







Research Article

Tuberculosis Treatment Outcomes and Associated Factors at Zewditu Memorial Hospital, Ethiopia

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Abstract

Background: Tuberculosis (TB) remains a leading cause of morbidity and mortality in Ethiopia, with treatment success rates consistently below the WHO target. Various factors contribute to poor treatment outcomes. **Objective:** To assess treatment outcomes for TB and associated factors at Zewditu Memorial Hospital (ZMH) from 2017 to 2021. **Methods:** An institutional-based analytical cross-sectional study was conducted using TB logbook data. After bivariable analysis, clinically relevant variables and variables with a p-value < 0.2 were included in multivariable logistic regression analysis. Statistical significance was set at p-value < 0.05. **Results:** The overall successful treatment outcome (cured or completed) was 197 (83.1%). Factors significantly associated with poor treatment outcomes included age group 35 to 44 years (AOR=4.663; 95% CI: 1.215-17.901), extrapulmonary TB (AOR=3.451; 95% CI: 1.172-10.16), and registration in 2019 (AOR=4.367; 95% CI: 1.2-15.87). **Conclusion:** The treatment success rate falls short of the national target of 85%, highlighting the need for targeted improvements in TB management. The associations with age and extrapulmonary TB emphasize the necessity for focused control measures. Strengthening targeted TB programs at ZMH is recommended.

Keywords

TB Treatment, Treatment Outcomes, Zewditu Memorial Hospital, Extrapulmonary TB

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Received: 1 September 2024; **Accepted:** 18 September 2024; **Published:** 10 October 2024



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1. Introduction

Tuberculosis (TB), is a primarily lung infection caused by *Mycobacterium tuberculosis* (MTB), an acid-fast bacillus [1]. It is one of the top 10 causes of death globally, surpassing HIV/AIDS, with an estimated 1.2 million deaths among HIV-positive individuals and 0.208 million deaths among HIV-negative individuals in 2019 [2].

Although global TB treatment success has improved in recent years, challenges persist, especially in developing regions like Africa and Asia, which account for 24% and 44% of the global TB burden, respectively [2]. In Ethiopia, the second most populous country in Africa, TB remains a leading cause of morbidity and mortality [2, 3].

In Sub-Saharan Africa, TB patient follow-up losses are reported to be very high, ranging from 11.3% to 29.6% [4]. Irregular treatment regimens heighten the risks of therapy failure, recurrence, and the development of drug-resistant strains, which can subsequently increase and prolong TB infectiousness [5]. To combat this, the WHO developed the DOTS (Directly Observed Treatment, Short-course) strategy, widely adopted as the most cost effective method for reducing TB incidence and mortality in developing countries [6].

The goals of tuberculosis treatment are to cure the patient, prevent death, avoid relapse and resistance, and reduce transmission [7]. Tracking treatment outcomes is crucial for assessing the success of the DOTS program, and understanding the specific reasons for unsatisfactory results is essential for improving treatment methods [8, 9].

Ethiopia's TB treatment success rate remains below the WHO target, with a pooled treatment success of 86%. Factors such as old age, HIV co-infection, retreatment cases, smear-negative and extrapulmonary TB, drug resistance, lack of support, transfers from other hospitals, and rural residence were the contributors to poor outcomes [10-14].

The COVID-19 pandemic has slowed the progress in reducing the global TB burden, with public health measures potentially disrupting TB diagnostic and treatment services. Ongoing disruptions could decrease TB recognition and treatment by 25-50% within three months [2]. Furthermore, the pandemic's long-term socio-economic effects may exacerbate poverty, malnutrition, and living conditions, possibly making TB the leading cause of infectious mortality worldwide [14, 15]. No studies have assessed TB treatment outcomes and associated factors in Ethiopia during the COVID-19 era, highlighting the need for this study.

This study assesses TB treatment outcomes at Zewditu Memorial Hospital from 2017 to 2021, considering the updated FMOH treatment guidelines and the impact of the COVID-19 pandemic, with the goal of informing policy-makers, enhancing case management, and shaping future strategies.

2. Methods

2.1. Study Setting and Design

An institutional-based analytical cross-sectional study was performed from December 2021 to February 2022 G.C. at Zewditu Memorial Hospital (ZMH), Addis Ababa, Ethiopia. A hospital with a TB clinic that sees an average of 250 patients annually.

2.2. Population and Eligibility

The source population comprised all TB patients treated at Zewditu Memorial Hospital (ZMH). The study included all documented TB cases registered in the TB logbook from January 2017 to December 2021 that met the inclusion criteria. Specifically, patients aged 18 years or older with documented TB cases within this period were included in the study.

2.3. Sample Size and Sampling Technique Determination

The sample size was calculated using the single population proportion formula with a 95% confidence level, 5% margin of error, and an estimated 80.7% prevalence of successful TB treatment outcomes from a previous study done in Ethiopian [30]. After applying the finite population correction and accounting for a 10% non-response rate, the final sample size was 212 patients. A convenient sampling technique was used to include the entire 5-year TB patient population.

2.4. Variables

1. Dependent variables

Treatment outcomes (unsuccessful outcome, Successful outcome).

2. Independent variables

Sex, Age, Type of PTB: EPTB, Smear positive PTB, Smear negative PTB, HIV status, BMI.

2.5. Data Collection and Analysis

Data was collected using a checklist derived from existing literature, covering socio-demographic characteristics, TB types, HIV status, and treatment outcomes. Collection took place from December 2021 to February 2022, including TB patient records from January 2017 to December 2021 at ZMH. A pretest with 5% of the sample was conducted at Ras Desta Damtew Memorial Hospital to ensure checklist clarity and completeness, resulting in necessary revisions. Eight data collectors (Internal Medicine residents) received training on checklist use and data entry procedures.

Data entry utilized Epi Data version 3.01, and analysis was performed with SPSS version 26. Descriptive statistics, including means, standard deviations, and percentages, were

computed. Bivariable analysis was performed and all clinically relevant variables and those having of p-value < 0.2 in the simple binary logistic regression analysis were included in the multivariate logistic regression analysis to determine associated factors of treatment outcomes. The p-value < 0.05 is considered as statistically significant.

2.6. Operational Definitions

TB types – EPTB, smear-positive PTB, smear-negative PTB [16].

Treatment Completed- A patient who completed treatment without evidence of failure but lacks records showing negative sputum or culture results in the final month of treatment or on at least one prior occasion, either due to tests not being performed or results being unavailable [16].

Cured – A patient whose sputum smear or culture was positive at the start of treatment but became smear- or culture-negative in the final month of treatment and on at least one prior occasion [16].

Treatment Failure– A TB patient whose sputum smear or culture remains positive at month 5 or later during treatment [16].

Died – A patient who dies for any reason during TB treatment [16].

Lost to follow-up –A patient who has been on treatment for at least four weeks and experienced an interruption in treatment for eight or more consecutive weeks [16].

Not Evaluated – A TB patient for whom no treatment outcome is assigned, including those "transferred out" to another treatment unit and cases where the treatment outcome is unknown to the reporting unit [16].

Moved to MDR-TB–TB Patients who were found to have RR-TB or MDR-TB before the fifth month of treatment and were referred to the MDR TB unit to begin a full MDR-TB treatment regimen (i.e. patient is moved to the second-line treatment register) [16].

Treatment Success-The sum of cured and treatment com-

pleted [16].

Treatment success rate- A sum of smear-positive TB cases who completed treatment and who were declared cured divided by the total smear-positive TB cases in the same period.

Successful treatment outcome- If the outcome of TB Patients is cured or completed treatment.

Unsuccessful Treatment outcome: If the outcome of TB Patients is death, moved to MDR/treatment failure, lost to follow up/defaulted, or not evaluated.

New TB case – Patients who have never had treatment for TB or have taken anti-TB drugs for less than 1 month [16].

Retreatment – A patient who starts treatment again [16].

Intensive phase – The first two months of the treatment [16].

Continuation phase – The phase that immediately follows the intensive phase [16].

2.7. Ethical Issues Considerations

Ethical approval for this study was obtained from the Institutional Review Boards of Zewditu Memorial Hospital and St. Paul's Hospital Millennium Medical College. The ethical committees granted a waiver for informed consent due to the use of secondary data. All collected data was used solely for the purposes of this research and was maintained with strict confidentiality.

3. Result

3.1. Demographic and Clinical Characteristics

A total of 237 TB patients with the age range of 18–85 years were registered during the five years. The highest percentage (43.5%) of the cases was in the age range of 35–44 years. The proportion of PTB negative was 18.6% and TB/HIV co-infection was 44.3% (112/232). [Table 1](#).

Table 1. Demographic and clinical characteristics of TB patients registered at ZMH (Dec. 2017-Jan. 2021).

Characteristics		General TB Treatment Outcome		
		Successful (%)	Unsuccessful (%)	Total N (%)
Age (in years)	18-24	2 (66.7%)	1 (33.3%)	3 (1.27%)
	25-34	50 (90.9%)	5 (9.1%)	55 (23.21%)
	35-44	86 (83.5%)	17 (16.5%)	103 (43.46%)
	45-54	38 (79.2%)	10 (20.8%)	48 (20.25%)
	>55	21 (75.0%)	7 (25.0%)	28 (11.81%)
Sex	Female	102 (86.4%)	16 (13.6%)	118 (49.79%)
	Male	95 (79.8%)	24 (20.2%)	119 (50.21%)

Characteristics		General TB Treatment Outcome		
		Successful (%)	Unsuccessful (%)	Total N (%)
BMI	Underweight	70 (87.5%)	10 (12.5%)	80 (33.76%)
	Normal	102 (80.3%)	25 (19.7%)	127 (53.59%)
	Overweight	18 (78.3%)	5 (21.7%)	23 (9.70%)
	Obese	1 (100.0%)	0 (0.0%)	1 (0.42%)
Year of registration for TB treatment	2017	36 (78.3%)	10 (21.7%)	46 (19.41%)
	2018	54 (93.1%)	4 (6.9%)	58 (24.47%)
	2019	32 (82.1%)	7 (17.9%)	39 (16.46%)
	2020	25 (78.1%)	7 (21.9%)	32 (13.5%)
	2021	50 (80.6%)	12 (19.4%)	62 (26.16%)
Type of TB	EPTB	99 (81.8%)	22 (18.2%)	121 (51.05%)
	PTB -	34 (72.3%)	13 (27.7%)	47 (19.83%)
	PTB +	61 (92.4%)	5 (7.6%)	66 (27.85%)
	Unknown	4 (80.0%)	1 (20.0%)	5 (2.11%)
HIV test result	Negative	104 (86.7%)	16 (13.3%)	120 (50.63%)
	Positive	89 (79.5%)	23 (20.5%)	112 (47.26%)
Total		197 (83.1%)	40 (16.9%)	237 (100%)

3.2. TB Treatment Outcome

The overall Successful TB treatment outcome (i.e. cured or treatment completed) in Zewditu Memorial Hospital was 197 (83.10%). Of all patients 52 (21.90%) were cured, 145 (61.2%) completed treatment, 20 (8.4%) died, 5 (2.1%) lost to follow-up, and 1 (0.4%) were moved to MDR as indicated in the [Figure 1](#) and [Table 2](#).

Table 2. Trends of TB treatment outcome among TB patients registered at ZMH (Dec. 2017-Jan. 2021).

Treatment Outcome/Year	Year of treatment n (%)					Overall treatment Outcome
	2017	2018	2019	2020	2021	
Cured	7 (15.2%)	10 (17.2%)	11 (28.2%)	10 (31.3%)	14 (22.6%)	52 (21.9%)
Rx Completed	29 (63%)	44 (75.9%)	21 (53.8%)	15 (46.9%)	36 (58.1%)	145 (61.2%)
Treatment success	36 (78.2%)	54 (93.1%)	32 (82.0%)	25 (78.2%)	50 (80.7%)	197 (83.10%)
Died	3 (6.5%)	4 (6.9%)	4 (10.3%)	4 (12.5%)	5 (8.1%)	20 (8.4%)
Lost follow up	0 (0%)	0 (0%)	0 (0%)	2 (6.3%)	3 (4.8%)	5 (2.1%)
Move to MDR	1 (2.20%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (0.40%)
Not Evaluated	6 (13.0%)	0 (0.00%)	3 (7.70%)	1 (3.10%)	4 (6.50%)	14 (5.90%)
Unsuccessful TB Treatment outcome	7 (21.70%)	4 (6.9%)	7 (18.00%)	7 (21.90%)	12 (19.4%)	40 (16.80%)

Rx: Treatment, MDR: multiple drug resistant

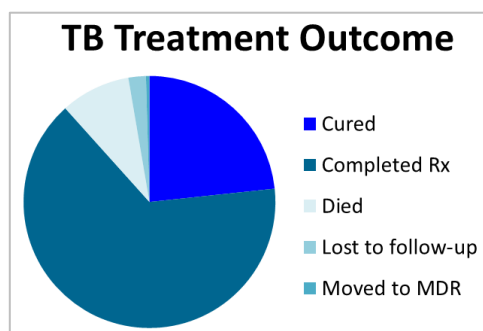


Figure 1. TB treatment outcome at ZMH (Dec. 2017- Jan. 2021).

3.3. TB Treatment and Its Associated Factors

Regression analysis for factors contributing to TB treatment showed that age category 35 to 44 (AOR=4.663; 95% CI, 1.215-17.901), EPTB (AOR= 3.451, 95% CI 1.172 -10.16) and TB patient registered in the year of 2019 (AOR= 4.367, 95% CI 1.2-15.87) are significantly associated with odds of having poor TB treatment outcomes from 2017 to 2021 at Zewditu Memorial Hospital. However, the HIV status of the patient and sex were not significant in determining the treatment outcome of TB patients during that period. [Table 3.](#)

Table 3. Factors associated with TB treatment outcome among TB patients registered at ZMH (Dec 2017-Jan 2021).

Variables		Total N	Crude OR (95%CI)	P value	Adjusted OR (95%CI)	P value
Sex	Female	116	1		1	
	Male	118	1.611 (0.807-3.216)	0.177	1.448 (0.684-3.063)	0.333
HIV Status	Negative	118	1	0.341	1	0.249
	Positive	111	1.034 (0.11-9.698)	0.977	1.964 (0.888-4.344)	0.96
	Unknown	5	1.680 (0.836-3.376)	0.145	1.529 (0.132-17.714)	0.734
Age (in years)	18-24	3	1	0.334	1	0.247
	25-34	55	0.667 (0.52-8.524)	0.755	0.908 (0.59-14.007)	0.945
	35-44	102	3.333 (.950-11.701)	0.060	4.663 (1.215-17.901)	0.025*
	45-54	46	1.686 (.620-4.589)	0.306	2.205 (0.72-6.75)	0.166
	55+	28	1.267 (.420-3.817)	0.674	2.258 (0.659-7.73)	0.195
Type of TB	PTB -	47	1	0.025	1	0.017*
	PTB +	66	0.581 (0.264-1.279)	0.177	0.635 (0.270-1.498)	0.300
	EPTB	121	2.711 (0.979-7.534)	0.056	3.451 (1.172 -10.16)	0.025*
Year of registration	2017	45	1	0.265	1	0.132
	2018	58	0.864 (0.337-2.217)	0.761	1.087 (0.367-3.219)	0.880
	2019	38	3.240 (0.981-10.705)	0.054	4.367 (1.2-15.87)	0.025*
	2020	31	1.097 (0.391-3.080)	0.860	0.992 (0.33-2.99)	0.989
	2021	62	0.857 (0.3-2.446)	0.773	0.727 (0.023-2.3)	0.588

* = statistically significant; p values were calculated using multivariate logistic regression analysis

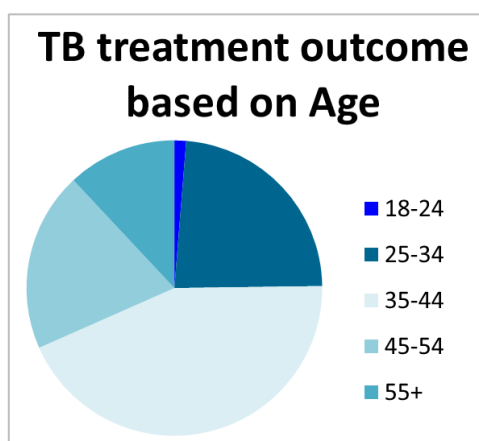


Figure 2. TB treatment outcome based on age at ZMH (Dec. 2017-Jan. 2021).

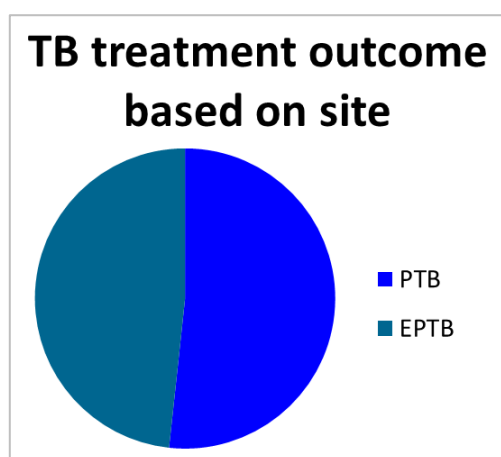


Figure 3. TB treatment outcome based on site at ZMH (Dec. 2017-Jan. 2021).

4. Discussion

This study analyzed data from TB patient case management records at Zewditu Memorial Hospital for the period from 2017 to 2021. During this five-year period, a total of 237 TB patients were diagnosed at the hospital's TB clinic. Of these patients, 47.68% had pulmonary TB and 51.05% had extrapulmonary TB. These findings are consistent with other studies conducted in Ethiopia [17].

The TB treatment success rate in this study was 83.1%, which falls short of the WHO target of $\geq 90\%$ and the national TB program target of 85% [3, 18]. This rate is comparable to findings from a meta-analysis by Torres et al [19]. However, it is higher than the success rates observed in Denmark (80.5%), Southeast Nigeria (56.5%), South-West Nigeria (78.09%), and Sudan (75.7%) [20-23]. Conversely, it is lower than the success rates reported in other Ethiopian studies, such as those from Harare (92.5%), Gambella (85.2%), Afar (86.2%), and Addis Ababa (94.6%) [17, 24-26]. The percentage of overall unsuccessful treatment outcomes reported by the present study was

similar to that of a study conducted in Brazil (17%), while less than another study performed in Malaysia (19.3%) [27, 28].

The prevalence of HIV among the patients in this study was 47.26%, which is higher than other reports from Malaysia (6.6%) Debre Tabor (12.7%), Enfranz (11.7%), Western Ethiopia (Harar) (17%) [24, 28-30]. This elevated HIV prevalence may have contributed to higher rates of death, which was one of the unsuccessful treatment outcomes, and may partially explain the lower treatment success rate compared to other studies. Additionally, the observed unsuccessful TB treatment outcomes may be influenced by the general socio-economic status of patients and other comorbidities.

In this study, TB treatment success was higher among females compared to males, a finding also observed in research conducted at Jinka. [31]. This contrasts with studies conducted in Europe, where no significant gender differences in treatment success were noted [19]. The discrepancy might be explained by higher risk-taking behaviors among males, as well as better health-seeking behavior and adherence to treatment among females. Other contributing factors could include stronger social support networks, improved access to healthcare, biological differences, and socioeconomic and cultural influences.

The age group of 35 to 44 years was associated with unsuccessful TB treatment outcomes in this study, aligning with findings from research conducted in Jinka [31]. Additionally, extrapulmonary TB (EPTB) was linked to unsuccessful treatment outcomes, a finding consistent with the majority of studies conducted in Ethiopia [17, 25, 32]. However, other research has not found a significant association between TB type and treatment success [30, 33].

5. Strength and Limitations

The collected data was recorded using a standard DOTS program registry, ensuring data integrity and preventing manipulation. As this study relied on secondary data, not all factors influencing TB treatment outcomes were considered. Missing data for certain variables may also affect result validity. Moreover, the study's focus on a specific geographic area may limit generalizability, as patients from this region may differ from those in other parts of the country.

6. Conclusion and Recommendation

The TB treatment success rate in this study fell short of the national target set by Ethiopia's TB program, indicating a need for further investigation and urgent management improvements. Unsuccessful treatment outcomes were notably associated with the 35-44 age group and extrapulmonary TB, suggesting a need for targeted TB control measures. Enhancing comprehensive and targeted TB programs are recommended for both the study site and the Federal Ministry of Health (FMOH).

Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
DC	Data Collector
DOTS	Directly Observed Treatment, Short-course
EPTB	Extra-pulmonary Tuberculosis
FMOH	Federal Ministry of Health
HIV	Human Immunodeficiency Virus
MDR	Multiple Drug Resistant
PI	Principal Investigator
PTB	Pulmonary Tuberculosis
SPHMMC	St. Paul Hospital Millennium Medical College
SPSS	Statistical Package for Social Sciences
TB	Tuberculosis
WHO	World Health Organization
XDR	Extremely Drug Resistant
ZMH	Zewditu Memorial Hospital

Acknowledgments

We would like to thank the SPHMMC Department of Internal Medicine for paving the way for this research experience which would have a great contribution in being a competent academician.

Author Contributions

Rediet Ajebu Nurfeta: Conceptualization, Formal analysis, Resources, Writing—review and editing, Project administration

Tsion Habtamu Ababiya: Methodology, Formal analysis, Investigation, Supervision

Nebiyou Yemanebrhane Woldeamanuele: Methodology, Software

Robel Habtamu Ababiya: Conceptualization, Software, Writing, Supervision, Project administration

Bezaye Lemma Deregasso: Resources, Data curation, Funding acquisition.

Lijalem Abera Tema: Validation, Investigation, Visualization

Selamawit Seifu Hailu: Validation, Data curation

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Funding

There was no funding source either from the government or

non-governmental organizations.

Conflicts of Interest

The authors declare no conflicts of interest.

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