

Original Research Article

Resistance Patterns and Patient Characteristics as Predictors of Treatment Outcomes in Drug-Resistant Tuberculosis: Evidence from a District TB Centre in Western Maharashtra

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ABSTRACT

Background: The emergence & dissemination of Drug-Resistant Tuberculosis (DR-TB) pose one of the most formidable public health challenges that threaten to undermine global TB control efforts. While the national and state-level data on DR-TB are available, detailed district-level analyses are limited. This study was conducted to fill this knowledge gap and provide insights into the demographic characteristics, resistance patterns, and treatment outcomes of DR-TB patients, specific to the local population, which can help to inform policy decisions and improve the patient management strategies.

Objectives: 1) To determine the proportion of DR-TB among microbiologically confirmed TB cases, 2) To evaluate patient characteristics, drug resistance patterns, and treatment outcomes in DR-TB patients, and 3) To analyze the correlations between treatment outcomes, patient characteristics, and resistance patterns to identify predictors of treatment success or failure.

Material and methods: A retrospective analysis of data was conducted from the NIKSHAY portal, focusing on DR-TB patients registered at the District Tuberculosis Centre, Kolhapur, Western Maharashtra. Patient demographics, clinical characteristics, drug resistance profiles and treatment outcomes were extracted and analyzed. Multivariate logistic regression identified outcome predictors.

Results: The proportion of DR-TB patients among all the Microbiologically confirmed cases was found to be 10.05%. The majority of patients were males (61.36%) and belonged to 18-59 years age group (79.7%). Based on BMI, 59.90% belonged to the underweight category. Maximum patients i.e. 48.16% had MDR/RR-TB, followed by 32.51% H-monoresistance and 19.31% Pre-XDR cases. Out of 296 DR-TB patients whose outcome was available, 71.96% achieved successful treatment outcomes. 15.54% of these 296 cases had died.

Conclusion: Adults in the economically productive age group (18-59 years), males & underweight people were commonly affected. MDR-TB was found to be the leading form of DRTB. Patients under 18 years, Males, patients with pulmonary TB, HIV-reactive patients, underweight patients, Pre-XDR pattern, had higher odds of unsuccessful outcomes.

Keywords: drug-resistant tuberculosis; extensively drug-resistant tuberculosis; national tuberculosis elimination program; multi-drug-resistant tuberculosis; drug resistance patterns

INTRODUCTION

Tuberculosis is one of the world's deadliest infectious diseases, affecting nearly one-quarter of the world's population, with 30,000 people becoming ill and 3,500 people losing their lives to TB each day. Globally in 2023, an estimated 10.8 million people fell ill with TB with India accounting for 26% of the total burden.^{1,2}

TB has grown resistant to the best available drugs. Drug-resistant TB is deadlier, costlier, and harder to treat. DR-TB is defined as resistance to at least one first-line anti-TB drug, while MDR-TB refers to resistance to at least rifampicin and isoniazid, the two most potent first-line drugs.^{1,2} The spectrum of drug resistance in TB ranges from mono-resistance to rifampicin-resistant TB (RR-TB), multidrug-resistant TB (MDR-TB), pre-extensively drug-resistant TB (pre-XDR-TB), and extensively drug-resistant TB (XDR-TB).^{3,4}

DR-TB is found in every country with 410,000 new cases of MDR / RR TB in 2022. In 2023, the estimated proportion of people with TB who had MDR/RR-TB was 3.2% among new cases and 16% among those previously treated. India reported 27% of global MDR/RR-TB cases in 2023.^{1,2} The National Anti-Tuberculosis Drug Resistance Survey (NDRS) indicated that approximately 28% of TB patients had resistance to at least one anti-tubercular drug, with MDR-TB prevalence at 6.1% among newly diagnosed patients.^{5,6} Only about 2 in 5 people with drug-resistant TB accessed treatment in 2023. Drug resistance emerges when TB medicines are used inappropriately, through incorrect prescription by health care providers, poor quality drugs, or patients stopping treatment prematurely. Maharashtra, the second-most populous state in India, reported 20,583 DR-TB cases in 2022, representing approximately 14% of the country's DR-TB burden, emphasizing the need for region-specific analysis of resistance patterns and treatment outcomes.^{5,6,7}

WHO's End TB strategy (2016–2035) proposes to “end the global TB epidemic” by 2035. India needs to intensify and accelerate its TB control strategies to reach the goal of National Strategic plan (2017–2025) and UN Sustainable Development Goal 3.3 (2016–2030) to end TB by 2025 & 2030 respectively. The 2025 milestone and 2030/2035 targets of the End TB Strategy can only be achieved if everyone who

develops TB disease is promptly diagnosed and then treated with drug regimens recommended by WHO.^{1,2}

The relationship between antimicrobial resistance patterns and treatment outcomes in DR-TB is multifaceted and influenced by various patient-specific factors such as comorbidities, BMI, previous treatment history, socioeconomic status, etc. This understanding is crucial for optimizing treatment strategies and improving patient outcomes in regional TB control programs. The current study was conducted to provide some valuable insights into the epidemiology of DR-TB in Kolhapur, a district in Western Maharashtra and to fill existing critical gaps in understanding how local resistance patterns and patient characteristics interact to influence treatment success rates, within a specific regional context through the district level analysis, ultimately contributing to broader understanding of drug resistance in India & thereby enhancing national and global tuberculosis control efforts.

OBJECTIVES

1. To determine the proportion of drug-resistant tuberculosis (DR-TB) among microbiologically confirmed tuberculosis (TB) cases registered at the District Tuberculosis Centre, Kolhapur.
2. To evaluate the patient characteristics (demographic and clinical), drug resistance patterns & treatment outcomes of the DR-TB patients
3. To analyze the correlation of treatment outcomes with patient characteristics & identified resistance patterns among DR-TB patients to determine statistically significant predictors of treatment success or failure.

MATERIAL AND METHODS

A retrospective record-based study was carried out after receiving approval from the Institutional Ethics Committee and District Tuberculosis Officer, using data obtained from the notification register at the NIKSHAY portal. All microbiologically confirmed DR-TB patients from rural areas registered under DTC, Kolhapur from 1st Jan 2021 to 30th Sept 2024 (Total study period of 3yrs 9mths) were included in the study. The patients whose data was found incomplete & who were transferred out, were

excluded from the study. Parameters included in the study were patients' demographics, clinical data, resistance patterns, and certain treatment-related factors. Treatment outcomes of patients were analyzed from 1st Jan 2021 to 30th June 2023, since they were not available for rest of the enrolled patients. **(Figure 1)** Resistance patterns and treatment outcomes were assessed using standard definitions.

BMI categories for the Asian population (> 18 years of age) were considered: underweight (<18.5 kg/m²), normal weight (18.5–22.9 kg/m²), overweight (23–24.9 kg/m²), and obese (≥25 kg/m²).⁸ WHO BMI for age percentile tables for boys and girls were used for those aged ≤ 18 years

BMI for age percentile categories:

- **Underweight:** BMI is less than the 5th percentile
- **Healthy weight:** BMI is between the 5th and 85th percentile
- **Overweight:** BMI is between the 85th and 95th percentile
- **Obese:** BMI is at or above the 95th percentile

Definitions used in the study:¹⁰

Microbiologically/Bacteriologically confirmed TB:

TB diagnosed in a biological specimen by smear microscopy, culture, or a WHO-endorsed rapid molecular test adopted by NTEP.

Isoniazid-resistant TB (Hr-TB): TB is caused by M.tb strains that are resistant to isoniazid, and susceptibility to rifampicin has been confirmed.

Mono-resistant TB (MR TB): TB caused by M.tb strains that are resistant to one first- line anti-TB drug only.

Rifampicin-resistant TB (RR-TB): TB caused by M.TB strains that are resistant to R, detected using phenotypic or genotypic methods, with or without resistance to other anti-TB drugs. It includes any resistance to R in the form of mono-resistance, poly-resistance, MDR-TB, or XDR-TB.

Multidrug-resistant TB (MDR-TB): TB caused by M.TB strains that are resistant to both H and R with or without resistance to other first-line anti-TB drugs. MDR-TB patients may have additional resistance to any/all FQ or any other second-line anti-TB drug

Pre-extensively drug-resistant TB (Pre-XDR-TB): TB caused by M.TB strains that fulfill the definition of MDR/ RR-TB and are also resistant to any fluoroquinolone

Treatment Outcomes definitions: -

Drug-resistant tuberculosis (TB) disease is caused by TB bacteria that are resistant to at least one of the most effective TB medicines.

Cured: A pulmonary TB patient with bacteriologically confirmed TB at the beginning of treatment who completed treatment as recommended by the national policy with evidence of bacteriological response and no evidence of treatment failed.

Treatment completed: A patient who completed treatment as recommended by the national policy whose outcome does not meet the definition of cure or treatment failed.

Treatment failed: A patient whose treatment regimen needs to be terminated or changed permanently to a new regimen option or treatment strategy. The reasons for changing the regimen permanently include: a) No clinical response and/ or no radiological response b) No bacteriological response (no bacteriological conversion achieved or bacteriological reversion after initial conversion) c) ADRs, d) Evidence of additional drug resistance to medicines in the regimen.

Died: A patient who died before starting or during the course of treatment.

Lost to follow-up: A patient who did not start treatment or whose treatment was consecutively interrupted for one month or more.

Not evaluated: A patient for whom no treatment outcome was assigned.

Treatment regimen changed: Those patients who has been initiated on treatment, in case of baseline resistance to the drugs in the regimen (whenever available) is found, the treatment need to be changed to an appropriate regimen and the outcome to be given as “treatment regimen changed”.

Statistical analysis:

Data was analyzed by IBM SPSS software version 20. To determine the mean, median, IQR, frequency, and percentages of variables, such as age group and gender, descriptive analysis was conducted. Odds ratios (OR) with 95% confidence interval were calculated. Multivariate logistic regression analysis was used to assess the association of treatment outcomes with the patient characteristics & their identified resistance patterns. p-value < 0.05 was considered statistically significant.

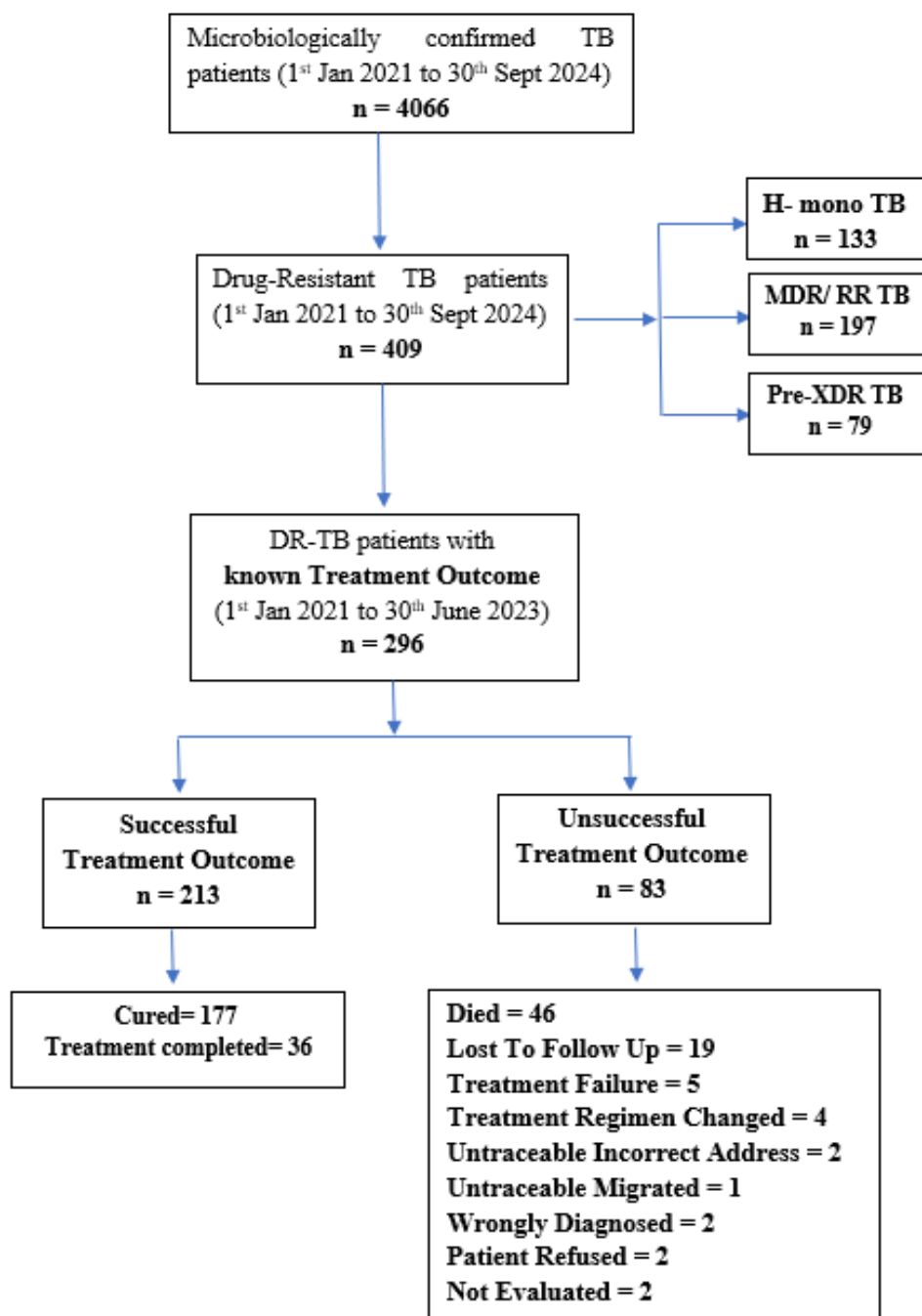


Figure 1. Flow diagram of study participants. Abbreviations: H-mono- Isoniazid mono-resistant; RR-Rifampicin resistance; MDR- Multidrug resistant; Pre-XDR- Pre- Extensively drug-resistant; DRTB- drug-resistant tuberculosis

Permission & Ethical Considerations. The permission for conducting the study was taken from the District Tuberculosis Officer, Kolhapur. This study was also reviewed and approved by the Institutional Ethics Review Committee of RCSM GMC, Kolhapur.

RESULTS

A total of 4066 TB cases were found to be Microbiologically confirmed and having valid test results available. Of these 409 patients were found to be drug-resistant based on drug susceptibility testing (DST) carried out for the first- and second-line drugs (FLDs and SLDs). The proportion of DR-TB patients among all the Microbiologically confirmed cases (from 1st Jan 2021 to 30th Sept 2024) was found to be 10.05%. **(Figure 1)**

Socio-Demographic Characteristics of DR-TB Patients. (Table 1)

Among the 409 DR-TB cases, the majority (46.69%) were in the age group 31-59 years, followed by 33% in 18-30 years, 15.40% in ≥ 60 years & 4.88% in < 18 years old. While males constitute the majority (61.36%) across all resistance types, with 64.66% in H monoresistance, 58.38% in MDR/RR, and 63.29% in Pre-XDR, females account for 35.34%, 41.62%, and 35.44%, respectively. The majority i.e. 97.31% of DR-TB patients were receiving treatment in public health facilities while only a small percentage (2.68%) were treated in private facilities.

Clinical Characteristics of DR-TB Patients. (Table 1)

Comorbid conditions were observed in 18.33% of DR-TB patients. Diabetes was found in 14.91% of DR-TB patients while 4.15% patients were HIV-reactive. 3 patients had both diabetes and HIV (0.73%).

Among 409 DR-TB patients, 91.44% patients had pulmonary TB while Extrapulmonary TB was found in 8.56%.

As per the BMI categories, maximum DR-TB patients were found to be underweight (59.90%), followed by 30.03% having normal BMI, 4.40% overweight & 5.62% obese.

Treatment-related characteristics of DR-TB Patients (Table 2)

Treatment delays and durations were found to be significantly associated with resistance severity ($p < 0.001$). Treatment duration increases with resistance severity: H monoresistance (204 days), MDR/RR (539 days), and Pre-XDR (543 days). This underscores the challenges of managing severe resistance.

Resistance patterns: Of the 409 DR-TB patients, the majority (48.16%) had MDR/RR-TB, followed by 19.31% Pre-XDR cases and 32.51% H-monoresistance. **(Figure 2)**

Treatment Outcome of DR-TB patients. (Table 3)

Only 296 of the 409 DR-TB patients in the study had treatment outcomes available. Of these 296 patients analyzed, 71.96% achieved successful treatment outcomes, which included being cured (59.80%) or completing treatment (12.16%). Patients with MDR/RR resistance have the highest cure rate (70.27%), followed by those with H monoresistance (52.67%) and those with pre-XDR (55.56%). Of all the cured patients (177) maximum belonged to MDR/RR (44.06%), followed by H-monoresistance (38.98%) & Pre-XDR (16.9%).

Unsuccessful treatment outcomes were recorded in 28.04% of cases, with mortality being a significant contributor. Mortality rates were highest in pre-XDR patients (20.37%), followed by MDR/RR resistance (9.91%) and H monoresistance (18.32%). Overall, deaths constituted 15.54% of the total cases. Loss to follow-up was another major challenge observed in 6.42% of patients.

Treatment Outcome & associated Factors (Table 4)

Table 4 provides insights into the association between socio-demographic and clinical characteristics and the treatment outcomes of drug-resistant TB patients. It compares unsuccessful treatment outcomes ($n=83$) with successful outcomes ($n=213$) across various demographic and clinical factors, along with the corresponding odds ratios and p-values. Patients under 18 years had significantly higher odds of unsuccessful outcomes ($OR = 3.61$, $p = 0.048$) compared to the 18–30 age group, which served as the reference. The mean age of patients with unsuccessful outcomes ($43.47 \pm$

18.54 years) was significantly higher than that of patients with successful outcomes (38.09 ± 16.45 years, $p = 0.022$), further highlighting a possible relationship between age and treatment outcomes. Gender did not significantly affect treatment outcomes, although males showed a slightly higher tendency for unsuccessful outcomes.

In the current study, Diabetes was not found to have a significant impact on treatment success. In the unsuccessful group, 13.25% of patients had diabetes, while 15.49% in the successful group had diabetes. The odds of unsuccessful outcomes for HIV-reactive patients were higher (OR = 2.27), though the association was not statistically significant ($p = 0.190$).

Table 1: Socio-demographic and clinical characteristics of patients with different resistance patterns

Patients Characteristics		Resistance patterns						Any Drug Resistance (ADR) (409)	
		H Monoresistance (133)		MDR/RR resistance (197)		Pre- XDR (79)			
		n	%	n	%	n	%	n	%
1. Socio-Demographic characteristics									
Age (in Completed years)	<18	8	6.02	6	3.05	6	7.59	20	4.88
	18-30	30	22.56	74	37.56	31	39.24	135	33
	31-59	66	49.62	92	46.70	33	41.77	191	46.69
	≥ 60	29	21.80	25	12.69	9	11.39	63	15.40
	Median/IQR	41/29		35/26		32/24			
Gender	Male	86	64.66	115	58.38	50	63.29	251	61.36
	Female	47	35.34	82	41.62	28	35.44	157	38.38
	Transgender	0	0.00	0	0.00	1	1.27	1	0.24
Type of Health facility	Public	129	96.99	191	96.95	78	98.73	398	97.31
	Private	4	3.01	6	3.05	1	1.27	11	2.68
2. Clinical characteristics									
Any comorbidity*	Yes	26	19.55	37	18.78	12	15.19	75	18.33
	No	107	80.45	160	81.22	67	84.81	334	81.66
Diabetes	Yes	25	18.80	25	12.69	11	13.92	61	14.91
	No	108	81.20	172	87.31	68	86.08	348	85.08
HIV status	Reactive	2	1.50	14	7.11	1	1.27	17	4.15
	Non-reactive	131	98.50	183	92.89	78	98.73	392	95.84
Site of Disease	Pulmonary	129	96.99	169	85.79	76	96.20	374	91.44
	Extrapulmonary	4	3.01	28	14.21	3	3.80	35	8.56
BMI (Kg/m²)	Underweight	75	56.39	119	60.41	51	64.56	245	59.90
	Normal	43	32.33	60	30.46	20	25.32	123	30.07
	Overweight	7	5.26	6	3.05	5	6.33	18	4.40
	Obese	8	6.02	12	6.09	3	3.80	23	5.62
	Median/IQR	17.77/3.95		17.31/5.04		16.89/4.27			

*Patients having both Diabetes and Hypertension (i.e 3 patients out of 409) were considered only once while calculating those having any comorbidity.

Table-2: Treatment initiation and duration of DR-TB patients

Treatment-related characteristics		H Mono-resistance (133)	MDR/RR resistance (197)	Pre- XDR (79)	p-value
Delay in TB treatment (Days)	Median/IQR	1/2.5	4/7	3/2	<0.001
Treatment duration (Days)	Median/IQR	204/59	539/364	543/74	<0.001

Table-3: Final treatment outcome of drug-resistant TB patients (n=296)

Outcome of cases	Resistance pattern						Total	
	H Monoresistance		MDR/RR		Pre- XDR			
	n	%	n	%	n	%	n	%
Successful (213)								
Cured	69	52.67	78	70.27	30	55.56	177	59.80
Treatment Complete	20	15.27	12	10.81	4	7.41	36	12.16
Unsuccessful (83)								
Died	24	18.32	11	9.91	11	20.37	46	15.54
Lost To Follow Up	11	8.40	4	3.60	4	7.41	19	6.42
Not Evaluated	1	0.76	1	0.90	0	0.00	2	0.68
Treatment Failure	1	0.76	2	1.80	2	3.70	5	1.69
Treatment Regimen Changed	1	0.76	1	0.90	2	3.70	4	1.35
Untraceable Incorrect Address	0	0.00	2	1.80	0	0.00	2	0.68
Untraceable Migrated	1	0.76	0	0.00	0	0.00	1	0.34
Wrongly Diagnosed	2	1.53	0	0.00	0	0.00	2	0.68
Patient Refused	1	0.76	0	0.00	1	1.85	2	0.68
Total	131	100	111	100	54	100	296	100

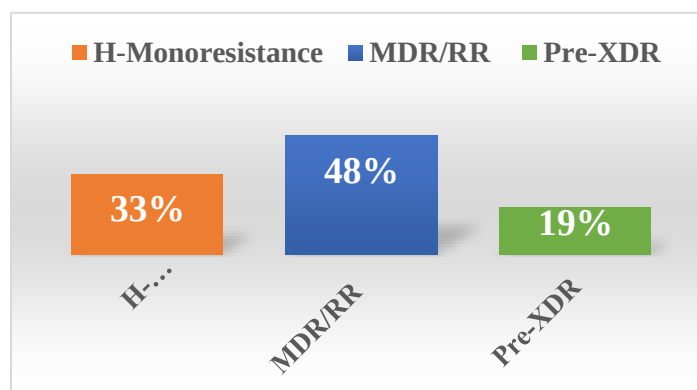


Figure-2: Drug resistance patterns of the DR-TB patients

The odds of unsuccessful outcomes for patients with pulmonary TB were 2.27 times higher than those with extrapulmonary TB, although this association was not statistically significant ($p = 0.202$).

Drug resistance was found to be a major determinant of treatment outcomes. Patients with Pre-XDR resistance had the highest odds of unsuccessful outcomes (OR = 2.52), followed by those with MDR/RR resistance (OR = 2.02), compared to patients with H Monoresistance (reference category). This relationship was statistically significant ($p = 0.020$), emphasizing the adverse impact of drug resistance on treatment outcomes. The odds ratio for underweight patients was 1.29, suggesting a slightly increased risk of treatment failure, although this was not statistically significant ($p = 0.157$). The mean BMI of patients with unsuccessful outcomes was significantly lower ($17.34 \pm 3.596 \text{ kg/m}^2$) compared to successful patients ($18.45 \pm 3.787 \text{ kg/m}^2$, $p = 0.020$).

Patients with unsuccessful outcomes had a much shorter treatment duration (137.66 ± 173.82 days) compared to those with successful outcomes (372.30 ± 175.58 days, $p < 0.001$). This highlights the importance of completing the full prescribed course of treatment for TB to ensure the highest likelihood of success.

In **Table 5**, the multivariate logistic regression analysis explored the association between selected variables and unsuccessful treatment outcomes. Age and BMI were not significantly associated with unsuccessful outcomes, as indicated by high p-values and odds ratios close to 1. Treatment duration, on the other hand, demonstrated a protective effect, with a significant p-value (<0.0001) and an odds ratio of 0.9893 (95% CI: 0.9857–0.9922), suggesting that longer treatment duration reduces the odds of an unsuccessful outcome. Drug resistance was found to be a strong predictor of treatment failure.

Patients with MDR/RR resistance had significantly higher odds of an unsuccessful outcome (OR: 3.5883, 95% CI: 1.6805–7.8811), and those with Pre-XDR resistance exhibited an even stronger association, with odds 31.9 times higher (OR: 31.8853, 95% CI: 9.0022–137.2361) compared to the reference group (H Monoresistance).

These results underscore the critical importance of addressing drug resistance and optimizing treatment duration to improve treatment outcomes.

Table-4: Association of socio-demographic & clinical characteristics with treatment outcome (n=296)

Patients Characteristics		Unsuccessful (83)		Successful (213)		Total (296)		Odds ratio	p-value
		n	%	n	%	n	%		
1. Socio-Demographic characteristics									
Age (in Completed years)	<18	7	8.43	10	4.69	17	5.74	3.61	0.048
	18-30	19	22.89	98	46.01	117	39.53	Reference	
	31-59	37	44.58	129	60.56	166	56.08	1.48	
	≥ 60	20	24.10	52	24.41	72	24.32	1.98	
	Mean ± SD	43.47±18.540		38.09±16.451		39.60±17.201			0.022
	Median/IQR	40/29		35/29		36/29			0.396
Gender	Male	52	62.65	127	59.62	179	60.47	1.17	0.231
	Female	30	36.14	86	40.38	116	39.19	Reference	
	Transgender	1	1.20	0	0.00	1	0.34	-	
Type of Health facility	Public	79	95.18	207	97.18	286	96.62	0.57	0.392
	Private	4	4.82	6	2.82	10	3.38	Reference	

2. Clinical characteristics									
Any comorbidity	Yes	15	18.07	37	17.37	52	17.57	1.05	0.887
	No	68	81.93	176	82.63	244	82.43	Reference	
Diabetes	Yes	11	13.25	33	15.49	44	14.86	0.83	0.627
	No	72	86.75	180	84.51	252	85.14	Reference	
HIV status	Reactive	5	6.02	6	2.82	11	3.72	2.27	0.190
	Non-reactive	76	91.57	207	97.18	283	95.61	Reference	
Site of Disease	Pulmonary	79	95.18	191	89.67	270	91.22	2.27	0.202
	Extrapulmonary	4	4.82	22	10.33	26	8.78	Reference	
Any resistance	H Monoresistance	21	25.30	90	42.25	111	37.50	Reference	0.020
	MDR/RR resistance	42	50.60	89	41.78	131	44.26	2.02	
	Pre- XDR	20	24.10	34	15.96	54	18.24	2.52	
BMI (Kg/m ²)	Underweight	56	67.47	130	61.03	186	62.84	1.29	0.157
	Normal	22	26.51	66	30.99	88	29.73	Reference	
	Overweight	1	1.20	14	6.57	15	5.07	0.21	
	Obese	4	4.82	13	6.10	17	5.74	0.92	
	Mean ± SD	17.34±3.596		18.45±3.787		18.45±3.76			0.020
	Median/IQR	16.89/3.62		17.80/4.34		17.63/4.19			0.120
3. Treatment related characteristic									
Delay in TB treatment (Days)	Mean ± SD	4.84±7.082		4.87±7.656		4.86±7.488			0.975
	Median/IQR	2/8		2/4		2/5			0.992
Treatment duration (Days)	Mean ± SD	137.66±173.817		372.30±175.584		306.50±204.205			<0.001
	Median/IQR	68/174		294/344		245/372			<0.001

Table-5: Multivariate logistic regression analysis of selected study variables for unsuccessful outcome

Variables		Estimate (β)	P-value	Odds ratio (95% CI)
Age		1.6406	0.8198	1.0023 (0.9819 - 1.0233)
BMI		0.0023	0.1564	0.9348 (0.8471 - 1.0224)
Treatment duration		-0.0674	<0.0001	0.9893 (0.9857 - 0.9922)
Resistance	H Monoresistance	Reference	-	Reference
	MDR/RR resistance	1.2777	0.0011	3.5883 (1.6805 - 7.8811)
	Pre- XDR	3.4621	<0.0001	31.8853 (9.0022- 137.2361)

DISCUSSION

The current study provides valuable data on the proportion of DR-TB among microbiologically confirmed TB cases, along with the locally identified resistance patterns and their impact on treatment outcomes within a district TB centre in Western

Maharashtra, offering essential insights for refining the patient management strategies at the local level.

A higher proportion of DR-TB among males in the economically productive age group in the current study aligns with the findings of studies by Giri VP et.al¹¹, Kumar P et. al.¹² & Bharti A et. al.¹³ This could be attributed to increased mobility and exposure,

making them more vulnerable to infection and the development of resistance. Furthermore, the majority of DR-TB patients were found to be underweight (59.9%) in the present study emphasizing the importance of nutritional support in TB treatment programs. This finding was similar to those in studies by Kumar P et. al.¹² & Bharti A et. al.¹³

Multidrug-resistant TB (MDR-TB) was the predominant form of resistance (48%), which is consistent with other studies^{11, 13}. Additionally, the study identified a substantial proportion of pre-extensively drug-resistant TB (pre-XDR-TB) cases, which highlights the importance of comprehensive drug susceptibility testing (DST) and the use of newer medications in the treatment of DR-TB.

The study by Kumar P et. al.¹² also found MDR-TB to be the most common (64.9%), followed by Pre-XDR-TB (14.9%) and XDR-TB (1.1%). However, the study by Dalal et al reported pre-XDR-TB as the most common form (56.8%) followed by MDR-TB (29.4%).¹⁴

In the current study, 71.96% achieved successful treatment outcomes with MDR/RR resistance patients having the highest cure rate. These findings were similar to those of Giri VP et al¹¹ & Oliveira O et al.¹⁵ Patients with Pre-XDR resistance had the highest odds of unsuccessful outcomes, followed by those with MDR/RR resistance. These results were consistent with the findings of Giri VP et al¹¹ & Bharti A et. al.¹³

Our study also aimed to determine the correlation of treatment outcomes with patient characteristics and their identified resistance patterns. The analysis suggested that treatment success rates might not be significantly associated with patient characteristics like age, sex or comorbidities. Similar findings were reported in studies by Bharti A et. al.¹³ & Oliveira O et al.¹⁵ which attributed the treatment success to the implementation of universal drug susceptibility testing (UDST).

Treatment duration, on the other hand, demonstrated a protective effect, with a significant p-value (<0.0001). In the current study, drug resistance was found to be a strong predictor of treatment failure. Patients with

MDR/RR resistance had significantly higher odds of an unsuccessful outcome. 71.96% achieved successful treatment outcomes with MDR/RR resistance patients having the highest cure rate.

Patients with Pre-XDR resistance had the highest odds of unsuccessful outcomes (OR = 2.52), followed by those with MDR/RR resistance. This indicates that timely diagnosis, appropriate treatment regimens and optimized treatment duration can improve & also overcome the effects of some patient characteristics on treatment outcomes.

However, in the study by Giri VP et al¹¹, the factors associated with unsuccessful treatment outcomes were found to be low-body mass index, HIV-DR-TB co-infection, diabetes DR-TB co-infection, bilateral cavities/extensive parenchymal disease on X-ray chest/HRCT chest, poor tolerability of anti-TB drugs, and additional resistance developing during the course of a treatment regimen.

Limitation of the Study. As retrospective secondary data was obtained from the NIKSHAY portal, it was not possible to determine all factors that could affect the patient's treatment outcomes. Moreover, since the study was conducted among patients registered under a District TB Centre, it was difficult to generalize the findings to all TB patients in the country.

CONCLUSIONS

Adults in the economically productive age group (18-59 years), males & underweight people were commonly affected. MDR-TB was found to be the leading form of DRTB. 71.96% achieved successful treatment outcomes while 15.54% cases had died. Patients with MDR/RR have the highest cure rate (70.27%). Mortality rates were highest in pre-XDR patients (20.37%). Patients under 18 years, Males, patients with pulmonary TB, HIV-reactive patients, underweight patients, Pre-XDR pattern, had higher odds of unsuccessful outcomes.

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