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Risk factors and survival analysis of time to death among multidrug-resistant tuberculosis patients: a case study at Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital

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ABSTRACT:

— ***Objective:*** Multidrug-resistant tuberculosis (MDR-TB), caused by bacteria that are resistant to the most effective anti-tuberculosis drugs, is a rising global issue with varying mortality rates among patients. This study aimed to identify the factors contributing to mortality in MDR-TB patients at the Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital (NEMMCSH) in Hosanna, Ethiopia.

— ***Patients and Methods:*** A retrospective study was conducted using a cohort of patients diagnosed with MDR-TB at the NEMMCSH from January 2016 to December 2022. Data analysis included the Kaplan-Meier method to estimate survival rates, the log-rank test to assess differences in survival among the patients and a Cox regression model to identify factors influencing survival.

— ***Results:*** Of 268 MDR-TB patients, 111 (41.4%) died, and 157 (58.6%) were censored. The average mortality rate of the patients with MDR-TB in the hospital was 12 months. Female patients had a significantly shorter time to death than males, as we have seen the value of hazard ratio (HR) (HR = 0.937; $p = 0.003$), alcohol users (HR = 0.866), and those with decreased weight (HR = 0.998; $p = 0.001$). Conversely, patients with extra-pulmonary MDR-TB (HR = 1.209; $p = 0.000$), urban residents (HR = 1.039; $p = 0.001$), and those with negative HIV status (HR = 1.664; $p = 0.001$) had a longer time to death.

— ***Conclusions:*** Among the various factors examined in this study, significantly higher mortality rates and shorter survival times were observed in males, rural residents, smokers, HIV patients, and extra-pulmonary MDR-TB patients. Significant predictors of mortality included sex, residence, HIV status, smoking status, clinical completion, comorbidities, drug history, weight, MDR-TB type, and alcohol use. Therefore, modified healthcare strategies for high-risk variables to improve survival outcomes and reduce MDR-TB-related mortality are needed. Moreover, comprehensive medical care and dedicated counseling services are essential.

— ***Keywords:*** Multidrug-resistant tuberculosis, Time to death, Cox regression model, Kaplan-Meier survival function, median survival.

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— ***List of Abbreviations:*** HR: Hazard ratio, CI: Confidence Interval, HIV: Human Immunodeficiency Virus, MDR-TB: Multidrug-Resistant Tuberculosis, SPSS: statistical package for Social Science, Cum: Cumulative, TB: Tuberculosis, WHO: World Health Organization, XDR: Extensively Drug-Resistant, RR, Rifampicin, NEMMCSH: Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital.

INTRODUCTION

Tuberculosis (TB) is a major health problem worldwide, resulting in numerous illnesses and deaths. Although better medicines are currently available, TB remains the ninth leading cause of death worldwide, killing more than a million people yearly[1]. This long-lasting illness disproportionately affects individuals from low-income backgrounds, particularly those living in areas with limited access to healthcare, poor living conditions, and inadequate nutrition[2].

Multidrug-resistant TB (MDR-TB), defined as TB caused by Mtb bacilli resistant to rifampicin and isoniazid, is a major threat to global TB control[3]. According to the World Health Organization (WHO), China has a significant burden of multidrug-resistant tuberculosis (MDR-TB). While specific percentages of new bacteriologically confirmed TB cases that are MDR-TB are not detailed in the provided sources, WHO reports that China accounts for a substantial portion of global MDR-TB cases[3]. Evidence also indicates a growing burden of MDR-TB in several African regions. This suggests that the agricultural use of antibiotics may play a role in the emergence of MDR-TB in certain areas[4]. For instance, recent studies[4] report MDR-TB rates of 54%, 9.5%, 9.4%, and 3.4% in Nigeria, Zambia, Rwanda, and South Africa, respectively. Simultaneously, the prevalence of TB is significantly higher in Africa, contributing to 25% of the global TB burden, with an incidence rate of around 237 cases per 100,000. Cases of MDR-TB were estimated to be 450,000 in 2012, representing a 3.1% increase from the previous year[5]. Approximately 464,000 global cases of rifampicin-resistant TB were noted in 2019, of which 78% were MDR-TB[6], and approximately 25% of TB-related deaths can be attributed to antimicrobial drug resistance[7]. Studies have confirmed that MDR-TB is a catastrophic disease associated with severe and sustained physical effects (it causes prolonged side effects and worsens other health conditions)[8], mental impact (the long treatment, isolation, and stigma lead to depression and anxiety)[9], and financial burden (the high cost of treatment and loss of income push many patients into poverty)[10]. Although an increasing number of MDR-TB cases have been reported due to the introduction of comprehensive diagnostic tools developed in several countries in recent years, the global burden remains high. Traditional high-burden regions, including Central Asia and Eastern Europe, as well as countries like China, India, and the Russian Federation, are still severely affected[10]. Moreover, MDR-TB places a heavy strain on health systems, with treatment costs 20 times that of drug-susceptible TB[11]. In light of its global impact, attention given to MDR-TB should be amplified and accelerated.

In 2019, Ethiopia was among the top 30 countries with the highest burden of tuberculosis (TB) and multidrug-resistant TB (MDR-TB)[11]. This type of TB constitutes 36% of all TB cases in Ethiopia[12], with approximately 275 every 100,000 individuals developing TB. Research conducted in different parts of Ethiopia shows that MDR-TB is common, with rates as high as 11.8% in the Oromia region[13], 15.3% in the Amhara Region[13], 46.3% in Addis Ababa[14], and 38.5% in southern Ethiopia[15]. While MDR-TB can be treated and cured with specific medications, these treatments are not widely available, involve prolonged durations (up to two years), are less effective, can be more harmful, and cost significantly more than standard TB medications.

A critical barrier to progressing toward TB elimination in Ethiopia remains the low TB case detection rate. Significant efforts have been made, yet recent data indicate that the case detection rate is still below optimal levels, with around 67% of cases detected in the most recent reports of WHO[11]. In 2014, only 60% of cases were detected, leaving an estimated 80,000 Ethiopians undiagnosed and untreated, contributing to the ongoing spread of TB. The prevalence of MDR-TB among new cases is approximately 3.6%, with a much higher rate of 27.5% among previously treated cases, underscoring the need for continued efforts in surveillance and treatment. Despite these challenges, the treatment success rate for MDR-TB in Ethiopia has improved to about 76%, but reaching undiagnosed populations, particularly in remote and underserved areas, remains a significant challenge[11]. The disparity in case detection rates is even more significant for severe MDR-TB, with annual identifications falling below 25% of an estimated 2,200 cases in Ethiopia patients[3].

The diagnosis of drug resistance is challenging in low-resource countries. Owing to this worldwide issue, only 3 out of every 10 MDR-TB patients initiating second-line MDR-TB treatments are diagnosed, resulting in approximately 214,000 deaths[3]. Mortality due to MDR-TB is also high in other countries around the world. For instance, 36.4% and 21.3% of MDR-TB patients died in Ukraine in 2018[16].

Furthermore, in Ethiopia, the incidence rate and insufficient treatment outcomes of MDR-TB are high and have significant effects on treatment outcome efficiency. The prevalence of patients with poor treatment outcomes has increased over time from 6% per year during 2010-2012 to 12% per year during 2013-2015[17].

MDR-TB is a major health problem in Ethiopia and a lifelong struggle. Although strategies have been implemented to offer tests that check the reaction of TB to different drugs, the disease still affects many people across the country. The risk increases especially for individuals with additional health concerns like high blood pressure, diabetes, heart disease, asthma, kidney issues, or collapsed lung pneumonia. In addition, patients with MDR-TB often require financial assistance from their families.

Studying the survival time of patients with multidrug-resistant tuberculosis (MDR-TB) is critical for addressing public health challenges by identifying risk factors associated with mortality in these patients. The results of this study provide valuable evidence for government and non-government organizations, as well as other stakeholders, to develop effective policies, strategies, and plans for controlling and managing the mortality of MDR-TB patients. Therefore, it is important to determine which factors are closely linked to MDR-TB and work on solving these problems to help those with the disease live longer. This study aimed to identify the risk factors contributing to mortality in MDR-TB patients and assess the time to death of MDR-TB patients in Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital, Central Ethiopia, using different survival functions and models.

PATIENTS AND MATERIALS

Study Area and Period

The study was conducted at the MDR-TB treatment center in Wachemo University Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital, located at Hosanna, Haddiya zone, Central Ethiopia. The town is 232 km from Addis Ababa, the capital city of Ethiopia. This Hospital was established in 1984 to serve a catchment population of more than 2.5 million in the area and nearby zones and districts. The study was conducted from January 2016 to December 2022.

Study Design and Setting

A retrospective cohort study design was employed. Data were obtained from MDR-TB patients admitted to the Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital (NEMMCSH), and the study had an 84-month follow-up period.

Data Source and Data Collection

The required data were extracted from the follow-up charts and cards of patients with MDR-TB admitted to NEMMCSH from January 2016 to December 2022. The data collectors were trained healthcare professionals (nurses) under the supervision of the investigators, and the data quality was checked daily for completeness, consistency, and accuracy.

Study Population and Inclusion-Exclusion Criteria

The study population included all patients with MDR-TB registered at Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital. Patients with a confirmed diagnosis of multidrug-resistant tuberculosis based on laboratory testing, patients admitted and registered for treatment at NEMMCSH during the study period, patients who started second-line anti-TB treatment at the hospital and patients with complete and detailed epidemiological, clinical, and laboratory records, including follow-up information on treatment and survival outcomes were included. Patients with insufficient recorded information in the registration book or card, patients who did not start second-line MDR-TB treatments or those with XDR-TB, and patients with no complete history of epidemiological, clinical and laboratory results were excluded from the study.

Study Variables

Dependent variables: time to death of MDR-TB patients, measured in months. The event of interest was death due to MDR-TB [1 = death and 0 = censored (lost to follow-up, under treatment, cure)].

Predictor variables sex, age, place of residence, marital status, HIV status, smoking history, adherence based on pill count, comorbidities, previous drug history, MDR-TB type, patient weight, occupation, history of TB in family, education status and alcohol use.

Statistical Analysis

Data were entered using SPSS 23 (IBM Corp., Armonk, NY, USA) and analyzed using STATA-15 software (StataCorp LLC, College Station, TX, USA). Survival analysis was performed to assess time to death among MDR-TB patients from the start of treatment to the occurrence of death or censoring[18]. Kaplan-Meier survival curves were constructed to estimate survival probabilities[19], and median survival times were calculated for different subgroups[20,21]. The log-rank test was used to compare survival distributions between groups such as sex, residence, and HIV status. A Cox proportional hazards regression model was used to identify independent predictors of mortality[22]. Variables with a p-value lower than 0.05 in univariate analysis were included in the multivariate model. The proportional hazards assumption was tested using Schoenfeld residuals, and no significant violations were found.

RESULTS

The main objective of this study was to identify the risk factors contributing to mortality in MDR-TB patients and investigate the time to death due to MDR-TB. Between January 2016 and December 2023, 268 patients were diagnosed and treated at the Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital in Hosanna, Ethiopia. Of the total, 111 (41.4%) patients with MDR-TB died, and 157 (58.6%) were censored. According to this study, the average death rate or overall median time for patients with MDR-TB in the hospital was 14 months, with a minimum and maximum of 11 and 15 months, respectively (Table 1). As shown in Table 2, the mortality rate of MDR-TB was higher in males (53.6%) than in females (46.6%). In addition, rural residents (45.12%) died more frequently due to MDR-TB than urban residents (38.5%). According to the study, of the 268 patients with MDR-TB, 29 (10.82%) had extra-pulmonary MDR-TB, and 239 (89.2%) had pulmonary MDR-TB. The mortality rate of extra-pulmonary MDR-TB was higher (51.72%) than that of pulmonary MDR-TB (40.17%). Specifically, 40.17% of the 239 patients with pulmonary MDR-TB died, whereas 51.72% of the 29 patients with extra-pulmonary MDR-TB died. This indicates that extra-pulmonary MDR-TB is associated with a higher mortality rate than pulmonary MDR-TB.

Mortality rates for patients with MDR-TB were markedly high among smokers (42.05%), those with comorbidities (41.67%), and those with a previous history of TB (28.83%). Patients with no prior drug history had a lower mortality rate than those with a history of drug use. Or alcohol use (42.23%), and those who did not complete their clinical treatment (44.32%). These rates were higher than those of their respective reference groups (Table 2).

The proportion of MDR-TB patients was notably high among smokers (79.9%), those with co-morbidities (85.1%), individuals with a previous history of TB (60.8%), alcohol users (60.1%), and patients who did not complete their clinical treatment (63.8%). These rates were higher than those of the respective reference groups. Most patients (52%) who passed away were within the age group of 0 to 17 years. Among individuals without HIV who died of MDR-TB, the mortality rate was 42.4%, whereas the mortality rate for people with HIV was 65.6% for MDR-TB. Mortality rates for MDR-TB were higher among farmers (62.4%), those with fair adherence to treatment (45.6%), and individuals with only a primary level of education (46.8%) compared to their respective reference groups (Table 2).

Survival Analysis of MDR-TB Patient's Results

The Kaplan-Meier survival function test was used to estimate the cumulative probability of survival based on various factors, including sex, HIV status, MDR-TB type, and patient's place of residence. The survival graphs revealed statistically significant differences (Figures 1 and 2).

The Log-rank test for the death time of MDR-TB patients at Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital demonstrated differences in survival rates among various patient groups. Table 3 shows a statistically significant difference in survival time between sex, residence, HIV status in MDR-TB patients, smoking status, comorbidities, previous drug history, MDR-TB type, history of TB, and alcohol use at a 5% significance level ($p < 0.05$). In addition, the interaction effect was statistically significant between sex and HIV status, as well as between drug use history and smoking status in MDR-TB patients; no significant differences in survival times were found based on marital status ($p = 0.318$), adherence levels ($p = 0.806$), or occupation ($p = 0.329$).

Cox proportional hazards regression analysis was conducted, with a p-value lower than 0.05 considered statistically significant. According to the Cox regression model, the variables sex, patient weight, patient residence, HIV status, smoking status, comorbidities, previous drug history, MDR-TB type, clinical complications, and alcohol use were all significant (Table 4).

A hazard ratio (HR) greater than 1 indicates the time to death. Female MDR-TB patients experienced a shorter time to death than male MDR-TB patients (HR = 0.937; Coeff = -0.065; 95% CI: 0.808, 1.244; $p = 0.003$). This means that female patients with MDR-TB had a significantly shorter time to death than male patients with MDR-TB. The hazard ratio (HR) for patients who consumed alcohol was 0.866, indicating that alcohol users had a shorter time to death than non-alcohol users. Additionally, Table 4 results show that a decrease in patient weight (HR = 0.998; Coeff = -0.002; 95% CI: 0.982, 1.015; $p = 0.001$) led to a decrease in time to death.

The study showed that patients with extra-pulmonary MDR-TB had a hazard ratio (HR) of 1.209 (95% CI: 0.928, 1.326; $p = 0.000$), indicating that patients

Table 1. Outcome of patients.

Status of patients	Frequency	Percentage	Median
Death (event)	111	41.4%	
Censored (lost to follow up, under treatment, cure)	157	58.6%	12
Total	268	100%	

Table 2. Descriptive results on demographic, clinical, and epidemiological characteristics of patients with multidrug-resistant tuberculosis from Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital (n = 268).

Variables	Categories	Number of patients (%)	Event (death) (%)	Censored	Median
Sex	Female	125 (46.6%)	48 (38.4%)	77	12
	Male	143 (53.4%)	63 (44.06%)	80	14
Age	0-17 years	25 (9.3%)	13 (52%)	12	14
	18-64 years	233 (86.9%)	94 (40.34%)	139	14
	Above 65 years	10 (3.7%)	4 (40%)	6	13
Residence	Rural	133 (49.6%)	60 (45.12%)	73	15
	Urban	135 (50.4%)	52 (38.5%)	83	15
HIV status	Negative	236 (88.1%)	100 (42.4%)	136	13
	Positive	32 (11.9%)	21 (65.6%)	11	16
Smoking status	Smoker	214 (79.9%)	90 (42.05%)	124	14
	Non-smoker	54 (20.1%)	21 (38.8%)	33	15
Adherence	Poor	56 (20.9%)	21 (37.5%)	35	13
	Fair	57 (21.3%)	26 (45.6%)	31	15
	Good	155 (57.8%)	64 (41.13%)	91	14
Comorbidities	Yes	228 (85.1%)	95 (41.67%)	133	17
	No	40 (14.9%)	16 (40%)	24	12
Drug use history	Yes	206 (76.9%)	86 (41.74%)	120	16
	No	62 (23.1%)	25 (40.32%)	37	12
MDR-TB type	Pulmonary	239 (89.2%)	96 (40.17%)	140	14
	Extra-pulmonary	29 (10.8%)	15 (51.72%)	17	16
Occupations	Employed	47 (17.5%)	17 (36.2%)	30	13
	Farmer	133 (49.6%)	83 (62.4%)	50	10
	Merchant	59 (22%)	9 (15.25%)	50	12
	Other	29 (10.8%)	2 (6.9%)	27	14
History of TB	Yes	163 (60.8%)	47 (28.83%)	116	15
	No	105 (39.2%)	64 (60.95%)	41	13
Education status	Not educated	35 (13.1%)	15 (42.85%)	20	15
	Primary	83 (31.0%)	39 (46.98%)	44	15
	Secondary	89 (33.2%)	31 (34.83%)	58	13
	Above all	61 (22.8%)	26 (42.6%)	35	12
Alcohol use	Yes	161 (60.1%)	68 (42.23%)	93	15
	No	107 (39.9%)	43 (40.18%)	64	13
Clinical completion	Completed	97 (36.2%)	43 (44.32%)	54	15
	Not completed	171 (63.8%)	68 (39.76%)	103	14
Continuous variables	**Mean**	**Standard deviation**	**Minimum**	**Maximum**	**Median**
Baseline weight	46.50	13.20	8.53	85.50	48.50
Time	10.945	2.03	8.50	24	14.01

with pulmonary MDR-TB had a longer time to death compared to those with extra-pulmonary MDR-TB. Patients living in urban areas had a longer time to death than those living in rural areas (HR = 1.039; 95% CI: 0.978, 1.159; $p = 0.001$). Patients with a negative HIV status in MDR-TB cases had a hazard ratio of 1.664 (95% CI: 0.960, 1.223; $p = 0.001$), suggesting that these patients experienced a longer time to death compared to those with a positive HIV status in MDR-TB cases (Table 4).

Patients with MDR-TB comorbidities also experienced a shorter time to death than those of the reference group. The time ratio for MDR-TB patients with a history of previous drug use was 0.091 ($p = 0.002$), indicating a shorter time to death than that of patients with no history of prior drug use. Additionally, MDR-TB patients with a history of smoking (HR = 1.102; Coeff = 0.097; 95% CI: 0.848, 1.876; $p = 0.010$) had a shorter time to death compared to MDR-TB patients with no smoking history (Table 4).

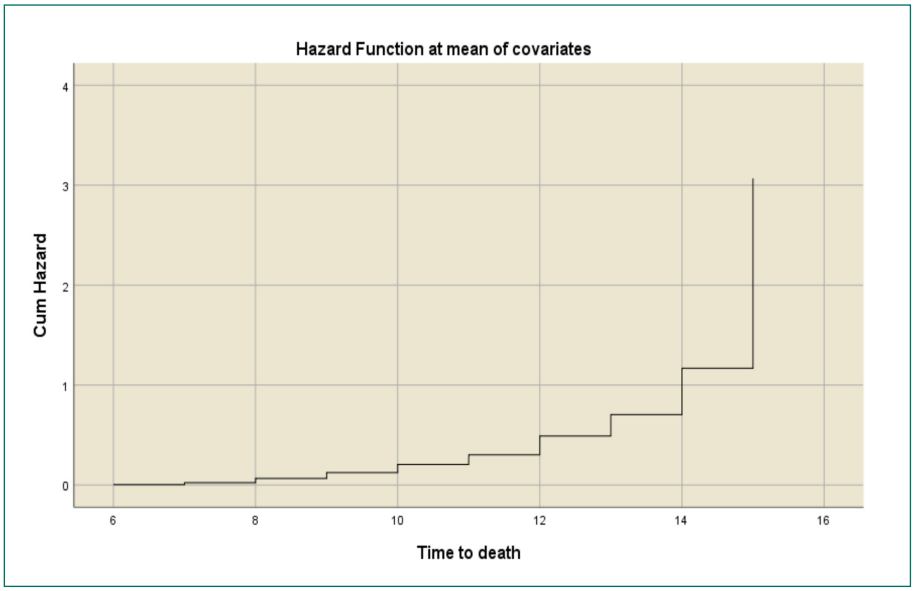

Figure 1. Time to death (month) cumulative hazard rate of multidrug-resistant tuberculosis patients in Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital.

DISCUSSION

In this study, we aimed to identify risk factors and investigate the time to death from multidrug-resistant tuberculosis (MDR-TB) in 268 patients registered at the Nigist Ellen Mohammed Memorial Hospital in Central Ethiopia between 2016 and 2023. Of these patients, 111 (41.4%) died, and 157 (58.6%) were censored for weight, patient residence, HIV status, smoking status, comorbidities, previous drug history, MDR-TB type, clinical complications, and alcohol use.

In this study, the mortality rate of MDR-TB was higher in males (53.6%) than in females (46.4%). This indicates that males are more likely to die from MDR-TB than females. Similarly, several other studies[23] have shown that male patients with MDR-TB tend to die within a shorter time. This might be related to their higher tendencies toward alcohol and drug abuse, as well as interruptions in their medication, which can have significant economic consequences for males compared to females[24]. The results also indicated that patients who lived in rural areas had shorter survival times than those in urban areas. This is consistent with the findings of previous studies conducted in East Shoa[25], Sudan[26]. Unlike previous studies[25], our study found that age had minimal effect on mortality in patients with MDR-TB. This finding is consistent with those of other studies[27] conducted in Russia.

This might be because people living in rural areas are less aware of health issues; they may have fewer health-seeking behaviors[28].

The results of this study suggest that the interaction between smoking status and previous drug use history is a significant predictive factor for time to death for patients with MDR-TB at the Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital in Central Ethiopia. This indicates that smokers with a history of drug use have a shorter time to death than other patients[26].

The current study showed that patients with extra-pulmonary MDR-TB had shorter mortality times than those with pulmonary MDR-TB, which is supported by a study by Kassa et al[29]. Patients with MDR-TB with comorbidities and clinical complications also experienced shorter deaths than those in the control group. This result is in line with the previous findings in Ethiopia[29].

CONCLUSIONS

The findings of this study revealed a high mortality rate of 41.4% with a median survival time of 12 months. Remarkably, males exhibited a higher mortality rate (53.6%) than females (46.4%), and rural residents had shorter survival times than urban residents. Additionally, extra-pulmonary MDR-TB patients had a significantly higher mortality rate (51.72%) than those with pulmonary MDR-TB (40.17%).

The Kaplan-Meier survival function, log-rank test, and Cox proportional hazards regression analysis revealed several predictors of mortality among patients with MDR-TB. Significant differences in survival times were observed based on sex, residence, HIV status, smoking status, comorbidities, drug history, and MDR-TB type. These findings suggest the need for modified healthcare strategies to address the unique challenges faced by high-risk groups. It is crucial to prioritize modified interventions for patients with extra-pulmonary MDR-TB, effectively manage clinical complications, and implement robust support programs to reduce alcohol

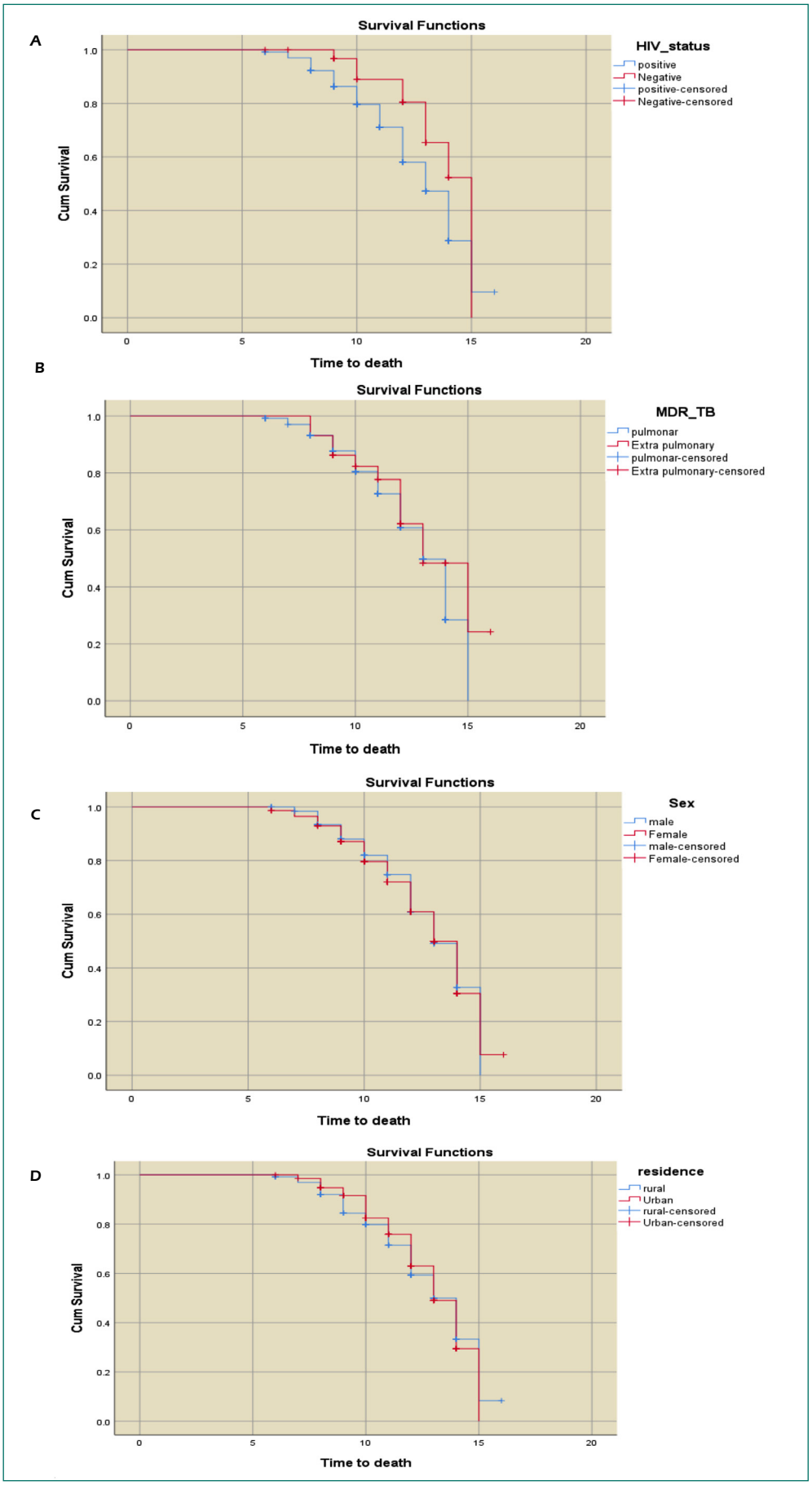

Figure 2. Cumulative (Cum) survival functions of predictors on multidrug-resistant tuberculosis patients in Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital. **A**, Human Immunodeficiency Virus (HIV) status of patients. **B**, Multidrug-resistant tuberculosis type of patients. **C**, Sex of patients. **D**, Residence of patients.

Table 3. Result of Log-rank test for the death time of multidrug-resistant tuberculosis patients in Nigist Ellen Mohammed Memorial Comprehensive Specialized Hospital.

Covariates	Category	Median	Degree of freedom	Log-rank test (Chi-square)	*p*-value
Sex	Male	14	1	3.195	0.014
	Female	12			
Residence	Rural	13	1	2.851	0.005
	Urban	15			
Marital status	Married	13	3	3.52	0.318
	Single	13.01			
	Widowed	12.8			
	Divorced	13.2			
HIV status	Negative	13	1	1.026	0.002
	Positive	8			
Smoking status	Smokers	9	1	1.280	0.004
	Nonsmokers	12			
Adherence	Poor	13	2	2.412	0.806
	Fair	11			
	Good	14			
Comorbidities	Yes	11	1	1.251	0.002
	No	12			
Previous drug history	Yes	10	1	1.244	0.001
	No	12			
MDR-TB type	Pulmonary	14	1	0.639	0.0024
	Extra-pulmonary	8			
Education Level	Not education	12	3	2.187	0.005
	Primary	10			
	Secondary	13			
	Above all	12			
Occupation	Employed	14	3	2.304	0.329
	Farmer	13.5			
	Merchant	13			
	Other	21			
History of TB	Yes	23	1	1.180	0.002
	No	22			
Alcohol use	Yes	23	1	0.785	0.0019
	No	22			

use. These targeted strategies should include comprehensive medical care, regular monitoring, and dedicated counseling services to address the specific challenges associated with each high-risk factor.

Conflict of Interest:
The authors declare no conflicts of interest.

Ethics Approval:
The study was reviewed and approved by the Institutional Review Board (IRB) of Wachemo University, Ethiopia, under reference number WCU-115/2023 on 13/12/2023. Confidentiality and privacy of the data were strictly maintained in accordance with ethical principles and guidelines.

Informed Consent:
This study utilized a retrospective analysis of existing secondary data. The data were already documented and recorded with strict adherence to confidentiality and privacy protocols. As no direct interaction with participants occurred, informed consent was not required.

Table 4. Cox proportion hazard regression analysis of predictors for time to death outcome among 268 multidrug-resistant tuberculosis patients in NEMMCSH.

Variables	Coefficients	Standard Error	*p*-value	Hazard ratio	95% CI HR	
					Lower	Upper
Sex (female)	-.065	.221	.003	.937	.808	1.244
Age (0-17 years)						
Age b/n 18 and 64 years	.424	.672	.528	1.528	.410	2.701
Age above 65	-.185	.540	.732	.831	.289	1.395
Residence (urban)	.038	.218	.001	1.039	.978	1.592
Marital status (married)						
Single	-.236	.573	.081	.790	.557	1.428
Widowed	-.855	.620	.168	.425	.126	1.432
Divorced	.897	.786	.254	2.453	1.526	3.443
HIV status (negative)	.509	.337	.001	1.664	.960	2.223
Smoking history (smoker)	.097	.271	.011	1.102	.848	1.876
Comorbidities	.303	.308	.006	1.354	1.174	1.479
Previous drug history	.087	.253	.002	1.091	1.065	1.791
MDR-TB (extra-pulmonary)	.190	.334	.000	1.209	.928	1.326
Weight	-.002	.008	.001	.998	.982	1.015
Clinical completion	-.162	.215	.0021	.851	.659	1.295
Alcohol use	-.144	.213	.000	.866	.770	1.314

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Authors' Contributions:
SSA designed the study, wrote the first draft of the manuscript, and analyzed data by using statistical software. LLT and GTM managed the analysis, searched all possible literature, and collected, inserted, and analyzed data using software. All authors read and approved the final manuscript.

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Data Availability:
The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI Disclosure:
The authors confirm the use of artificial intelligence, specifically QuillBot, for grammar checking and language editing. However, it was not involved in the research design, data analysis, or scientific content generation.

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