Risk Factors and Treatment Outcomes of Multidrug Resistant Tuberculosis Among Patients in Oshana Region at Oshakati Hospital, Namibia

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ABSTRACT

Background: Multidrug resistant tuberculosis is still a huge challenge to Tuberculosis control globally, particularly in resource limited regions of the world. Namibia still suffers these challenges in control of MDR-TB due to poor diagnostic facilities, low treatment compliance and suboptimal follow up measures.

Methods: This was a mixed-method quantitative survey study conducted at Oshakati Intermediate Hospital in September-October 2025. The research comprised of a case control study that established the risk factors of multidrug-resistant tuberculosis and a retrospective cohort designed to evaluate treatment outcomes. Convenience sampling was used due to the limited number of multidrug-resistant tuberculosis patients available. A standardized form of structured questionnaires was used for data collection from patient interviews and hospital registries. This data was then analysed descriptively with the use of tests such as Fisher's exact and Chi-square where appropriate.

Results: The case control study contained four patients (one multidrug-resistant case and three drug susceptible controls). The case was an older married man in a rural setting and had a history of imprisonment. In the retrospective cohort (n=20) mean age was 46.4 years with males of 60%. Seventeen patients (85%) were transferred out to complete the treatment at home through a TB clinic, and three (15%) expired during the hospital stay. There were no significant associations between demographic or clinical characteristics and treatment outcome ($p>0.05$).

Conclusion: MDR-TB at Oshakati Intermediate Hospital is seemingly driven by social and environmental factors such as rural dwelling and imprisonment. This high percentage of patients moved out from the ward to continue treatment at home highlights that estimating treatment outcomes among those previously treated in the ward is not indicative. Improvements in Access to diagnosis, strategies for follow-up and patient tracking systems are crucial in strengthening the MDR-TB control in North Namibia

Keywords: Multidrug-resistant Tuberculosis, Risk factors, Treatment outcomes

INTRODUCTION

Background and Orientation of the proposed study

Tuberculosis (TB), caused by *Mycobacterium tuberculosis*, is one of the world's oldest infectious diseases, yet it still remains a leading cause of illness and death across the globe. . According to the World Health Organization

(WHO), about 10.6 million people developed TB in 2022, and 1.3 million of them died from the disease (WHO, 2023. While TB itself is already a serious health challenge, an even greater concern has emerged in the form of multidrug-resistant TB (MDR-TB). This form of TB does not respond to at least two of the most effective anti-TB drugs—isoniazid and rifampicin. In 2022 alone, roughly 450,000 people were diagnosed with MDR-TB or rifampicin-resistant TB (WHO, 2023).

Treating MDR-TB is far more complicated than treating drug-susceptible TB. It requires longer, more toxic, and more expensive drug regimens, which unfortunately have a much lower success rate—around 52% globally (Falzon et al., 2017). In many parts of sub-Saharan Africa, including Namibia, controlling MDR-TB is particularly difficult due to high rates of HIV, poverty, overcrowded living conditions, and overburdened healthcare systems. Between 2015 and 2016, the WHO African Region recorded between 36,000 and 44,000 MDR-TB cases, reflecting the scale of the problem in this part of the world (WHO Regional Office for Africa, 2018). Contributing factors such as poor adherence to treatment, incomplete regimens, and the ongoing spread of resistant strains in communities continue to fuel the epidemic.

The emergence of MDR-TB in the region has been closely linked to suboptimal TB control programs, lack of resources, and shortages of trained healthcare workers (Vulika Nangombe, et al., 2024). While various studies have attempted to estimate the burden of MDR-TB in sub-Saharan Africa, findings have been inconsistent. For example, in an article written by Muse et al. (2017), they referenced different studies whereby aa study done by Lukoye reported a cumulative MDR-TB prevalence of 1.5% (95% CI: 1.0–2.3), whereas a study done by Berhan found a five-fold higher risk of MDR-TB in previously treated TB cases compared to new cases. Variability in prevalence has also been observed within and between countries, including in South Africa (Muse et al., 2017).

Namibia is listed among the world's 30 high TB burden countries, with an incidence rate of around 460 cases per 100,000 people in 2020 (WHO, 2023). A national drug resistance survey carried out in 2014– 2015 found that 4.5% of new TB cases and 7.9% of previously treated cases were MDR-TB. Prior TB treatment was one of the strongest risk factors identified (Shavuka et al., 2024). However, despite these national statistics, very little is known about the specific risk factors and treatment outcomes at the individual level, especially in facilities like Oshakati Intermediate Hospital, which sees a high number of MDR-TB patients.

This lack of localized evidence creates a gap in understanding that may limit how effective TB control efforts can be on the ground. To help fill this gap, this study will focus on identifying the main risk factors that lead to MDR-TB and assessing how patients at Oshakati Hospital respond to treatment. The findings aim to support more targeted interventions and strengthen Namibia's broader TB control strategies.

Problem statement

Tuberculosis (TB) remains a major global health problem and Namibia is no exception. While TB control has improved significantly, the rise in MDR-TB poses a major public health threat in Namibia. Oshakati Hospital, which is a major referral centre in northern Namibia, manages a significant number of MDR-TB annually, however there's a lack of comprehensive data regarding the risk factors involved in the development of multidrug resistance and how these patients fare after treatment or therapy.

Current literature available on sub-Saharan Africa shows variability in factors contributing to MDR- TB. This then limits the applicability of such literature in the setting of Namibia where social, clinical, and health system elements may vary. Furthermore, it is difficult for health officials to customize treatments and enhance treatment plans in the absence of localized evidence. This study aims to close this important knowledge gap, identify important risk factors, evaluate treatment results among MDR- TB patients at Oshakati Hospital, and therefore assist evidence-based TB reduction initiatives in northern Namibia

Significance of the study

MDR-TB remains a growing concern globally, and Namibia is no exception. With an estimated TB incidence of 460 per 100,000 people, Namibia is currently ranked by the World Health Organisation as one of the 30 high TB burden countries in the world (WHO, 2023). It also raises concerns considering that MDR-TB accounts for 7.9%

of previously treated cases and 4.5% of new cases in Namibia. Further complicating the management of MDR-TB is the fact that 47% of patients also have HIV (WHO, 2023). These numbers highlight the urgent need for locally targeted research in order to develop effective strategies to combat MDR-TB, particularly Oshakati Hospital which serves as one of the main referral centres in northern Namibia.

By investigating the risk factors associated with the development of MDR-TB among patients at Oshakati Hospital, this study aims to fill an important knowledge gap in the current research data we have available. By understanding the risk factors, we can also design prevention strategies that are more tailored to the community's needs.

This study will also assess how MDR-TB patients at Oshakati Hospital fared after receiving therapy or treatment, and it will then help pinpoint areas that could use improved interventions.

Objectives of the study

Main Objective

To determine the risk factors associated with the development of multidrug resistant tuberculosis and establish treatment outcomes among treated patients at Oshakati Hospital.

Specific Objectives:

1. To identify the risk factor of MDR TB among patients treated at **Oshakati Hospital** .
2. To establish the treatment outcome of MD-TB treatment of MDR-TB patients at Oshakati Hospital.
3. To determine the comorbidities of MDR-TB patients at Oshakati Hospital.

LITERATURE REVIEW

Introduction

Tuberculosis is an infectious disease caused by Mycobacterium tuberculosis that mainly affects the lungs, though it can also involve other organs such as the brain, kidneys, and spine. It spreads through the air when a person with active TB coughs, sneezes, or speaks, releasing tiny droplets that can infect others nearby. TB has been around for centuries and continues to be one of the world's deadliest infectious diseases, especially in low- and middle-income countries (WHO, 2023).

In 1993, the World Health Organization declared TB a global health emergency due to its widespread impact and rising death toll. By 2017, about 10 million people were estimated to have TB, with 6.4 million newly diagnosed cases and nearly 3 million deaths annually (WHO, 2023). What makes this situation even more complex today is the growing presence of drug-resistant forms of TB. MDR-TB, in particular, is defined as resistance to at least isoniazid and rifampicin—the two key first-line drugs used to treat TB. This type of resistance is increasingly common and poses a major challenge to TB control efforts worldwide. In 2022, about 450,000 new cases of MDR or rifampicin-resistant TB were reported (WHO, 2023).

The aim of this literature review would be to describe in detail the current state of knowledge about multidrug-resistant tuberculosis (MDR-TB) and its therapeutic outcomes. This includes understanding what is already known about the causes of MDR-TB and how this affects treatment outcomes. The literature review will also serve to increase knowledge about MDR tuberculosis and its treatment outcomes by summarizing, synthesizing and critiquing existing research. Understanding the factors that contribute to the development of MDR-TB and their impact on treatment outcomes is critical to improving TB control strategies.

Risk Factors of multidrug-resistant tuberculosis

The emergence of MDR-TB is linked to several risk factors, many of which are related to health system gaps and patient behaviour. A case-control study conducted in Ethiopia's Amhara region showed that treatment failure was the most significant risk factor for MDR-TB (Mulu et al., 2015). Similarly, a national drug resistance study

found that most MDR-TB patients had previously been treated for TB, while a smaller portion were newly diagnosed (Mulu et al., 2015). The National Drug Resistance Study in Ethiopia also noted that 11.8% of MDR-TB cases had a history of anti-TB treatment, while 1.6%

were newly diagnosed. Poor adherence to treatment regimens, insufficient monitoring, and improper prescription practices can worsen resistance. Mulu et al. (2015) further reported that patients who had undergone more than two rounds of anti-TB treatment had a 1.9-fold increased risk of MDR-TB. Poor adherence remains a central driver of resistance. To strengthen these findings, Pradipta et al. (2018) conducted a large global meta-analysis and found that patients with a history of TB treatment were nearly six times more likely to develop MDR-TB. Xi et al. (2022) also confirmed this elevated risk in their meta-analysis of over 430,000 TB patients worldwide.

Another case-control study conducted in southern Ethiopia, using patients with multidrug- resistant tuberculosis as cases and non-resistant tuberculosis as controls, found that patients who had a history of contact with patients with established tuberculosis had a higher risk of developing tuberculosis multidrug-resistant tuberculosis. TB. VG compared to their peers. Among the respondents were 31 (39.24% of cases) and 58 (18.53% of the controls) had had contact with patients with known tuberculosis in the past. This may be because tuberculosis patients who have been exposed to tuberculosis have a higher risk of developing tuberculosis or contracting tuberculosis, depending on factors such as the nature of the contact infectivity of the source of infection and the characteristics of the environment. At the same time, transmission of MDR strains or selection of unique drug-resistant strains may have contributed to the emergence of MDR tuberculosis (Admassu et al., 2023). Similar findings can be found in a study by Desissa et al. (2018) where a case-control study was done in East Shoa Region, involving 120 MDR-TB cases and matched controls, and found that prior exposure to known MDR-TB patients increased the odds of developing MDR-TB by over 3-fold (AOR ≈ 3.2, 95% CI 1.8–5.7).

Geographic and lifestyle factors can also play a role. For instance, Admassu et al. (2023) suggested that people living in rural areas might be more at risk due to poor access to health facilities and limited education about medication adherence. However, this finding has not been consistent across all studies. Research from places like Bhutan, Yemen, and other parts of Ethiopia has not always shown a clear link between rural living and MDR-TB, suggesting that other local factors may influence the relationship

Impact on treatment outcomes

The development of multidrug-resistant tuberculosis (MDR-TB) in patients has significant and profound implications for individuals, communities and healthcare systems. First, there is the question

Having MDR-TB doesn't just make treatment harder — it also puts patients at greater risk for poor health outcomes. Unlike drug-susceptible TB, which is typically treated over six months, MDR-TB treatment can last anywhere from 18 to 24 months or more. It involves second-line medications that are often less effective, more expensive, and more likely to cause side effects (Seung et al., 2015). As a result, patients may struggle to stick to their treatment, and the likelihood of treatment failure or relapse goes up.

Secondly, MDR-TB is associated with increased mortality compared to drug-resistant tuberculosis. Results show that multidrug-resistant tuberculosis strains significantly increase the risk of death compared to suspected Drug susceptible-TB cases during tuberculosis treatment. The cause of the increased risk of death from multidrug-resistant forms is multifactorial. Multidrug-resistant tuberculosis is generally considered to be comorbid with other diseases such as HIV infection, diabetes and chronic kidney disease, as well as with lifestyles such as alcohol abuse, smoking, drug use, etc. with a high rate of treatment failure and relapse, which directly increases the mortality rate of these patients. Prolonged exposure to anti-TB drugs may also increase the risk of death because the antibiotics used to treat MDR-TB have a higher toxicity profile and incidence of side effects. There is therefore no doubt that multidisciplinary management of drug-resistant tuberculosis is necessary and of great importance. (Chung-Delgado et al., 2015). Longer and more complex treatments increase the risk of treatment failure, which can lead to disease progression and death.

Multiple studies have established that HIV co-infection significantly influences MDR-TB treatment outcomes, although it may not directly increase resistance risk. A 2021 global meta-analysis including over 430,000 TB patients found that HIV-positive individuals had 1.42 times higher odds of having MDR-TB compared to HIV-

negative patients (Sultana et al., 2021) Moreover, a regional systematic review encompassing Africa and Asia reported that HIV co-infected patients experienced a 35% higher risk of mortality during MDR-TB treatment.(Kajogoo et al., 2022) These findings suggest that HIV's primary impact lies in affecting and worsening clinical outcomes rather than directly causing resistance. World Health Organization (WHO) stated that Namibia is ranked among the top 30 high TB and TB/HIV burden countries, with approximately 31% of TB patients also living with HIV, therefore in Namibia HIV co-infection may contribute to treatment complexity and mortality risks. (*Ending Tuberculosis (TB) a Priority for Namibia | WHO | Regional Office for Africa*, 2024 & Vulika Nangombe, et al., 2024) Another treatment effect of MDR-TB patients is disease progression to extensively drug-resistant tuberculosis (XDR-TB). Highly drug-resistant tuberculosis (XDR-TB) is a rare form of multidrug-resistant tuberculosis (MDR-TB) that is resistant to isoniazid, rifampicin, fluoroquinolone, and second- line injectable drugs (amikacin, capreomycin, and kanamycin), or isoniazid. rifampicin, fluoroquinolone, and bedaquiline or linezolid (Factsheets, 2016). Highly drug-resistant tuberculosis is resistant to even more drugs and is even more difficult to treat. This makes the fight against tuberculosis even more difficult

After conducting research and analyzing the current literature on factors contributing to the development of multidrug-resistant tuberculosis (MDR-TB) and their impact on treatment outcomes, several unanswered questions and knowledge gaps were identified. While there are numerous studies on risk factors for MDR-TB, there are very few studies specific to Namibia. Bridging this information gap can be critical to designing specific countermeasures and interventions. Few studies have examined the perspectives, challenges, and experiences of MDR- TB patients during treatment. This qualitative aspect can provide relevant information. Finally, due to social stigmatization, patients' willingness to seek medical care decreases. MDR-TB stigma, societal beliefs, and community treatment can be examined to reduce barriers to treatment uptake and adherence.Methodology

Research Design and Setting

This study made use of a quantitative research design comprising two components. It involved a case-control study which compared MDR-TB patients(cases) with drug-susceptible TB patients(controls) to identify potential to risk factors associated with the development of multidrug-resistant tuberculosis (MDR- TB). This study also comprised of a retrospective cohort component which to evaluated treatment outcomes among patients diagnosed with MDR-TB.

The study was conducted at Oshakati Intermediate Hospital a major referral center in northern Namibia for TB diagnosis and treatment. The hospital's TB ward and MDR-TB treatment program provided the clinical data used in this study.

Sample and sampling method

The study population included all patients who were diagnosed and treated for Tuberculosis (TB) at Oshakati Intermediate Hospital. This group consisted of patients with drug susceptible TB as well as those with multidrug-resistant confirmed through GeneXpert or culture-based drug susceptibility testing.

For the case-control component, all patients who had a confirmed diagnosis of MDR-TB and were admitted during the study period were included as cases. Patients with drug-susceptible TB admitted during the same period were included as controls. Because there were very few TB patients admitted in the ward during the month-long study period, a convenience sampling method was used. This meant that every eligible patient who was present and complete clinical records were included. In total, four patients participated in this part of the study, one case and three controls.

For the retrospective cohort component, Data collection began with the most recent hospital admissions and continued retrospectively until information from 20 MDR-TB patients was obtained. This approach was practical, as MDR-TB admissions occur infrequently and it ensured that enough cases were available for meaningful analysis.

Data collection tools

A structured questionnaire was used to collect data from patients during an interview {Appendix B) for the case

control component. The questionnaire will consist of questions related to different possible risk factors such as exposure history, HIV status socio-demographic information, clinical history, comorbidities, and behavioral factors.

For the retrospective cohort, a form (Appendix C) was used to extract data from the already existing patient files and hospital registers.

Data collection Method

The questionnaire (appendix B) was used in a face-to-face interview format. Before data collection, a trial study was done in order to refine the questionnaire and ensure clarity and appropriateness. The patients' medical records were also reviewed for further clarity. Data for treatment outcomes was extracted from the hospital TB registers. To maintain confidentiality, no patient names or identifiers were recorded; each participant was assigned a unique code.

Data analysis

Data was entered into Microsoft Excel 2019 and analyzed using Epi info version 7. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize demographic and clinical characteristics. In the case control component, Fisher's exact tests were considered for small sample categorical comparisons, although meaningful statistical testing was limited by the small sample size in the cohort component, bivariate analyses were performed to explore relationships between sociodemographic and clinical factors and treatment outcomes. Chi-square and Fisher's exact tests were used with a significance threshold of $p < 0.05$.

Dissemination of results

The final research report will be submitted to the University of Namibia, School of Medicine, as part of the academic requirements for the Bachelor of Medicine and Bachelor of Surgery (MBChB) degree. A copy will also be submitted to the Oshakati Intermediate Hospital management and the TB ward team who are directly involved in patient care.

Ethical Considerations

Ethical approval for this study was obtained from the University of Namibia's Ethics committee the Ministry of Health and Social Services Appendix E), and the management of Oshakati Intermediate Hospital.

In situations where direct communication with patients was done, informed written consent (Appendix D) was taken after describing purpose and procedures of research to eligible participants. The participation was voluntary, and patients were informed that they could refuse at any time without influencing their treatment. Anonymity was preserved throughout the study. No patient identifiers were recorded on the data collection forms.

RESULTS

This study consisted of two components: a case-control study which investigated risk factors associated with multidrug-resistant tuberculosis and a retrospective cohort study which assessed treatment outcomes among MDR-TB patients treated at Oshakati Intermediate Hospital.

Risk Factors associated with MDR-TB

A total of 4 patients participated in the case-control aspect of this study. Of these, one (25%) was diagnosed with multidrug-resistant tuberculosis, while three (75%) had drug-susceptible tuberculosis. The mean age of the study participants was 46.5 years (SD=22.4). The MDR-TB case was noticeably older at 73 years, while the DS-TB controls had a mean age of 38.7 years. Overall, three participants (75%) were male, and one (25%) was female. The MDR-TB case was male.

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Half of the participants (50%) were married, and half was single. Two participants (50%) had no formal education, while the remaining two had completed primary or tertiary education. All participants (100%) were unemployed. Two out of the three controls (66.7%) lived in urban areas, while the MDR-TB case resided in a rural area

Two controls (66.7%) were HIV-negative, and one (33.3%) had was unknown, while the MDR-TB case was HIV-negative. One control (33.3%) had a history of prior TB treatment, whereas the MDR-TB case had no prior treatment history. One control (33.3%) also reported contact with a TB patient, while the MDR-TB case had no known contact. All participants denied a history of treatment default.

Institutional exposure was relatively common: one control (33.3%) and the MDR-TB case (100%) reported a history of prison or migrant stay. None of the participants reported smoking, alcohol consumption, or the use of recreational drugs or sedatives. These findings are summarized in Table 1.

Table 1: Socio-demographic and clinical characteristics of MDR-TB case and drug-susceptible TB controls

Characteristic	Controls, n (%)	Case, n (%)
Sex		
Female	1 (33.3%)	0 (0.0%)
Male	2 (66.7%)	1 (100.0%)
Marital Status		
Married	1 (66.7%)	1 (100.0%)
Single	2 (33.7%)	0 (0.0%)
Education Level		
No formal education	1 (33.3%)	1(100.0%)
Primary/Tertiary	2 (66.7%)	0 (0.0%)
Occupation		
Unemployed	3 (100.0%)	1 (100.0%)
Residence		
Urban	2 (66.7%)	0 (0.0%)
Rural	1 (33.3%)	1 (100.0%)
HIV Status		
Negative	2 (66.7%)	1 (100.0%)
Unknown	1 (33.7%)	0 (0.0%)
Positive	0 (0.0%)	0 (0.0%)
History of TB Treatment		
Yes	1 (33.7%)	0 (0.0%)
No	2 (66.7%)	1 (100.0%)
Contact with TB Patient		
Yes	1 (33.3%)	0 (0.0%)
No	2 (66.7%)	1 (100.0%)
History of Defaulting		
No	3 (100.0%)	1 (100.0%)
Yes	0 (0.0%)	0 (0.0%)
Prison/Migrant Stay		
Yes	1 (33.3%)	1 (100.0%)
No	2 (66.7%)	0 (0.0%)
Smoking		
No	3 (100.0%)	1 (100.0%)
Yes	0 (0.0%)	0 (0.0%)

Alcohol Use		
No	3 (100.0%)	1(100.0%)
Yes	0 (0.0%)	0 (0.0%)
Drug/Sedative Use		
No	3 (100.0%)	1 (100.0%)
Yes	0 (0.0%)	0 (0.0%)

Given the small sample size (n = 4) and the lack of variability across multiple categorical variables, bivariate analysis could not produce statistically meaningful results. Fisher's exact tests could not be applied for most factors due to zero cell counts. Hence descriptive analysis was used to summarize the patterns observed while also supporting these patterns with relevant literature.

Treatment Outcomes among MDR-TB Patients

Demographic Characteristics

A total of 20 patients with multidrug resistance were included in this study. The mean age of the participants was 46.4 years (range 19-81). Of these, 12(60%) were male and 8(40%) were female. Majority of participants were diagnosed in 2024(n=12, 60%), with 4 patients (20%) in 2023 and 3 patients (15%) in 2025. All patients had pulmonary TB (100%).

Table 2: Demographic and clinical characteristics of MDR-TB patients

Characteristic	Frequency (n)	Percentage (%)
Sex		
Male	12	60
Female	8	40
Year of diagnosis		
2023	4	20
2024	12	60
2025	3	15
HIV status		
Positive	4	20
Negative	16	80
Comorbidities		
None	19	95
Comorbidities(malaria)	1	5
Type of TB		
Pulmonary	20	100
Extrapulmonary	0	0

Clinical Characteristics

Of the 20 patients included in the study, 16 (80%) were HIV-negative and 4 (20%) were HIV-positive. The majority of patients, 19 (95%) had no other comorbid conditions, while 1 patient (5%) was recorded as having malaria. All patients 20 (100%) had pulmonary tuberculosis. The clinical characteristics are summarized in table 2

Treatment Outcomes

Of the 20 patients, 17(85%) were transferred out to continue treatment at home via TB clinic. While 3(15%) died during hospitalization. Since outcomes for transferred patients were not available, definitive treatment success/ failure could not be determined form this dataset.

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Table 3: Treatment Outcomes among MDR-TB patients

Treatment Outcomes	Outcome Type	Frequency	Percentage
Successful N = 0 (0 %)			
	Cured	0	0
	Completed	0	0
Transferred out (discharged home via TB clinic) N= 17 (85%)		17	85
Unsuccessful N = 3 (15.0%)			
	Failed	0	0
	Defaulted	0	0
	Died	3	15
Total		20	100

Factors Associated with MDR-TB Treatment Outcomes

Factors which could possibly affect the treatment outcome of MDR-TB amongst patients were assessed using the bivariable logistic regression model. Since the only treatment outcomes captured were "transferred out (discharged via TB clinic)" and "Died", the variables in the bivariate analysis were hence only matched against those treatment outcomes. None of the socio-demographic or clinical variables showed a statistically significant association with treatment outcomes ($p>0.05$). The results are summarized in table 1.4. Fisher's Exact test was used for 2x2 variables, while Chi-square tests were applied for variables with more than two categories.

Table 4: Association between selected patient characteristics and treatment outcomes among MDR-TB patients

Variable	Category	Died n(%)	Transferred n(%)	Total	Test Used	p-value	Significant (p<0.05)
Sex	F	1 (12.5%)	7 (87.5%)	8	Fisher's Exact	1	No
	M	2 (16.7%)	10 (83.3%)	12	Fisher's Exact	1	No
Year of diagnosis	2023	0 (0.0%)	5 (100.0%)	5	Chi-square	0.484	No
	2024	2 (16.7%)	10 (83.3%)	12	Chi-square	0.484	No
	2025	1 (33.3%)	2 (66.7%)	3	Chi-square	0.484	No
HIV Status	Negative	3 (18.8%)	13 (81.2%)	16	Fisher's Exact	1	No
	Positive	0 (0.0%)	4 (100.0%)	4	Fisher's Exact	1	No
Other Comorbidities	Complicated with malaria	1 (100.0%)	0 (0.0%)	1	Fisher's Exact	0.15	No
	none	2 (10.5%)	17 (89.5%)	19	Fisher's Exact	0.15	No
Type of TB	Pulmonary	3 (15.0%)	17 (85.0%)	20	Chi-square	1	No

DISCUSSION

This study investigated both the determinants of development of MDR-TB and the treatment outcomes of MDR-TB patients at Oshakati Intermediate Hospital. Despite the small number of participants in the case control component, the combined findings provide important insights into local MDR-TB dynamics in the Oshana region.

Risk Factors for MDR-TB

This part of the study explored socio-demographic ad clinical factors associated with multidrug-resistant tuberculosis among patients managed at Oshakati Intermediate Hospital. Although the number of participants was small, the descriptive findings provide important preliminary insights that reflect trends observed in other African settings

The single MDR-TB case was an older, married man from a rural area who had a history of incarceration. These characteristics closely resemble profiles of those described in similar studies from other African countries. A study done in the Eastern Cape, South Africa, found that patients from rural areas experienced higher rates of treatment non-adherence and poorer outcomes due to transportation barriers and limited health care access (Faye et al., 2024). Similar observations were made by Zereabruk et al. (2024) who observed that rural patients in Ethiopia were more likely to develop MDR-TB than urban dwellers, suggesting that geographic inequality contributes significantly to resistance development (Zereabruk et al., 2024). These parallels suggest that the rural-urban divide observed at Oshakati Intermediate Hospital mirrors patterns seen in regions outside the country.

Institutional exposure, such as imprisonment was also reported in the MDR-TB case. This finding is supported by growing evidence that correctional facilities play a major role in sustaining MDR-TB epidemics. A recent epidemiology study found that individuals with current or prior incarceration were significantly more likely to belong to MDR-TB transmission clusters, indicating that prisons function as amplifiers for resistant strains of Multidrug-resistant tuberculosis. The presence of incarceration history in the MDR-TB case here reflects these global findings, suggesting that even in small samples, institutional environments can serve as catalysts for TB transmission and drug resistance. (Utpatel et al., 2024 & Vulika Nangombe, et al., 2024). This finding is consistent with the profile of the MDR-TB case in this study, suggesting that even in small samples, history of incarceration may be important epidemiological clues when assessing resistance risk.

Furthermore, the older age and male sex of the MDR-TB case in this study are consistent with patterns reported globally, although these factors may not independently predict resistance. A meta-analysis by Xi et al. (2022) found that neither sex nor age had a statistically significant association with MDR-TB after adjusting for confounding variables such as treatment history and HIV status (Xi et al., 2022). This indicates that demographic patterns may reflect broader social and healthcare access differences rather than inherent biological susceptibility.

While behavioural risk factors such as smoking and alcohol use were absent in this study, literature on their role in MDR-TB remains inconsistent. Some studies, such as Welekidan et al. (2020), have linked smoking to increased MDR-TB odds (Welekidan et al., 2020), while others, including Alemu et al. (2022), found these behaviours to be inconsistent predictors once adjusted for stronger determinants like prior TB treatment and unemployment (Alemu et al., 2022, & Vulika Nangombe, et al., 2024). Overall, the evidence suggests that treatment-related and health system factors particularly previous treatment, contact history, and institutional exposure, remain the strongest and most consistent drivers of MDR-TB.

Treatment Outcomes of MDR-TB

In this cohort of 20 patients that were treated for MDR-TB at Oshakati hospital, 17 patients (85%) were transferred out (discharged home) to continue care at home at to follow up to the TB clinic and 3 patients (15%) died during their hospital stay. No patients were recorded as cured, treatment completed, failed treatment or defaulted.

The high proportion of patients classified as “transferred out” is a major finding and limits the ability of the study to report a valid treatment success rate at the referral site (Vulika Nangombe, et al., 2024). The World Health Organization clearly states that patients transferred out, or for whom no final recorded outcome exits should be classified a s “not evaluated” rather than as successful cases. This then prevents the inflation of the outcome figures. (World Health Organization, 2022)

Decentralized models of MDR-TB care describe a health care system where patients are initially beginning treatment at a referral centre and are then managed at peripheral clinics once stabilized. These models are widely used especially in settings like Oshakati hospital with limited hospital capacity. Research however shows that when linkage between referral centres and peripheral clinics is weak, large numbers of patients may finish treatment without a documented outcome. For example, a study in Central and West Africa (Toft et al., 2022) found a treatment success rate of 74.6% in published cohorts, however emphasis was made on the fact that many of these cases were lost to follow-up or classified as “not evaluated”, which complicate interpretation of final

outcomes. In this study where 85% of patients are classified as "transferred out/not evaluated" major problems may arise. Firstly, we are not able to legitimately calculate a treatment success rate because the outcomes of the patients remain unknown. Secondly, identifying predictors of poor outcomes becomes extremely difficult. Other studies in similar settings have also flagged "transferred out/not evaluated" as a primary limitation and have called for improved patient tracking and register linkage (Koroma et al., 2024).

Our observed mortality of 15% is within the range reported in low- and middle-income countries. Although direct comparisons are difficult when many patients are transferred out and outcomes remain unknown. A recent Ethiopian retrospective cohort (Kebede & Mamo, 2024) reported a treatment success rate of 50% (95% CI 44.1-55.9%) among 276 confirmed MDR-TB cases, highlighting the challenge of achieving favourable outcomes when follow-up is limited.

Strengths and Limitations

This study's greatest strength lies in the fact that it is double design study. It includes acase-control and retrospective cohort. This has enabled the study to simultaneously explore MDR-TB risk factors and treatment outcomes within a single institutional setting. Detailed level patient data made the analysis more powerful and facilitated internal consistency across datasets.

But the research had its limitations. The sample size of the case-control study was small, which imposed a limitation on statistical inference and the ability to generalize the data to the rest of the population. Likewise, in the cohort analysis, the majority of patients were transferred out making it not possible to obtain valid estimates for rates of treatment success. The fact that the study was retrospective also made certain findings reliant on the accuracy and completeness of the available medical data. Additionally, the small sample size was a result of the few eligible TB patients who were recruited during the study period, indicating low MDR-TB patient load at Oshakati Intermediate Hospital.

CONCLUSION AND RECOMMENDATIONS

This research study utilized a case control and a retrospective cohort to provide comprehensive data on both the factors associated with MDR-TB and the treatment outcomes among patients treated at Oshakati hospital. The case control component revealed that individuals with MDR-TB tended to be older males, commonly from rural areas, and often with a history of incarceration. These patterns are consistent with findings from other African countries, highlighting the influence of social and structural determinants such as geographic inequity, poor access to care, and institutional exposure in the development of MDR-TB. The Retrospective Cohort portion of the study showed that although a large portion of MDR-TB patients were successfully transferred out to community-based care, outcomes were not known for most and valid calculation of treatment success rates was not possible. There were no statistically significant socio-demographic or clinical variables, which are potentially related to sample size as well as incomplete follow-up data. Overall, the findings of the study highlight that MDR-TB is a complex problem, and it is not just due to individual level factors but considerably by larger systemic factors. These results offer important knowledge on the epidemiology and clinical course of MDR-TB in northern Namibia to support focused interventions for prevention, early detection/management and optimised treatment monitoring.

Recommendations

Based on the findings of this study, several recommendations can be made to strengthen the diagnosis, management, and follow-up of multidrug-resistant tuberculosis in Oshana Region.

Firstly, coordination between Oshakati Intermediate Hospital and the TB clinic should be improved to ensure that patients who are transferred out remain under consistent follow-up. Establishing a clear communication and feedback system between facilities would make it easier to track patient progress and document treatment outcomes more accurately.

Secondly, access to diagnostic services in rural areas should be implemented. The use of rapid molecular tests such as GeneXpert would allow for earlier detection of resistance and reduce delays in starting appropriate

therapy. Outreach diagnostic services could also help reach patients in remote communities and limit community transmission.

Thirdly, targeted screening and infection control measures should be strengthened in correctional facilities and other institutional settings where overcrowding and poor ventilation increase transmission risk. Collaboration between the Ministry of Health and correctional health services would help ensure that TB screening and treatment continue seamlessly when individuals are released or transferred.

Finally, future research should involve larger, multicentre studies across northern Namibia to validate these findings and explore patient-related barriers to treatment adherence. Such studies would help design more patient-cantered and sustainable MDR-TB care strategies.

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