JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Outcome of Tuberculosis patients under directly observed short course treatment in western Ethiopia

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Abstract

Introduction: Treatment outcome is an important indicator of tuberculosis control programs, as suggested by the World Health Organization. However, this has not been well documented in the study area. This work contributes to a better understanding this issue.

Methodology: A five-year (2009–2013) retrospective cohort study was conducted between April and May 2014, in six randomly selected health institutions providing tuberculosis treatment in western Ethiopia. Bivariate and multivariate logistic regression analyses were used to assess the association between treatment outcomes and predictor variables.

Results: A total of 1,175 tuberculosis patients with a mean (standard deviation) age of 29.91 (13.99) were involved in the study. The majority of the study participants had smear-negative pulmonary tuberculosis (39.7%) and extrapulmonary tuberculosis (39.7%). Of all the study participants, 14.5% were cured, 56.3% completed treatment, 0.2% had treatment failure, 8.1% died during follow-up, 7.1% were reported as defaulters, and 13.8% were transferred out to another health institution. The overall treatment success rate was 70.8% and show progressive increases over the course of the study. The associated predictors were enrollment years, HIV co-infection, and sputum smear follow-up in the second, fifth, and seven months.

Conclusions: The treatment success rate was unsatisfactory in spite of improvement seen over the study period. Thus, continued follow-up of patients, with frequent supportive supervision during the course of treatment, and provision of early detection and follow-up for HIV infection need to be strengthened to achieve an effective treatment outcome.

Key words: treatment outcome; tuberculosis; DOTS; western Ethiopia.

J Infect Dev Ctries 2015; 9(7):752-759. doi:10.3855/jidc.5963

(Received 26 September 2014 – Accepted 12 January 2015)

Introduction

Tuberculosis (TB) is one of the major public health problems worldwide. In 2012 alone, there were 8.6 million new cases and 1.3 million deaths globally [1]. TB continues to be the leading cause of death globally despite the availability of reliable diagnostic approaches and effective drugs for over a decade [2]. The World Health Organization (WHO) declared TB a global emergency and introduced the directly observed treatment of short course (DOTS) strategy for global TB control. In the face of this intensified effort to diagnose and treat TB, the treatment success rates in sub-Saharan Africa continue to be too low [3]. For effective TB control, it is very important to detect the disease as early as possible and to ensure that those diagnosed complete their treatment and get cured [4].

Ethiopia is one of the highly TB-endemic countries in the world, where the disease is the leading cause of mortality and morbidity. Ethiopia ranks ninth among 22 high-TB burden countries and is one of the top three in Africa. In 2012, the estimated annual incidence and prevalence of all forms of TB were 230 and 224 per 100,000 of the population, respectively [1]. A recent population-based survey showed that the prevalence of new sputum smear-positive TB was 174 per 100,000 of the population [5].

In Ethiopia, a standardized TB prevention and control program incorporating DOTS was started as a pilot in 1992, at Arsi zone in Oromia region [6]. The DOTS strategy has been subsequently scaled up and implemented at a national level. Currently, the DOTS geographic coverage has reached 90%, whereas the DOTS health facility coverage is 75% [6].

Understanding the specific reasons for unsuccessful outcomes under the DOTS program is important in order to improve treatment strategy [7].

In this regard, results from studies in Ethiopia ranged from 26% to 94% [8-26]. The previous report of TB defaulter, failure, and death rates in Ethiopia ranged from 0.6% to 18.3% [8-18], 0.2% to 18.6% [8-11,15], and 2.6% to 10.1% [8-10, 12,15,16,19,20], respectively. Some of the identified independent risk factors for poor treatment outcome were receiving retreatment, age over 55 years, male gender, distance from home to treatment center, and the added burden of using public transportation to get to a treatment center. However, treatment outcomes of tuberculosis have not yet been exhaustively studied in Ethiopia. Therefore, this study was to assess the treatment outcome and its associated risk factors among TB cases attending DOTS clinics in the last five years (2009–2013) in western Ethiopia.

Methodology

A five-year (2009–2013) retrospective cohort study was conducted to investigate treatment outcomes among TB patients attending TB clinics under the DOTS program from April to May, 2014. Study participants were all TB patients attending treatment in the last five year (2009 to 2013) in six randomly selected health institutions in western Ethiopia. The selected health institutions were Nekemte Referral Hospital, Nekemte Health Center, Awash Higher Clinic, National Higher Clinic, Red Cross Clinic, and Abdi Clinic. These health institutions were provided DOTS service for the people living in the area. The patients were diagnosed, registered, treated, and referred to other DOTS clinics following the National Tuberculosis and Leprosy Control Program (NTLCP) guideline adopted from the WHO [6].

The data were collected from the TB clinic registration book for the selected health institutions in the study area. The unit registers reviewed contained basic information such as the patient's age, sex, address, category, TB type, drug regimen, date treatment started, treatment follow-up, follow-up sputum result, and treatment outcome.

Based on the standard definitions of the NLCP [6], adapted from the WHO, three types of TB were included in this study and defined for the clinical cases. The first is smear-positive pulmonary TB (SPPTB), which was identified if a patient had at least two initial sputum smear examinations positive for acid-fast bacilli (AFB) by direct microscopy, one initial smear-positive examination for AFB by direct microscopy and a positive culture, or one initial smear-positive examination for AFB by direct microscope and radiographic abnormalities consistent with active TB as determined by a clinician. The second type was smear-negative pulmonary TB (SNPTB), which was characterized by a patient having (a) symptoms suggestive of TB with at least three initial smear-negative examinations for AFB by direct microscopy and no response to a course of broad-spectrum antibiotics; (b) three smear-negative examinations by direct microscopy, and radiological abnormalities consistent with pulmonary tuberculosis, and decision by a clinician to treat with a full course of anti-TB therapy; or (c) a diagnosis based on a positive culture for *Mycobacterium tuberculosis* after three initial smear-negative examinations by direct microscopy. The third type was extrapulmonary TB (EPTB), which included TB in organs other than the lungs. EPTB was proven by one positive culture from specimens of an extrapulmonary site or histopathological evidence from a biopsy, or TB based on strong clinical evidence consistent with active EPTB and the decision by a physician to treat with a full course of anti-TB therapy.

Treatment outcomes were categorized and defined according to NTLCP [6] guidelines as follows: (a) cured, a patient who was initially sputum smear-positive and who finished treatment with a negative bacteriology result at the end of treatment or was sputum smear negative on two occasions at the end of treatment; (b) treatment completed, a patient who completed treatment but did not meet the criteria for cure or failure; this definition applies to sputum smear-positive and sputum smear-negative patients with pulmonary TB and to patients with EPTB; (c) died, a patient who died from any cause during treatment time; (d) failed, a patient who was initially sputum smear-positive and remained bacteriology or sputum smear-positive at month five or later during treatment; (e) defaulted, a patient whose treatment was interrupted for two consecutive months or more; (f) transferred out, a patient who was referred to another health facility for treatment from whom information on treatment outcome could not be obtained; and (g) successfully treated, a patient who was cured and/or completed treatment, or sum of cases that were cured and completed treatment.

Statistical analyses were performed using SPSS version 20 statistical software, where the results are presented using a descriptive statistics tool in the tables and figures. The associations and strength between the dependent and independent variables were assessed using binary and multiple logistic regression models at 95% confidence interval.

The study design and procedures were approved by the institutional research ethical review board of Wollega University. Official permission was also obtained from respective institutions administration office. Anonymity was guaranteed for all patients whose records were reviewed.

Results

A total of 1,175 TB patients were registered in the last five years in the study area, of which 638 (54.3%) were males. Most of the patients (1,004; 85.4%) were urban residents and within the 15-44 age range (898; 76.4%). The patients had a mean, standard deviation, and median age of 29.91, 13.99, and 26.00, respectively. In terms of patients' categories, 1,070 (91.1%) patients were registered as new cases and 2% were transfer-in patients. In total, 239 (20.3%) patients were registered as pulmonary positive, 466 (39.7%) as pulmonary negative, and 466 (39.7%) as EPTB patients. Two hundred and one (17.1%) of the TB cases were co-infected with HIV. The frequency of all forms of TB increased from 82 to 276 in the last five years, with a peak in 2011 (Table 1).

Treatment outcomes

Of the 1,175 TB patients registered in the last five years, 170 (14.5%) were cured, 662 (56.3%) completed treatment, 95 (8.10%) died during follow-up, 2 (0.20%) had treatment failure, 84 (7.1%) defaulted, and 162 (13.8%) transferred out to other health institutions. The trends of cured cases showed a steady increase from 2 (0.20%) to 43 (3.70%) in the last five years, and the death rate showed a remarkable increase, from 0.30% to 1.70%. However, the default rates declined from 37% to 8% in 2009–2013, with the exception of 2011, where the rate was 26.2% (Table 2).

On the other hand, the transfer-out rate of TB patients progressively increased, from 14 (1.20%), 28 (2.40%), and 62 (5.30%) in 2009, 2010, and 2011, respectively, and then declined from 45 (3.80%) in 2012 to 13 (1.10%) in 2013 (Table 2).

Table 1. Characteristics of TB patients in in the selected health institutions providing DOTS services in western Ethiopia from 2009 to 2013

Character		Type of TB n (%)			Total n (%)
		SPPTB	SNPTB	EPTB	
Address	Urban	216 (18.4)	401 (34.1)	387 (32.9)	1,003 (85.4)
	Rural	27 (2.3)	65 (5.5)	79 (6.7)	171 (14.6)
Sex	Male	143 (12.2)	263 (22.4)	232 (19.7)	637 (54.3)
	Female	100 (8.5)	203 (17.3)	234 (19.9)	537 (45.7)
Age	0-14	3 (3.6)	24 (2.0)	57 (4.9)	84 (7.2)
	15-24	107 (26.0)	150 (12.8)	155 (13.2)	411 (35.0)
	25-34	74 (24.7)	107 (9.1)	119 (10.1)	300 (25.6)
	35-44	35 (18.9)	78 (6.6)	72 (6.1)	185 (15.8)
	45-54	12 (11.8)	55 (4.7)	35 (3.0)	102 (8.7)
	55-64	9 (15.5)	30 (2.6)	19 (1.6)	58 (4.9)
	>=65	3 (8.8)	22 (1.9)	9 (0.8)	34 (2.9)
TB patient category	New	213 (18.1)	435 (37.1)	436 (37.2)	1,071 (91.1)
	Relapse	9 (0.8)	2 (0.2)	0 (0.0)	11 (0.9)
	Treatment failure	1 (0.1)	0 (0.0)	0 (0.0)	1 (0.1)
	Default	0 (0.0)	4 (0.3)	1 (0.1)	5 (0.4)
	Transfer in	9 (0.8)	8 (0.7)	7 (0.6)	24 (2.0)
	Unknown	11 (0.9)	17 (1.4)	22 (1.9)	63 (5.4)
HIV test result	Reactive	44 (3.7)	95 (8.1)	62 (5.3)	201 (17.1)
	Non-reactive	188 (16.0)	348 (29.6)	388 (33.0)	924 (78.6)
	Unknown	11 (0.9)	23 (2.0)	50 (1.4)	84 (4.3)
Treatment year	2009	12 (14.6)	38 (46.3)	32 (39.0)	82 (7.0)
	2010	50 (27.2)	62 (33.7)	72 (39.1)	184 (15.7)
	2011	61 (18.6)	124 (37.8)	143 (43.6)	328 (27.9)
	2012	57 (18.7)	131 (43.0)	117 (38.4)	305 (26.0)
	2013	63 (22.9)	111 (40.2	102 (37.0)	276 (23.5)
Total		**243 (20.7)**	**466 (39.7)**	**466 (39.7)**	**1,175 (100)**

SPPTB: smear-positive pulmonary TB; SNPTB: smear-negative pulmonary TB; EPTB: extrapulmonary TB

Table 2. Treatment outcomes of TB patients in western Ethiopia between 2009 and 2013

Characteristics		Treatment outcome n (%)						Total N (%)
		Cured	Treatment completed	Died	Treatment failure	Default	Transferred out	
Address	Urban	155 (13.2)	558 (47.5)	82 (7.0)	2 (0.2)	68 (5.8)	139 (11.8)	1,003 (85.4)
	Rural	15 (1.3)	104 (8.9)	13 (1.1)	0 (0)	16 (1.4)	23 (2.0)	171 (14.6)
Sex	Male	101 (8.6)	339 (28.9)	52 (4.4)	1 (0.1)	51 (4.3)	94 (8.0)	637 (54.3)
	Female	69 (5.9)	323 (27.5)	43 (3.7)	1 (0.1)	33 (2.8)	68 (5.8)	537 (45.7)
Age	0-14	2 (0.2)	65 (5.5)	3 (0.3)	0 (0)	9 (0.8)	5 (0.4)	84 (7.2)
	15-24	75 (6.4)	211 (18.0)	23 (2.0)	1 (0.1)	24 (2.0)	78 (6.6)	411 (35.0)
	25-34	49 (4.2)	168 (14.3)	18 (1.5)	1 (0.1)	24 (2.0)	40 (3.4)	300 (25.6)
	35-44	24 (2.0)	106 (9.0)	27 (2.3)	0 (0)	14 (1.2)	14 (1.2)	185 (15.8)
	45-54	9 (0.8)	62 (5.3)	15 (1.3)	0 (0)	5 (0.4)	11 (0.9)	102 (8.7)
	55-64	8 (0.7)	31 (2.6)	7 (0.6)	0 (0)	3 (0.3)	9 (0.8)	58 (4.9)
	>=65	3 (0.3)	19 (1.6)	2 (0.2)	0 (0)	5 (0.4)	5 (0.4)	34 (2.9)
TB Patient category	New	151 (12.9)	612 (52.1)	88 (7.5)	2 (0.2)	74 (6.3)	144 (12.3)	1071 (91.1)
	Relapse	7 (0.6)	0 (0)	1 (0.1)	0 (0)	1 (0.1)	2 (0.2)	11 (0.9)
	Treatment failure	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.1)	1 (0.1)
	Default	0 (0)	3 (0.3)	0 (0)	0 (0)	0 (0)	2 (0.2)	5 (0.4)
	Transfer in	5 (0.4)	17 (1.4)	0 (0)	0 (0)	0 (0)	2 (0.2)	24 (2.0)
	Other	7 (0.6)	20 (1.7)	4 (0.3)	0 (0)	8 (0.7)	11 (0.9)	63 (5.4)
HIV test result	Reactive	32 (2.7)	90 (7.7)	35 (3.0)	19 (0.1)	20 (1.7)	23 (2.0)	201 (17.1)
	Non-reactive	133 (11.3)	551 (46.9)	54 (4.6)	1 (0.1)	57 (4.9)	128 (10.9)	923 (78.6)
	Unknown	5 (0.4)	21 (1.8)	6 (0.5)	0 (0)	7 (0.6)	11 (0.9)	50 (4.3)
Treatment centers	NRH	38 (3.2)	173 (14.7)	37 (3.1)	1 (0.1)	9 (0.8)	49 (4.2)	307 (26.1)
	NHC	101 (8.6)	339 (28.9)	46 (3.9)	1 (0.1)	59 (5.0)	85 (7.2)	631 (53.7)
	nhc	13 (1.1)	66 (5.6)	5 (0.4)	0 (0)	8 (0.7)	19 (1.6)	110 (9.4)
	AHC	12 (1.0)	59 (5.0)	6 (0.5)	0 (0)	1 (0)	6 (0.5)	84 (7.2)
	RCC	0 (0.0)	6 (0.5)	0 (0)	0 (0)	2 (0.2)	1 (0.1)	9 (0.8)
	Abdi Clinic	6 (0.5)	19 (1.6)	1 (0.1)	0 (0)	5 (0.4)	2 (0.2)	33 (2.8)
Year	2009	2 (0.2)	26 (2.2)	3 (0.3)	0 (0)	37 (3.1)	14 (1.2)	82 (7.0)
	2010	39 (3.3)	91 (7.7)	19 (1.6)	1 (0.1)	6 (0.5)	28 (2.4)	184 (15.7)
	2011	40 (3.4)	177 (15.1)	26 (2.2)	1 (0.1)	22 (1.9)	62 (5.3)	328 (27.9)
	2012	46 (3.9)	176 (15)	27 (2.3)	0 (0)	11 (0.9)	45 (3.8)	305 (26.0)
	2013	43 (3.7)	192 (16.3)	20 (1.7)	0 (0)	8 (0.7)	13 (1.1)	276 (23.5)
Total		**170 (14.5)**	**662 (56.3)**	**95 (8.1)**	**2 (0.2)**	**84 (7.1)**	**162 (13.8)**	**1,175 (100)**

NRH: Nekemte Referral Hospital; NHC: Nekemte Health Center; AHC: Awash Higher Clinic; nhc: National Higher Clinic; RCC: Red Cross Clinic

Table 3. Factors associated with treatment success rate of TB patients in western Ethiopia, 2009-2013

Variables		Treatment outcome, n (%)		Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
		Success	Failure		
Patient categories	New	762 (64.9)	308 (26.2)	0.574 (0.342-0.965)*	0.676 (0.373-1.22)
	Relapse	7 (0.6)	4 (0.3)	0.813 (0.216-3.065)	3.12 (0.56-17.30)
	Return after default	3 (0.3)	2 (0.2)	0.949 (0.148-6.083)	0.805 (0.118-5.493)
	Transfer in	22 (1.9)	2 (0.2)	0.129 (0.028-0.599)*	0.261 (0.052-1.304)
	other	37 (3.1)	26 (2.2)	1.00	1.00
HIV test result	Reactive	122 (14.7)	79 (23)	1.845 (1.341-2.539)*	1.986 (1.398-2.822)*
	Un recorded	26 (3.1)	24 (7)	2.631 (1.482-4.670)*	2.236 (1.191-4.199)*
	Nonreactive	684 (82.2)	240 (70)	1	1
Year	2009	28 (3.4)	54 (15.7)	11.05 (6.28-19.434)*	11.06 (6.048-20.24)*
	2010	130 (15.6)	54 (15.7)	2.381 (1.504-3.768)*	2.54 (1.576-4.10)*
	2011	217 (26.1)	111 (32.4)	2.932 (1.960-4.387)*	2.637 (1.734-4.012)*
	2012	222 (26.7)	83 (24.2)	2.143 (1.413-3.251)*	2.16 (1.407-3.324)*
	2013	235 (28.2)	41 (12)	1.00	1.00
Sputum smear results at two months	Positive	2 (0.2)	2 (0.2)	8.76 (1.172-65.47)*	4.278(0.104-176.6)
	Not done	646 (55.0)	320 (27.2)	4.34 (2.71-6.951)*	0.399(0.178-0.892)*
	Negative	184 (15.7)	21 (1.8)	1	1
Sputum smear results at five months	Positive	0 (0)	1 (0.1)		
	Not done	661 (56.3)	334 (28.4)	10.8 (5.25-22.213)*	4.75 (1.052-21.495)*
	Negative	171 (14.6)	8 (0.7)	1	1
Sputum smear results at seven months	Positive	0 (0)	1 (0.1)		
	Not done	662 (56.3)	337 (28.7)	17.3 (7.044-42.526)	9.66 (2.04-45.745)*
	Negative	170 (14.5)	5 (0.4)	1	1
Address	Urban	713 (85.7)	291 (84.8)	0.934 (0.656-1.330)	
	Rural	119 (14.3)	52 (15.2)	1.00	
Sex	Male	440 (52.9)	198 (57.7)	1.217 (0.944-1.568)	
	Female	392 (47.1)	145 (42.3)	1.00	
Age range	0-14	67 (8.1)	17 (5.0)	0.465 (0.193-1.124)	
	15-24	286 (34.4)	126 (36.7)	0.808 (0.388-1.683)	
	25-34	217 (26.1)	83 (24.2)	0.701 (0.332-1.481)	
	35-44	130 (15.6)	55 (16)	0.776 (0.359-1.677)	
	45-54	71 (8.5)	31 (9)	0.800 (0.352-1.818)	
	55-64	39 (4.7)	19 (5.5)	0.893 (0.66-2.179)	
	>=65	22 (2.6)	12 (3.5)	1.00	
Form of TB	SPPTB	182 (21.9)	57 (16.6)	0.157 (0.014-1.759)	
	SNPTB	321 (38.6)	146 (42.6)	0.227 (0.020-2.528)	
	EPTB	328 (39.4)	138 (40.2)	0.210 (0.019-2.339)	
	Unrecorded	1 (0.1)	2 (0.6)	1.00	
Treatment center	NRH	211 (25.4)	96 (28)	1.422 (0.619-3.267)	
	NHC	440 (52.9)	191 (55.7)	1.357 (0.601-3.062)	
	nhc	79 (9.5)	32 (9.3)	1.266 (0.517-3.100)	
	AHC	71 (8.5)	13 (3.8)	0.572 (0.212-1.542)	
	RCC	6 (0.7)	3 (0.9)	1.562 (0.316-7.726)	
	Abdi Clinic	25 (3.0)	8 (2.3)	1.00	

*Statistical significance ($p < 0.05$); 1.00: Reference group; SPPTB: smear-positive pulmonary TB; SNPTB: smear-negative pulmonary TB; EPTB: extrapulmonary TB; NRH: Nekemte Referral Hospital; NHC: Nekemte Health Center; AHC: Awash higher clinic; nhc: National Higher Clinic; RCC: Red Cross Clinic

Treatment success rate and its predictors

The overall treatment success rate in the last five years was 70.8%. The success rate showed progressive increases in the last five years. On the other hand, the unsatisfactory treatment success showed a slight increase, from 15.7% in 2009 to 32.4% in 2011, but exhibited a dramatic decline in 2012 and 2013.

In bivariate analysis, forms of TB, patient category, year of treatment, smear result, and follow-up at the second, fifth, and seventh months were significantly associated with treatment success rates. However, address, sex, age range, form of TB, and treatment center were not significantly associated. Controlling the effect of confounding factors, HIV sero-status, year of treatment, sputum conversion rate, and follow-up at the second, fifth, and seventh months were predicator factors that affected the treatment success rate (Table 3).

Discussion

The present retrospective cohort study assessed treatment outcome and its associated risk factors of TB patients in the last five years (2009–2013) in western Ethiopia. A total of 1,175 TB patients were registered in the DOTs program, of which 637 (54.3%) were males. This is consistent with other studies in south Ethiopia [10] and Gambella Regional Hospital [24], in which 55.8% and 54.5% patients were males, respectively, but the rate is contrary to a study done in KollaDiba Health Center and Addis Ababa, where 51.3% [16] and 53.2% [25] of the registered TB patients, respectively, were females.

In agreement with the previous studies conducted in south Ethiopia [10], KollaDiba Health Center [16], Gambella Regional Hospital [24], and Addis Ababa [25], 76.4% of the registered TB patients in this study were in the productive age group. This might indicate the negative impact of TB on the socioeconomic condition of the society.

In this study, EPTB was the prevailing form of TB (39.7%). It was also the dominant (66.1%) form of TB among HIV sero-reactive patients, which is similar to what was found in the study done in Addis Ababa [25], where EPTB accounted for 40.5% of cases, and similar to numbers reported from different parts of the country [27,28].

In the present study, the prevalence of HIV among TB patients was 17.1%, which is higher than that found in previous studies done in the northern part of Ethiopia (11.5%) [14], KollaDiba Health Center 10.9% [16], North Gondar Zone Prison (12.4%) [22], and Enfraz Health Center (11.7%) [23]. However, in the present study, TB-HIV co-infection was lower than that reported from different health centers in Addis Ababa (27.2%) [21], Gondar University Hospital (52.1% [26], and Felege Hiwot Referral Hospital (25%) [15]. The difference between TB-HIV co-infection was partly due to local HIV prevalence difference in different parts of the country.

The overall treatment success rate was 70.8%, which is higher than that reported from studies done in southern Ethiopia (49%) [10] and Gambella Regional Hospital (63.4%) [24], but lower than that reported from studies done in Addis Ababa (82.7%) [25], KollaDiba Health Center (85.6%) [16], Enfraz Health Center (94.8%) [23], nationwide across Ethiopia (85%) [6] , and the average treatment success rate of 22 high burden countries (83%) [29]. This observed difference partly elucidated by high unrecorded rate in south Ethiopia and, high rate of transfer out and unrecorded rate in the present study. The observed progress in the trend of treatment success from 2009 through 2013 in the current study was similar to that found in previous studies in south Ethiopia [10], Addis Ababa [25], and Enfraz Health Center [23]. This progress may be partly explained by the improvements in the diagnosis of the diseases and by the expansion of health institutions.

The overall default rate in the current study was 7.1%, which is higher than the average (6.20%) observed among the 22 high-burden countries [25], but lower than that in a previous study done in Gambella Regional Hospital (22.9%) [24] and the rural households in northwest Ethiopia 10% [30]. The default rate of TB patients decreasing across years in this study was in contrast to that reported from Gambella Regional Hospital [24]. The observable difference in default rate and trend in the study area might be due to the valuable effect of DOTs, an increase in patients' awareness of infectious diseases, satisfaction with the health provider, and expansions of health institutions in the country, which can alleviate the effects of distance on treatment outcomes, as illustrated by previous studies on determinants of defaulter [30-33].

The overall death rate was 8.10% in this study, which is higher than that reported from Addis Ababa (3.70%) [25] and Gambella Region Hospital (3.60%) [24]. In addition, the death rate showed a progressive increase from 0.30% to 1.70% over the study period. The observable difference might be due to a weak smear result follow-up and defaulter tracing mechanism; 44.5% of patients had no smear result

follow-up record in the second, fifth, and seventh months.

In the present study, the controlling effect of confounding factors, HIV sero-status, year of enrollment, sputum conversion rate, and smear result follow-up at the second, fifth, and seventh months were predator factors that affected the treatment success rate. This could be observed by the effect of smear result follow-up on treatment success and the effect of HIV on clinical presentation and prognosis of the TB disease treatment.

Apart from such important findings, this study is not without limitations. As common for secondary-data studies, important variables had not been recorded; smear result follow-up was not recorded in approximately 44.5% of cases, and treatment outcome was not recorded for approximately 4.30% of cases.

Conclusions

The present study showed that treatment outcome of TB patients who received TB treatment at the study area was unsatisfactory because it did not meet the target success rate set by the WHO. The predictors for unsuccessful treatment were HIV sero-status, year of enrollment, and smear result follow-up at the second, fifth, and seventh months. These predictors are in line with the WHO's recommendation for DOTs programs. Thus, continuous follow-up of patients, with frequent supportive supervision during the course of treatment, and provision of early detection and follow-up for patients co-infected with TB-HIV must be strengthened to achieve an effective treatment outcome.

Acknowledgements

The authors would like thank the teams of TB clinic at Nekemte Referral Hospital, Nekemte Health Center, Awash Higher Clinic, National Higher Clinic, Red Cross Clinic, and Abdi Clinic for the help rendered during the study period. Wollega University is also gratefully acknowledged for logistic support for the data collection and process.

Authors' contributions

Eyasu Ejeta, Gebeyaw Arega, Kassahu Ayalsew, Muda Chala, Lensa Tesfaye designed the study, collected data, analysis and drafted the manuscript. Tadesse Birhanu, Haimanot Disassa, and Eyasu Ejeta reviewed and edited the manuscript. All authors read, critically revised, and approved the final manuscript.

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Conflict of interests: No conflict of interests is declared.