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RESEARCH

Factors Influencing Tuberculosis Treatment Outcomes in Lalitpur District, Nepal: A Retrospective Cohort Study

Krishna Kumar Khatri[1,2] · Durga Datta Chapagain[2,3] · Tae Hyun Kim[4] · Suk-Yong Jang[4] · Sunjoo Kang[2] · Vasuki Rajaguru[5] · Do Won Kim[4]

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Abstract

Purpose Tuberculosis (TB) remains a major public health challenge in low- and middle-income countries, including Nepal. Understanding the factors associated with TB treatment outcomes is essential for improving disease control and patient management.

Methods A retrospective study was conducted using TB program data from Lalitpur District, Nepal. De-identified patient records were extracted from the Health Information Management System and the national e-TB register. Sociodemographic, behavioral, and clinical variables were analyzed. Descriptive statistics summarized patient characteristics, while Pearson's chi-square test assessed associations between variables and treatment outcomes. Multivariable logistic regression was used to identify predictors of treatment success.

Results A total of 2,779 TB patients were included in the study. The overall treatment success rate was high, with most patients completing treatment successfully. Age, gender, and HIV status were significantly associated with treatment outcomes. Patients older than 60 years had higher odds of unsuccessful treatment compared with younger patients. Female patients showed higher odds of treatment success than males. HIV-positive patients had significantly poorer treatment outcomes compared with HIV-negative individuals. Other factors, including ethnicity, residence, smoking status, TB type, registration type, treatment category, DOTS delivery approach, and GeneXpert results, were not significantly associated with treatment success.

Conclusion Age, gender, and HIV status were key predictors of TB treatment outcomes in Lalitpur District. Strengthening integrated TB–HIV care, improving follow-up among older patients, and enhancing treatment adherence among male patients may help improve treatment success rates. These findings provide evidence to support targeted TB control strategies and contribute to achieving the World Health Organization's End TB Strategy goals.

Keywords Tuberculosis · Treatment outcomes · HIV co-infection · Epidemiology · Nepal · Global health

Krishna Kumar Khatri and Durga Datta Chapagain contributed equally to this work.

✉ Vasuki Rajaguru
vasuki@yuhs.ac

✉ Do Won Kim
wondok@yuhs.ac

1 Federal Parliament Secretariat, Health Unit, Kathmandu, Nepal

2 Department of Global Health and Disease Control, Graduate School of Public Health, Yonsei University, Seoul 03722, Republic of Korea

3 Minsitry of Health, Bagmati Province, Nepal

4 Department of Biohealth Industry, Graduate School of Transdisciplinary Health Sciences, Yonsei University, Seoul 03722, Republic of Korea

5 Department of Healthcare Management, Graduate School of Public Health, Yonsei University, Seoul 03722, Republic of Korea

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1 Introduction

Tuberculosis (TB), a disease caused by Mycobacterium tuberculosis, remains one of the most significant public health challenges worldwide. Transmitted through droplet infection, TB has serious implications for individuals and healthcare systems alike [1]. According to the World Health Organization (WHO), TB ranks as the second leading infectious killer, following COVID-19 and surpassing HIV/AIDS [2]. Despite various prevention and treatment efforts, global TB incidence has only decreased by 11% from 2015 to 2021, falling short of the Global End TB Strategy's target of a 20% reduction by 2020 [3]. Recent data highlight that, in 2022, an estimated 10.6 million people worldwide developed TB, with 98% of cases occurring in low- and middle-income countries (LMICs), further emphasizing the disease's substantial global burden [4].

TB's impact is particularly severe in South Asia, a region that accounts for almost 40% of the global TB burden, with over 4.8 million new cases reported in 2022 [4–6]. India, Indonesia, and Bangladesh are among the highest-burden countries [7, 8]. Complicating TB control efforts, the COVID-19 pandemic disrupted healthcare services, leading to increased TB cases and setbacks in containment measures. In 2022, an estimated 170,000 cases of multi-drug-resistant TB (MDR-TB) were reported, with only 74,300 patients receiving treatment [9]. Nevertheless, political commitment remains strong, as evidenced by the 2023 Gandhinagar Declaration, which aims to strengthen TB elimination efforts across the region [10].

In Nepal, the National Tuberculosis Program (NTP) was established in 1965 with WHO and UNICEF support, aiming to improve access to TB treatment and monitor the disease's incidence and prevalence [11–13]. Since 2006, the NTP has achieved a treatment success rate of nearly 85%. However, despite a gradual 3% annual decline in TB cases until 2019, TB case notifications and treatment outcomes remain suboptimal in certain areas, such as Lalitpur District [14]. Several challenges, including low diagnostic access, inadequate awareness, and poor living conditions in vulnerable areas like slums, contribute to the ongoing prevalence of TB in this district [15]. Specifically, densely populated areas with substandard housing and limited sanitation services present barriers to adequate TB detection and treatment [16].

TB cases in Lalitpur District may be underreported due to various factors, including stigmatization, environmental issues, and limited healthcare access. Certain populations, such as the elderly and individuals in crowded, low-income settlements, may be at higher risk. Additionally, the government's annual TB targets are often unmet, raising concerns about gaps in data collection and service delivery. This necessitates a more targeted approach to tuberculosis prevention, treatment, and monitoring, particularly in underserved regions with increased vulnerability to the disease [13, 17].

This study seeks to address these gaps by evaluating the treatment outcomes of TB in Lalitpur District, particularly focusing on socio-demographic factors linked to TB infection and recovery. By investigating the association between TB outcomes and variables such as age, gender, ethnicity, and residential type, the study aims to contribute valuable insights to inform targeted public health interventions. Additionally, the study will examine factors hindering effective TB detection and treatment within specific high-risk populations in Lalitpur, with a particular emphasis on urban slums and rural areas with limited health infrastructure.

Through its focus on TB treatment outcomes, this research aligns with the WHO's TB elimination goals by offering localized data that can help optimize resource allocation and improve public health responses. The study findings could inform policy decisions, support public awareness campaigns, and strengthen the role of local stakeholders including community health volunteers, local governments, and social mobilizers in addressing TB effectively.

2 Methodology

2.1 Research Design and Data Source

The cohort study investigated the socio-demographic factors, and treatment outcomes of tuberculosis (TB) among patients in the Lalitpur District, Nepal, using secondary data collected from the Health Management Information System (HIMS) and e-TB Register from July 16, 2020, to July 15, 2024. Participants in the study are TB patients recorded in the Lalitpur District's e-TB Register, managed by Nepal's National Tuberculosis Control Program (NTP). The register includes patient demographics, treatment history, and outcomes from all public healthcare facilities in the district, including both government and private health centers. This system ensures standardized, case-based reporting and supports comprehensive data collection at all treatment stages.

2.2 Study Participants

Convenience sampling was employed to include all TB patients who met the inclusion criteria and were treated within the Lalitpur District during the study period. This approach allows for a comprehensive overview of the treatment outcomes across the population of interest. We included TB patients newly registered in the e-TB system within the study period (July 16, 2020, to July 15, 2024) who have completed a full six-month treatment regimen and Patients not registered in the e-TB system, those who did not complete the treatment, and those who received less than six months of treatment were excluded from the study. A total of 2779 Tb patients were included for the final analysis (Fig. 1). Only patients with complete treatment records and defined treatment outcomes were included in the analysis. Patients with incomplete, missing, or ongoing treatment outcomes were excluded to ensure accurate classification of treatment outcomes.

Permission to access and use the data was obtained from the Lalitpur District Health Office (Ref. No. 185). The study utilized de-identified secondary data from routine TB program records; therefore, confidentiality and anonymity were strictly maintained throughout. As part of routine program procedures, patients receive standard counseling at the time of registration, and no additional informed consent was required for this secondary data analysis, in accordance with national guidelines.

3 Variables

The main outcome of this study was tuberculosis (TB) treatment outcome, which was classified into two categories: successful and unsuccessful [18]. Successful outcomes included patients who were cured or completed their treatment, while unsuccessful outcomes included death, treatment failure, loss to follow-up, transfer to second-line treatment due to drug resistance, or cases where the outcome was not evaluated.

Several sociodemographic, behavioral, and clinical factors were considered as independent variables. Sociodemographic variables included age, gender, ethnicity, and residence. Age was grouped into four categories: <20 years, 21–40 years, 41–60 years, and ≥61 years. Although the Nepal National Tuberculosis Program (NTP) uses more granular age categories (0–4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, ≥65 years), we aggregated them in the present study to ensure sufficient sample size within each group and to avoid sparse data, thereby improving the stability and interpretability of statistical estimates. Gender was classified as male or female. Ethnicity was classified according to HMIS categories and aggregated into four groups (Dalit, Janajati, Upper Caste, and Others), with Madhesi, Muslim, and smaller ethnic groups combined under “Others” to ensure adequate sample size for analysis. Residence was categorized as rural (Rural Municipality) or urban (Metro-, Sub-Metropolitan City and Municipality).

Behavioral and clinical variables included smoking status, HIV status, TB type, registration type, treatment category, treatment method, and GeneXpert test results. Smoking status was categorized as non-smoker, current smoker, or quitter. HIV status was recorded as positive, negative, or unknown. TB type was grouped into extra-pulmonary TB (EP), Pulmonary Bacteriologically Confirmed Tuberculosis (PBC), and clinically diagnosed pulmonary TB (PCD). Registration type was defined according to NTP categories and dichotomized into “new” and “others” (including relapse, treatment after failure, treatment after loss to follow-up, other previously treated cases and cases with unknown treatment history) to ensure adequate sample size and stable estimates. .

Patients were also categorized by treatment category and delivery methods included Community-Based Directly Observed Treatment Short Course (CB-DOTS) and facility-based DOTS. In addition, GeneXpert results were recorded as rifampicin sensitive, MTB not detected, or others (including rifampicin resistance or indeterminate results). GeneXpert was used as a diagnostic tool for detecting *Mycobacterium tuberculosis* and rifampicin resistance, and not for treatment follow-up. These variables were included to explore their potential influence on TB treatment outcomes.

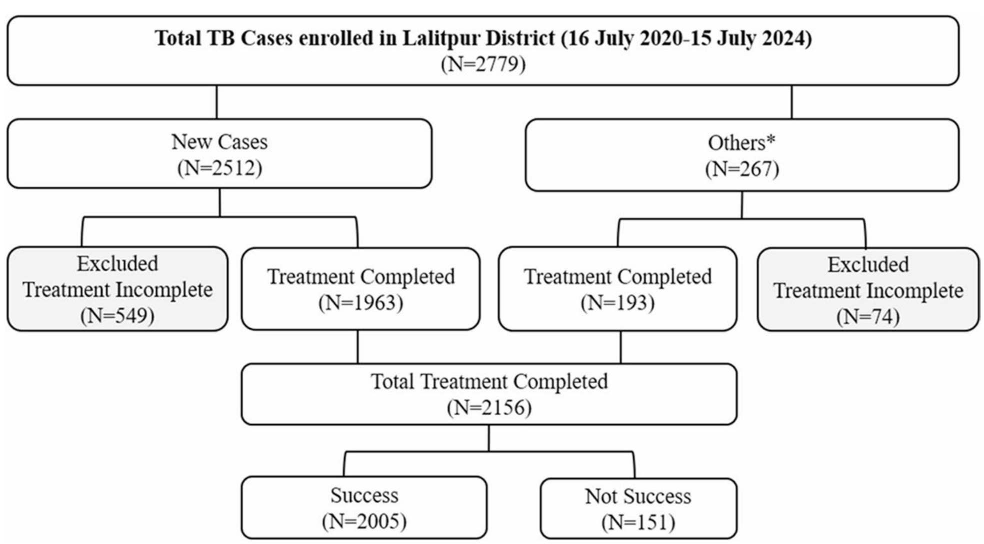

Fig. 1 Flowchart for population selection process

3.1 Data Analysis

Data analyses were performed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Descriptive statistics were first performed to summarize the characteristics of the study population. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means and standard deviations (SD). Descriptive statistics provided an overview of the population's demographics and clinical characteristics. Second, Pearson's chi-square test was used to assess associations between categorical variables and treatment outcomes. Third, multivariable logistic regression analysis was performed to predict the treatment success based on sociodemographic factors. An odd ratio (ORs) with 95% confidence intervals (95% CI) were calculated to measure the strength of associations. All statistical tests were two-tailed, and statistical significance was set at a p-value <0.05.

4 Results

4.1 Sociodemographic and clinical characteristics

Table 1. describes the sociodemographic, behavioral and clinical characteristics of TB patients. Of the 2779 patients evaluated for TB treatment outcomes in Lalitpur District, Nepal. The analysis revealed that TB was most prevalent among individuals aged 21–40 years (40.3%) and predominantly affected males (55.2%). Janajati populations accounted for 66.5% of cases, with urban residents disproportionately represented (89.1%). Clinically, Pulmonary Bacteriologically Confirmed Tuberculosis (PBC) was the most common form (47.9%), achieving a treatment success rate of 72.1%.

4.2 Association between the treatment outcomes

Table 2 presents the association between selected variables and TB treatment outcomes. Most of the TB patients achieved successful treatment outcomes (93%), while 7% experienced treatment failure. Younger age groups (<20 years) showed highest success rate (98%) than patients over 60 years (84%) and Females has a slightly higher success rate (95%) compared to males (92%). HIV-positive patients had a markedly lower success rate (72.2%) and a higher failure rate (27.8%) compared to HIV-negative patients (93.5% success) and all were showed a significant association ($p<0.05$). In contrast, ethnicity, residence, smoking status, TB type, registration type, treatment category, DOTS delivery method, and GeneXpert results were not significantly associated with treatment outcomes ($p>0.05$).

Table 1 Socioeconomic and clinical Characteristics of Tuberculosis patients from 2020 to 2024

Variables	Categories	*N*	%
	Total	2779	100
Age (Years)	<20	484	17.4
	21–40	1121	40.4
	41–60	679	24.4
	>60	495	17.8
Gender	Male	1535	55.3
	Female	1244	44.7
Ethnicity	Dalit	183	6.6
	Janajati	1850	66.5
	Upper Cast	586	21.1
	Others	160	5.8
Residence	Rural	300	10.8
	Urban	2479	89.2
Smoking	No Smoking	1677	60.4
	Current Smoker	951	34.2
	Quitter	151	5.4
HIV	Positive	27	1
	Negative	2298	82.7
	Unknown	454	16.3
Types of TB	EP	1182	42.6
	PBC	1333	47.9
	PCD	264	9.5
TB related information			
Registration type	New	2512	90.4
	Others*	267	9.6
Treatment Category	Child	68	2.4
Adult/Child	Adult	2711	97.6
DOTS Based	CB-DOTS	161	5.8
	DOTS	2618	94.2
GeneXpert Results	RIF Sensitivity	943	65.39
	MTB Not Detected	393	27.26
	Others**	106	7.35
Treatment Outcomes	Success	2005	93
	Failure	151	7

Others*= Relapse cases, previously treated patients, treatment after failure, treatment after loss to follow-up, and cases with unknown treatment history Others (GeneXpert results) = Rifampicin resistance, indeterminate results requiring repeat testing, and failed tests without valid results. *EP* Extra-pulmonary tuberculosis, *PBC* pulmonary bacteriologically confirmed tuberculosis, *PCD* clinically diagnosed pulmonary tuberculosis, *DOTS* Directly Observed Treatment Short-course, *CB-DOTS* Community-Based Directly Observed Treatment Short-course, *RIF* Rifampicin, *MTBMycobacterium tuberculosis,HIV* Human Immunodeficiency Virus

4.3 Multivariate logistic regression analysis

Table 3 presented the multivariable logistic regression analysis examining the factors associated with successful TB treatment outcomes in Lalitpur, Nepal. Age showed a significant association with treatment success, as patients aged 21–40 years (OR = 0.095, 95% CI: 0.041–0.222), 41–60 years (OR = 0.304, 95% CI: 0.203–0.456), and >61 years

Table 2 Chi-Square Test Association Between Variables and TB Treatment Outcomes

Variables	Categories		Treatment Outcomes				p
			Success (2005)		Failure (151)		
			N	%	N	%	
Age (Years)	<20	393	385	98	8	2	0.001
	21–40	873	824	94	49	6	
	41–60	512	480	94	32	6	
	>60	378	316	84	62	16	
Gender	Male	1170	1071	92	99	8	0.004
	Female	986	934	95	52	5	
Ethnicity	Dalit	148	135	91	13	9	0.366
	Janajati	1433	1342	94	91	6	
	Upper Cast	457	421	92	36	8	
	Others	118	107	91	11	9	
Residence	Rural	218	204	94	14	6	0.723
	Urban	1938	1801	93	137	7	
Smoking Status	No Smoking	1171	1099	94	72	6	0.200
	Current Smoker	853	783	92	70	8	
	Quitter	132	123	93	9	7	
HIV	Positive	18	13	72.2	5	27.8	0.001
	Negative	1752	1638	93.5	114	6.5	
	Unknown	386	354	91.7	32	8.3	
Types of TB	EP[1]	936	873	93	63	7	0.528
	PBC[2]	1031	960	93	71	7	
	PCD[3]	189	172	91	17	9	
Registration Type	New	1963	1828	93	135	7	0.463
	Others*	193	177	92	16	8	
Treatment Category	Child	55	53	96	2	4	0.322
	Adult	2101	1952	93	149	7	
DOTS Based	CB-DOTS[4]	101	90	89	11	11	0.117
	DOTS[5]	2055	1915	93	140	7	
GeneXpert Results	RIF Sensitivity	715	663	92.7	52	7.3	0.230
	MTB Not Detected	279	225	91.4	24	8.6	
	Others**	73	71	97.3	2	2.7	

(OR = 0.341, 95% CI: 0.216–0.537) had significantly lower odds of treatment success compared with patients aged < 20 years ($p < 0.001$). Female patients had higher odds of treatment success compared with males (OR = 1.453, 95% CI: 1.014–2.081, $p = 0.040$). HIV status showed a significant relationship with treatment outcomes, as HIV-negative patients had higher odds of treatment success compared with HIV-positive patients (OR = 3.951, 95% CI: 1.095–14.258, $p = 0.036$). In contrast, ethnicity, residence, smoking status, type of TB, registration type, treatment category, DOTS treatment approach, and GeneXpert results were not significantly associated with treatment success ($p > 0.05$).

5 Discussion

This study, conducted in Lalitpur District, Nepal, aligns with global findings on TB treatment outcomes while highlighting regional nuances. Comparing the key sociodemographic, behavioral, and clinical factors influencing treatment outcomes in Lalitpur with global research reveals commonalities and differences in age, gender, HIV co-infection, smoking status, and healthcare access [13, 17]. Overall, the treatment success rate observed in this study is comparable with global TB program targets and findings reported in other low- and middle-income countries, suggesting that Nepal's TB control program has achieved relatively effective treatment coverage.

Age was found to be an important factor associated with TB treatment outcomes. Older patients in this study, particularly those above 60 years of age, experienced higher treatment failure rates compared with younger patients. This pattern has been widely reported in global TB research. Studies conducted in Turkey, Indonesia, China, and several sub-Saharan African countries have also shown that older individuals tend to have poorer treatment outcomes [19–22]. These outcomes are often explained by delayed diagnosis, the presence of other chronic illnesses,

Table 3 Multivariable Logistic Regression Analysis of Factors Associated with TB Treatment Success in Lalitpur, Nepal

Covariates	Categories	OR	95% CI	*p*-value
Age Group	< 20	1.00 (Ref)	–	–
	21–40	0.095	0.041–0.222	< 0.001
	41–60	0.304	0.203–0.456	< 0.001
	> 61	0.341	0.216–0.537	< 0.001
Gender	Male	1.00 (Ref)	–	–
	Female	1.453	1.014–2.081	0.040
Ethnicity	Dalit	1.00 (Ref)	–	–
	Janajati	1.051	0.442–2.496	0.910
	Upper Caste	0.642	0.326–1.265	0.200
	Others	0.799	0.386–1.655	0.550
Residence	Rural	1.00 (Ref)	–	–
	Urban	0.872	0.484–1.568	0.650
Smoking Status	No Smoking	1.00 (Ref)	–	–
	Current Smoker	0.972	0.465–2.030	0.940
	Quitter	0.715	0.527–0.971*	0.029
HIV Status	Positive	1.00 (Ref)	–	–
	Negative	3.951	1.095–14.258	0.036
	Unknown	0.589	0.304–1.143	0.118
Type of TB	EP	1.00 (Ref)	–	–
	PBC	0.911	0.509–1.630	0.750
	PCD	0.826	0.465–1.468	0.520
Registration Type	New	1.00 (Ref)	–	–
	Others	0.898	0.512–1.574	0.710
Treatment Category	Child	1.00 (Ref)	–	–
	Adult	0.583	0.116–2.926	0.510
DOTS Based	CB-DOTS	1.00 (Ref)	–	–
	DOTS	1.559	0.793–3.065	0.200
GeneXpert Results	RIF Sensitivity	1.00 (Ref)	–	–
	MTB Not Detected	2.731	0.622–11.994	0.183
	Others	3.376	0.682–16.706	0.136

and weakened immune systems among older adults. In contrast, younger patients in this study had very high treatment success rates, which is consistent with findings from studies in Mumbai and Zambia where younger patients generally experience fewer health complications and respond better to treatment [23, 24]. However, the extent to which age affects TB outcomes may also depend on the strength of the healthcare system. For example, studies from China have reported improved treatment outcomes among elderly patients due to stronger healthcare infrastructure and better follow-up systems [21, 25]. Conversely, resource-limited settings like sub-Saharan Africa lack targeted interventions for elderly TB patients, aligning more closely with Nepal's findings [26].

Gender disparities in TB outcomes were also observed in this study. Male patients had slightly higher rates of unsuccessful treatment outcomes compared with female patients. Similar findings have been reported in several international studies, suggesting that men are more likely to experience unfavorable TB outcomes [19]. One possible explanation is that men are more likely to delay healthcare-seeking and have lower adherence to treatment. Studies from Ghana, Nigeria, and Zambia have reported higher treatment default rates among male TB patients [27, 28]; [1]. In contrast, research from Cameroon and Indonesia has shown that women tend to adhere more consistently to TB treatment, which contributes to higher success rates [1, 20]. Women tend to seek healthcare earlier and follow treatments better, leading to higher success rates globally, including in India [23]. An exception was found in Indonesia, where males had slightly better outcomes, possibly due to differences in health education and healthcare accessibility [20]. Cultural and social factors may also influence these patterns. In many countries, including Nepal, women may interact more frequently with healthcare services through maternal and child health programs, which can increase their engagement with treatment services [17].

HIV co-infection was another important factor affecting TB treatment outcomes in this study. Patients who were HIV positive had significantly lower treatment success rates compared with HIV-negative patients. This finding is consistent with evidence from several countries where HIV infection complicates TB treatment because of weakened immunity and increased risk of opportunistic infections [1, 29]. Studies from Zambia, Nigeria, and Papua New Guinea have reported similar challenges among TB-HIV co-infected patients [1, 28, 29]. Delays in initiating antiretroviral therapy (ART) and limited coordination between TB and HIV programs can further worsen treatment outcomes [27, 28, 30]. Studies from Namibia and Papua New Guinea suggest integrated TB and HIV care yields better results [26, 29]. The results from Lalitpur therefore highlight the importance of strengthening TB-HIV collaborative services and ensuring routine HIV testing for TB patients, in line with WHO guidelines [6]. The relatively high proportion of patients with unknown HIV status in this study also indicates a need to improve HIV testing coverage within TB programs.

Most TB cases in this study were reported from urban areas, which reflects patterns seen in many countries where TB is more frequently detected in densely populated cities [2, 7, 30]. Studies from Mumbai and Accra have also shown higher TB case detection rates in urban settings due to better diagnostic facilities and stronger reporting systems [23]. Despite this urban concentration, treatment outcomes did not differ significantly between urban and rural patients in Lalitpur. This finding may reflect the consistent implementation of the DOTS strategy across Nepal, which helps ensure access to TB treatment services even in rural areas. In contrast, several studies from sub-Saharan Africa and Papua New Guinea have reported poorer treatment outcomes in rural communities because of limited healthcare infrastructure and barriers to accessing treatment services [22, 29].

Drug-resistant TB continues to be a major global concern. Countries such as China, India, and several African nations have reported lower treatment success rates due to the growing burden of multidrug-resistant TB [21]; [22, 31]. Although this study mainly focused on drug-susceptible TB, the use of GeneXpert testing in Nepal plays an important role in identifying rifampicin resistance at an early stage [13]. Countries like China and India have expanded the use of GeneXpert technology to strengthen drug-resistant TB detection and management [21, 23]. Compared with these countries, Nepal still has relatively limited data on drug resistance patterns. While GeneXpert enhances early case detection and drug-resistance identification, treatment monitoring in TB programs relies on clinical and bacteriological follow-up rather than molecular diagnostic tools, expanding access to molecular diagnosis could help improve early detection and strengthen TB control efforts in the country.

Overall, the findings of this study reflect many of the global patterns seen in TB treatment outcomes while also highlighting specific challenges in the Nepalese context. Age, gender, and HIV co-infection emerged as important factors influencing treatment success. Strengthening HIV testing among TB patients, expanding access to advanced diagnostic tools, and providing targeted support for high-risk groups such as older adults and male patients could help further improve TB treatment outcomes in Nepal. These efforts would also support the broader goal of aligning Nepal's TB control strategies with global best practices.

6 Limitations

This TB treatment outcome study in Lalitpur, Nepal, reveals key findings but has limitations. The exclusion of patients with incomplete or ongoing treatment outcomes may introduce selection bias, as individuals with poorer adherence or unfavorable outcomes could be underrepresented. This may lead to an overestimation of treatment success rates. Data from HIMS and the e-TB Register may be inaccurate or inconsistent, limiting detail. Protocol changes over four years could cause measurement bias, and confounding factors like nutrition and mental health might influence outcomes despite adjustments. Self-reported behaviors, such as smoking and HIV status, risk recall or desirability bias. The study excludes analysis of multidrug-resistant TB (MDR-TB), missing insights into drug resistance impacts. Focus on urban Lalitpur limits generalizability to rural Nepal, where healthcare access differs. Future research should involve prospective data, MDR-TB analysis, and wider geographic coverage for a comprehensive understanding of TB determinants in Nepal.

6.1 Policy Implications

The findings highlight several priorities for strengthening TB control policies in Nepal. Targeted interventions are needed for high-risk groups, particularly older adults, males, and people living with HIV. Age-specific care, improved follow-up for elderly patients, and stronger treatment adherence support should be integrated into TB programs. Expanding family based Directly Observed Treatment (DOT), integrated within existing community health systems, could enhance treatment adherence and improve outcomes, especially among children and elderly patients who require additional support during therapy. The poorer outcomes among HIV-positive patients emphasize the importance of integrated TB–HIV services, including routine HIV testing for TB patients and timely initiation of antiretroviral therapy (ART). Strengthening coordination between TB and HIV programs can improve patient outcomes and reduce mortality. Although most TB cases were reported in urban areas, treatment outcomes were similar across urban and rural settings, suggesting effective implementation of the DOTS strategy. Expanding diagnostic capacity, particularly GeneXpert testing, and strengthening community-based DOTS (CB-DOTS) in underserved areas could further improve access to care. Finally, improving data quality and surveillance, particularly regarding HIV status and drug resistance, will be important for effective program monitoring. Strengthening the e-TB register and integrating it with national health information systems can support more responsive and evidence-based TB control policies aligned with Nepal's national TB strategy and the WHO End TB Strategy. Tuberculosis-related stigma remains a key barrier to timely diagnosis and treatment adherence. Integrating stigma-reduction strategies, such as community education, counseling services, and involvement of female community health volunteers, into TB programs could improve patient engagement and treatment outcomes.

7 Conclusion

This study identified key sociodemographic and clinical factors associated with TB treatment outcomes in Lalitpur District, Nepal. Age, gender, and HIV status were significant predictors of treatment success. Older patients and HIV-positive individuals had poorer outcomes, highlighting the need for targeted interventions and stronger TB–HIV integrated care. Male patients also showed slightly higher rates of unsuccessful outcomes, suggesting the importance of improving treatment adherence and healthcare access. Although ethnicity and residence were not significantly associated with outcomes, strengthening diagnostic and treatment services across both urban and rural settings may further improve TB control efforts [12]. These findings support the need for focused strategies targeting high-risk groups to help achieve the World Health Organization's End TB Strategy goals.

Abbreviations

ART	Antiretroviral therapy
AOR	Adjusted odds ratio
CB-DOTS	Community-based directly observed treatment, short-course
CI	Confidence interval
DOTS	Directly observed treatment, short-course
EP	Extra-pulmonary tuberculosis
HIMS	Health Information Management System
HIV	Human immunodeficiency virus
LMICs	Low- and middle-income countries
MDR-TB	Multidrug-resistant tuberculosis
MTB	Mycobacterium tuberculosis
NTP	National Tuberculosis Programme
OR	Odds ratio
PBC	Pulmonary Bacteriologically Tuberculosis
PCD	Clinically diagnosed pulmonary tuberculosis
RIF	Rifampicin
TB	Tuberculosis
WHO	World Health Organization

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

Declarations

Ethics Approval and Consent to Participate Permission to access and use the data was obtained from the Lalitpur District Health Office (Ref. No. 185). The study utilized de-identified secondary data from routine program records; therefore, confidentiality and anonymity were maintained. As part of routine TB program procedures, patients receive counseling at the time of registration, and no additional consent or approval was required for this secondary analysis.

Consent for Publication Not applicable.

Competing interests The authors declare no competing interests.

References

1. Chilyabanyama R, Kamanga N, Mwandia JN. Factors associated with tuberculosis treatment outcomes among TB patients aged 15 years and older at chawama level one hospital in Lusaka, Zambia. Glob Public Health. 2024;19(1):2307979.
2. Bagcchi S. WHO's global tuberculosis report 2022. Lancet Microbe. 2023;4(1):e20.
3. Mekonen H, Negesse A, Dessie G, Desta M, Mihiret GT, Tarik YD, et al. Impact of HIV coinfection on tuberculosis treatment outcomes in Ethiopia: A systematic review and meta-analysis. BMJ open. 2024;14(7):e087218.
4. Koura KG, Harries AD. The Trend of Tuberculosis Case Notification Rates from 1995 to 2022 by Country Income and World Health Organization Region. Trop Med Infect Disease. 2024;9(12):294.
5. Basnyat B, Caws M, Udwadia Z. Tuberculosis in South Asia: a tide in the affairs of men. Multidisciplinary respiratory Med. 2018;13:1–8.
6. Narain JP, Lo Y-R. Epidemiology of HIV-TB in Asia. Indian J Med Res. 2004;120(4):277.
7. van Gurp M, Rood E, Fatima R, Joshi P, Verma SC, Khan AH, et al. Finding gaps in TB notifications: spatial analysis of geographical patterns of TB notifications, associations with TB program efforts and social determinants of TB risk in Bangladesh, Nepal and Pakistan. BMC Infect Dis. 2020;20:1–14.
8. Nair N, Wares F, Sahu S. Tuberculosis in the WHO South-East Asia Region. Bull World Health Organ. 2010;88(3):164. https://doi.org/10.2471/blt.09.073874 . PubMed PMID: 20428378; PubMed Central PMCID: PMCPMC2828794.

9. Kumar A, Kaur R, Chauhan DS, Maurya MK, Ahmed I, Tripathi S et al. Emergence of MDR and XDR Tuberculosis Brought Forth New Strains and Challenges. 2023.
10. Bhatia V, Rijal S, Sharma M, Islam A, Vassall A, Bhargava A et al. Ending TB in South-East Asia: flagship priority and response transformation. Lancet Reg Health-Southeast Asia. 2023;18.
11. Gurung SC, Dixit K, Rai B, Caws M, Paudel PR, Dhital R, et al. The role of active case finding in reducing patient incurred catastrophic costs for tuberculosis in Nepal. Infect Dis Poverty. 2019;8(1):99. https://doi.org/10.1186/s40249-019-0603-z.
12. Iwaki Y, Rauniyar SK, Nomura S, Huang MC. Assessing factors associated with TB awareness in Nepal: A national and subnational study. Int J Environ Res Public Health. 2021;18(10):5124.
13. Gautam N, Karki RR, Khanam R. Knowledge on tuberculosis and utilization of DOTS service by tuberculosis patients in Lalitpur District, Nepal. PLoS ONE. 2021;16(1):e0245686.
14. Rai B, Dixit K, Prasad Aryal T, Mishra G, Teixeira de Siqueira-Filha N, Paudel PR, et al. Developing feasible, locally appropriate socioeconomic support for TB-affected households in Nepal. MDPI; 2020.
15. WHO. Nepal Completes First National Tuberculosis Prevalence Survey. Another Step towards# EndTB [Internet]. 2020; 24.
16. WHO. World Bank. Countries and economies: Nepal. 20182019. Available from: https://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=NPL.
17. Sah B, Sah J, Shah S, KC A. Knowledge on tuberculosis among students of higher secondary school, lalitpur, Nepal. MOJ Public Health. 2016;4(4):00091.
18. World Health Organization. Definitions and reporting framework for tuberculosis – 2023 update. Geneva: WHO. 2023. Accessed 23 Apr 2026 https://wkc.who.int/resources/publications/i/item/9789241505345
19. Babalik A, Balikçi A, Turkar A, Teke NH, Demir FK, Yavuz S, et al. Affecting Factors Unfavorable Treatment Outcomes of Rifampicin-resistant/Multidrug-resistant Tuberculosis Patients Treated with Long-term Regimen. Int J Mycobacteriology. 2024;13(3):265–74.
20. Machmud PB, Gayatri D, Ronoatmodjo S. A survival analysis of successful and poor treatment outcome among patients with drug-resistant tuberculosis and the associated factors: a retrospective cohort study. Acta Med Indones. 2021;53(2):184.
21. Zou L, Kang W, Guo C, Du J, Chen Q, Shi Z et al. Treatment Outcomes and Associated Influencing Factors Among Patients with Rifampicin-Resistant Tuberculosis: A Multicenter, Retrospective, Cohort Study in China. Infect Drug Resist. 2024:3737–49.
22. Tudor C, Van der Walt ML, Margot B, Dorman SE, Pan WK, Yenokyan G, et al. Occupational risk factors for tuberculosis among healthcare workers in KwaZulu-Natal, South Africa. Clin Infect Dis. 2016;62(suppl3):S255–61.
23. Khan S, Silsarma A, Mahajan R, Khan S, Davuluri P, Sutar N, et al. Treatment outcomes among patients with isoniazid mono-resistant tuberculosis in Mumbai, India: A retrospective cohort study. J Clin Tuberculosis Other Mycobact Dis. 2024;37:100481.
24. Chilyabanyama R, Kamanga N, Mwandia JN. Factors associated with tuberculosis treatment outcomes among TB patients aged 15 years and older at chawama level one hospital in Lusaka, Zambia. Glob Public Health. 2024;19(1). https://doi.org/10.1080/17441692.2024.2307979.
25. Chen W, Li Y, Yang H, Ehiri J, Chen Z, Liu Y, et al. Is tuberculosis health education reaching the public in China? A cross-sectional survey in Guizhou Province. BMJ open. 2016;6(9):e013534.
26. Amkongo M, Mitonga HK, Alfeus A, Shipingana LNN, Keendjele T, Eelu H, et al. Factors associated with the unsuccessful TB treatment outcomes in the northern regions of Namibia: a mixed methods study. BMC Infect Dis. 2023;23(1):342.
27. Puplampu P, Kyeremateng I, Asafu-Adjaye O, Asare AA, Agyabeng K, Sarkodee R, et al. Evaluation of treatment outcomes among adult patients diagnosed with tuberculosis in Ghana: A 10 year retrospective review. IJID Reg. 2024;10:9–14.
28. Oladimeji O, Oladimeji KE, Nanjoh M, Banda L, Adeleke OA, Apalata T, et al. Contributory factors to successful tuberculosis treatment in southwest Nigeria: A cross-sectional study. Trop Med Infect Disease. 2022;7(8):194.
29. Toua W, Lape V, Bolnga J, Daimen M, Kelebi T, Vaccher S, et al. High rates of unfavourable TB treatment outcomes observed in Madang Province, Papua New Guinea. Public Health Action. 2024;14(3):105–11.
30. Mutembo S, Mutanga JN, Musokotwane K, Kanene C, Dobbin K, Yao X, et al. Urban-rural disparities in treatment outcomes among recurrent TB cases in Southern Province, Zambia. BMC Infect Dis. 2019;19:1–8.
31. Rupani MP, Vyas S, Shah IA. Cohort study on association between catastrophic costs and unfavorable tuberculosis treatment outcomes among TB-HIV and TB-diabetes comorbid patients in India. BMC Public Health. 2024;24(1):2028.