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Identification of Risk Factors for Mortality Due to Multidrug-Resistant Tuberculosis Among Patients Managed at the Lufungula Tuberculosis Screening and Treatment Center in the National Police Health Zone, Kinshasa Provincial Health Division: A Survival Analysis.

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Abstract

Introduction:

Multidrug-resistant tuberculosis (MDR-TB) is a major public health problem, particularly in sub-Saharan Africa. The Democratic Republic of Congo (DRC) is among the countries with a high burden of tuberculosis and multidrug-resistant tuberculosis. Identifying factors associated with mortality is essential to improving patient management and survival. This study aimed to identify risk factors for mortality among patients with MDR-TB followed at the Lufungula Tuberculosis Screening and Treatment Health Center, in the National Police Health Zone, Kinshasa.

Methods:

A retrospective study was conducted using data from 404 patients aged 20 to 54 years, registered between 2010 and 2019. Exhaustive sampling was used. Data were analyzed using SPSS version 25, R, and Stata 12. Survival analysis was performed using the Kaplan-Meier and Cox methods to identify factors associated with mortality.

Results:

Mortality was significantly higher among patients aged 20–29 years ($p<0.001$). The main factors associated with mortality were treatment interruption ($p=0.044$), treatment failure ($p=0.001$), relapse ($p<0.001$), missed appointments ($p<0.001$), tobacco use ($p=0.013$), alcohol consumption ($p=0.048$), and a family history of MDR-TB ($p<0.001$). Shorter survival was also observed among patients who were unaware of their MDR-TB status and those who experienced treatment failure, relapse, or poor treatment adherence.

Conclusion:

Mortality related to MDR-TB is associated with sociodemographic, behavioral, and therapeutic factors. Strengthening early diagnosis, therapeutic education, patient follow-up, and treatment adherence is essential to improving patient survival.

Keywords: *risk factors; mortality; multidrug-resistant tuberculosis; survival; treatment adherence; Kinshasa; Democratic Republic of Congo.*
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I. INTRODUCTION

Tuberculosis (TB) remains one of the leading causes of infectious morbidity and mortality worldwide. According to the most recent estimates from the World Health Organization (WHO), approximately 10.7 million people developed tuberculosis in 2024, and 1.23 million died from the disease, including approximately 150,000 people living with HIV. Tuberculosis therefore remains the leading cause of death from a single infectious agent worldwide (World Health Organization [WHO], 2025.

The situation is particularly concerning in Africa, where TB remains strongly associated with poverty, HIV co-infection, limited access to diagnosis, and treatment interruptions. In 2024, approximately 57,000 people developed multidrug-

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resistant or rifampicin-resistant tuberculosis (MDR/RR-TB) in the WHO African Region, representing approximately 15% of the estimated global MDR/RR-TB burden. Despite a global downward trend since 2015, drug resistance remains a major threat to achieving the objectives of the End TB Strategy (WHO, 2025).

Multidrug-resistant tuberculosis (MDR-TB) is a form of tuberculosis caused by a strain of *Mycobacterium tuberculosis* resistant to at least rifampicin and isoniazid, the two main first-line anti-tuberculosis drugs. The MDR/RR-TB category also includes rifampicin-resistant forms. Drug resistance may result from inappropriate prescribing, poor-quality medicines, treatment interruptions, or poor adherence; however, it may also be transmitted directly from one person to another (WHO, 2024)

The burden of MDR-TB remains considerable. In 2024, approximately 390,000 people were estimated to have developed MDR/RR-TB worldwide, with an uncertainty interval of 360,000–430,000 cases. At the same time, access to treatment remains inadequate: WHO data indicate that only approximately two out of five people with drug-resistant tuberculosis received treatment in 2024. This diagnostic and therapeutic gap contributes to ongoing community transmission and worsens the prognosis of patients who are not diagnosed and treated promptly (WHO, 2025)

Recent therapeutic advances have nevertheless substantially changed the management of MDR/RR-TB. Shorter, fully oral regimens, particularly six-month regimens based on bedaquiline, linezolid, and fluoroquinolones, are now preferred for eligible patients. In April 2025, WHO specifically recommended the BDLLfxC regimen, a six-month, all-oral treatment regimen for MDR/RR-TB, including patients with or without fluoroquinolone resistance in the situations specified by the guidelines. These innovations have the potential to reduce treatment duration, exposure to adverse effects, and difficulties related to treatment adherence (WHO, 2025).

This evolution has been accompanied by improvements in treatment outcomes. The global proportion of patients with MDR/RR-TB who achieved treatment success increased from 50% in 2012 to 64% in 2020, 68% in 2021, and 71% in 2022. Nevertheless, these outcomes remain lower than those observed among patients with drug-susceptible tuberculosis, for whom the global treatment success rate reached 88% in 2023 (WHO, 2025).

African data confirm substantial disparities. A systematic review and meta-analysis conducted in Central and West Africa estimated an overall MDR/RR-TB treatment success rate of 74.6%, with 80.8% in Central Africa and 69.2% in West Africa. However, the authors reported substantial heterogeneity between studies and limited availability of data from several countries (Toft et al., 2022).

Mortality nevertheless remains a major concern, particularly among patients with unfavorable prognostic factors. In Uganda, a case-control study showed that HIV co-infection, poor treatment adherence, age above 50 years, and lack of formal education were significantly associated with mortality during MDR-TB treatment. Poor adherence was associated with nearly twice the risk of death (aOR = 1.92), whereas age above 50 years was associated with an approximately threefold higher risk (aOR = 3.04) (Kizito et al., 2021).

Other African studies have shown that mortality is also associated with the accumulation of poor prognostic factors. A national study conducted in Uganda reported that anemia, previous exposure to second-line drugs, and the accumulation of several unfavorable prognostic indicators were associated with reduced treatment success and increased mortality. Each additional unfavorable prognostic factor was associated with a significant increase in the risk of death Alupo P, Wosu AC, Mahofa A, et al., 2021).

A systematic review of tuberculosis-related mortality in South Africa highlighted the particularly poor prognosis associated with drug-resistant forms of the disease. The pooled case-fatality rate was estimated at 37.5% (95% CI: 24.8–50.3) among patients with drug-resistant tuberculosis, compared with 12.5% (95% CI: 1.1–23.9) among those with drug-susceptible tuberculosis. These findings underscore the high mortality burden associated with drug-resistant tuberculosis and the need for timely diagnosis, effective treatment, and close clinical follow-up (Nicholson et al., 2023).

TB/HIV co-infection is also an important determinant of prognosis. A meta-analysis of patients with MDR-TB in Africa and Asia found that mortality was significantly higher among HIV-co-infected patients, with a relative risk of death of 1.35 compared with HIV-negative patients (Kajogoo et al., 2022). These findings indicate that MDR-TB management should systematically incorporate HIV testing, access to antiretroviral therapy, and management of comorbidities (Kajogoo et al., 2022).

In the Democratic Republic of the Congo (DRC), tuberculosis remains a major public health concern. The country is among the 30 countries classified by the WHO as having a high burden of multidrug-resistant or rifampicin-resistant tuberculosis (MDR/RR-TB). In 2023, only 22% of people with bacteriologically confirmed pulmonary TB in the DRC were tested for rifampicin resistance, compared with the WHO-recommended target of testing all people

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with bacteriologically confirmed TB. In 2024, testing coverage increased to 35%, representing a substantial improvement but remaining well below the 80% level achieved by most high MDR/RR-TB burden countries and below 50% in the DRC. This persistent diagnostic gap may delay the identification of drug-resistant TB and the initiation of appropriate treatment (WHO, 2024, 2025).

This diagnostic gap is particularly important because rapid identification of drug resistance determines the appropriate treatment regimen and contributes to prevention of transmission. In 2023, WHO still classified MDR/RR-TB treatment coverage in the DRC among the lowest levels reported in high-burden countries, at less than 20%. This situation reflects a substantial gap between people likely to develop MDR/RR-TB and those who are actually diagnosed and initiated on treatment (WHO, 2024).

The DRC also has a substantial overall tuberculosis burden. WHO data estimate TB incidence at approximately 385 cases per 100,000 population in 2023, with a considerable uncertainty interval, reflecting the magnitude of transmission and persistent challenges in case detection (WHO, 2025).

The situation in Kinshasa deserves particular attention because of its large population and concentration of specialized healthcare services. A retrospective cohort study conducted in Kinshasa among patients with pre-XDR and XDR-TB reported a treatment success rate of 53.2% and a mortality rate of 46.8% among the 32 patients who initiated a bedaquiline-containing regimen. TB/HIV co-infection was particularly unfavorable, as all three co-infected patients died during treatment (Kashongwe et al., 2020). Although these findings were derived from a small, specialized cohort treated between 2015 and 2017 with individualized, bedaquiline-containing regimens, they illustrate the severity of advanced drug-resistant tuberculosis in Kinshasa and the substantial mortality that was observed even with access to bedaquiline-based treatment.

Recent changes in TB management in the DRC should nevertheless be interpreted in light of international therapeutic advances. In 2023, the DRC was already widely using nine-month, all-oral regimens for eligible patients with MDR/RR-TB, while international recommendations issued in 2024–2025 progressively strengthened the role of six-month regimens. This transition represents an important opportunity to improve treatment adherence, reduce loss to follow-up, and improve clinical outcomes (WHO, 2024, 2025).

Thus, the current MDR-TB problem in the DRC is no longer limited to drug availability. It also involves early detection of drug resistance, effective access to treatment, treatment adherence, continuity of care, management of comorbidities, psychosocial and nutritional support, and health-system organization. Recent evidence indicates that individual, clinical, and organizational determinants interact in contributing to deaths and treatment failures. In this context, investigating factors associated with mortality and treatment outcomes among patients with MDR-TB in Kinshasa is scientifically and operationally relevant.

Accordingly, the following research question was formulated: What sociodemographic, cultural, environmental, clinical, and treatment-related factors are associated with mortality among patients aged 20–54 years with multidrug-resistant tuberculosis who were followed at the Lufungula Tuberculosis Screening and Treatment Center, located in the National Police Health Zone, Kinshasa Provincial Health Division, Democratic Republic of the Congo, between 2010 and 2019?

We hypothesized that sociodemographic, cultural, environmental, clinical, and treatment-related characteristics, particularly poor adherence to anti-tuberculosis treatment, previous anti-tuberculosis treatment, comorbidities, HIV status, nutritional status, severe clinical forms of disease, and difficulties in accessing or maintaining continuity of care, would be significantly associated with an increased risk of mortality among patients aged 20–54 years with MDR-TB followed at the Lufungula Tuberculosis Screening and Treatment Center between 2010 and 2019.

The main objective of this study was to analyze the sociodemographic, cultural, environmental, clinical, and treatment-related factors associated with mortality among patients aged 20–54 years with multidrug-resistant tuberculosis who were followed at the Lufungula Tuberculosis Screening and Treatment Center, National Police Health Zone, Kinshasa Provincial Health Division, between 2010 and 2019.

To achieve this objective, the following specific objectives were established:

1. To describe the sociodemographic, cultural, and environmental characteristics of patients aged 20–54 years with MDR-TB followed at the Lufungula Tuberculosis Screening and Treatment Center between 2010 and 2019.
2. To determine the association between treatment adherence and mortality among patients with MDR-TB followed at this center.
3. To identify clinical and biological factors, particularly HIV status, comorbidities, previous anti-tuberculosis treatment, relapse, and disease characteristics, associated with the risk of death.

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4. To assess the influence of treatment-related and organizational factors, particularly treatment interruptions, continuity of care, medical follow-up, and difficulties in accessing treatment, on patient survival.
5. To estimate the probability of survival and the instantaneous risk of death during follow-up and, using the Cox proportional hazards model, identify factors independently associated with mortality among patients with MDR-TB.

II. METHODS

2.1. Study Design

This was a retrospective observational analytical longitudinal study based on the medical records of patients diagnosed with multidrug-resistant tuberculosis (MDR-TB) and managed at the Lufungula Tuberculosis Screening and Treatment Center.

2.2. Study Setting and Period

The study was conducted at the Lufungula Tuberculosis Screening and Treatment Center, located in the National Police Health Zone, Kinshasa Provincial Health Division, Democratic Republic of the Congo. Medical records of eligible patients managed between 2010 and 2019 were reviewed.

2.3. Participants and Eligibility Criteria

The study included patients aged 20–54 years with a documented diagnosis of MDR-TB who were managed at the study center during the study period. Patients were eligible if their medical records contained sufficient information to determine treatment outcome and survival status. Records with insufficient information to establish the primary outcome were excluded. Exhaustive sampling was used, and all eligible patients identified during the study period were included. A total of 404 patients were therefore included in the analysis.

2.4. Bias

To minimize selection bias, all eligible patients identified during the study period were included through exhaustive sampling. Data were extracted from medical records using predefined variables and were checked for consistency and completeness. Potential confounding was addressed using multivariable Cox proportional hazards regression.

2.5. Variables and Outcomes

The primary outcome was death from any cause during follow-up. Survival time was defined as the time from initiation of MDR-TB treatment to death or the end of follow-up for patients who remained alive. The explanatory variables included age, sex, marital status, educational level, socioeconomic status, history of tuberculosis, relapse, treatment adherence, treatment interruption, comorbidities, HIV status, and treatment-related characteristics.

2.6. Ethical Considerations

The study was conducted in accordance with the principles of research ethics, confidentiality, and respect for participants' rights. Ethical approval was obtained from the Bioethics Committee of the Institut Supérieur des Techniques Médicales (ISTM) of Kinshasa, Democratic Republic of the Congo, under approval number 0029/CBE/ISTM/KIN/RDC/PMBBL/2019, dated November 25, 2019**.** The study was conducted within the framework of a doctoral thesis.

Authorization to access the patients' medical records was obtained from the relevant health authorities. Patient confidentiality was maintained throughout data collection, data management, analysis, and reporting. Personal identifiers were removed from the analytical database, and the data were used exclusively for scientific research purposes.

2.7. Statistical Analysis

Data were entered, cleaned, and analyzed using SPSS, R, and Stata. Descriptive statistics were used to summarize the characteristics of the study population. Associations between categorical variables were assessed using the chi-square (χ^2) test or Fisher's exact test, as appropriate. Survival probabilities were estimated using the Kaplan–Meier method, and survival curves were compared using the log-rank test. Factors associated with mortality were initially assessed using univariable Cox proportional hazards regression. Variables considered statistically significant and/or clinically relevant were subsequently entered into a multivariable Cox proportional hazards model to control for potential confounding.

Results were reported as hazard ratios (HRs) with 95% confidence intervals (CIs). The proportional hazards assumption was assessed to verify the validity of the Cox regression model. Statistical significance was set at $p < 0.05$. Records with missing information required for the analysis were excluded, and no imputation of missing data was performed.

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III. RESULTS

3.1. Univariate Analysis

Table 1. Sociodemographic characteristics of the study participants (n = 404)

Variable	Category	Deaths, n (%)	Survivors, n (%)	*p*-value
Age (median [IQR])	—	25.00 [23.00, 28.00]	35.00 [27.00, 40.00]	<0.001
Age (%)	20–29 years	67 (77.0)	121 (38.2)	<0.001
	30–44 years	12 (13.8)	148 (46.7)	
	>44 years	8 (9.2)	48 (15.1)	
Sex (%)	Female	24 (27.6)	83 (26.2)	0.889
	Male	63 (72.4)	234 (73.8)	
Occupation (%)	Trader	27 (31.0)	71 (22.4)	0.045
	Teacher	18 (20.7)	56 (17.7)	
	Student	10 (11.5)	31 (9.8)	
	Homemaker	6 (6.9)	47 (14.8)	
	Police officer	8 (9.2)	64 (20.2)	
	Unemployed	18 (20.7)	48 (15.1)	
Educational level (%)	No formal education	9 (10.3)	54 (17.0)	0.312
	Primary education	25 (28.7)	71 (22.4)	
	Secondary education	42 (48.3)	162 (51.1)	
	University education	11 (12.6)	30 (9.5)	
Marital status (%)	Single	18 (20.7)	83 (26.2)	0.684
	Divorced	12 (13.8)	40 (12.6)	
	Married	41 (47.1)	149 (47.0)	
	Widowed	16 (18.4)	45 (14.2)	
Tailman (median [IQR])	—	6.00 [5.00, 6.00]	6.00 [5.00, 6.00]	0.413
Religion (%)	Other	7 (8.0)	16 (5.0)	0.601
	Catholic	39 (44.8)	134 (42.3)	
	Revival Church	13 (14.9)	47 (14.8)	
	Protestant	28 (32.2)	120 (37.9)	
Meals per day (%)	Twice daily	76 (87.4)	283 (89.3)	0.027
	Three times daily	11 (12.6)	34 (10.7)	

The median age was significantly higher among survivors than among patients who died **(**35.0 vs. 25.0 years; p < 0.001**).** Mortality was significantly higher among patients aged 20–29 years **(**77.0% vs. 38.2%; p < 0.001**).** No significant difference was observed by sex (*p* = 0.889). Occupation was significantly associated with mortality (*p* = 0.045), with a higher proportion of deaths among traders **(**31.0% vs. 22.4%**).** Educational level, marital status, and religion were not significantly associated with mortality (*p* = 0.312, 0.684, and 0.601, respectively). The number of daily meals was significantly associated with mortality (*p* = 0.027), with deaths being more frequent among patients consuming two meals per day **(**87.4%**)** than among those consuming three meals **(**12.6%**).**

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Table 2. Treatment-Related Characteristics

Variable	Category	Deaths, n (%)	Survivors, n (%)	*p*-value
Knowledge of multidrug-resistant tuberculosis (%)	No	52 (59.8)	208 (65.6)	0.470
	Yes	35 (40.2)	109 (34.4)	
Treatment interruption (%)	No	42 (48.3)	195 (61.5)	0.044
	Yes	45 (51.7)	122 (38.5)	
Failure to comply with dosage (%)	No	38 (43.7)	126 (39.7)	0.522
	Yes	49 (56.3)	191 (60.3)	
Treatment discontinuation (%)	No	48 (55.2)	165 (52.1)	0.599
	Yes	39 (44.8)	152 (47.9)	
Temporary treatment interruption (%)	No	56 (64.4)	172 (54.3)	0.088
	Yes	31 (35.6)	145 (45.7)	
Drug stock-out (%)	No	40 (46.0)	163 (51.4)	0.510
	Yes	47 (54.0)	154 (48.6)	
Contact (%)	No	35 (40.2)	113 (35.6)	0.450
	Yes	52 (59.8)	204 (64.4)	
Treatment duration, months (mean [SD])	—	10.00 [9.00, 11.00]	9.00 [8.00, 9.00]	<0.001
Treatment failure (%)	No	38 (43.7)	227 (71.6)	<0.001
	Yes	49 (56.3)	90 (28.4)	
Relapse (%)	No	39 (44.8)	212 (66.9)	<0.001
	Yes	48 (55.2)	105 (33.1)	
Missed appointments (%)	No	23 (26.4)	157 (49.5)	<0.001
	Yes	64 (73.6)	160 (50.5)	
Tobacco use (%)	No	41 (47.1)	201 (63.4)	0.013
	Yes	46 (52.9)	116 (36.6)	
Alcohol consumption (%)	No	32 (36.8)	155 (48.9)	0.048
	Yes	55 (63.2)	162 (51.1)	
Family history of MDR-TB (%)	No	38 (43.7)	239 (75.4)	<0.001
	Yes	49 (56.3)	78 (24.6)	

The mean treatment duration was significantly longer among patients who died than among survivors (10.00 [9.00–11.00] vs. 9.00 [8.00–9.00] months; $p < 0.001$). Regarding treatment-related characteristics, no statistically significant differences were observed for knowledge of MDR-TB ($p = 0.470$), dosage non-adherence ($p = 0.522$), treatment discontinuation ($p = 0.599$), temporary treatment interruption ($p = 0.088$), drug stock-outs ($p = 0.510$), or contact history ($p = 0.450$).

However, treatment interruption was significantly more frequent among patients who died (51.7% vs. 38.5%; $p = 0.044$). Treatment failure was also significantly more common among deaths (56.3% vs. 28.4%; $p < 0.001$), as were relapse (55.2% vs. 33.1%) and missed appointments (73.6% vs. 50.5%; both $p < 0.001$). Similarly, tobacco use (52.9% vs. 36.6%; $p = 0.013$), alcohol consumption (63.2% vs. 51.1%; $p = 0.048$), and family history of MDR-TB (56.3% vs. 24.6%; $p < 0.001$) were significantly more frequent among patients who died. These variables were therefore considered potential risk factors for MDR-TB-related mortality.

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3.2. SURVIVAL ANALYSIS

Table 3. Comparison of the median survival time to MDR-TB-related death according to patients' age groups

Age group	Mean survival time				Median survival time			
	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound
20–29 years	11.142	0.357	10.443	11.841	11.000	0.231	10.546	11.454
30–44 years	12.283	0.389	11.521	13.046	12.000	0.426	11.165	12.835
>44 years	11.177	0.281	10.627	11.727	11.000	0.473	10.073	11.927
Overall	11.779	0.401	10.993	12.566	11.000	0.238	10.534	11.466

Note: CI = Confidence Interval; MDR-TB = multidrug-resistant tuberculosis.

a. The estimate is limited to the largest survival time if it is censored.

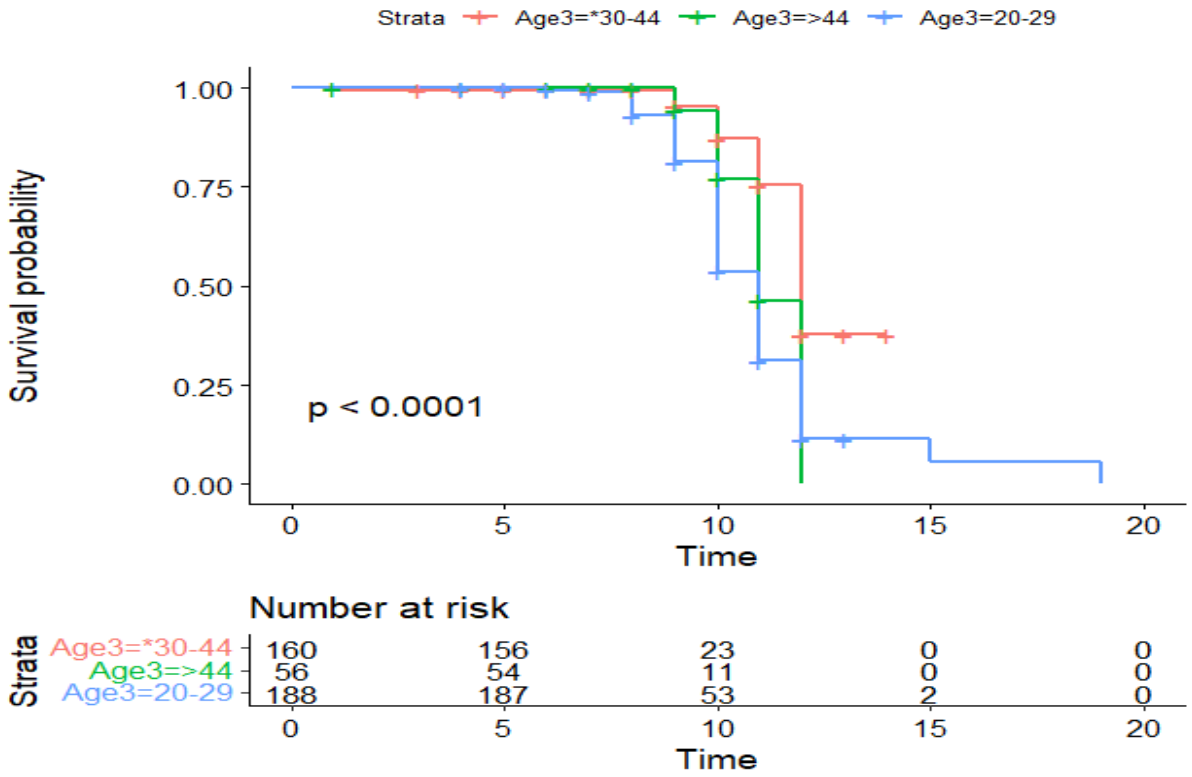

Fig. 1. Comparison of survival curves for MDR-TB-related mortality according to patients' age groups.

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Regarding Table 3 and Figure 1, the results indicate that patients aged 20–29 years and those aged 45 years and older had shorter survival times than patients aged 30–44 years. The difference was statistically significant ($p < 0.0001$).

Table 4. Comparison of the median survival time to MDR-TB-related death according to patients' sex

Mean and median survival times

Sex	Mean survival time				Median survival time			
	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound
Male	11.828	0.458	10.930	12.725	11.000	0.243	10.523	11.477
Female	11.245	0.328	10.602	11.888	12.000	0.447	11.124	12.876
Overall	11.779	0.401	10.993	12.566	11.000	0.238	10.534	11.466

Note: *CI = Confidence Interval; MDR-TB = multidrug-resistant tuberculosis.*

a. The estimate is limited to the largest survival time if it is censored.

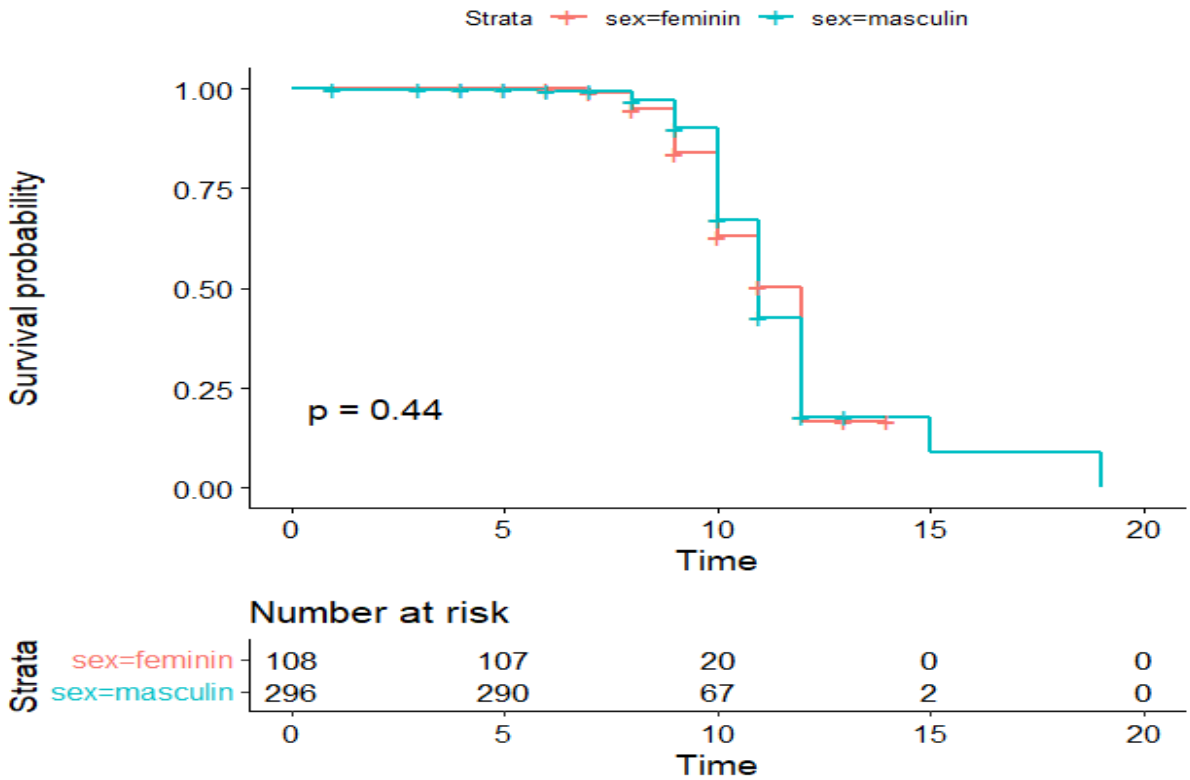

Figure 2. Comparison of survival curves for MDR-TB-related mortality according to sex.

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Regarding Table 4 and Figure 2, the results indicate that men died earlier from multidrug-resistant tuberculosis than women. However, the difference was not statistically significant ($p = 0.44$).

Table 5. Comparison of the median survival time to MDR-TB-related death according to knowledge of MDR-TB

Mean and median survival times

Knowledge of MDR-TB	Mean survival time				Median survival time			
	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound
No	12.164	0.506	11.173	13.155	12.000	0.205	11.598	12.402
Yes	10.753	0.264	10.235	11.271	11.000	0.240	10.530	11.470
Overall	11.779	0.401	10.993	12.566	11.000	0.238	10.534	11.466

Note: *MDR-TB = multidrug-resistant tuberculosis; CI = confidence interval.*

a. The estimate is limited to the largest survival time if it is censored.

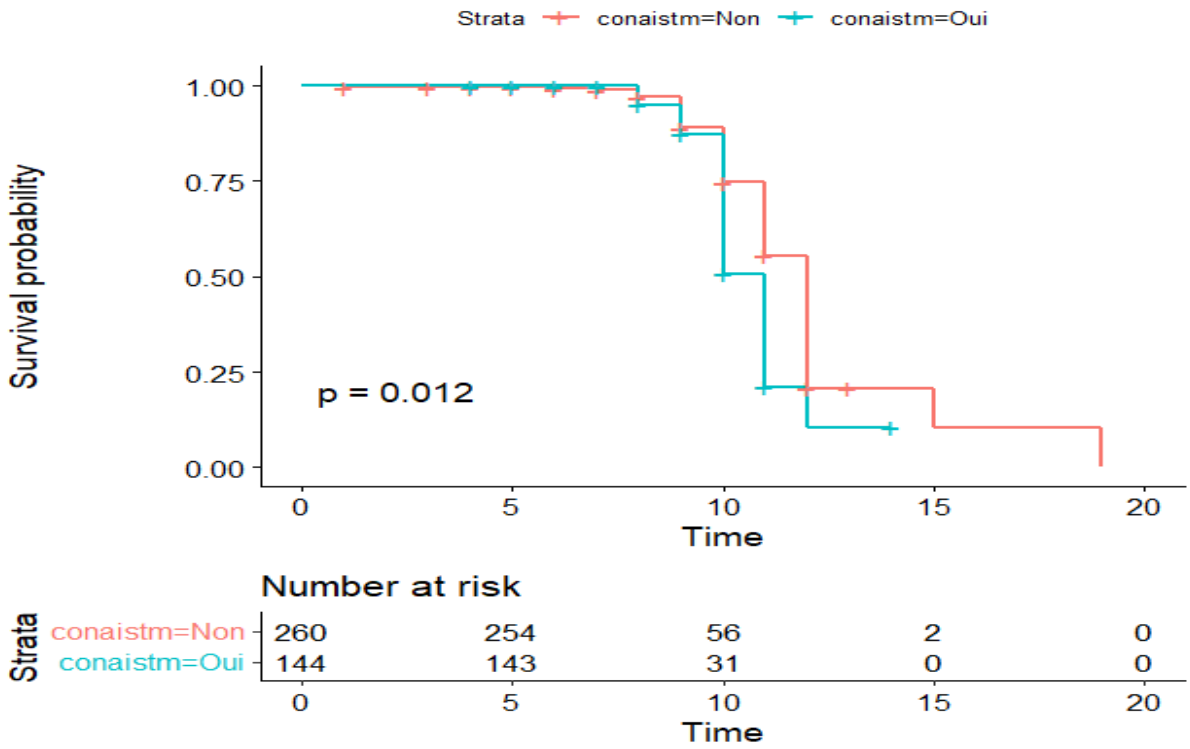

Figure 3. Comparison of survival curves for MDR-TB-related mortality according to patients' knowledge of multidrug-resistant tuberculosis.

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Regarding Table 5 and Figure 3, the results revealed that patients who were unaware that they had multidrug-resistant tuberculosis died earlier from MDR-TB than those who were aware of their condition**.** This difference was statistically significant ($p = 0.012$).

Table 6. Comparison of the median survival time to MDR-TB-related death according to treatment outcome

Mean and median survival times

Treatment failure	Mean survival time				Median survival time			
	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound
No	11.821	0.262	11.307	12.334	12.000	0.405	11.207	12.793
Yes	10.778	0.323	10.145	11.411	11.000	0.265	10.480	11.520
Overall	11.779	0.401	10.993	12.566	11.000	0.238	10.534	11.466

Note: *MDR-TB = multidrug-resistant tuberculosis; CI = confidence interval.*

a. The estimate is limited to the largest survival time if it is censored.

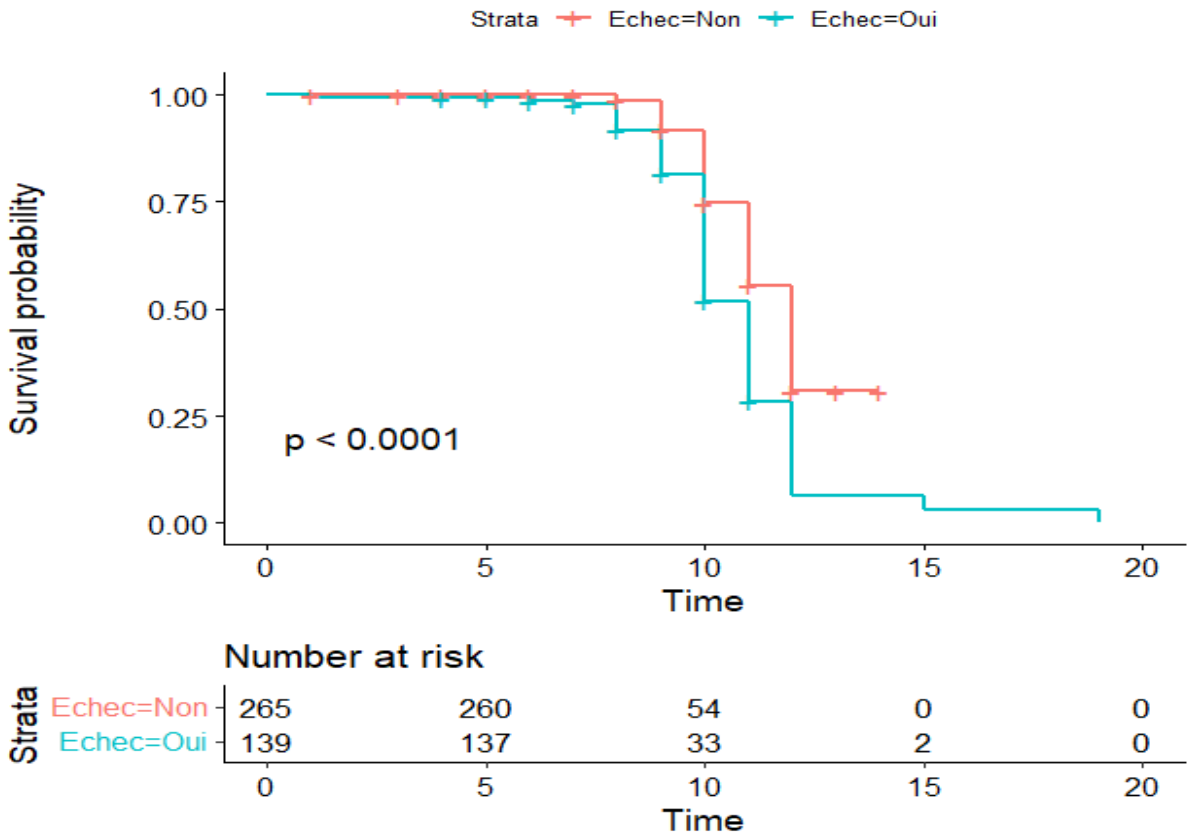

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Figure 4. Comparison of survival curves for MDR-TB-related mortality according to treatment outcome.

Regarding Table 6 and Figure 4, the results indicate that patients who experienced treatment failure had a shorter median survival time than those who did not experience treatment failure. The difference was statistically significant ($p < 0.0001$).

Table 7. Comparison of the median survival time to MDR-TB-related death according to bacteriological relapse

Mean and median survival times

Bacteriological relapse	Mean survival time				Median survival time			
	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound
No	13.862	0.744	12.404	15.320	12.000	0.607	10.810	13.190
Yes	10.745	0.197	10.359	11.131	11.000	0.293	10.426	11.574
Overall	11.779	0.401	10.993	12.566	11.000	0.238	10.534	11.466

Note: *MDR-TB = multidrug-resistant tuberculosis; CI = confidence interval.*

a. The estimate is limited to the largest survival time if it is censored.

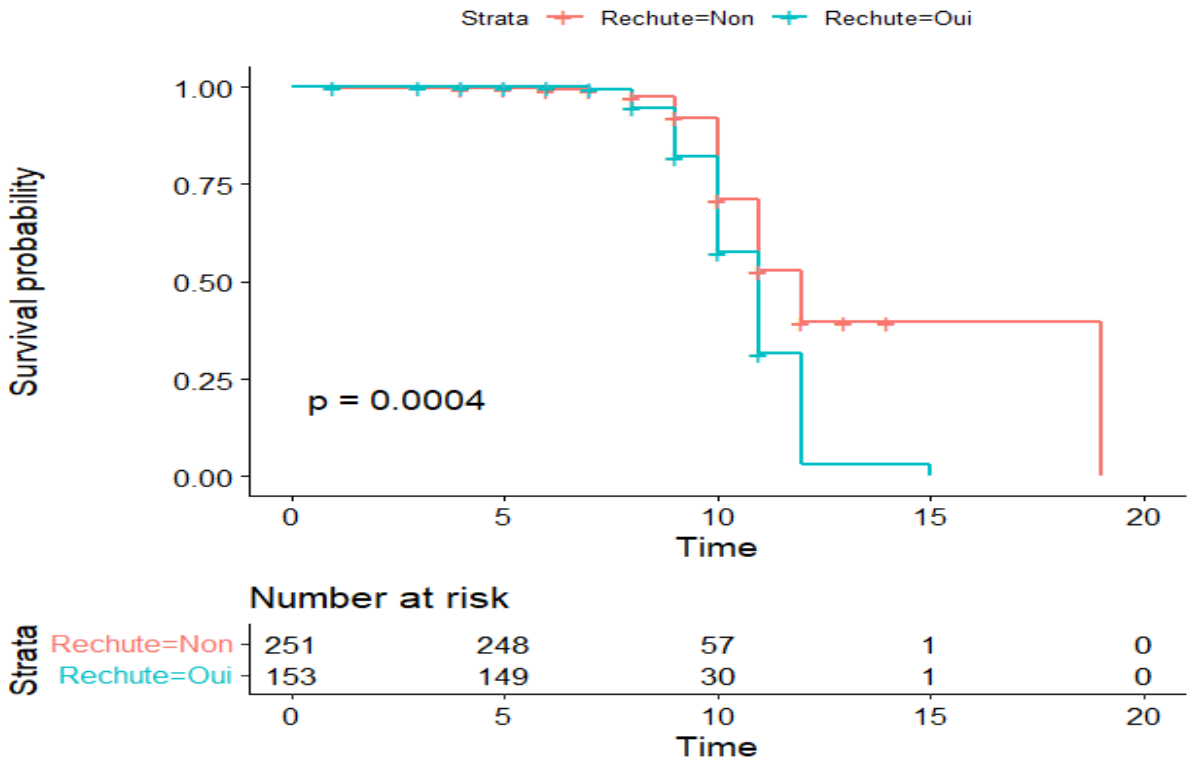

Figure 5. Comparison of survival curves for MDR-TB-related mortality according to bacteriological relapse

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Regarding Table 7 and Figure 5, the results indicate that patients with a history of relapse died earlier from multidrug-resistant tuberculosis than those without a history of relapse**.** The difference was statistically significant ($p = 0.0004$).

Table 8. Comparison of the median survival time to MDR-TB-related death according to adherence to medical appointments.

Mean and median survival times

Missed medical appointments	Mean survival time				Median survival time			
	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound	Estimate	Standard Error	95% CI Lower Bound	95% CI Upper Bound
No	12.212	0.347	11.531	12.893	12.000	—	—	—
Yes	11.043	0.286	10.482	11.604	11.000	0.211	10.586	11.414
Overall	11.779	0.401	10.993	12.566	11.000	0.238	10.534	11.466

Note: *MDR-TB = multidrug-resistant tuberculosis; CI = confidence interval.*

a. The estimate is limited to the largest survival time if it is censored.

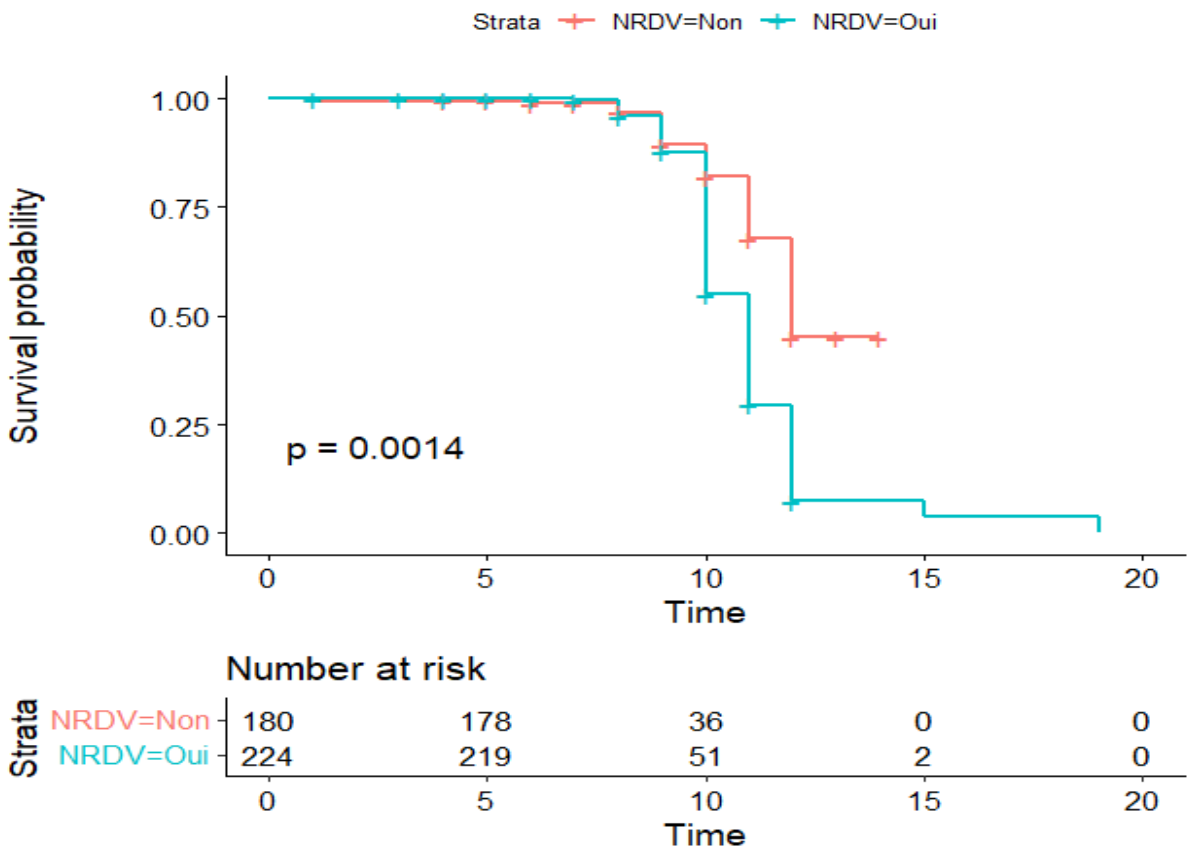

Figure 6. Comparaison de courbes de survie de décès dû à la TB - MR selon le rendez-vous médical

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Regarding Table 8 and Figure 6

The results presented in Table 8 and Figure 6 indicate that patients who did not adhere to their medical appointments experienced earlier death from multidrug-resistant tuberculosis (MDR-TB) than those who adhered to their appointments. The difference was statistically significant ($p = 0.0004$).

Table 9. Comparison of the Median Survival Time to Death from MDR-TB According to Tobacco Use

Means and Medians for Survival Time

Tobacco use	Mean		95% Confidence Interval		Median		95% Confidence Interval	
	Estimate	Standard Error	Lower Bound	Upper Bound	Estimate	Standard Error		
No	12.751	0.615	11.545	13.957	12.000	0.194		
Yes	10.225	0.114	10.001	10.449	10.000	0.194		
Overall	11.779	0.401	10.993	12.566	11.000	0.238		

Note: The estimate is limited to the largest survival time if censored.

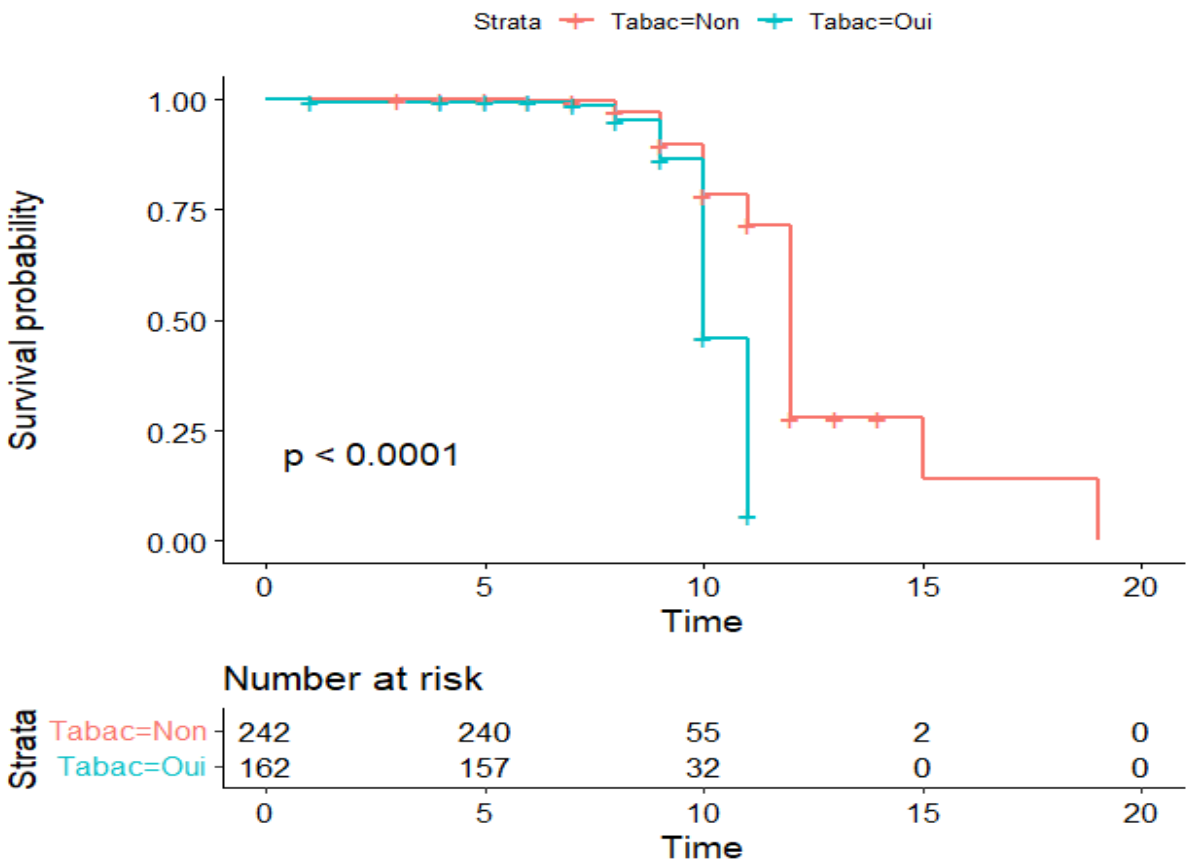

Figure 7. Comparison of Survival Curves for Death from MDR-TB According to Tobacco Use

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Regarding Table 9 and Figure 7, the results show that 50% of patients who smoked tobacco died from multidrug-resistant tuberculosis (MDR-TB) earlier, compared with non-smokers, who had a median survival time of 12 months. The difference was statistically significant ($p < 0.0001$).

Table 10. Comparison of the Median Survival Time to Death from MDR-TB According to Alcohol Use

Means and Medians for Survival Time

Alcohol use	Mean		95% Confidence Interval		Median		95% Confidence Interval	
	Estimate	Standard Error	Lower Bound	Upper Bound	Estimate	Standard Error		
No	13.033	0.767	11.530	14.536	12.000	0.282		
Yes	10.660	0.115	10.435	10.885	11.000	0.160		
Overall	11.779	0.401	10.993	12.566	11.000	0.238		

Note: The estimate is limited to the largest survival time if censored.

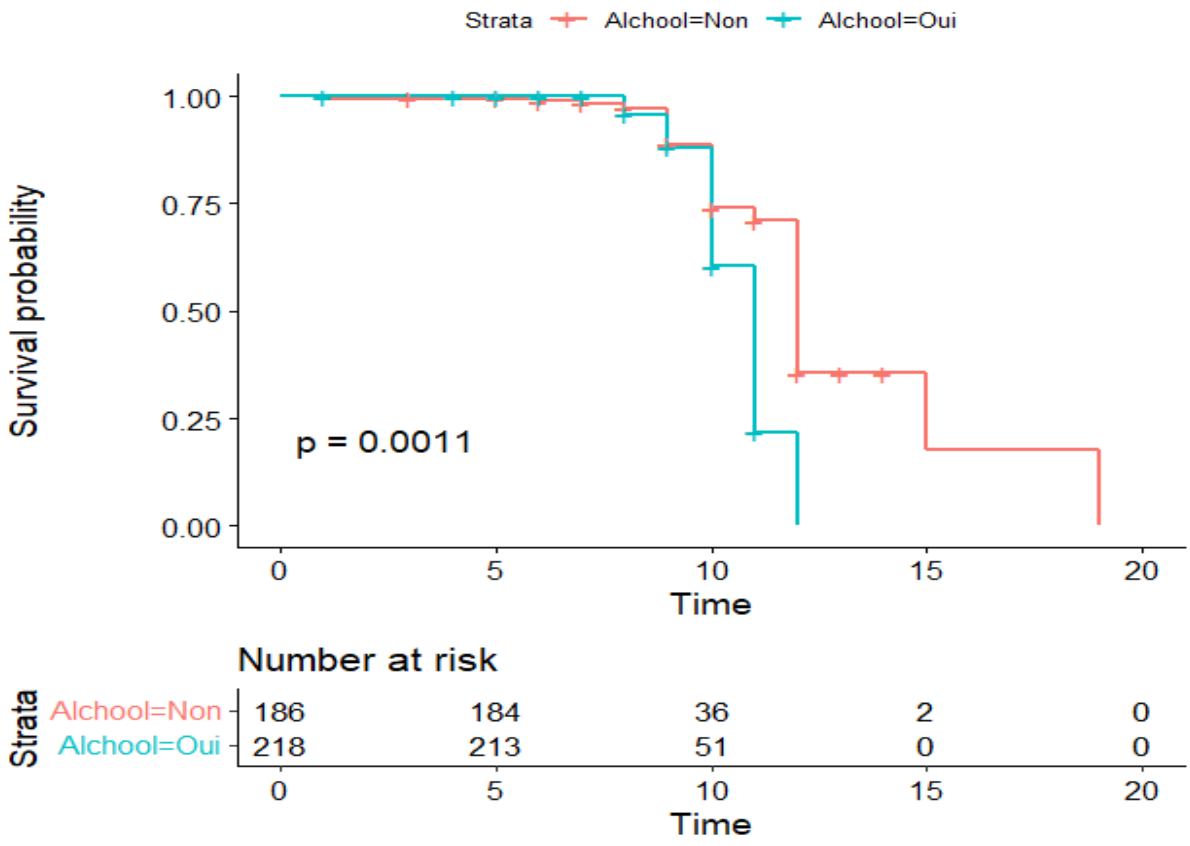

Figure 8. Comparison of Survival Curves for Death from MDR-TB According to Alcohol Use

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Regarding Table 10 and Figure 8, the results indicate that patients who consumed alcohol had a shorter median survival time than those who did not consume alcohol. The difference was statistically significant ($p = 0.0011$).

Table 11. Comparison of the Median Survival Time to Death According to a Family History of MDR-TB

Means and Medians for Survival Time

Family history of MDR-TB	Mean		95% Confidence Interval		Median	95% Confidence Interval
	Estimate	Standard Error	Lower Bound	Upper Bound	Estimate	Standard Error
No	12.845	0.603	11.664	14.027	12.000	0.196
Yes	9.933	0.092	9.753	10.113	10.000	0.116
Overall	11.779	0.401	10.993	12.566	11.000	0.238

Note: The estimate is limited to the largest survival time if censored.

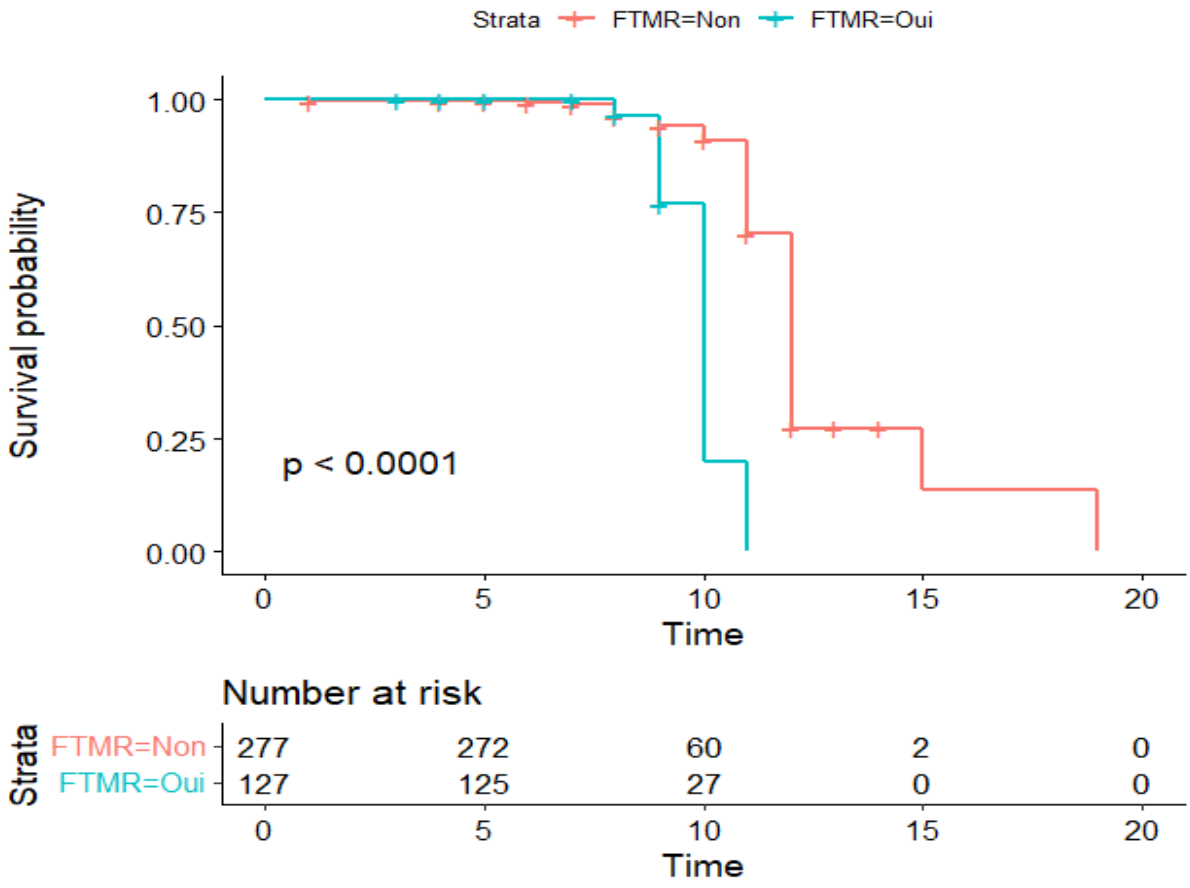

Figure 9. Comparison of Survival Curves for Death According to a Family History of MDR-TB

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Regarding Table 11 and Figure 9, the results indicate that patients without a family history of multidrug-resistant tuberculosis (MDR-TB) died later, with a median survival time of 12 months (95% CI: 11.6–12.4), compared with 10 months (95% CI: 9.7–10.2) among those with a family history of MDR-TB. The difference was statistically significant ($p < 0.0001$).

3.3. ANALYSES MULTI VARIÉES

Tableau 14. Modèle de COX

Variable		N	Hazard ratio	p
Age3	*30-44	160	Reference	
	>44	56	1.35 (0.53, 3.45)	0.533
	20-29	188	2.70 (1.45, 5.02)	0.002
Echec	Non	265	Reference	
	Oui	139	1.69 (1.08, 2.65)	0.022
Rechute	Non	251	Reference	
	Oui	153	1.45 (0.92, 2.27)	0.106
Tabac	Non	242	Reference	
	Oui	162	1.74 (1.05, 2.88)	0.031
FTMR	Non	277	Reference	
	Oui	127	5.68 (3.31, 9.75)	<0.001

This study showed that patients aged 20–29 years had a 2.7-fold higher hazard of death from multidrug-resistant tuberculosis (MDR-TB) compared with patients in the other age groups (HR = 2.70; 95% CI: 1.45–5.02). This association was statistically significant (p < 0.001). In contrast, no statistically significant increase in the hazard of death was observed among the other age groups.

Regarding treatment history, our study found that patients with a history of previous tuberculosis (TB) treatment had a 1.69-fold higher hazard of death from MDR-TB than those who had never received TB treatment (HR = 1.69; 95% CI:

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1.08–2.65; p = 0.022). This finding suggests that previous TB treatment may represent an adverse prognostic factor among patients with MDR-TB.

The findings of the present study are also consistent with existing evidence regarding the association between previous TB treatment and the occurrence of MDR-TB. In a multicenter case-control study conducted in Pakistan, Ahmad et al. (2012) reported that a history of previous TB treatment was strongly associated with MDR-TB (adjusted OR = 4.2; 95% CI: 1.1–15.4). Similarly, Casal et al. (2005), in a case-control study conducted in four European countries, identified previous pulmonary TB as a significant risk factor for MDR-TB (OR = 2.03).

Furthermore, Suárez-García et al. (2009), in a retrospective cohort study conducted in Madrid, Spain, found that patients with a history of previous TB treatment had significantly higher odds of MDR-TB (OR = 3.44; 95% CI: 1.58–7.50; p = 0.003). These findings are also consistent with those reported in a study conducted in Dakar, Senegal, which identified previous TB treatment, particularly treatment failure, as an important factor associated with MDR-TB.

Although the studies by Ahmad et al. (2012), Casal et al. (2005), and Suárez-García et al. (2009) primarily investigated risk factors for the occurrence of MDR-TB rather than mortality among patients already diagnosed with MDR-TB, their findings provide relevant epidemiological evidence supporting our observation. In our study, the association between previous TB treatment and mortality among patients with MDR-TB highlights the importance of careful management and close monitoring of patients with a history of TB treatment.

Several mechanisms may explain this association. Previous exposure to anti-TB drugs may favor the selection of drug-resistant Mycobacterium tuberculosis strains, particularly when treatment has been inadequate, interrupted, or associated with poor adherence. In addition, patients with a history of treatment failure may have more advanced disease, a higher bacillary burden, or resistance to multiple anti-TB drugs, potentially limiting effective treatment options and increasing the risk of poor outcomes, including death. Therefore, a history of previous TB treatment should be considered an important clinical and prognostic indicator in the management of patients with MDR-TB.

A 1.45-fold higher hazard of death from MDR-TB was observed among patients who had experienced relapse compared with those without a history of relapse (HR = 1.45; 95% CI: 0.92–2.27). However, this association did not reach statistical significance (p = 0.106). Tobacco smokers had a 1.74-fold higher hazard of death from MDR-TB, approximately twice that of non-smokers (HR = 1.74; 95% CI: 1.05–2.88). This association was statistically significant (p = 0.031). Furthermore, patients with a family history of MDR-TB had a 5.68-fold, approximately sixfold, higher hazard of death from MDR-TB (HR = 5.68; 95% CI: 3.31–9.75). This association was statistically significant (p < 0.001).

IV. DISCUSSION

This study aimed to identify factors associated with multidrug-resistant tuberculosis (MDR-TB)-related mortality among patients aged 20–54 years followed at the Lufungula Tuberculosis Screening and Treatment Center, in the National Police Health Zone of Kinshasa. The findings mainly highlight the role of age, treatment adherence, treatment failure, relapse, tobacco use, alcohol consumption, and family history of MDR-TB.

4.1. Sociodemographic Characteristics and Mortality

The median age was significantly lower among patients who died than among survivors (25 years versus 35 years, respectively; p < 0.001). Mortality was particularly concentrated among patients aged 20–29 years, who accounted for 77.0% of deaths compared with 38.2% of survivors. This age distribution differs from findings reported in several studies, which have generally identified older age as an important predictor of mortality among patients with drug-resistant tuberculosis.

A worldwide systematic review and meta-analysis including 49 studies found that older age was significantly associated with an increased risk of mortality among patients with drug-resistant tuberculosis (pooled HR = 2.13; 95% CI: 1.64–2.62). The association remained significant when age was considered as a continuous variable, with each one-year increase in age associated with a higher risk of death (HR = 1.01; 95% CI: 1.00–1.03) (Getachew et al., 2021). These findings suggest that advanced age may increase vulnerability to poor outcomes among patients with drug-resistant tuberculosis, potentially because of a greater burden of comorbidities, reduced physiological reserve, and increased susceptibility to treatment-related complications.

Similarly, a large retrospective cohort study conducted across 42 MDR-TB treatment centres in Ethiopia, involving 3,395 patients, identified older age as an independent predictor of mortality. Each increase in age was associated with a higher hazard of death (AHR = 1.03; 95% CI: 1.03–1.05; p < 0.001) (Tola et al., 2021). These findings are consistent with the broader evidence indicating that

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mortality among patients with MDR-TB tends to increase with advancing age.

More recently, a retrospective follow-up study conducted in Addis Ababa among 245 patients with MDR-TB also identified older age as an independent predictor of mortality. Patients aged ≥41 years had a substantially higher risk of death than those aged ≤24 years (AHR = 14.0; 95% CI: 3.0–60.4; p = 0.0001) (Getahun et al., 2023). This finding further supports the association between advanced age and mortality among patients receiving treatment for MDR-TB.

The higher proportion of deaths observed among patients aged 20–29 years in the present analysis therefore contrasts with the pattern generally reported in the literature. This discrepancy may reflect differences in the age structure of the study populations, sample size, epidemiological context, distribution of comorbidities, access to care, treatment characteristics, or other unmeasured factors. In particular, the concentration of mortality in the 20–29-year age group may be influenced by the demographic characteristics of the population under study and should therefore be interpreted cautiously. Further studies are warranted to determine whether this age-specific pattern represents a population-specific phenomenon or reflects other clinical or epidemiological characteristics associated with mortality.

The difference observed in our study may therefore be related to the specific characteristics of the study population, which was limited to adults aged 20–54 years, but may also reflect behavioral, social, and treatment-related factors that are more prominent among young adults. The Cox model confirmed this particular pattern: patients aged 20–29 years had a 2.70-fold higher hazard of death than patients in the other age categories (HR = 2.70; 95% CI: 1.45–5.02; $p < 0.001$). However, this finding should be considered specific to the study context rather than interpreted as a universal association.

No statistically significant association was observed between sex and mortality in the present analysis (p = 0.889), despite the predominance of male patients. This finding contrasts with evidence from several studies suggesting a higher risk of mortality among male patients with tuberculosis. A large systematic review and meta-analysis including 398 studies and more than 3.9 million patients found that male sex was associated with higher all-cause mortality compared with female sex, with a pooled adjusted OR of 1.31 (95% CI: 1.18–1.45) (Huang et al., 2021). The association was also observed for tuberculosis-related mortality, with a pooled OR of 1.28 (95% CI: 1.10–1.60) (Huang et al., 2021). These findings suggest that sex may contribute to differences in tuberculosis outcomes, although substantial heterogeneity was observed across the included studies.

Similarly, a retrospective cohort study conducted among 245 patients with MDR-TB in Addis Ababa, Ethiopia, identified male sex as an independent predictor of mortality. Male patients had a significantly higher hazard of death than female patients (AHR = 3.7; 95% CI: 1.2–11.4; p = 0.023) (Getahun et al., 2023). However, the absence of a significant association between sex and mortality in the present analysis indicates that this relationship may not be consistent across all MDR-TB populations.

The differences between these findings may be related to variations in the demographic and epidemiological characteristics of study populations, patterns of healthcare utilization, treatment adherence, comorbidities, socioeconomic conditions, and access to timely diagnosis and appropriate treatment. In addition, the effect of sex on mortality may be influenced by other clinical and behavioral factors that vary according to the population and healthcare setting. Therefore, the absence of a significant association in the present analysis should not necessarily be interpreted as evidence that sex has no influence on mortality, but rather as an indication that its effect may depend on the broader clinical and epidemiological context.

Occupation was significantly associated with mortality (p = 0.045), with a particularly high proportion of deaths observed among traders. This association should, however, be interpreted cautiously, as occupation may act as a proxy for broader socioeconomic and healthcare-related conditions rather than representing an independent biological risk factor for mortality. Occupational characteristics may influence income, mobility, working conditions, continuity of care, and the ability to attend scheduled medical appointments.

Recent evidence from a national cohort study in Sierra Leone supports the importance of considering the broader social and health context when interpreting treatment outcomes in patients with MDR/RR-TB. In this study, adverse treatment outcomes were associated with socioeconomic and clinical factors, including unemployment, underweight, HIV infection, chronic lung disease, renal impairment, and previous unsuccessful tuberculosis treatment (Greenwood et al., 2026). These findings suggest that social vulnerability and nutritional and clinical conditions may interact to influence outcomes among patients with drug-resistant tuberculosis.

Similarly, an earlier national retrospective cohort study from Sierra Leone identified severe underweight, untreated HIV infection, chronic lung disease, previous unsuccessful tuberculosis retreatment, and socioeconomic vulnerability

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as important factors associated with adverse treatment outcomes among patients with MDR-TB (Kamara et al., 2022). The authors emphasized the need for integrated tuberculosis, HIV, nutritional, and socioeconomic support rather than focusing on a single occupational category.

Therefore, the higher mortality observed among traders in the present analysis may reflect underlying differences in socioeconomic circumstances, occupational mobility, healthcare utilization, or continuity of treatment. However, because these mechanisms were not directly assessed, causal interpretations should be avoided. Further investigation incorporating income, employment stability, working conditions, distance to healthcare facilities, and treatment adherence would be necessary to determine whether occupation itself independently contributes to mortality among patients with MDR-TB.

4.2. Treatment-Related Factors and Adherence

Treatment interruption was significantly associated with mortality (51.7% among patients who died versus 38.5% among survivors; $\boldsymbol{p}$ = 0.044**).** Missed appointments were also strongly associated with mortality, occurring in 73.6% of patients who died compared with 50.5% of survivors (p < 0.001). These findings directly support the hypothesis that poor treatment adherence is an important determinant of MDR-TB prognosis. Recent evidence confirms the importance of treatment adherence. In Tanzania, Lalashowi et al. (2025) showed that good acceptability of short oral treatment regimens was associated with better adherence, whereas concerns about adverse effects significantly influenced adherence. A South African study also demonstrated that differentiated support combining adherence monitoring, telephone calls, home visits, and motivational counseling substantially improved treatment adherence (Charalambous et al., 2024). However, digital interventions alone do not constitute a sufficient solution. Recent multicenter trials have not demonstrated a significant reduction in unfavorable treatment outcomes with certain digital adherence technologies, highlighting the importance of a comprehensive and individualized approach (Charalambous et al., 2025).

4.3. Treatment Failure, Relapse, and Survival

Treatment failure was strongly associated with mortality**:** 56.3% of patients who died had experienced treatment failure compared with 28.4% of survivors (p < 0.001). Survival analysis also showed a shorter median survival time among patients experiencing treatment failure **(**11 months versus 12 months; $\boldsymbol{p}$ < 0.0001**).** In the Cox model, treatment failure increased the hazard of death by **69%** (HR = 1.69; 95% CI: 1.08–2.65; p = 0.022).

These findings are consistent with recent evidence from sub-Saharan Africa. In South Kivu, Democratic Republic of the Congo, a 2026 cohort study reported that retreatment was associated with a higher risk of unsuccessful treatment outcomes (aHR = 1.71; 95% CI: 1.03–2.83), while mortality remained substantial (13.4%) despite the use of all-oral bedaquiline-containing regimens (Musafiri et al., 2026). Similarly, a Ugandan study of patients receiving bedaquiline-based regimens reported a mortality rate of 11.3%, highlighting the persistence of mortality despite advances in MDR/RR-TB treatment (Dumo Lodiong et al., 2024).

Relapse was also associated with significantly reduced survival (p = 0.0004). However, it was no longer statistically significant after adjustment in the multivariable model (HR = 1.45; 95% CI: 0.92–2.27; p = 0.106). This difference between the univariable and multivariable analyses suggests that the apparent effect of relapse may be partly explained by other factors, including treatment history, adherence, and disease severity.

4.4. Tobacco Use, Alcohol Consumption, and Family History

Tobacco use was significantly associated with mortality (52.9% vs. 36.6%; p = 0.013), with a median survival of 10 months among smokers compared with 12 months among non-smokers. After adjustment, tobacco use remained associated with a 1.74-fold higher hazard of death (HR = 1.74; 95% CI: 1.05–2.88; p = 0.031). This finding is consistent with a systematic review and meta-analysis showing that tobacco use was associated with increased mortality during TB treatment (RR = 1.55; 95% CI: 1.32–1.81) (Azdah et al., 2023).

Alcohol consumption was also associated with shorter survival (p = 0.0011). This finding is particularly relevant in the Congolese context, as alcohol use may contribute to poor adherence, treatment-related behavioral challenges, and nutritional vulnerability. Recent MDR-TB cohorts in Kinshasa also confirm the importance of behavioral and clinical factors in patient outcomes.

Finally, a family history of MDR-TB was one of the factors most strongly associated with mortality. Patients with a family history had a median survival time of approximately 10 months compared with 12 months among those without such a history (p < 0.0001), while the Cox model indicated a 5.68-fold higher risk of death **(**HR = 5.68; 95% CI: 3.31–9.75; p < 0.001). This finding may reflect both increased

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exposure to drug-resistant strains and the presence of shared household risk conditions. The recent study conducted in South Kivu also highlights the importance of retreatment-related factors and continuity of care in vulnerable settings in the DRC.

4.5. Summary of the Discussion

Overall, the findings indicate that MDR-TB-related mortality in this population is determined by the interaction of **individual, behavioral, treatment-related, and family factors**. The main factors independently associated with death were age 20–29 years, treatment failure, tobacco use, and, particularly, a family history of MDR-TB. These findings underscore the need for early diagnosis, close monitoring of treatment adherence, management of addictive behaviors, intensified monitoring of patients experiencing treatment failure or retreatment, and systematic screening of household contacts.

This approach is consistent with current WHO recommendations, which favor shorter, better-tolerated, all-oral treatment regimens and patient-centered care. In 2024, approximately 390,000 people developed MDR/RR-TB worldwide, with around 150,000 deaths attributable to drug-resistant TB. Despite an improvement in treatment success to 71%, only approximately two out of five people requiring treatment for drug-resistant TB actually received it.

V. CONCLUSION

This study aimed to identify factors associated with mortality and survival among patients aged 20–54 years with MDR-TB followed at the Lufungula Tuberculosis Screening and Treatment Center between 2010 and 2019. The findings from 404 patients showed that mortality was significantly associated with several factors. Patients aged 20–29 years had particularly high mortality and **a** 2.70-fold higher hazard of death than patients in the other age categories. Treatment interruption, missed appointments, treatment failure, relapse, tobacco use, alcohol consumption, and a family history of MDR-TB were also associated with unfavorable outcomes.

The survival analysis confirmed the importance of these factors: treatment failure, missed appointments, tobacco use, alcohol consumption, and a family history of MDR-TB were associated with significantly shorter survival. The multivariable analysis particularly identified age 20–29 years, treatment failure, tobacco use, and family history of MDR-TB as independent factors associated with the risk of death. These findings support the hypothesis that poor treatment adherence and certain sociodemographic, behavioral, and treatment-related factors significantly contribute to mortality among patients with MDR-TB**.** They are broadly consistent with recent evidence demonstrating the important role of treatment adherence, previous treatment history, individual vulnerabilities, and healthcare conditions in the prognosis of drug-resistant TB.

Generalizability

The findings of this study may be applicable to MDR-TB patients managed in other tuberculosis treatment centers in Kinshasa and in similar urban healthcare settings in the Democratic Republic of the Congo. The identified factors associated with mortality, including treatment interruption, treatment failure, relapse, missed medical appointments, tobacco use, alcohol consumption, and family history of MDR-TB, may be relevant in settings with comparable patient characteristics and healthcare conditions.

However, the generalizability of these findings is limited by the single-center setting and the specific characteristics of the study population. The study was conducted at the Lufungula Tuberculosis Screening and Treatment Center in the National Police Health Zone, Kinshasa, and included patients managed between 2010 and 2019. Differences in healthcare access, treatment practices, socioeconomic conditions, MDR-TB management programs, and patient characteristics may influence mortality outcomes in other settings.

Therefore, the findings should be extrapolated to other populations with caution. Multicenter studies involving different healthcare facilities and geographic areas of the Democratic Republic of the Congo are needed to confirm the observed associations and assess their applicability to broader MDR-TB populations.

Limitations

This study has several limitations. First, its retrospective design relied on routinely recorded medical information. The accuracy and completeness of the findings therefore depended on the quality of the available medical records.

Second, the study was conducted at a single MDR-TB treatment center in Kinshasa, which may limit the representativeness of the study population and the generalizability of the findings to other provinces, rural areas, or healthcare settings.

Third, although exhaustive sampling was used, the study included only patients diagnosed and managed at the study center. Patients who were not diagnosed, referred elsewhere, or managed outside the center were not captured, which may have introduced selection bias.

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Fourth, some potentially relevant determinants of mortality, including nutritional status, disease severity at diagnosis, socioeconomic characteristics, delays in diagnosis, and detailed clinical and treatment-related factors, may not have been consistently documented and could therefore not be fully assessed.

Fifth, because of the observational design, the identified associations cannot be interpreted as causal relationships. The results indicate associations between the studied factors and mortality but do not establish causality.

Finally, patients with missing information were excluded from the analysis, as specified in the study methodology. This complete-case approach may have reduced the number of observations available for some variables and could have introduced bias if patients with missing information differed systematically from those included in the analysis.

Recommendations

Based on the findings of this study, several recommendations are proposed.

First, early identification and intensified follow-up of patients at increased risk of mortality should be strengthened. Particular attention should be given to patients experiencing treatment interruption, treatment failure, relapse, or repeated missed medical appointments.

Second, treatment adherence support should be reinforced through systematic patient education, individualized counseling, appointment reminders, active tracing of patients who miss appointments, and appropriate community-based follow-up.

Third, early detection and management of treatment failure and relapse should be prioritized through regular clinical and bacteriological monitoring. Patients with suspected treatment failure or relapse should receive timely clinical reassessment and appropriate management in accordance with national and international MDR-TB guidelines.

Fourth, tobacco and alcohol use should be systematically assessed during MDR-TB care. Patients reporting tobacco or alcohol use should receive appropriate counseling and support to reduce or discontinue these behaviors.

Fifth, MDR-TB treatment centers should strengthen patient-centered care and adherence-monitoring strategies**,** particularly for patients identified as being at increased risk of poor treatment outcomes.

Finally, multicenter prospective studies should be conducted in different provinces of the Democratic Republic of the Congo to validate the risk factors identified in this study, investigate additional determinants of MDR-TB mortality, and improve the generalizability of the findings.

List of Abbreviations

AHR – Adjusted Hazard Ratio
CI – Confidence Interval
HR – Hazard Ratio
HIV – Human Immunodeficiency Virus
IQR – Interquartile Range
MDR-TB – Multidrug-Resistant Tuberculosis
MDR/RR-TB – Multidrug-Resistant/Rifampicin-Resistant Tuberculosis
OR – Odds Ratio
RR – Relative Risk
SD – Standard Deviation
TB – Tuberculosis
WHO – World Health Organization
XDR-TB – Extensively Drug-Resistant Tuberculosis
χ^2 – Chi-square test

Data availability

Data supporting the findings of this study can be obtained from the corresponding author upon reasonable request.

Competing interests

The authors have declared that no competing interests exist.

Author contributions

Jacques NKOLANGI BAKOKELA: Conceptualization, formal analysis, project management, writing—original draft; **Gérard ELOKO EYA MATANGELO**: Data curation, writing—review and editing; **Emmanuel Kitete Mulongo:** Writing—critique and editing. Jean-Paul **Koto-Te-Nyiwa Ngbolua (**Corresponding author**):** Methodology and writing—review & editing. **MBADU ZEBE:** Methodology, supervision, writing-review, and editing; **Jules KANGITE MOTI and Bob SENKER NDIMBA**: Methodology, data curation and analysis, supervision, and writing-review & editing

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This research has been conducted in accordance with the Bioethics Committee of ISTM KINSHASA, number 0029 /CBE/ISTM/KIN/RDC/PMBBL/2019, dated 25 /NOV/2019

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