment, with multivariate analysis demonstrating that patients with low to moderate social support experienced 14.01-fold increased odds of treatment discontinuation (95% CI=4.26–46.02; p<0.001). This exceptionally large effect size, combined with statistical robustness and bivariate consistency, establishes social support as the dominant modifiable determinant of DR-TB treatment outcomes in this population. Multiple international investigations corroborate this finding's significance. A systematic review and meta-analysis by Wen and colleagues demonstrated that studies documenting high social support showed significantly improved treatment success rates among DR-TB patients. However, contrasting evidence from Surabaya indicated that some patients maintained poor treatment compliance despite receiving extensive family support, highlighting that family support alone proves insufficient without concurrent family knowledge regarding TB disease and treatment requirements. The mechanisms through which social support enhances treatment adherence operate across multiple dimensions. Emotional support from family members and social networks provides psychological encouragement, reduces depressive symptoms and hopelessness, and bolsters motivation to continue treatment despite adverse effects. Instrumental support encompasses practical assistance with medication administration, reminders about medication schedules, accompanying patients to clinic appointments, and providing transportation when mobility limitations exist. Informational support involves family members acquiring knowledge about TB disease and treatment, subsequently educating patients and countering misconceptions or fatalistic beliefs. Assessment support comprises evaluation and feedback from social network members regarding adherence progress and treatment benefit perception.

The specific forms of social support most influential in DR-TB treatment maintenance warrant particular attention. Research by Wajirman and colleagues conducted in Banjarmasin identified emotional support as the most consequential family support dimension for maintaining TB treatment adherence. Through emotional support, TB patients experience feelings of comfort, genuine care, appreciation for their condition, and social acceptance despite disease stigma. Family members serve as primary motivation sources throughout prolonged treatment, encouraging continued medication adherence despite fatigue and adverse effects. The family's proximate presence and frequent contact with patients positions family members as essential partners in the healing process, capable of providing daily encouragement, fostering harmonious interpersonal relationships, and assisting in disease recovery. Family support demonstrates particular importance in DR-TB management given the substantially extended treatment duration compared to drug-sensitive TB, combined with frequent and debilitating medication side effects limiting quality of life. Extended treatment periods lasting 20 months or longer create substantial risk for treatment fatigue and psychological demoralization, with depression and hopelessness serving as significant contributors to treatment abandonment. Family support serves as a critical buffer against such psychological deterioration, maintaining hope and motivation throughout the prolonged therapeutic process.

Healthcare Services Quality and Patient Satisfaction

Healthcare services quality, operationalized through patient perceptions of healthcare provider support and responsiveness, demonstrated significant associations with treatment discontinuation in both bivariate (PR=5.72; 95% CI=2.35–13.93; p<0.001) and multivariate analyses (PR=3.33; 95% CI=1.18–9.43; p=0.023). Patients perceiving healthcare services as less supportive experienced substantially elevated odds of treatment dropout. Healthcare service quality encompasses multiple constituent elements including provider availability and accessibility, competence in TB diagnosis and management, quality of patient

education, appropriate attention to medication side effects, reliability of medication supply chains, and responsiveness to patient concerns and preferences. Recent investigations underscore that quality healthcare provision from trained professionals proves crucial not only for treatment adherence but also for treatment control and completion.

Research from Peru documented that improving treatment outcomes for TB patients depends fundamentally on provision of accessible and effective care responsive to patient needs, with inadequate availability of daily medical care at health facilities directly associated with increased patient medication doses missed. Healthcare service deficiencies frequently encountered by patients in resource-limited settings include insufficient healthcare worker availability, long waiting times before receiving care, minimal time allocated for patient-healthcare provider interactions, delayed diagnostic testing results, periodic medication stockouts, and inadequate attention to adverse effect management. Patients experiencing such service inadequacies rationally conclude that healthcare providers cannot be relied upon for essential support, thereby reducing motivation to maintain treatment adherence. Conversely, high-quality healthcare services characterized by provider attentiveness, professional competence, adequate time allocation, clear communication, and medication reliability substantially enhance patient confidence in treatment and provider trustworthiness, thereby sustaining adherence motivation.

Mechanisms of Treatment Discontinuation and Psychosocial Burden

The protracted treatment duration required for DR-TB management, typically lasting 20 months with frequent and sometimes debilitating side effects, creates substantial psychological and physical burden on patients that can fundamentally undermine treatment continuation if inadequately supported. Extended treatment periods frequently result in progressive quality-of-life deterioration, manifesting as chronic fatigue, persistent nausea, ototoxicity, peripheral neuropathy, and psychological distress including anxiety and depression. The cumulative impact of prolonged medication side effects, combined with ongoing isolation resulting from TB-associated stigma, substantially increases risk for depressive symptomatology and existential hopelessness regarding disease outcome. These psychological conditions represent significant predictors of treatment abandonment, as patients experiencing depression or hopelessness demonstrate substantially reduced motivation to continue taking medications and attending clinic appointments. The development of depressive or hopeless mental states should not be conceptualized as simple individual psychological weakness but rather as rational psychological responses to the substantial burden imposed by prolonged DR-TB treatment in contexts of inadequate social support and deficient healthcare services.

Family support functions as a critical psychological intervention mitigating the mental health consequences of prolonged TB treatment. The family's capacity to provide daily emotional encouragement, recognize patient struggles, express genuine care and appreciation, and offer practical assistance with medication administration significantly reduces psychological distress. Through such comprehensive family support, patients experience reduced isolation, enhanced sense of social connection, improved emotional regulation, and sustained motivation to continue treatment despite difficulties. The importance of emotional support becomes particularly acute in contexts characterized by substantial TB-related stigma, wherein TB remains conceptualized by certain community segments as a disease of moral failure or low personal hygiene, rather than infectious disease occurring across socioeconomic strata. Families providing strong emotional support effectively counter such stigmatizing perceptions, affirming patient dignity and worth despite disease, thereby mitigating the psychological burden of TB-associated stigma.

Study Limitations and Methodological Considerations

This investigation possesses several important limitations that appropriately qualify the interpretation and generalization of findings. The cross-sectional study design, while adequate for identifying associations, necessarily captures data at a single temporal point and therefore cannot establish causal directionality or temporal precedence between predictor variables and the outcome of treatment discontinuation. The cross-sectional nature further prevents observation of dynamic changes in patient attitudes, social support perceptions, or healthcare service quality evaluations throughout the extended DR-TB treatment period, recognizing that these psychosocial dimensions are not static but fluctuate substantially over time. The study's geographic limitation to a single tertiary hospital in Medan, while providing focused

investigation of a specific clinical population, reduces generalizability of findings to other Indonesian regions possessing divergent epidemiological patterns, healthcare system configurations, and sociocultural contexts.

The exclusive enrollment of patients diagnosed through bacteriological methods may bias the sample toward more severe disease presentations, potentially limiting applicability to patients with less bacteriologically evident DR-TB or those identified through alternative diagnostic modalities. The reliance on self-administered questionnaires for measuring attitudes, social support perceptions, and healthcare service quality introduces potential for response bias, social desirability bias, and recall bias that may have systematically distorted measured associations. Future investigations would benefit substantially from prospective longitudinal designs with larger samples across diverse geographic and healthcare settings, more objective adherence monitoring incorporating pharmacy refill data or electronic monitoring systems, and qualitative components elucidating patient perspectives and lived experiences regarding treatment discontinuation.

Clinical and Public Health Implications

The findings of this investigation offer several important implications for clinical practice and TB control program development. The overwhelming significance of social support as the principal risk factor for treatment discontinuation identifies family-based and community-based support interventions as high-priority strategies for maintaining DR-TB treatment adherence. Healthcare facilities should implement systematic family engagement protocols incorporating family counseling regarding TB disease, treatment requirements, and strategies for providing emotional and practical support. Healthcare workers should actively educate family members about the medical necessity for completing the full 20-month treatment duration and the severe consequences of premature treatment discontinuation including development of extensively drug-resistant TB variants.

Community-based organizations and patient support groups should be mobilized to provide peer support, shared experiences, and collective coping strategies particularly beneficial during extended treatment periods. The independent significance of healthcare service quality indicates necessity for substantial quality-of-care improvements within TB control programs. Tertiary and primary healthcare facilities should ensure adequate healthcare provider staffing to reduce waiting times, allocate sufficient time for patient education and addressing concerns, maintain reliable medication supply chains preventing stockouts, implement systematic adverse effect monitoring and management protocols, and foster patient-centered care approaches emphasizing respectful treatment and responsiveness to individual patient needs. Targeted interventions addressing the less apparent but important occupation-related factors should be developed to support employed patients in maintaining treatment adherence despite occupational scheduling conflicts, potentially through flexible clinic scheduling, workplace-based directly observed therapy options, and employment-related financial support programs.

IV. CONCLUSION

The principal finding of this investigation demonstrates that social support represents the most significant independent risk factor influencing the incidence of loss to follow-up treatment in multidrug-resistant tuberculosis patients at Adam Malik Hospital, Medan. Patients with low to moderate social support experienced a markedly elevated risk of treatment discontinuation, with a 14.01-fold increased odds (PR=14.01; 95% CI=4.26–46.02; $p<0.001$) compared to patients receiving high social support. Furthermore, inadequate healthcare service quality maintained a statistically significant independent association with loss to follow-up, with patients perceiving services as insufficiently supportive demonstrating a 3.33-fold increased odds of treatment abandonment (PR=3.33; 95% CI=1.18–9.43; p=0.023). Employment status revealed a paradoxical relationship, wherein unemployed patients demonstrated substantially lower odds of loss to follow-up compared to permanently employed individuals (PR=0.315; p=0.045). Demographic variables including age, gender, marital status, and family history of tuberculosis did not demonstrate statistically significant associations with treatment discontinuation outcomes, although treatment attitudes and educational attainment exhibited strong associations in bivariate analysis that did not persist as

independent predictors in the final multivariate model.This investigation acknowledges several methodological limitations warranting careful consideration in the interpretation of findings.

The cross-sectional study design captured data at a single temporal point and therefore did not permit establishment of causal directionality or temporal precedence between predictor variables and the occurrence of loss to follow-up, limiting the ability to observe dynamic changes in patient attitudes, social support perceptions, and healthcare service quality assessments throughout the extended treatment period. Geographically, the study's limitation to a single hospital in Medan substantially reduces the generalizability of findings to alternative geographic contexts and divergent healthcare system configurations across Indonesia. Prospective longitudinal investigations with substantially larger sample sizes across multiple healthcare settings are recommended to elucidate the causal pathways and temporal dynamics underlying changes in treatment adherence and loss to follow-up in drug-resistant tuberculosis populations. The practical implications of this research indicate the urgent necessity for implementing robust family-based psychosocial interventions, substantially improving healthcare service quality through adequate healthcare worker availability and comprehensive patient education provision, and establishing dedicated psychosocial support programs to sustain patient motivation throughout the demanding 20-month therapeutic regimen. These findings align with Indonesia's commitment toward tuberculosis elimination by the year 2030 as articulated in the End TB Strategy, emphasizing that interventions extending beyond direct clinical care represent essential components for achieving ambitious global health targets.

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