Impact of HIV-AIDS on tuberculosis treatment outcome in Southern Ethiopia – A retrospective cohort study

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ABSTRACT

Background: Globally, the Tuberculosis treatment success rate was worse for HIV-positive TB patients compared with HIV- negative TB patients. This study aimed at determining the impact of HIV-AIDS and factors associated with TB treatment outcomes.

Methods: This study was a retrospective cohort study of five years of tuberculosis data from four public health facilities in Hosanna Town. A total of 604 study participants were included using a systematic random sampling technique. Descriptive analysis of ratios, rates, and proportions was done and binary logistic regression, bivariable and multivariable, analysis was also done.

Result: A total of 604 TB patients were enrolled in this study. 302 (50%) were HIV co-infected. The overall treatment success rate was 90.1% (544/604). Treatment success rates are 86.4% (261/302) for TB-HIV co-infected patients and 93.7% (283/302) for non-co-infected patients. TB-HIV co-infected patients had a higher risk of an unsuccessful treatment outcome (Adjusted Relative Risk [ARR]: 2.7; 95% Confidence Interval [CI]: 1.4 – 5.2). The risk of unsuccessful treatment outcome is also higher among rural residents (ARR: 3.3; CI: 1.4 – 5.0), patients on the re-treatment category (ARR: 2.7; CI: 1.4 – 5.1), and with chronic disease (ARR: 3.3; CI: 1.3 – 8.1).

Conclusion: TB treatment success rate is good as compared to the WHO minimum requirement. Successful treatment outcome is lower among patients with HIV infection, rural residents, patients on re-treatment, and patients with chronic disease. Therefore, due emphasis should be given to these high-risk groups.

1. Background

Tuberculosis (TB) is an infectious disease that commonly affects the lung and is caused by a bacterium called *Mycobacterium Tuberculosis.* The bacterium mostly affects people with impaired immunity [1]. TB becomes the second leading cause of morbidity and mortality among infectious diseases, following the emergence of the human immunodeficiency virus (HIV). HIV is the commonest risk factor for developing a life-threatening tuberculosis disease, on the other hand, HIV related immunodeficiency is worsened by TB infection [2,3].

Globally, an estimated ten million people were affected by tuberculosis in 2018. The burden of the disease varies among countries, from fewer than five to >500 new cases per 100 000 population per year, with a global average of 130 [4]. The burden is highly concentrated in low-income countries, especially in Sub-Saharan African Countries and

Asia, where the prevalence of TB-HIV co-infection was highest. Studies in Ethiopia also indicated that tuberculosis is one of the major contributors to HIV associated mortality [5,6].

Patient's treatment success is a major challenge in TB programs. TB treatment outcomes are influenced by several factors including TB-HIV co-infection [7]. TB-HIV co-infected patients have multiple individuals, disease-specific and treatment-related factors that can adversely affect their treatment outcomes. Co-infection with HIV is associated with an increased likelihood of mortality from TB and lower cure rates and lower treatment success rates [8].

TB-HIV co-infection leads to diagnostic and therapeutic challenges in the health care system. Clinical problems like long duration of treatment, frequency of drug administration, pill burden, management of drug interactions, and complications of therapy like drug toxicity and immune reconstitution inflammatory syndrome (IRIS) are some of the

challenges [9].

World Health Organization (WHO) developed a strategy to end the global tuberculosis epidemic by 2035. These strategies are with corresponding global targets of a 95% reduction in numbers of tuberculosis deaths and a 90% reduction in the number of tuberculosis cases compared with a baseline of 2015 [10].

In Ethiopia, TB has been recognized as a common public health problem since the 1950s, and the country has been implementing the World Health Organization (WHO) recommended directly observed treatment short-course (DOTS) strategy since 1992 [11], But TB is one of the major public health problems of the country. Ethiopia is one of the fourteen TB, TB-HIV, and multi-drug resistant tuberculosis (MDR TB) high burden countries worldwide [12,13].

Despite strong political commitment and implementation of different strategies such as extensive expansion of directly observed therapy short-course (DOTS) services in Ethiopia and the massive involvement of Health Extension Workers (HEWs) in TB prevention and control activities at the grass-root level, and integrated TB/HIV activities in place, the country could not achieve WHO's target level for TB treatment success rate. TB/HIV coinfection played a very significant role to prevent the achievement of this target [14–18].

This study is aimed at determining the impact of HIV co-infection on TB treatment outcomes and also other sociodemographic and clinical factors associated with unsuccessful TB treatment outcomes.

2. Methods

2.1. Study setting

This study was conducted in Hosanna Town, Hadiya Zone of SNNPR. The total population of Hosanna Town is 75,963, 50.8% (38,589) of them are males. A total of 2636 tuberculosis patients were registered from January 2015 to December 2019, of those 37.2% (981) were TB-HIV co-infected. Hosanna Town is located 230 Km far from Addis Ababa and 164 Km far from Hawasa. The town has three public health centers and one referral hospital. This study was completed within six months, from December 2019 to May 2020.

2.2. Study design

An institutional-based retrospective cohort study was conducted. HIV co-infection was considered as exposure. Individuals diagnosed with active tuberculosis based on Ethiopian National TB Guideline and who have been treated from January 2015 to December 2019 were included in the study.

2.3. Sample size and sampling technique

The sample size calculation was calculated by double population proportion formula by using Epi Info 7 statistical software. The ratio of the exposed group to the non-exposed group was one to one. According to a study conducted in Addis Ababa, Ethiopia, the treatment success rates of TB among HIV AIDS and none HIV AIDS TB patients were 81.2% and 71.2% respectively [16]. A two-sided confidence interval of 95% and 80% power were used for calculating the sample size. Hence, a total of 604 samples were obtained, 302 HIV AIDS infected and 302 none HIV AIDS infected TB cases.

Regarding sampling techniques, the number of samples selected from each health facility was allocated proportionally. The proportional allocation was done separately for TB HIV co-infected and TB patients. A systematic random sampling method was implemented to enroll eligible study participants. Participants with incomplete information were replaced by the next participant.

2.4. Operational definitions

Cured: An initially smear-positive patient whose sputum smear is negative at or one month before the completion of TB treatment and on at least one previous occasion (usually at the end of the 2nd or 5th month).

Treatment completed: A patient who has completed anti-TB treatment without evidence of failure but for whom sputum smear or culture results are not available in the last month of treatment and on at least one previous occasion.

Treatment failure: A patient whose sputum smear or culture is positive at 5 months or later during treatment. Also included in this definition are patients found to harbor a multidrug-resistant (MDR) strain at any point of time during the treatment, whether they are smear-negative or -positive.

Defaulter: A patient who has been on treatment for at least 4 weeks and whose treatment was interrupted for 8 or more consecutive weeks.

Died: A patient who died for any reason during the course of treatment.

Transfer out: A patient who started treatment and has been transferred to another reporting unit and for whom the treatment outcome is not known at the time of evaluation of treatment results.

Treatment success/successful outcome: The sum of patients who are declared 'cured' and those who have 'completed' treatment.

Unsuccessful treatment outcome: The sum of patients who are declared 'died', 'defaulter', and 'failure' of the treatment [25].

3. Data collection

Data was collected by using an android application called Open Data Kit (ODK). The data collection checklist is uploaded into ODK Collect. Data sent from each data collection device was stored in a google sheet. Data collectors were nurses and health officers from each data collection site (health facilities), not including those working in the TB clinic of the same health facilities. Four nurses and two health officers were recruited based on their experience for the data collection. One day Training on data collection was provided for data collectors. The principal investigator was checking the data every day for completeness, consistency, and quality. The data source was the TB registry in TB clinics of Nigist Eleni Mohammed Memorial Referral Hospital, Hosanna Health Center, Bobicho Health Center, and Lichambo Health Center.

4. Data analysis and presentation

The data was copied from the google sheet and pasted on Microsoft excel. After it was cleaned, exported to SPSS windows version 23 for analysis. Descriptive analysis was done and presented in ratios, rates, and proportions. The binary logistic regression model was executed to determine the relationship between TB treatment outcomes with HIV status and other predictors. Any variable whose bivariable test had a p-value < 0.2 were included in the multivariable analysis. P-values<5% were considered significant. Model fitness was checked by Hosmer and Lemeshow test (0.08).

The dependent variable for this study is TB treatment outcome (successful treatment outcome and unsuccessful treatment outcome). The main exposure variable is HIV/AIDS status. Other independent variables include age, sex, occupation, marital status, educational status, residence, TB classification, TB treatment category, and having a chronic disease.

4.1. Ethical considerations

This proposal was submitted to St. Paul's Hospital Millennium Medical College (SPHMMC) institutional review board and ethical approval was issued (Ref. No: pm.23/172). A support letter from SPHMMC was received and submitted to Hosanna Town Health Office

and Nigist Eleni Mohammed Memorial Referral Hospital.

Written consent was obtained from the hospital and health center managers after the objective of the study was clearly explained.

The name or any identifying variables of patients were not included in the report and the confidentiality of the information in the record was kept.

5. Result

5.1. Sociodemographic characteristics of participants

A total of 604 TB patients were enrolled in this study. Fifty percent (302) were HIV AIDS co-infected. Fifty-eight percent (352) of the participants were male and 81.8% (494) were urban residents (Table 1).

5.2. TB Treatment outcomes

The overall treatment success rate was 90.1% (95% CI 87.4–92.2) (544/604), 86.4% (95% CI 82.1–89.8) (261/302) for TB-HIV co-infected patients and 93.7% (95% CI 90.4–95.9) (283/302) for TB only patients.

From total participants, 67.9% (95% CI 64.1–71.5) (410/604) have

completed their treatment and 22.2% (95% CI 19.1–25.7) (134/604) have been cured at the end of the treatment period. Treatment competition rate is 64.2% (95% CI 58.9–69.4) and 71.5% (95% CI 66.2–76.3) for TB-HIV co-infected and non-co-infected patients respectively.

Cure rate is 22.2% (95% CI 19.1–25.7) (67/302) for both TB-HIV co-infected and non-co-infected patients while death rates are 5.6% (95% CI 3.5–8.8) (17/302) and 2% (95% CI 0.9–4.3) (6/302) for TB-HIV co-infected and non-co-infected patients respectively. Treatment failure is 5.6% (95% CI 3.5–8.8) (17/302) among TB-HIV co-infected patients and 1% (95% CI 0.3–2.9) (3/302) among non-co-infected patients (Table 2).

5.3. Factors associated with TB treatment outcome

In bivariate analysis, ten factors were analyzed for their possible impact on TB treatment outcomes. In this analysis, six variables have a P-value of<0.2 and entered into multivariable analysis to avoid a confounding effect.

In the multivariable analysis patients with TB-HIV coinfection are 2.7 times at higher risk (Adjusted Relative Risk [ARR]: 2.7; 95% Confidence Interval [CI]: 1.4 – 5.2) of having an unsuccessful treatment outcome compared to non-co-infected patients. The risk of having unsuccessful treatment outcome is also higher among rural residents than urban residents (ARR: 3.3; CI: 1.4 – 5.0), patients on re-treatment than new treatment category (ARR: 2.7; CI: 1.4 – 5.1), and patients with other chronic diseases than those without chronic diseases (ARR: 3.3; CI: 1.3 – 8.1) (Table 3).

6. Discussion

In this study, the overall TB treatment success is 90.1%, 22.2% cured and 67.9% completed treatment. The treatment success rate is 93.7% for non-co-infected patients and 86.4% for those co-infected with TB-HIV. However, the cure rate is equal (22.2%) for both TB-HIV co-infected and non-co-infected TB patients, which implies that TB-HIV co-infection does not determine cure rate. TB-HIV co-infected patients have a higher rate of unsuccessful treatment outcomes. Rural residents, patients in the re-treatment category, and patients with other chronic diseases have a higher rate of unsuccessful treatment outcomes.

Overall treatment success rate and the cure rate is higher than a study in Sothern Ethiopia but the treatment completion rate is lower than this study [20]. Both cure and treatment completion rates in our study are higher than the findings of a study in Addis Ababa [21]. However, the overall treatment success rate in our study is lower compared to a study in Northern Ethiopia, and also cure rate is lower than the finding of a study in Gambella, Ethiopia as well as a systematic review in South Africa [15,22,23]. But the overall treatment success rate is higher than the WHO minimum requirement of 85% [13].

The treatment success rate among TB-HIV co-infected patients in this study is higher than the findings of a study in Gondar City and Tigray Region of Ethiopia but it is lower than a study in Addis Ababa, Ethiopia [8,9,24]. In our study the treatment success rate is higher among Non-co-infected patients than TB-HIV co-infected patients, this finding is supported by studies done in Ethiopia and Northern Nigeria. But, analysis of TB program data from countries showed that treatment success is higher among TB-HIV co-infected patients despite higher death rates than non-co-infected patients [11,14,25,26]. This can be due to good treatment adherence among HIV patients and a high default rate among HIV-negative patients as explained in the same study.

The death rate among TB-HIV co-infected patients and non-co-infected patients are 5.7% and 2% respectively. Similarly, a study in Malawi showed that the death rate is higher among TB-HIV co-infected patients, 6% versus 3% [7]. The death rate among co-infected patients is almost similar to a study in southwest Ethiopia (5.5%) [27]. However, the overall death rate in this study (3.8%) is lower than the death rate in Assela Town, Oromia Region of Ethiopia (6%), and also a study in India (15.7%) [3,28].

Table 1
Sociodemographic characteristics of study participants, Hossana Town, Southern Ethiopia, 2015–2019.

S/No.	Variable	HIV AIDS Negative (%)	HIV AIDS Positive (%)	Total (%)
1	Sex			
	Male	181 (59.9)	171 (56.6)	352 (58.3)
	Female	121 (40.1)	131 (43.4)	252 (41.7)
2	Age			
	<15	18 (5.9)	30 (9.9)	48 (7.9)
	15–24	86 (28.5)	35 (11.6)	121 (20.0)
	25–34	82 (27.2)	105 (34.8)	187 (31.0)
	35–44	42 (13.9)	98 (32.5)	140 (23.2)
	45–54	30 (9.9)	26 (8.6)	56 (9.3)
	55–64	22 (7.3)	4 (1.3)	26 (4.3)
	>64	22 (7.3)	4 (1.3)	26 (4.3)
3	Education			
	No formal education	63 (20.9)	69 (22.9)	132 (21.8)
	Primary school	109 (36.1)	91 (30.1)	200 (33.1)
	Secondary school	78 (25.8)	83 (27.5)	161 (26.7)
	Diploma and above	52 (17.2)	59 (19.5)	111 (18.4)
4	Marital status			
	Single	148 (49.0)	102 (33.8)	250 (41.4)
	Married	144 (47.7)	178 (58.9)	322 (53.3)
	Divorced	6 (2.0)	0 (0)	6 (1.0)
	Widowed	4 (1.3)	22 (7.3)	26 (4.3)
5	Residence			
	Rural	62 (20.5)	48 (15.9)	110 (18.2)
	Urban	240 (79.5)	254 (84.1)	494 (81.8)
6	Occupation			
	Farmer	51 (16.9)	47 (15.6)	98 (16.2)
	Government employee	36 (11.9)	27 (8.9)	63 (10.4)
	Housewife	42 (13.9)	52 (17.2)	94 (15.6)
	Merchant	36 (11.9)	76 (15.2)	112 (18.6)
	Unemployed	99 (32.8)	42 (13.9)	141 (23.3)
	Other	38 (12.6)	58 (19.2)	96 (15.9)

Table 2

Tuberculosis treatment outcome in Hosanna Town, Southern Ethiopia, 2015–2019.

Variables	Treatment outcome				
	Cured (%)	Treatment completed (%)	Treatment failure (%)	Defaulter (%)	Died (%)
Sex					
Male	96 (27.3)	220 (62.5)	12 (3.4)	8 (2.3)	16 (4.5)
Female	38 (15.1)	190 (75.4)	8 (3.2)	9 (3.5)	7 (2.8)
Age					
<15	10 (20.8)	33 (68.8)	2 (4.2)	3 (6.2)	0 (0)
15–24	34 (28.1)	82 (67.7)	2 (1.7)	1 (0.8)	2 (1.7)
25–34	50 (26.7)	120 (64.2)	5 (2.7)	6 (3.2)	6 (3.2)
35–44	23 (16.4)	105 (75)	6 (4.3)	2 (1.4)	4 (2.9)
45–54	11 (19.6)	34 (60.7)	2 (3.6)	2 (3.6)	7 (12.5)
55–64	2 (7.7)	19 (73.1)	2 (7.7)	2 (7.7)	1 (3.8)
>64	4 (15.4)	17 (65.4)	1 (3.8)	1 (3.8)	3 (11.6)
Residence					
Urban	114 (20.2)	339 (68.6)	14 (2.8)	15 (3.0)	12 (2.4)
Rural	20 (18.2)	71 (64.5)	6 (5.5)	2 (1.8)	11 (10.0)
Occupation					
Farmer	13 (13.3)	72 (73.5)	6 (6.1)	2 (2.0)	5 (5.1)
Gov't employee	23 (36.5)	35 (55.6)	4 (6.3)	1 (1.6)	0 (0)
Housewife	8 (8.4)	75 (7.9)	2 (2.1)	3 (3.2)	6 (6.4)
Merchant	27 (24.1)	73 (65.2)	1 (0.9)	5 (4.4)	6 (5.4)
Other	22 (22.9)	67 (69.8)	3 (3.1)	4 (4.2)	0 (0)
Unemployed	41 (29.1)	88 (62.4)	4 (2.8)	2 (1.4)	6 (4.3)
Marital status					
Single	66 (26.4)	162 (64.8)	6 (2.4)	8 (3.2)	8 (3.2)
Married	64 (19.9)	223 (69.3)	12 (3.7)	9 (2.8)	14 (4.3)
Divorced	1 (16.7)	5 (83.3)	0 (0)	0 (0)	0 (0)
Widowed	3 (11.5)	20 (76.9)	2 (7.7)	0 (0)	1 (3.9)
Educational status					
No formal education	19 (14.4)	96 (72.7)	7 (5.3)	4 (3.0)	6 (4.6)
Primary school	31 (15.5)	151 (75.5)	6 (3.0)	3 (1.5)	9 (4.5)
Secondary school	44 (27.3)	99 (61.5)	3 (1.9)	7 (4.4)	8 (4.9)
Diploma and above	40 (36.0)	64 (57.7)	4 (3.6)	3 (2.7)	0 (0)
HIV status					
Positive	67 (22.2)	194 (64.2)	17 (5.6)	7 (23.3)	17 (5.7)
Negative	67 (22.2)	216 (71.5)	3 (1.0)	10 (3.3)	6 (2.0)
Type of TB					
Pulmonary TB	132 (25.8)	328 (64.2)	18 (3.5)	14 (2.7)	19 (3.7)
Extrapulmonary TB	2 (2.2)	82 (88.1)	2 (2.2)	3 (3.2)	4 (4.3)
Treatment category					
New	118 (23.5)	345 (68.7)	19 (3.8)	15 (3.0)	5 (1.0)
Re-treatment		65 (63.7)	1 (1.0)		2 (1.9)

Table 2 (*continued*)

	16 (15.7)				18 (17.7)
Have chronic disease					
Yes	2 (6.2)	20 (62.5)	3 (9.4)	3 (9.4)	4 (12.5)
No	132 (23.1)	390 (68.2)	17 (2.3)	15 (2.6)	19 (3.3)
Total	134 (22.2)	410 (67.9)	20 (3.3)	17 (2.8)	23 (3.8)

Table 3

Multivariable binary logistics regression analysis of factors determining TB treatment outcome in Hosanna Town, Southern Ethiopia, 2015–2019.

Variable	Treatment Outcomes		CRR (95%CI)	ARR (95% CI)	P-Value
	Unsuccessful (%)	Successful (%)			
HIV status					
Negative	19 (6.3)	283 (93.7)	1	1	
Positive	41 (13.6)	261 (86.4)	2.3 (1.3–4.1)	2.7 (1.4–5.2)	0.004*
Age					
<15	5 (10.4)	43 (89.6)	1	1	
15–24	5 (4.1)	116 (95.9)	0.4 (0.1–1.3)	0.2 (0.1–1.1)	0.06
25–34	17 (9.1)	170 (90.9)	0.9 (0.3–2.5)	0.5 (0.1–1.5)	0.2
35–44	12 (8.6)	128 (91.4)	0.8 (0.3–2.4)	0.4 (0.1–1.5)	0.17
45–54	11 (19.6)	45 (80.4)	2.1 (0.7–6.5)	1.5 (0.4–5.4)	0.54
55–64	5 (19.2)	21 (80.8)	2.0 (0.5–7.8)	1.8 (0.4–8.3)	0.47
>64	5 (19.2)	21 (80.8)	2.0 (0.5–7.8)	2.1 (0.4–10.4)	0.36
Residence					
Urban	41 (8.3)	453 (91.7)	1	1	
Rural	19 (17.3)	91 (82.7)	2.3 (1.3–4.2)	3.3 (1.4–5.0)	0.005*
Educational status					
Diploma and above	7 (6.3)	104 (93.7)	1	1	
Secondary school	18 (11.2)	143 (88.8)	2.1 (0.9–5.5)	0.7 (0.2–2.2)	0.55
Primary school	18 (9.0)	182 (91.0)	1.5 (0.6–3.6)	0.9 (0.3–2.7)	0.94
No formal education	17 (12.9)	115 (87.1)	1.9 (0.8–4.6)	1.6 (0.6–4.0)	0.34
Treatment category					
New	39 (7.8)	463 (92.2)	1	1	
Re-treatment	21 (20.6)	81 (79.4)	3.1 (1.7–5.5)	2.7 (1.4–5.1)	0.003*
Have chronic disease					
No	51 (8.9)	522 (91.1)	1	1	
Yes	9 (29.0)	22 (71.0)	4.2 (1.8–9.6)	3.3 (1.3–8.1)	0.01*

P-value <0.05.

In our study, TB-HIV co-infected patients have a higher risk of having an unsuccessful treatment outcome compared to non-co-infected patients. This finding is consistent with a study finding in Debre Berhan, Central Ethiopia which indicated that treatment success rate, mainly treatment cure, is lower for TB-HIV co-infected patients, and also death rate is higher among co-infected patients [26]. Studies conducted in Southern Ethiopia and Assela Teaching Hospital also showed that the risk of death is higher among TB-HIV co-infected patients [18,28]. Other studies also indicated that TB-HIV co-infected patients have a higher risk of an unsuccessful TB treatment outcome compared to non-co-infected patients [1,7,25,29–32]. However, different studies showed the HIV status of TB patients has no significant association with their treatment outcome [11,22,33]. This can be because, though TB-HIV co-infected

patients have a lower cure rate, non-co-infected patients have a higher defaulter rate [15].

A study in Northern Nigeria indicated that rural residents have a higher risk of an unsuccessful treatment outcome than urban residents with death rates of 46% [25]. Similarly, our study also showed that rural residents have a high risk of an unsuccessful treatment outcome than urban residents. Another study in South-Western Ethiopia and a hospital-based study in Gondar University also showed that urban residents are in favor of successful TB treatment outcome [9,29].

In this study also, the risk of an unsuccessful treatment outcome is higher among patients with chronic diseases than their counterparts. A systematic review and meta-analysis finding also indicates that unpleasant TB treatment outcomes are higher among Diabetes Mellitus (DM) patients [33]. Contrary to this, a study in Malaysia revealed that being Diabetes Mellitus (DM) patient has no significant impact on TB treatment outcome [2]. Another study in North-Western Ethiopia also found that chronic diseases like DM, congestive heart failure, hypertension, and hepatitis have no association with TB treatment outcomes [34].

Concerning the treatment category, this study found that patients in the re-treatment category have a higher risk of having an unsuccessful treatment outcome compared to patients in the new treatment category. Likewise, a study in Eastern Ethiopia and another study among patients treated in university hospitals in Ethiopia indicated that re-treated patients have lower treatment success than newly enrolled patients [32,35]. The other studies conducted in Zambia Lusaka, Mogadishu Somalia, and India also support this finding [1,29,36].

Studies conducted in South West Ethiopia and Eastern Ethiopia indicated that patients with age below 18 years old have a positive impact on successful treatment outcome and those older than 64 years negatively affects TB treatment success [5,12]. Another study in Malawi indicated that being female is a risk factor for unsuccessful treatment outcome (7). But, contrary to the above findings, a study in Gambella, Ethiopia showed that being female is in favor of having a successful treatment outcome [32]. However, in our study both gender and age have no significant association with TB treatment outcome. This finding is similar to a study in Addis Ababa which showed that there is no significant association between age and sex with TB treatment outcome [21]. These differences may be because of socio-cultural differences among the study areas.

According to our study, being pulmonary or extrapulmonary TB patient does not affect the treatment outcome, though a study in Cameroon showed unsuccessful treatment outcome is higher among patients with extrapulmonary TB [37]. But a study done in Eastern Ethiopia showed that treatment success is higher among patients with extrapulmonary TB than pulmonary TB patients [34]. Whereas studies conducted in Assela, Gondar, Southern, and South West Ethiopia showed that there is no significant association between TB treatment outcome and type of TB [9,18,28,38].

However, this study might have the following limitations. First, the variables included in this study are limited to those found in the TB registry. Second, some variables in the TB registry were excluded because of incompleteness. Third, the present study includes TB cases treated at health facilities. TB cases not detected and treated at health facilities could be missed.

7. Conclusion

The overall TB treatment success rate in Hosanna Town satisfies the WHO minimum requirement. It is also good compared to previous studies in Ethiopia and other countries.

The tuberculosis treatment success rate is higher among TB patients without HIV than TB-HIV co-infected patients, which attributes to the higher death and defaulter rate among co-infected patients. In addition, unsuccessful TB treatment outcome is higher among rural residents than urban residents, patients on re-treatment category than new, and

patients with other chronic diseases compared to those without chronic diseases. Therefore, due emphasis should be given to these high-risk groups, and specific strategies to address these groups should be designed.

8. Author's contributions

MA and AY design the study and write the final manuscript. FG, MB, TA, KM, and MS were involved in data collection and cleaning. MA, AY, and FG were involved in data analysis. All authors reviewed and approved the final manuscript for submission.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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