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Treatment outcome of tuberculosis patients under directly observed treatment in Addis Ababa, Ethiopia

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ABSTRACT

Background: Tuberculosis is one of the leading causes of mortality among infectious diseases worldwide. For effective tuberculosis control, it is a pre-requisite to detect the cases as early as possible, and to ensure that the tuberculosis patients complete their treatment and get cured. However, in many resource-constrained settings treatment outcome for tuberculosis has not been satisfactory.

Objective: The aim of the study was to assess the treatment outcome of tuberculosis patients and investigate the association of demographic and clinical factors with treatment success of patients enrolled in Directly Observed Treatment Short Course program in government owned health centers over the course of five consecutive years in Addis Ababa, Ethiopia.

Methods: A register based historical cohort study covering the period of July 2004 to June 2009 was conducted to determine the treatment outcome of Directly Observed Treatment Short Course in government owned health centers in Addis Ababa. Sex and age of tuberculosis patients, health center at which the patient was treated, year of treatment, type of tuberculosis for which the patient was treated, type of treatment offered to the patient, follow-up status and documented treatment outcome were extracted from the Directly Observed Treatment Short Course clinics of three randomly selected health centers.

Result: Records of 6450 registered tuberculosis patients ($n = 3147$ males and 3433 females) were included in this document review. Of these patients 18.1% were reported as being cured, 64.6% were documented as treatment completed, 3.7% died during follow-up, 5.1% were reported as defaulters, 0.4% were documented as treatment failure and 8.2% were transferred out to another health institution. Treatment center and year of enrollment were significantly associated with treatment success.

Conclusion: Year of enrollment and treatment center were significantly associated with treatment success. Although the overall treatment success obtained in this study is in line with the World Health Organization (WHO) target, continuous follow-up of patients with frequent supportive supervision during the course of treatment, and further investigate the cause for the observed difference in treatment success across treatment centers are recommended.

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Introduction

Tuberculosis (TB) is a major public health problem throughout the world.[1] According to the 2010 World Health Organization (WHO) Global Health Report there were an estimated 9.4 million incident cases of TB globally.[1] The target set within the context of the Millennium Development Goal (MDGs) is to halt and reverse the incidence of TB by 2015.[2] 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.[3] Over 95% of new TB cases and deaths occur in low and middle-income countries.[4] The highest incidence of TB and the highest number of deaths due to TB occur in Asia and sub-Saharan Africa.[5] The case fatality rate has exceeded 50% in some African countries where HIV infection rates are high.[5,6]

In Ethiopia, a standardized TB prevention and control program incorporating Directly Observed Treatment, Short Course (DOTS) was started as a pilot in 1992, at Arsi zone in Oromia region.[7] Then 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%.[7] According to 2007 WHO's estimates the incidence of TB of all forms and smear-positive TB in Ethiopia stand at 341 and 152 per 100,000 population, respectively.[7]

Even where free medication is available, many patients are not successfully treated for TB.[8,9] Incomplete treatment may result in an extended period of infection, TB resistance to treatment, and lead to increased morbidity and mortality.[10] For the year 2005, the WHO target for treatment success was 85%.[2,11] Ideally, treatment outcome in all patients should be routinely monitored by the epidemiological surveillance system. So far, very few studies have documented treatment outcomes of DOTS in Ethiopia.[12–17] The limitation is that previous research focused on reports collected from Sub-city health offices of the city and subsequently reported to the Federal Ministry of Health, focusing on hospitals. Our research used TB patient record register data in the health centers to determine the factors for treatment success. The aim of the study was to assess the treatment outcome of TB patients and assess the association of demographic and clinical factors with treatment success of patients enrolled in Directly Observed Treatment Short Course (DOTS) program in government owned health centers over the course of five consecutive years in Addis Ababa, Ethiopia.

Methods

Study setting and context

Data for this historical cohort study were extracted from the documentation of government health care settings in Addis Ababa between December 2009 and March 2010. Addis Ababa is the capital city of Ethiopia. In 2007, Addis Ababa had an estimated population of 2.74 million.[18] Administratively, the city is divided into 10 Sub-cities which are in turn divided into 99 kebeles (the smallest government administrative units). The health service delivering institutions in the city comprise 41 hospitals, 169 higher clinics, 146 private medium clinics, and 31 health centers. With the objective of increasing accessibility DOTS program is currently implemented in all health centers in the city.[19]

Study design and selection of health centers

Health service delivery institution-based historical cohort study was conducted in Addis Ababa between December 2009 and March 2010. The objective was to investigate treatment outcomes among TB patients registered in DOTS program. Study participants were all TB patients registered from July 2004 to June 2009 in three randomly selected health centers' DOTS clinic in Addis Ababa. The required information was extracted from TB patients who received care at Teklehaymanot, Selam and Kolfe Heath Centers.

Definition of types of TB and treatment outcome

The registration documents of the DOTS clinic in each heath center contains information about TB patients' age, sex, address, weight, type of TB, Acid-Fast Bacilli (AFB) smear result at baseline, 2nd, 5th and 7th month after treatment initiation, treatment regimen used to treat each patient, date at which treatment was started, date at which treatment was stopped, and treatment outcome. According to the standard definitions of the National Tuberculosis and Leprosy control Program guideline of Ethiopia (NLCP),[7] the following definitions were used for treatment outcome: (a) cured if patients have finished treatment with negative bacteriological result at the end of treatment, (b) treatment completed if patients have finished treatment, but without bacteriological result at the end of treatment, (c) treatment failure if a pulmonary TB patient was smear-positive at five month follow-up despite correct intake of medication, (d) defaulter if the patient interrupted treatment for two consecutive months or more than two months after registration, (e) died if the patient died from any cause during the course of treatment, (f) transferred out if treatment result is unknown due to transfer out to another health facility, and (g) successfully treated if patients were declared "cured" and "completed" treatment as per the protocol.

Three types of TB were considered in this study. The first type was smear-positive pulmonary TB (PTB+) and it was identified if a patient had at least two initial sputum smear examinations positive for AFB by direct microscopy, or one initial smear-positive examination for AFB by direct microscopy and a positive culture, or a patient has 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 (PTB−) and it was characterized by a patient having (1) 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; (2) 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-tuberculosis; or (3) a diagnosis based on a positive culture

for *Mycobacterium tuberculosis* after three initial smear-negative examinations by direct microscopy. The third type was extra-pulmonary TB (EPTB). In this case TB occurs in organs other than the lungs, proven by one positive-culture from specimens of an extra-pulmonary site or histo-pathological 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.

Data collection procedures and quality assurance

Data were extracted from the registers of the selected health centers using a structured data sheet specially designed for this study. Data extraction was conducted by nurse/health officers working at the TB clinic of the selected health centers. Before embarking on the data collection process, all data collectors attended a one-day training provided by the principal investigator on how to fill the structured data collection sheet. To ensure data quality, the following measures were taken: (a) one-day training was given for data collectors before the start of data collection, (b) the overall activities of data extraction were monitored by the principal investigator, and there was strict supervision during data collection, (c) all completed datasets were examined by the principal investigator for completeness during data collection, and (d) from the data extracted from each health center, 5% of the sample was randomly selected and validated against the registration book by the principal investigator.

Main outcome and pre-specified explanatory factors

The main outcome of interest was treatment success of all TB patients. Study participants were categorized as having successful treatment if their record showed that they were cured or they had completed treatment. Otherwise, they were categorized as treatment not successful (i.e. the record showed that the patient was either treatment failure, defaulter, died, or transferred out). The pre-specified independent variables for treatment success were patients' age, sex, type of TB (smear-positive pulmonary TB, smear-negative pulmonary TB, extra-pulmonary TB), patient category at the start of treatment (Category I: new sputum smear-positive, seriously ill new sputum smear-negative, new EPTB, and others; Category II: relapse, failure and return after interruption; Category III: new sputum smear-negative, not seriously ill new EPTB, not seriously ill; Category IV: chronic TB patients defined as smear-positive pulmonary TB patients who had previously received a supervised re-treatment regimen. Transfer-in: TB patients referred in from other health service delivery institutions) and AFB smear-positive pulmonary TB patients result at selected follow-up time points (i.e. at baseline, 2 month, 5 month, and 7 months).

Data management and statistical analysis

The quantitative data extracted from the registration book of patients registered in DOTS program were checked for completeness and consistency by the principal investigator. Data entry and descriptive analysis were carried out using SPSS version 16.0 for Windows (SPSS, Chicago, IL, USA). STATA version 11 was used for simple and multivariate modeling. Descriptive statistical methods were used to generate frequencies for categorical variables and to summarize frequencies using graphical methods. Negative binomial logistic regression analysis was used to investigate the effect of selected risk factors on treatment success. Although logistic regression is the commonly used method to model binary outcome variable, odds ratio obtained from logistic regression is more likely to overestimate the true relative risk. Hence, we have reported incidence rate ratio and its corresponding 95% confidence interval, which was generated from negative binomial logistic regression. In this study any specific variable was not hypothesized as the main risk factor for treatment success. Hence, patient age, sex, treatment center, year of treatment initiation and baseline smear result of the patient were all considered in univariate and multivariate negative binomial logistic regression. Moreover, the effect of treatment category of the patient while starting treatment and sputum smear result at the 2nd, 5th, and 7th month of treatment on treatment success were investigated in bivariate negative binomial logistic regression. Results were reported as being statistically significant if p-value was less than 5%.

Ethical considerations

Ethical clearance for the conduct of this study was obtained from the Institutional Research Ethics Review Board of Aklilu Lemma Institute of Pathobiology, College of Health Sciences, Addis Ababa University (ALIPB AAU) and Addis Ababa City Administration Health Bureau with registration number of AAHB/3088/451. After this approval, the three Sub-cities health offices approved the study. In order to ensure confidentiality of the information, names or identification numbers of TB patients were not included in the data sheet.

Result

Demographic and clinical characteristics of study participants

A total of 6450 (100%) registered TB patients were included in this study, with 3017 (46.8%) patients being male. These patients had a mean, standard deviation and median age of 30.1, 13.7 and 28.0 years, respectively. In total, 1652 (25.6%) were pulmonary positive, 2187 (33.9%) were pulmonary negative, and 2611 (40.5%) were extra-pulmonary TB patients. In terms of treatment categories 5736 (88.9%) were new and 160 (2.5%) were relapse TB patients (Table 1).

Acid fast staining result of registered TB patients during treatment

Of the 1641 (25.4%) pulmonary positive TB patients, 1376 (83.9%) had AFB staining laboratory examination at the 2nd month of treatment. From these 1376 (100%) patients 49 (0.8%) were AFB positive. In addition 1193 (72.7%) of pulmonary positive TB patients had AFB staining examination at the 5th month with 24 (0.4%) being positive. At the 7th month 19 (0.3%)

Table 1 – Characteristics of registered TB patients in Addis Ababa, Ethiopia, March 2010.

Variables	Type of TB			Total number of TB patients *n* (%)
	Pulmonary positive *n* (%)	Pulmonary negative *n* (%)	Extra pulmonary *n* (%)	
Sex				
Male	717 (23.8)	988 (32.7)	1312 (43.5)	3017 (47)
Female	935 (27.2)	1199 (34.9)	1299 (37.8)	3433 (53)
Age categories				
0–14	58 (12.6)	168 (36.6)	233 (50.8)	459 (7.1)
15–24	583 (30.2)	551 (28.5)	798 (41.3)	1932 (30.0)
25–34	534 (26.4)	689 (34.1)	800 (39.5)	2023 (31.4)
35–44	253 (23.7)	390 (36.5)	426 (39.9)	1069 (16.6)
45–54	136 (25.3)	200 (37.2)	201 (37.4)	537 (8.3)
55–64	50 (19.9)	111 (44.2)	90 (35.9)	251 (3.9)
≥65	38 (21.2)	78 (43.6)	63 (35.2)	179 (2.8)
Treatment center				
Teklehaimanot HC	808 (26.9)	1259 (41.9)	935 (31.1)	3002 (46.5)
Selam HC	269 (25.0)	373 (34.6)	436 (40.4)	1078 (16.7)
Kolfe HC	575 (24.3)	555 (23.4)	1240 (52.3)	2370 (36.7)
TB patients category				
New	1450 (25.3)	1907 (33.2)	2379 (41.5)	5736 (88.9)
Relapse	134 (83.8)	14 (8.8)	12 (7.5)	160 (2.5)
Failure	4 (30.8)	5 (38.5)	4 (30.8)	13 (0.2)
Default	6 (50.0)	2 (16.7)	4 (33.3)	12 (0.2)
Transfer in	40 (24.4)	45 (27.4)	79 (48.2)	164 (2.5)
Others	18 (4.9)	214 (58.6)	133 (36.4)	365 (5.6)
Total	1652 (25.6)	2187 (33.9)	2611 (40.5)	6450 (100)

were AFB staining positive out of 1052 (63.6%) pulmonary positive TB patients.

Treatment outcomes

A detailed summary of treatment outcomes of the study participants is presented in Table 2. A total of 6450 tuberculosis patients were analyzed: 1167 (18%) cured, 4164 (64.6%) completed treatment, 2.36 (3.7%) died, 26 (0.4%) were treatment failure, 328 (5.1) defaulted, and 351 (5.4) transferred out. The rates of treatment completion and death were 810 (65.9) and 51 (4.1) in July 2004–June 2005 to 622 (69.7) and 37 (4.1) in July 2008–June 2009. In the same line, defaulting rate decreased drastically from 107 (8.7%) in July 2004–June 2005 to 17 (1.9%) in July 2008–June 2009.

Treatment success rate

Between July 2004 and June 2009 the mean treatment success of all registered TB patients was 82.7% without significant gender effect (84.4% among males and 81.4% among females; p-value > 0.05). The treatment success was 81.4% among pulmonary positive patients, 83.3% among pulmonary negative patients, and 83.1% among extra pulmonary TB patients.

Trend analysis over time: between July 2004 and June 2009

The proportions of smear-positive pulmonary TB (PTB+) patients were less than 30% per year. The proportion of smear-negative pulmonary TB and extra pulmonary TB increased from 2007 onwards whereas smear-positive pulmonary TG had a slight decrement. The trend of treatment success across the years for registered TB patients from July 2004 to June 2009 showed a rise in treatment success rates from 2004 onwards. Again, unsatisfactory TB treatment outcomes (died, failed, and defaulted) across 2004–2009 showed a rise in the rate of death from 2008 onwards and reduction of defaulting rate.

Factors associated with treatment success

Results from negative binomial logistic regression taking treatment success as an outcome of interest is summarized in Table 3.

After adjusting for pre-specified selected risk factors patients were less likely to have treatment success if they were treated in Selam health center (adjusted IRR = 0.76; 95%CI: (0.69–0.83) or Kolfe health center (adjusted IRR = 0.88; 95%CI: (0.82–0.95) compared to patients treated in Teklehaymanot health center. Although the statistical significance was marginal patients registered into DOTS program between July 2004 and June 2005 were more likely to have treatment success compared to patients registered into the DOTS program between July 2005 and June 2006 (Table 3).

Discussion

In this health institution based historical cohort study information was extracted from documents of 6450 registered TB patients; 53.2% of the patients were females. In contrary to this study, previous study in southern Ethiopia documented relatively small proportion of female patients registered for TB

Table 2 – Treatment outcomes of registered TB patients in Addis Ababa, Ethiopia, March 2010.

Variables	Treatment outcome						Total
	Cured *n* (%)	Treatment completed *n* (%)	Died *n* (%)	Treatment failure *n* (%)	Default *n* (%)	Transferred out *n* (%)	
TB patients category							
New	1038 (18.1)	3713 (64.7)	200 (3.5)	13 (0.2)	293 (5.1)	479 (8.3)	5736 (88.9)
Relapse	92 (57.5)	37 (23.1)	4 (2.5)	8 (5.0)	11 (6.9)	8 (5.0)	160 (2.5)
Failure	1 (7.7)	6 (46.2)	1 (7.7)	2 (15.4)	1 (7.7)	2 (15.4)	13 (0.2)
Return after default	4 (33.3)	6 (50.0)	0 (0)	1 (8.3)	0 (0)	1 (8.3)	12 (0.2)
Transfer in	21 (12.8)	101 (61.6)	17 (10.4)	2 (1.2)	8 (4.9)	15 (9.1)	164 (2.5)
Others	11 (3.0)	301 (82.5)	14 (3.8)	0 (0)	15 (4.1)	24 (6.6)	365 (5.6)
Type of TB							
Pul. positive	1071 (64.8)	274 (16.6)	45 (2.7)	22 (1.3)	100 (6.1)	140 (8.5)	1652 (25.6)
Pul. negative	48 (2.2)	1767 (80.8)	79 (3.6)	1 (0)	117 (5.3)	175 (8.0)	2187 (40.0)
Extra pulmonary	48 (1.8)	2123 (81.3)	112 (4.3)	3 (0.1)	111 (4.3)	214 (8.2)	2611 (40.1)
Age category							
0–14	46 (10.0)	346 (75.4)	16 (3.5)	1 (0.2)	17 (3.7)	33 (7.2)	459 (7.1)
15–24	415 (21.5)	1227 (63.5)	35 (1.8)	10 (0.5)	79 (4.1)	166 (8.6)	1932 (30.0)
25–34	385 (19.0)	1302 (64.4)	75 (3.7)	11 (0.5)	101 (5.0)	149 (7.4)	2023 (31.4)
35–44	169 (15.8)	694 (64.9)	48 (4.5)	4 (0.4)	67 (6.3)	87 (8.1)	1069 (16.6)
45–54	91 (16.9)	314 (58.5)	36 (6.7)	0 (0)	38 (7.1)	58 (10.8)	537 (8.3)
55–64	34 (13.5)	165 (65.7)	14 (5.6)	0 (0)	15 (6.0)	23 (9.1)	251 (3.9)
≥65	27 (15.1)	116 (64.8)	12 (6.7)	0 (0)	11 (6.1)	13 (7.3)	179 (2.8)
Treatment center							
Teklehaimanot HC	596 (19.9)	2085 (69.5)	16 (0.5)	6 (0.2)	116 (3.9)	183 (6.0)	3002 (46.5)
Selam HC	161 (14.9)	578 (53.6)	42 (3.9)	1 (0.1)	108 (10)	188 (17.4)	1078 (16.7)
Kolfe HC	410 (17.3)	1501 (63.3)	178 (7.5)	19 (0.8)	104 (4.4)	158 (6.7)	2370 (36.7)
Sex of the patients							
Male	533 (17.7)	2003 (66.4)	101 (3.3)	10 (0.3)	137 (4.5)	233 (7.7)	3017 (46.8)
Female	634 (18.5)	2161 (62.9)	135 (3.9)	16 (0.5)	191 (5.6)	296 (8.6)	3433 (53.2)
Year of treatment							
July 2004–June 2005	154 (12.5)	810 (65.9)	51 (4.1)	7 (0.6)	107 (8.7)	100 (8.1)	1229 (19.0)
July 2005–June 2006	255 (17.7)	811 (56.4)	48 (3.3)	2 (0.1)	131 (9.1)	191 (13.3)	1438 (22.3)
July 2006–June 2007	335 (21.9)	1013 (66.3)	53 (3.5)	7 (0.5)	24 (1.6)	97 (6.3)	1529 (23.7)
July 2007–June 2008	266 (19.5)	908 (66.7)	47 (3.5)	6 (0.4)	49 (3.6)	86 (6.3)	1362 (21.1)
July 2008–June 2009	157 (17.6)	622 (69.7)	37 (4.1)	4 (0.4)	17 (1.9)	55 (6.1)	892 (13.8)
Total	1167 (18)	4164 (64.6)	236 (3.7)	26 (0.4)	328 (5.1)	351 (5.4)	6450

treatment and an exceptionally lower proportion of patients older than 45 years of age.[16] In agreement with the previous study conducted in South Ethiopia,[20] 78% of the registered TB patients in this study were from the productive age group.[15–32] This may indicate negative impact of TB on the socio-economic condition of the society. In this study extra pulmonary TB patients constituted the prevailing form of TB. Extra pulmonary TB is more common in patients with HIV infection.[21,22] Overall, treatment success of registered TB patients in this study was 82.7% which is very high compared to previous finding in South Ethiopia[20] and in Gonder University Teaching hospitals.[16] Possible elucidations for the observed difference between the findings of this study and the previous two Ethiopian studies might be explained by high transfer out in the study of Gonder University hospital[16] and increased number of unrecorded treatment outcome in the study in South Ethiopia.[20] The overall treatment success rate in this study was higher than rates reported by studies conducted in Gondar University Teaching Hospital, Northwest Ethiopia[16] and in the Southern Ethiopia[20] and from the 66% successful treatment outcome in Thailand.[23] However, it was nearly similar to the finding of other two studies in southern Ethiopia.[24,25] It also substantiates the average treatment success (83%) rate of 22 high burden countries.[26]

In the current study the treatment success rate was 84.4% for male pulmonary TB patients and 81.4% for female pulmonary TB patients. Contrary to this finding, in South Ethiopia female smear-positive pulmonary TB (PTB+) patients had significantly higher treatment success (58% versus 54%; p-value = 0.001)[16] which might be showing the actual circumstances of gender difference in the TB epidemiology in the study area.[27,28]

The observed progress in the trend of treatment success from 2006 through 2009 in the current study was similar to the findings of the study in South Ethiopia, in which treatment success for smear-positive TB increased from 38% in 1994 to 56% in 1998, 70% in 1999 and 73% in 2000.[20] This progress may be partly explained by the improvement in the diagnosis of the diseases and partly by the practice of using triple and double FDC drugs which might have provided advantages to supporting adherence and program delivery.[29,30] In agreement with the previous study in southern Ethiopia[20] different treatment success rates among treatment centers were noted in this study. After adjusting for potential confounding variables

Table 3 – Negative binomial logistic regression analysis having treatment success as the outcome of interest. Addis Ababa, Ethiopia, March 2010.

Characteristics	Total number (%) of TB cases examined	Number (%) with treatment success	Crude incident rate ratio (95% CI)	Adjusted incident rate ratio (95% CI)
Age				
0–14	459 (7.1)	392 (85.4)	1.0	1.00
15–24	1932 (29.9)	1642 (85.0)	1.00 (0.89, 1.11)	1.01 (0.90, 1.12)
25–34	2023 (31.4)	1687 (83.4)	0.98 (0.87, 1.09)	0.98 (0.88, 1.10)
35–44	1069 (16.6)	863 (80.7)	0.95 (0.84, 1.07)	0.95 (0.84, 1.07)
45–54	537 (8.3)	405 (75.4)	0.88 (0.77, 1.01)	0.89 (0.77, 1.02)
55–64	251 (3.9)	199 (79.3)	0.93 (0.78, 1.10)	0.92 (0.78, 1.09)
≥65	179 (2.8)	143 (79.9)	0.94 (0.77, 1.13)	0.93 (0.77, 1.13)
Treatment center				
Teklehaimont HC	3002 (46.5)	2681 (89.3)	1.0	1.00
Selam HC	1078 (16.7)	739 (68.6)	0.77 (0.71, 0.83)	0.76 (0.69, 0.83)
Kolfe HC	2370 (36.7)	1911 (80.6)	0.90 (0.85, 0.96)	0.88 (0.82, 0.95)
Year of treatment				
July 2004–June 2005	424 (6.6)	358 (84.4)	1.00	1.00
July 2005–June 2006	1492 (23.1)	1132 (75.9)	0.90 (0.80, 1.01)	0.89 (0.79, 0.99)
July 2006–June 2007	1661 (25.8)	1330 (80.1)	0.95 (0.84, 1.07)	0.94 (0.84, 1.06)
July 2007–June 2008	1405 (21.8)	1234 (87.8)	1.04 (0.92, 1.17)	1.05 (0.93, 1.18)
July 2008–June 2009	1468 (22.8)	1277 (87.0)	1.03 (0.92, 1.16)	1.04 (0.92, 1.16)
Sex				
Male	3017 (46.8)	2536 (84.1)	1.00	1.00
Female	3433 (53.2)	2795 (81.4)	0.97 (0.92, 1.02)	0.97 (0.92, 1.03)
Baseline smear result				
Positive	1641 (25.4)	1342 (81.8)	1.00	1.00
Negative	3129 (48.5)	2670 (85.3)	1.04 (0.98, 1.11)	1.02 (0.95, 1.09)
Not done	1680 (26.1)	1319 (78.5)	0.96 (0.89, 1.04)	1.02 (0.94, 1.11)
Treatment category of the patients				
New	5736 (88.9)	4751 (82.8)	1.00	
Relapse	160 (2.5)	129 (80.6)	0.97 (0.82, 1.16)	
Failure	13 (0.2)	7 (53.9)	0.65 (0.31, 1.36)	
Default	12 (0.2)	10 (83.3)	1.01 (0.54, 1.87)	
Retreatment	164 (2.5)	122 (74.4)	0.90 (0.75, 1.07)	
Other	365 (5.7)	312 (85.5)	1.03 (0.92, 1.16)	
Sputum smear results at 2nd month				
Positive	49 (0.8)	36 (73.5)	1.00	
Negative	1327 (20.6)	1171 (88.2)	1.20 (0.86, 1.67)	
Not done	5074 (78.7)	4124 (81.3)	1.11 (0.80, 1.54)	
Sputum smear results at 5th month				
Positive	24 (0.4)	17 (70.8)	1.00	
Negative	1169 (18.1)	1067 (91.3)	1.29 (0.80, 2.08)	
Not done	5257 (81.5)	4247 (80.8)	1.14 (0.71, 1.84)	
Sputum smear results at 7th month				
Positive	19 (0.3)	13 (68.4)	1.00	
Negative	1033 (16.0)	942 (91.2)	1.33 (0.77, 2.30)	
Not done	5398 (83.7)	4376 (81.1)	1.18 (0.69, 2.04)	

patients treated in Teklehaymanot health center had the best treatment success rate compared with patients treated in Selam or Kolfe health centers. This might be explained by the heterogeneity of service provision among health centers. For example, the quality of follow up of patients on anti-TB treatment under DOTS might be better in Teklehaymanot health center resulting in increased likelihood of better treatment outcome. Some evidence shows that human resources for health (HRH) in TB control is unsatisfactory and there is a significant variability in workload and productivity of staff within and between countries[31] as well major factors contributing to this are patient load, organization of services and Human Resource Management activities, all will be different in different settings.[32]

Like any other study based on secondary data analysis the current study has strengths as well as limitations which need to be noted while interpreting the findings. The main strength of the study is that it was conducted at health centers that represent different level of potential health service coverage in Addis Ababa. Hence, the finding can clearly reflect the treatment outcome of TB patients under DOTS program at the primary health care level in Addis Ababa. One of the major

limitations was that information on co-infection with HIV was not collected and adjusted for. Additionally, the duration of regimen has been changed from 12 months to 9 months then to six months during the study years. However, the health centers did not change treatment regimen at the same time hence it was difficult to compare the effect treatment regimens. The historical data used in this paper was originally collected primarily for reporting purposes. The weakness of this type of data is well known, especially, in low income countries, where the quality of reports are often poor.[11]

Conclusion

The mean treatment success rate of all registered pulmonary TB patients was 82.6% and it was not significantly affected by gender, age and type of TB. However, year of treatment and treatment center were significantly associated with treatment success. During the study period there was significant number of lost to follow-up. Based on this finding it is recommended to implement frequent supportive supervision during the course of treatment, strengthen referral linkage among facilities, and conduct further research to find out the reasons for the observed difference among the DOTS services across treatment centers.

Conflict of interest

The authors declare no conflict of interest.

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REFERENCES

1. WHO. Global tuberculosis control. WHO report; 2010.
2. WHO. Global tuberculosis control. WHO report; 2009.
3. WHO: WHO Tuberculosis Programme: Framework for Effective Tuberculosis Control. Geneva, Switzerland, WHO/TB/94. 179.
4. UNFPA: United Nations Fund Population Activities (UNFPA). Tuberculosis a Global Health Emergency, vol. 17; 2013. p. 199.
5. WHO: WHO. Global Tuberculosis Control.
6. De Cock KMSB, Cooulibaly IM, Lucas SB. Tuberculosis and HIV infection in sub-Saharan Africa. JAMA. 1992;268:1581–7.
7. FMOH: Ministry of Health of Ethiopia: Tuberculosis. Leprosy and TB/HIV prevention and control programme manual. 4th ed. Addis Ababa: MOH; 2008.
8. Romanus V, Blom-Bulow JI, Larsson B, Normann LO, Boman G B. Shortages in Swedish tuberculosis care. Good results only in 71 percent of cases after 12-month treatment as shown in a current study. Lakartidningen. 2000;97:5613–6.
9. Zellweger JP. CP: outcomes of patient's s treated for tuberculosis in Vaud County. Switzerland Int J Tuberc Lung Dis. 1998;2:372–7.
10. Grzybowski SaE. The fate of cases of pulmonary tuberculosis under various treatment programmes. Bull Int Union Tuberc. 1978;53:70–5.
11. WHO: Tuberculosis control programme Resolution WHA44.8. Forty-fourth World Health Assembly. Handbook of resolutions and decisions of the World Health Assembly and the Executive Board, vol. III, 3rd ed. (1985–1992) Geneva: WHO: WHO document WHA44/1991/REC/1; 1993.
12. Getahun BAG, Biadgilign S, Medhin G. Mortality and associated risk factors in a cohort of tuberculosis patients treated under DOTS programme in Addis Ababa. Ethiopia BMC Infect Dis. 2011;16:127.
13. Woldeyohannes DKN, Erku W, Tadesse Z. Ten years experience of directly observed treatment short-course (dots) therapy for tuberculosis in Addis Ababa. Ethiopia Ethiop Med J. 2011;49:221–9.
14. Muñoz-Sellart MCL, Tumato M, Merid Y, Yassin MA. Factors associated with poor tuberculosis treatment outcome in the Southern Region of Ethiopia. Int J Tuberc Lung Dis. 2010;14:973–9.
15. Lindtjørn B. MT: the outcome of tuberculosis treatment at a rural hospital in southern Ethiopia. Trop Doct. 2001;31:132–5.
16. Tessema B, Muche A, Bekele A, Reissig D, Emmrich F, Sack U. Treatment outcomes of tuberculosis patients at Gondar University Teaching Hospital, Northwest Ethiopia. A five-year retrospective study. BMC Public Health. 2009;9.
17. Manuel J, Ramos F. Childhood and adult tuberculosis in a rural hospital in Southeast Ethiopia: a ten-year retrospective study. BMC Public Health. 2010;10.
18. CSA: Summary and Statistical Report of the 2007 Population and Housing Census Results. www.csa.gov.et/pdf/Cen2007_prelimineray.pdf; 2007.
19. FMOH: Federal Ministry of Health. Addis Ababa, Ethiopia: Planning and Programming Department. Health and Health Related Indicators; 2008/09.
20. Estifanos BSaLB. DOTS improves treatment outcomes and service coverage for tuberculosis in South Ethiopia: a retrospective trend analysis. BMC Public Health. 2005;5.
21. Shirasaka T. Diagnosis and treatment of tuberculosis or Mycobacterium avium-intracellulare complex infection in HIV-infected patients. Kekkaku. 2007;82:845–8.
22. Harries AD. MD: TB/HIV: a clinical manual. Geneva: World Health Organisation; 1996.
23. Anuwatnonthakate AL, Nateniyom S, Wattanaamornkiat W, et al. Directly observed therapy and improved tuberculosis treatment outcomes in Thailand. PLoS ONE. 2008;28:8.
24. Shargie EB. Determinants of treatment adherence among smear-positive pulmonary tuberculosis patients in Southern Ethiopia. PLoS Med. 2007;4:e37.
25. Yassin MA, Shargie EB. Ten-year experiences of the tuberculosis control programme in the southern region of Ethiopia. Int J Tuberc Lung Dis. 2006;10:1166–71.
26. WHO: World Health Organization: Global Tuberculosis Control: Surveillance, Planning, Financing. WHO Report 2005 Geneva, World Health Organization. WHO/HTM/TB/2005.49 2005.
27. Wandwalo E, Kapalata N, Egwaga S, Morkve O. Effectiveness of community-based directly observed treatment for tuberculosis in an urban setting in Tanzania: a randomized controlled trial. Int J Tuberc Lung Dis. 2004;8: 1248–54.
28. Balasubramanian RG, Santha T, Gopi PG, et al. Gender disparities in tuberculosis: report from a rural DOTS programme in south India. Int J Tuberc Lung Dis. 2004;8:323–32.
29. Pan FC, Fendrick AM. Impact of fixed-dose combination drugs on adherence to prescription medications. J Gen Intern Med. 2008;23:611–4.

30. Dionisio DGR, McDermott P, Racalbuto V, et al. What strategies to boost production of affordable fixed-dose anti-retroviral drug combinations for children in the developing world? Curr HIV Res. 2007;5:155–87.
31. Kurowski CMA. Estimating human resource requirements for scaling up priority health interventions in low income countries of Sub-Saharan Africa: a methodology based on service quantity, tasks and productivity. Health Economics and Financing Program Working Paper 01/06. London School of Hygiene and Tropical Medicine; 2006.
32. Blok L, Mfinanga SG, Kahwa A, et al. Measuring workload for tuberculosis service provision at primary care level: a methodology. Hum Res Health. 2012;10.