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Treatment outcomes of short-regimen multi-drug resistant tuberculosis in uMkhanyakude district (2018–2022) South Africa: a retrospective, cross-sectional study

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Abstract

Background Rifampicin-resistant / Multidrug-resistant tuberculosis (RR/MDR-TB), remains a major global health challenge, exacerbated by socioeconomic factors, poor treatment outcomes, and rising drug resistance. In response, RR/MDR-TB care has been decentralised to district hospitals in uMkhanyakude Health District to improve treatment access. This study aimed to assess treatment outcomes of patients receiving the nine-month short regimen for RR/MDR-TB in uMkhanyakude District from 2018 to 2022, and to identify socio-demographic and clinical factors associated with treatment success or failure.

Methods A retrospective cross-sectional study was conducted among patients aged 18 years and older who received a nine-month short-course RR/MDR-TB treatment regimen at decentralised facilities in KwaZulu-Natal's uMkhanyakude District from 2018 to 2022. Data were collected through clinical chart reviews, and descriptive statistics and multivariable regression analysis were used to identify predictors of treatment outcome.

Results Among 375 RR/MDR-TB patients on nine-month short-course therapy, 50.1% ($n=188$) were Males. Most patients 39.5%, ($n=148$) were aged 35–51 years. The treatment success rate was 81.3% ($n=305$), with 48.8% ($n=183$) cured and 32.5% ($n=122$) completing treatment without a confirmed bacteriological cure. Unsuccessful treatment outcomes occurred in 18.7% ($n=70$) of patients, including deaths 3.2% ($n=12$), treatment failures 3.7% ($n=14$), loss to follow-up was 6.7% ($n=25$) and treatment interruption leading to unsuccessful outcomes in 5.1% ($n=19$). Occupational status, treatment interruption, and adverse drug reactions (ADRs) were significant predictors of treatment failure. Employed patients had higher odds of failure (aOR = 10.5, $p=0.001$). Shorter treatment interruption (1 month) was protective (OR = 0.02, $p=0.001$). ADRs increased the risk of failure (OR = 4.2, $p=0.001$).

Conclusion The treatment success rate for patients on the RR/MDR-TB nine-month short-course in uMkhanyakude District was high. Being employed was identified as a significant predictor of treatment failure, emphasising the need for targeted interventions for employed individuals. Further research is needed to explore Directly Observed Treatment (DOT) options for employed patients.

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Keywords Tuberculosis, Multidrug-resistant tuberculosis, Treatment outcomes, Nine-month short-regimen therapy, UMkhanyakude district, South Africa

Background

In 2023, a total of 8.2 million new tuberculosis (TB) cases were reported globally, reflecting a steady increase from 7.5 million in 2022, 7.1 million in 2019, and significantly higher than the 5.8 million and 6.4 million cases reported in 2020 and 2021, respectively [1]. Resulting in a mortality rate of 16 deaths per 100,000 people, Making TB the 13th leading cause of death globally [2]. Furthermore, TB was the second leading infectious killer after COVID-19, surpassing HIV and AIDS globally in 2022 [1, 3]. This highlights the urgent need for effective interventions for the prevention, early detection, diagnosis, and treatment of TB. TB is a preventable and curable disease, yet it continues to affect millions of people worldwide [3]. In 2022, the TB mortality rate in the African region was 30 deaths per 100,000 people among those without HIV, whereas it was 12 deaths per 100,000 people for those with a co-infection of TB and HIV [4]. Additionally, the mortality rate of TB in South Africa in 2022 was reported to be 144 deaths per 100,000 people [4].

Rifampicin-resistant tuberculosis (RR-TB) is a Mycobacterium tuberculosis resistant to rifampicin (R), with or without resistance to other drugs, while Multidrug-resistant tuberculosis (MDR-TB) is a strain of tuberculosis (TB) resistant to two crucial first-line drugs, rifampicin (R) and isoniazid (INH). Given the overlap between these groups, we refer to the study population as RR/MDR-TB throughout the manuscript. The World Health Organization (WHO) has set a goal to eliminate TB by the year 2030, aligning with Sustainable Development Goal Three, emphasising strengthened health systems [5]. Despite these efforts, RR/MDR-TB cases continue to rise due to socioeconomic factors, poor treatment outcomes, and increasing drug resistance [4]. The uMkhanyakude Health District's hospitals, Manguzi District Hospital and Hlabisa District Hospital, serve as decentralised RR/MDR-TB sites. This study aimed to assess treatment outcomes of patients receiving the nine-month short regimen for RR/MDR-TB in uMkhanyakude District from 2018 to 2022, and to identify socio-demographic and clinical factors associated with treatment success or failure.

RR/MDR-TB is resistant to the two most effective first-line antibiotics used to treat TB, which can be caused by poor treatment and or interrupted treatment of drug-susceptible TB [6]. RR/MDR-TB is a particular concern, as it poses a significant challenge to global health security. The global progress in the number of people treated for RR/MDR-TB between 2018 and 2022 was only 43% of the targeted number of 1.5 million worldwide, highlighting the need for increased collaboration and coordinated efforts to tackle this disease [4].

In 2022, global access to treatment for RR/MDR-TB remained inadequate, with only about one in three individuals receiving the necessary care [7, 8]. The Global Project on Anti-TB Drug Resistance Surveillance has been instrumental in evaluating trends in anti-TB drug resistance over the past 25 years, highlighting the persistent public health crisis posed by drug-resistant TB [4]. The WHO TB report 2023 indicates that there were 450,000 cases of RR/MDR-TB worldwide or 5.63 new cases per 100,000 people [4]. Of which 62,000 RR/MDR-TB cases occurred in the African region in the year 2022 [4]. The report further states that from 2022, the global pooled prevalence of RR/MDR-TB is 11.6%, indicating that the prevalence of RR/MDR-TB is still a major problem globally [4]. South Africa faces a significant burden of RR/MDR-TB, with an incidence rate of 28 cases per 100,000 people, with varying prevalence across provinces in 2022 [9, 10]. KwaZulu-Natal, Western Cape, Eastern Cape, and Gauteng are among the provinces with notable RR/MDR-TB cases in 2022 [9].

The standard nine-month shorter treatment RR/MDR-TB regimen was initially recommended by the WHO in 2013 and Made available in South Africa in 2017 to lower expenses, boost cure rates, and enhance compliance [11]. However, not long after its introduction, significant ototoxicity levels were observed on a nine-month short-course regimen with injection (Kanamycin) [11]. The WHO revised the treatment regimen to an injection-free regimen in 2021, and South Africa was the first country to adopt the revised nine-month short-course regimen recommended by WHO (Table 3) [12].

South Africa has been grappling with a severe HIV epidemic for decades, with an estimated 19.5% of those aged 15 to 49 years of people living with HIV (PLWH) [13]. The pandemic is particularly devastating among women, who account for 63% of all new infections [13]. This is a population which is also at risk of developing TB, which can evolve into RR/MDR-TB if not well managed [13]. The prevalence of HIV among patients with RR/MDR-TB was found to be 73.7% in a study conducted in KwaZulu-Natal, South Africa, in 2021 [14]. The KwaZulu-Natal Department of Health's (KZN-DoH) Annual report indicated that 772 patients were enrolled on a nine-month short regimen RR/MDR-TB treatment course in 2022, of which 506 completed treatment with a 65.5% treatment success rate) [15]. The success rate was an encouraging result that indicates the effectiveness of the nine-month short regimen RR/MDR-TB treatment in KZN-DoH. The

report also highlights a high loss to follow-up due to limited resources for identifying missed appointments and tracing and monitoring patients in the community. However, further research is needed to investigate the factors that contribute to the treatment outcome.

Methods

This study employed an analytic, observational, cross-sectional retrospective design to examine nine-month short treatment regimen for RR/MDR-TB treatment outcomes in the uMkhanyakude District of KwaZulu-Natal, South Africa, for the period of five years (2028 – 2022).

Table 1 Sociodemographic characteristics of RR/MDR-TB case-patients on nine-month short course regimen in uMkhanyakude district, KwaZulu natal, 2018–2022 (*N* = 375)

Variables		Frequency	Percentage %
Sex	Male	188	50.1
	Female	187	49.9
Age group	18–34	115	30.7
	35–51	148	39.5
	52–68	81	21.6
	69–85	29	7.7
	86–102	2	0.5
Weight	33–62	143	38.1
	63–92	223	59.5
	93–122	9	2.4
Marital Status	Single	346	92.3
	Married	29	7.7
Smoking	Non Smoker	195	52.0
	Smoker	107	28.5
	Unknown	73	19.5
Education	No Schooling	24	6.4
	Primary	65	17.3
	Secondary	274	73.1
	Collage	9	2.4
	Tertiary	3	0.8
Occupation	Unemployed	166	44.3
	Employed	143	38.1
	Self-employed	11	2.9
	Not Specified	55	14.7
Type of income	No Income	177	47.2
	Casual	1	0.3
	Child Support Grant	11	2.9
	Pension Grant	46	12.3
	Salary/wage	137	36.5
Mode of Transport	Walking	23	6.1
	Bus	4	1.1
	Hired Car	7	1.9
	Taxi	341	90.9
Family Size [1]	1–4	163	43.5
	5–8	191	50.9
	9–12	20	5.3
	13–16	1	0.3

[1] Family Size includes the patient

The district, predominantly rural with high poverty and unemployment levels, reports one of the highest RR/MDR-TB incidence rates in the province. The study was conducted at two key decentralised RR/MDR-TB treatment sites, Hlabisa and Manguzi District Hospitals, which serve as referral centres for a network of primary health clinics in the district. These hospitals play a central role in managing RR/MDR-TB patients by providing both inpatient and outpatient care.

The study population consisted of all adult patients (aged 18 and above) who were diagnosed with RR/MDR-TB and treated with the nine-month short-course regimen between 2018 and 2022 at the two facilities. Purposive sampling was used to select relevant medical records retrospectively. Data were collected using a structured online tool (Google Forms) by a data collector to ensure consistency and completeness, capturing socio-demographic and clinical information. The data were then compiled and cleaned in Microsoft Excel and exported to STATA V18 for comprehensive statistical analysis. This structured, multi-step approach enabled accurate, reliable, and rigorous analysis of treatment outcomes in the decentralised care setting.

Results

A total of 375 patients with RR/MDR-TB undergoing the nine-month short-course regimen treatment were registered in the uMkhanyakude district between 2018 and 2022. Most patients were adults aged 35 to 51 years ($n = 148$; 39.5%), followed by youth aged 18 to 34 years ($n = 115$; 30.7%), adults aged 52 to 68 years ($n = 81$; 21.6%), and older adults aged 69 to 85 years ($n = 29$; 7.7%. The majority of participants had reached secondary school level ($n = 274$; 73.1%), followed by those with primary school education ($n = 65$; 17.3%), and those with no formal schooling ($n = 24$; 6.4%). Most of the patients were unemployed ($n = 166$; 44.3%), while 38.1% were employed ($n = 143$). (Table 1)

Clinical Characteristics

The highest number of patient treatment initiations occurred in 2019 ($n = 103$; 27.5%), followed by 2018 ($n = 84$; 22.4%), 2021 ($n = 77$; 20.5%), and 2020 ($n = 71$; 18.0%), and the lowest in 2022 ($n = 40$; 11.7%). The Majority of patients weighed between 63 and 92 kg ($n = 223$; 59.5%), while 38,1% ($n = 143$) weighed between 33 and 62 kg, and 2.4% weighed between 93 and 122 kg ($n = 9$). 72.8% ($n = 273$) of patients had a history of TB drug usage, while 27.2% ($n = 102$) had used TB drugs before. The type of resistance was predominantly to both Rifampicin and Isoniazid ($n = 353$; 94.1%), with a smaller percentage resistant only to Rifampicin ($n = 22$; 5.9%). The majority of patients had comorbidities ($n = 324$; 86.4%) such as hypertension and diabetes Mellitus, and 84.3% ($n = 316$)

were HIV reactive, while 15.7% ($n=59$) were HIV non-reactive. Pre-treatment TB culture results in $n=368$ patients had a positive result (98.1%), and 98.9% ($n=370$) had a positive pre-treatment smear for Acid-Fast Bacilli (AFB). After four months of treatment, most patients had converted to a negative AFB smear ($n=356$, 94.9%), while 5.1% ($n=19$) remained positive. RR/MDR-TB treatment interruptions occurred in 13.6% of patients ($n=51$), and of those, 8.8% ($n=33$) had interruptions lasting less than 2 months, while 4.8% ($n=18$) had interruptions lasting 2 months or longer. The remaining 86.4% ($n=324$) had no treatment interruption. In terms of adverse drug reactions (ADRs), 88.0% ($n=331$) reported no ADRs. (Table 2).

RR/MDR-TB Treatment Outcome

Among the 375 RR/MDR-TB patients enrolled on a nine-month short-course regimen, the overall treatment success rate was 81.3% ($n=305$). Within the successful outcomes, 48.8% ($n=183$) of patients were cured, while 32.5% ($n=122$) completed their treatment without a confirmed bacteriological cure but were considered

Table 2 Clinical characteristics of patients with RR/MDR-TB on the nine-month short-course regimen, 2018–2022 ($N=375$)

Variables		Frequency	Percentage %
Year of RR/MDR-TB nine-month Short course regimen Initiation	2018	84	22.4
	2019	103	27.5
	2020	71	18.0
	2021	77	20.5
	2022	40	10.7
Weight group (Kg)	33–62	143	38.1
	63–92	223	59.5
	93–122	9	2.4
Past History of TB drug usage	No	273	72.8
	Yes	102	27.2
Previous TB Treatment Category	None	273	72.8
	Interrupted	16	4.3
	Relapsed	51	13.6
	Treatment Failure	35	9.3
Type of Resistance	Rifampicin	22	5.9
	Rifampicin + Isoniazid	353	94.1
Comorbidity	No	51	13.6
	Yes[1]	324	86.4
HIV Status	None-reactive	59	15.7
	Reactive	316	84.3
Pre-treatment TB Culture	Negative	7	1.9
	Positive	368	98.1
Pre-treatment Smear Acid Fast Bacilli (AFB)	Negative	5	1.3
	Positive	370	98.9
Smear AFB conversion after 4 months on treatment	Negative	356	94.9
	Positive	19	5.1
Current RR/MDR-TB Treatment interruption	No	324	86.4
	Yes	51	13.6
Duration of RR/MDR-TB interruption	< 2 Months	33	8.8
	≥ 2 Months	18	4.8
	Not Applicable	324	86.4
Adverse Drug Reactions reported	No Adverse Drug reaction reported	331	88.0
	Drug-Induced Liver Injury	8	2.1
	Renal Impairments	32	8.5
	Other[2]	4	1.1
Grading of the Adverse Drug Reaction (ADR)	None	328	87.5
	Grade 1 Mild	10	2.7
	Grade 2 Moderate	33	8.8
	Grade 3 Severe	3	0.8
	Grade 4 Life-threatening	1	0.3

[1] Other conditions, Hypertension, Diabetes, [2] Persistent diarrhoea, Nausea or vomiting

Table 3 RR/MDR-TB nine-month short-course regimen treatment outcome uMkhanyakude district, KwaZulu-Natal, 2018–2022 ($N=375$)

Treatment outcome		Frequency	Percentage
Successful $n=305$ (81.3%)	Cured	183	48.8
	Completed	122	32.5
Unsuccessful $n=70$ (18.7%)	Died	12	3.2
	Failed	14	3.7
	Loss to follow-up	25	6.7
	Interrupted Treatment	19	5.1
Total		**375**	**100**

treatment successes. An estimated 18.7% ($n=70$) of the patients experienced unsuccessful outcomes. This group included 3.2% ($n=3.2$) who died during treatment, 3.7% ($n=14$) whose treatment failed, and 6.7% ($n=25$) who were lost to follow-up. The 5.1% ($n=19$) had interrupted treatment during the course of treatment, resulting in an unsuccessful outcome (Table 3).

The frequency of RR/MDR-TB drug stock-outs experienced by patients during treatment shows that most patients had no drug stock-out challenges. Specifically, 63.2,% ($n=237$) of patients experienced no stock-outs during their treatment. The 20,0% of patients ($n=75$) experienced stock-outs for one to two times during their visits at the facility, and 15,2% of patients ($n=57$) experienced stock-outs three to four times during their visits. A small fraction of patients ($n=6$; 1.6%) experienced stock-outs of 5 times or more during their visit to the facility (Fig. 1). All 375 RR/MDR-TB patients in the study were attended to by multiple healthcare professionals throughout their treatment. Every patient received care from a medical doctor, nurse, and pharmacist ($n=375$; 100.0%) (Fig. 2). In addition to this core group, an audiologist was involved in the treatment of the majority of patients ($n=342$; 91.2%). Dietitians provided support to $n=315$ patients (84.0%), and the Optometrist only attended to 84.0% ($n=315$) patients during the course of treatment for RR/MDR-TB in the uMkhanyakude district between 2018 and 2022.

Factors Associated with RR/MDR-TB Treatment Outcome

Possible factors associated with the RR/MDR-TB treatment outcome were assessed using a multivariable logistic regression model. Age was not a significant predictor of treatment failure, as participants aged > 34 years demonstrated a slightly lower likelihood of treatment failure compared to those aged ≤ 34 years (adjusted OR: 0.8; 95% CI: 0.4–1.7; $p=0.6$). Similarly, sex was not significantly associated with treatment outcomes, as males had comparable odds of failure to females (adjusted OR = 0.7, 95% CI: 0.4–1.5, $p=0.4$). Smoking status also showed no significant association however, participants with an unknown smoking status demonstrated a notably higher risk of failure (OR = 3.0, 95% CI: 1.6–5.6, $p<0.001$). Employment status emerged as a significant predictor of treatment failure. Employed patients had substantially higher odds of experiencing treatment failure compared to unemployed participants (adjusted OR = 10.5, 95% CI: 2.6–41.8, $p=0.001$). In contrast, income type showed varying associations, with social grant recipients exhibiting increased odds of failure relative to those with no income (unadjusted OR = 2.3, $p=0.05$), although this effect was not significant after adjustment ($p=0.2$). Treatment interruption also showed a strong association with treatment outcomes. Patients who interrupted treatment for only one month were significantly less likely to experience treatment failure compared to those who interrupted for two months or more (OR = 0.02, $p=0.001$). The presence of adverse drug reactions (ADRs) was associated with an increased likelihood of treatment failure. Patients who experienced ADRs had higher odds of

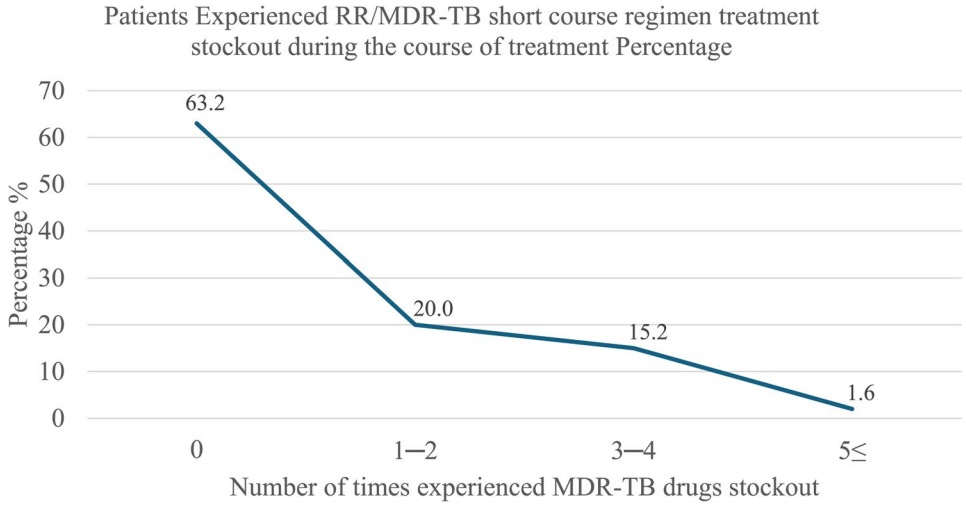

Fig. 1 Percentage of patients who experienced stockout of RR/MDR-TB course treatment by the number of times ($N=375$)

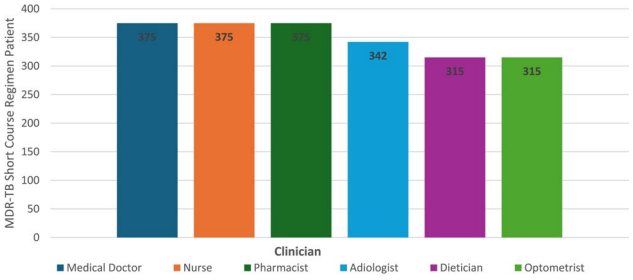

Fig. 2 Clinicians who have attended to the RR/MDR-TB nine-month short-course regimen patients during the course of treatment

treatment failure (OR = 4.2, $p = 0.001$), with ADRs themselves being reported as a predictor (OR = 1.5, $p = 0.001$). (Table 4).

Discussion

The treatment outcomes observed in this study suggest that the RR/MDR-TB nine-month short-course regimen is generally effective in the uMkhanyakude District context. The majority of patients achieved positive treatment outcomes, indicating good programmatic performance and potential for scalability in similar high-burden, resource-limited settings. However, the presence of unsuccessful outcomes such as loss to follow-up and treatment interruption highlights persistent challenges in patient adherence and continuity of care. These outcomes may reflect underlying socio-economic and health system barriers, such as poor access to care, stigma, or limited patient support mechanisms. The high success rate is encouraging and aligns with WHO targets, but efforts must be intensified to address patient retention and reduce the risk of treatment interruption or default.

The socio-demographic and clinical factors associated with treatment outcomes among patients receiving the RR/MDR-TB nine-month short-course regimen at decentralised sites. Age and sex were not found to be significant predictors of treatment failure. Interestingly, patients over 34 years of age had a slightly lower risk of treatment failure compared to their younger counterparts. This finding contrasts with global trends, where older age is typically associated with poorer outcomes due to weaker immunity and co-morbidities [16]. In this setting, the higher failure rate among younger adults may be attributed to behavioural and socio-economic challenges, including poor adherence, stigma, higher mobility, and potential undiagnosed HIV co-infection [17].

Sex was similarly not associated with unfavourable treatment outcomes in this study, despite evidence from other settings that suggests women may face worse outcomes due to gender-specific barriers such as healthcare access and HIV burden. In contrast, some literature points to worse outcomes in men due to higher TB incidence and diagnosis rates [17]. The findings here align with recent studies in China and Indonesia, which reported that sex was not the predictor of treatment outcome but contrast with research from Turkey and earlier South African studies which reported that men are linked with unfavourable treatment outcome [18–20]. This divergence may be due to improvements in healthcare access and the integration of HIV-TB services that reduce gender-related disparities. A notable finding was the significant association between employment status and treatment failure. Employed individuals had substantially higher odds of failure than their unemployed counterparts. This contrasts with existing literature that typically links unemployment and low income to poor TB outcomes [18, 21, 22]. One possible explanation is that employed individuals may miss treatment appointments due to work obligations, prioritising income over treatment adherence, particularly in communities with high unemployment and economic instability [23].

Treatment interruption was one of the strongest predictors of treatment failure. Interruptions of two months or more increased the odds of failure, with longer interruptions correlating with even greater risk even though on adjustment this effect was lost. These findings are supported by studies in Ethiopia and South Africa, which also highlight the critical importance of uninterrupted therapy for successful RR/MDR-TB treatment [24, 25]. Interventions targeting treatment adherence and patient support are essential to minimise treatment discontinuation.

Patients who experienced adverse drug reactions (ADRs) were more likely to experience treatment failure, likely as a result of interrupting or stopping treatment after the onset of side effects. ADRs are a well-documented barrier to adherence and have been consistently associated with poor compliance in RR/MDR-TB treatment [26]. A narrative review study done in 2023 reported a treatment success rate of just 56%, with 8% of patients discontinuing therapy due to ADRs globally, underscoring their impact on treatment outcomes [26, 27].

The study found no significant association between smoking status and treatment outcomes. However, participants with unknown smoking status had a notably higher risk of treatment failure. This finding diverges from studies in Mongolia and Israel, which reported a strong link between smoking and unsuccessful outcomes [28, 29]. The elevated risk among those with unknown status may indicate underlying behavioural risk factors or gaps in clinical documentation. Overall, the study emphasises the need for targeted interventions addressing socio-economic and behavioural barriers to improve RR/MDR-TB treatment success.

Table 4 Multivariable logistic regression analysis of RR/MDR-TB treatment outcomes among nine-month short-course regimens in the uMkhanyakude district, KwaZulu natal, 2018–2022

	Success		Failure		Total	Odds of a failure				adjusted OR			
	n	%	*n*	%		OR	95% CI		*p*	OR	95% CI		*p*
Age group													
≤ 34	88	76.5%	27	23.5%	115	Reference							
> 34	217	83.5%	43	16.5%	260	0.7	0.4	1.1	0.1	0.8	0.4	1.7	0.6
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Sex													
Female	151	80.7%	36	19.3%	187	Reference							
Male	154	81.9%	34	18.1%	188	0.9	0.6	1.6	0.8	0.7	0.4	1.5	0.4
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Marital Status													
Single	283	81.8%	63	18.2%	346	Reference							
Married	22	75.9%	7	24.1%	29	1.4	0.6	3.5	0.4				>0.3
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Smoking													
Non-smoker	165	84.6%	30	15.4%	195	Reference							
Smoker	93	86.9%	14	13.1%	107	0.8	0.4	1.6	0.588				
Unknown	47	64.4%	26	35.6%	73	3.0	1.6	5.6	< 0.001				
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Education													
No/primary	72	80.9%	17	19.1%	89	Reference							
Secondary/tertiary	233	81.5%	53	18.5%	286	1.0	0.5	1.8	0.9	>0.3			
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Occupation													
Unemployed/unknown	198	89.6%	23	10.4%	221	Reference							
employed	107	69.5%	47	30.5%	154	3.8	2.2	6.6	< 0.001	9.6	1.7	55.4	0.001
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Type of income													
No income	160	90.4%	17	9.6%	177	Reference							
Social Grant	46	80.7%	11	19.3%	57	2.3	1.0	5.1	< 0.054	2.2	0.7	7.1	0.2
Salary	96	69.6%	42	30.4%	138	4.1	2.2	7.6	< 0.001	0.7	0.1	3.4	0.6
Total	**302**	**81.2%**	**70**	**18.8%**	**372**								
Family Size													
1–4	132	81.0%	31	19.0%	163	Reference							
5–8	154	80.6%	37	19.4%	191	1.0	0.6	1.7	0.9	1.1	0.6	2.2	> 0.3
9–16	19	90.5%	2	9.5%	21	0.4	0.1	2.0	0.3	0.8	0.1	4.1	
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Mode of transport													
by vehicle	284	80.7%	68	19.3%	352	Reference							

Table 4 (continued)

	Success		Failure		Total	Odds of a failure				adjusted OR			
	n	%	*n*	%		OR	95% CI		*p*	OR	95% CI		*p*
walking	21	91.3%	2	8.7%	23	0.4	0.1	1.7	0.2	0.4	0.1	2.2	0.3
Total	**305**		**70**		**375**								
Previous TB diagnosis													
No	218	79.9%	55	20.1%	273	Reference							
Yes	87	85.3%	15	14.7%	102	0.7	0.4	1.3	0.2	0.6	0.2	2.2	0.5
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Previous TB treatment													
None	218	79.9%	55	20.1%	273	Reference							
Interrupted	13	81.3%	3	18.8%	16	0.9	0.3	3.3	0.9	0.33	0.4	17.3	0.3
treatment failure	28	80.0%	7	20.0%	35	1.0	0.4	2.4	0.9	1.0			
relapsed	46	90.2%	5	9.8%	51	0.4	0.2	1.1	0.09	1.3	0.3	6.1	0.8
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Weight group													
33–62	116	81.1%	27	18.9%	143	Reference							
63–92	185	83.0%	38	17.0%	223	0.9	0.5	1.5	0.7	1.2	0.6	2.4	0.6
93–122	4	44.4%	5	55.6%	9	5.4	1.4	21.3	0.02	6.7	0.8	52.9	0.1
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Comorbidity													
Absent	43	84.3%	8	15.7%	51	Reference							
Present	262	80.9%	62	19.1%	324	1.3	0.6	2.8	0.6				> 0.3
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
HIV													
Positive	256	81.0%	60	19.0%	316	Reference							
Negative	49	83.1%	10	16.9%	59	1.2	0.6	2.4	0.7				> 0.3
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Stock out MDR drugs													
No	195	82.3%	42	17.7%	237	Reference							
Yes	110	79.7%	28	20.3%	138	1.2	0.7	2.0	0.5				> 0.3
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
RR/MDR-TB Treatment interruption													
No	283	86.8%	43	13.2%	326	Reference							
Yes	22	44.9%	27	55.1%	49	8.1	4.2	15.4	< 0.001	41.9	7.6	230.6	0.001
Total	**305**	**81.3%**	**70**	**18.7%**	**375**								
Duration of RR/MDR-TB interruption													
No interruption	283	86.8%	43	13.2%	326	Reference							
1 month	15	78.9%	4	21.1%	19	1.8	0.6	5.5	0.3	0.0	0.0	0.2	0.001
2 months	5	35.7%	9	64.3%	14	11.9	3.8	37.2	< 0.001	1.0	0.1	8.3	0.97
≥ 3 months	2	12.5%	14	87.5%	16	46.1	10.1	209.8	< 0.001	1.0			

Table 4 (continued)

	Success		Failure		Total	Odds of a failure			adjusted OR		
	n	%	*n*	%		OR	95% CI	*p*	OR	95% CI	*p*
Total	**305**	**81.3%**	**70**	**18.7%**	**375**						
Adverse Drug Reactions reported											
No	185	80.1%	46	19.9%	231	Reference					
Yes	23	57.5%	17	42.5%	40	3.0	1.5 6.0	0.002	4.22	1.7 10.5	0.001
Unknown	97	93.3%	7	6.7%	104	0.3	0.1 0.7	0.04	0.38	0.1 1.1	0.07
Total	**305**	**81.3%**	**70**	**18.7%**	**375**						
Smear AFB conversion after 4 months of treatment											
Negative	293	82.3%	63	17.7%	356	Reference					
Positive	12	63.2%	7	36.8%	19	2.7	1.0 7.2	0.04			
Total	**305**	**81.3%**	**70**	**18.7%**	**375**						

Limitation

The study had several limitations, such as the retrospective nature of the medical records review. Data collection was subjected to incomplete, inconsistent or incorrectly complete values, which limited data quality and accuracy. We therefore excluded some variables and files to account for this limitation and maintain data validity. Moreover, the study's reliance on secondary data precludes the ability to assess certain variables or potential confounders that may influence RR/MDR-TB treatment outcomes. Selection bias as exclusion of variables and records due to poor data quality may have influenced generalisability of our results. Sampling two health facilities in this rural district limits generalisability of the inference to urban or other regions. There were wider confidence intervals on our logistic regression model, such as in employment status, that limit precision of effect estimates. However, there are strengths associated with our study as firstly, our high treatment success rates correlate with WHO targets. Our data collected from decentralised facilities routinely collected clinical data underscores real-world rural district performance.

Conclusions

This study highlights the complex and context-specific nature of factors influencing RR/MDR-TB treatment outcomes in decentralised settings. While traditional predictors such as age and sex were not significantly associated with treatment failure, younger age groups and employed individuals demonstrated higher risks of poor outcomes, suggesting that socioeconomic and behavioural factors play a critical role. Treatment interruption emerged as a key determinant of failure, emphasising the importance of adherence support and patient-centred care strategies. The unexpected association between unknown smoking status and treatment failure further indicates the need for comprehensive clinical assessments and improved record-keeping. These findings call for tailored interventions that address the unique challenges faced by younger, employed patients and reinforce the necessity of uninterrupted treatment to achieve better outcomes in RR/MDR-TB management.

Abbreviations

ADRs	Adverse drug reactions
AIDS	Acquired immune deficiency syndrome
DOT	Directly observed treatment
HIV	Human immunodeficiency virus
INH	Isoniazid
KZN-DoH	KwaZulu-natal department of health
MDR-TB	Multidrug-resistant tuberculosis
PLWH	People living with HIV
R	Rifampicin
RR	Rifampicin resistant
TB	Tuberculosis
WHO	World health organization

Supplementary Information

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Supplementary Material 1.

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Authors' contributions
LM= Lucky Mtolo SN = Saloshini NaidooNN =Nqobile Ngoma LM wrote the main manuscript. NN analysed the results and prepared Tables 1, 2, 3 and 4; Figs. 1 and 2. SN edited the whole manuscript.

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Data availability
The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval for the study was obtained from the University of KwaZulu-Natal Biomedical Research Ethics Committee (BREC/00002359/2021) in accordance with the Declaration of Helsinki and the Provincial Department of Health. Additionally, gatekeeper permission was secured from the uMkhanyakude Health District. Authorisation to conduct the research was also granted by Manguzi District Hospital and Hlabisa District Hospital. As this study involves a retrospective review of medical records, there was no direct interaction with participants; thus, no consent forms were used and a waiver granted by the University of KwaZulu-Natal Biomedical Research Ethics Committee.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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