

Retrospective assessment of the status and determinants of tuberculosis treatment outcome among patients treated in government hospitals in North Shoa Administrative Zone, Amhara Regional State, Ethiopia

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Background: One of the specific targets of Directly Observed Treatment, Short-course detailed in the updated Global Plan (2011–2015) was to achieve a treatment success rate of 87% by 2015. This strategy was introduced to Ethiopia in 1995 to reach full coverage in 2005; however, by 2009, treatment had not been as successful as expected.

Objective: This study was conducted to determine treatment success rate and identify risk factors for tuberculosis (TB) treatment outcomes in North Shoa Administrative Zone, Amhara Regional State, Ethiopia.

Methods: A retrospective cohort study was conducted on all TB patients (739) who registered for TB treatment from September 1, 2012 to August 31, 2014 at public hospitals in North Shoa Administrative Zone, Ethiopia. Data were gathered by using a pretested structured medical record checklist. Four data collectors and two supervisors were involved in gathering the data. The data were analyzed using descriptive statistics and logistic regression and were entered into Epi Info and analyzed by using the SPSS software package version 20.

Results: This study revealed that the TB treatment success rate was 86.1% (169 [22.9%] cured and 467 [63.2%] completed). In addition, 22 (3%) of the study participants defaulted their treatment of which 19 (86.4%) withdrew during the intensive phase. The multiple logistic regression model revealed that the study year of treatment, sputum smear positivity at the second-month follow-up, history of treatment default, and subsequent hospitalization were significantly associated with the TB treatment outcome.

Conclusion: The TB treatment success rate in the study area was low compared to that estimated by World Health Organization to achieve by 2015. Therefore, Federal Ministry of Health and Regional and Zonal Health Office have to strengthen the interventions on minimizing anti-TB treatment default rate through well-organized documentation, follow-up on TB patients, and awareness-creation programs.

Keywords: TB, treatment outcomes, risk factors, governmental hospitals, North Shoa, Ethiopia

Introduction

Tuberculosis (TB) is a chronic, necrotizing disease caused by the *Mycobacterium tuberculosis* complex that primarily affects the lungs. It is transmitted through droplet nuclei

that are aerosolized by coughing, sneezing, or speaking.¹ Globally, in 2010, there were 8.8 million incident cases of TB and 1.1 million deaths from TB among HIV-negative people with an additional 0.35 million deaths from HIV-associated TB. Most of the estimated number of cases occurred in Asia (59%) and Africa (26%). Regarding regions of World Health Organization (WHO), the mortality rate was higher in Africa followed by Southeast Asian regions.²

Ethiopia, ranked ninth among the world's 22 TB high burden countries, has been given the highest priority at the global level since 2000.² The statistical data of Ethiopian Federal Ministry of Health hospitals have shown that TB is the leading cause of morbidity, the third cause of hospital admissions (after deliveries and malaria), and the second cause of death in Ethiopia next to malaria.³

The specific target of Directly Observed Treatment, Short-course (DOTS) detailed in the updated Global Plan (2011–2015) was to achieve a treatment success rate (TSR) of 87% by 2015.⁴

During the intensive phase (first 2 months), the patients must collect the drugs daily and should take the medicine under the direct observation of a health worker. First-line treatment of TB in Ethiopia includes rifampicin, ethambutol, isoniazid, pyrazinamide, and streptomycin.³

Globally, in the 2009 cohort, TSR for the 2.6 million new cases of sputum smear-positive pulmonary TB was 87%. However, in the African region, one of the regions that did not meet the target, TSR was 81% despite its steady improvement since 1997.²

Ethiopia did not achieve the goal until 2009. In Ethiopia, the National Tuberculosis and Leprosy Control Programme introduced the DOTS strategy in 1995. Despite reaching full coverage in 2005, TSR was only 84% in 2009.²

Despite the global efforts to combat TB, the low TSR in Africa, especially in the sub-Saharan countries like Ethiopia, is intrinsically related to non-completion of treatment due to several factors, especially death and default.^{5,6}

The sociodemographic and economic status of TB patients has an impact on TB treatment outcomes. Studies showed that men were more likely to have a poor treatment outcome than women.^{7–12} In addition, age (40+ years) was a risk factor for unsuccessful TB treatment outcome.^{10,13–16} Also, low educational level was a risk factor for not to be cured¹⁷ and being default.¹⁸ Similarly, unemployment was a risk factor for unsuccessful treatment outcome.¹³

On the other hand, previous studies^{10,14,15} evidenced that treatment compliance was a major factor for TB treatment outcomes. History of default was a significant factor to have

unsuccessful treatment outcome.^{10,14,15} In addition, patients who were on retreatment were more susceptible for poor TB treatment outcomes.^{16,17,19}

Furthermore, subsequent hospitalization, comorbidity (HIV, liver disease, lung cancer, and others),^{7,12,16–18} having a treatment observer,¹⁷ having a positive smear at the second-month follow-up, and having smear-negative pulmonary TB,¹⁴ and family size¹³ were identified as significant factors for unsuccessful TB treatment outcomes.

Therefore, this study focused on investigating the status of TB treatment outcome rate and associated risk factors in North Shoa Administrative Zone, Amhara Regional State, Ethiopia.

Materials and methods

Study design and population

A retrospective cohort study design was used to conduct this study. The study population was all TB patients who were treated for TB in the public hospitals in North Shoa Administrative Zone from September 1, 2012 to August 31, 2014. This study included all TB-treated patients who had a complete document at the public hospitals in North Shoa Administrative Zone, Amhara Regional State, Ethiopia. The capital city of North Shoa Administrative Zone, Debre Berhan, is located on the northeastern part of Ethiopia, which is 130 km away from the capital city of Ethiopia, Addis Ababa. The population of North Shoa Administrative Zone was estimated to be 2.02 million.

Sampling procedure, data collection tools, and procedure

A retrospective assessment of the profile and treatment outcomes of all TB patients (739) who registered from September 1, 2012 to August 31, 2014 at the DOTS clinic in three public hospitals was conducted.

The data were collected from patients' routine records, including basic clinical and demographic information, directly observed therapy provider type, history of previous treatment, treatment adherence, adverse reactions, and retrieval actions. The data were gathered by using a pretested structured medical records checklist, which was adopted from previous literature.^{3,10,13,19} The data were collected by four trained BSc senior healthcare providers and two trained Masters of Public Health (MPH) supervisors. The field record checklists were checked on a daily basis for completeness.

Data processing and analysis

The collected data were coded and double entered into Epi Info and were analyzed by using the SPSS software package

version 20. Descriptive statistics was used to present the different characteristics of the study variables. Odds ratio (OR) and 95% confidence interval (CI) were calculated by using the multivariate logistic regression analysis to identify the independent risk factors for TB treatment outcomes (success or failure). The variables were included in the multivariate analysis when the *P*-values were <0.2 in the bivariate analysis. *P*-values <0.05 were considered as statistically significant.

Ethical consideration

This study was approved by the research review committee of College of Medicine and Health Sciences, Debre Berhan University. Permission to conduct the study was obtained from Debre Berhan Referral Hospital (DBRH), Mehal Meda Hospital, and Ataye Hospital. During document review, codes were used and anonymity was assured. According to the research review committee of College of Medicine and Health Sciences, written consent was not required as confidentiality and anonymity were strictly maintained. The study could cause no harm to the study participants.

Results

Sociodemographic characteristics of the respondents

A total of 739 patients who were treated for TB at the three public hospitals (Ataye, Debre Berhan, and Mehal Meda) were included in this study. More than half of the study participants were male, married, and urban residents (398 [53.9%], 415 [56.1%], and 439 [59.4%], respectively). Majority of the study participants were orthodox and unemployed (638 [86.3%] and 531 [71.9%], respectively) (Table 1).

TB disease-related conditions of patients

Of the 739 study participants, 430 (58.2%) and 309 (41.8%) were patients who were treated for TB at the period of September 2012 to August 2014 respectively. In addition, 349 (47.2%) of the study participants were from DBRH. Four hundred and ninety-five (67%) of the patients were smear negative at treatment initiation and pulmonary TB accounts 598 (80.9%), (sputum smear positive [SS+] 214 [29%] and 368 [49.8%]), of the study participants. Extra pulmonary TB account 129 (17.5%) includes lymph system, pleura, bone/spine/joint, disseminated, abdominal, and pericardiac. Only 19 (2.6%) of the study participants had a positive smear test at second months of the treatment (Table 2).

Table 1 Sociodemographic characteristics of tuberculosis patients who were treated from September 2012 to August 2014 at public hospitals of North Shoa Zone, Amhara Regional State, Ethiopia

Variable	Category	Frequency (N)	Percentage
Sex	Male	398	53.9
	Female	341	46.1
Age (years)	≤20	158	21.4
	21–30	223	30.2
	31–40	125	16.9
	41+	233	31.5
Marital status	Single	268	36.3
	Married	415	56.1
	Divorced	45	6.1
	Widowed	11	1.5
Ethnicity	Amhara	670	90.7
	Oromo	64	8.7
	Other	5	0.7
Residence	Urban	439	59.4
	Rural	300	40.6
Educational status	Cannot read and write	117	15.8
	Read and write, not formal	68	9.2
	1–8 elementary	113	15.3
	Secondary and above	106	14.3
Occupation	Not known	335	45.3
	Employed	208	28.1
	Unemployed	531	71.9
Religion	Orthodox	638	86.3
	Muslim	89	12.0
	Other	12	1.7
Family size	One	106	14.3
	Two	214	29.0
	Three	170	23.0
	Four or more	249	33.7

HIV/antiretroviral therapy (ART), substance use, and other related characteristics of patients

One hundred and fifty-five (21%) of the study participants were HIV positive, of which 99 (63.9%) were taking ART. According to the findings of this study, 46 (6.1%) of the study participants were subsequently hospitalized. On the other hand, 728 (98.5%) participants had a supporter when they were taking anti-TB treatment. Concerning substance use, only 11 (1.5%), 61 (8.3%), and 40 (5.4%) were smokers, khat chewers, and alcohol drinkers, respectively (Table 3).

TB treatment outcome, defaulting, and drug side effects

According to this study, 636 (86.1%) of the study participants completed the TB treatment successfully. Among these, 169

Table 2 TB-disease related conditions of patients who were treated from September 2012 to August 2014 in North Shoa Zone, Amhara Regional State, Ethiopia

Variables	Category	Frequency (N)	Percentage
Year of treatment initiation	2006	430	58.2
	2007	309	41.8
Health facility name	Debre Berhan Referral Hospital	349	47.2
	Ataye Hospital	220	29.8
	Mehal Meda Hospital	170	23.0
Sputum smear result at treatment initiation	Smear negative	495	67.0
	Smear positive	227	30.7
	Not known	17	2.3
TB contracted history	Present	50	6.8
	Absent	309	41.8
	Missed	380	51.4
TB type or disease classification	EPTB	129	17.5
	PTB	598	80.9
	Not known	12	1.6
Type of PTB	SS+	214	29.0
	SS-	368	49.8
	Not known	157	21.2
Site of EPTB	Lymph system	70	9.5
	Pleural	15	2.0
	Bone/spine/joint	21	2.8
	Disseminated	18	2.4
	Abdominal	8	1.1
	Pericardiac	11	1.5
Sputum smear positivity at the second-month follow-up	Yes	19	2.6
	No	694	93.9
	Not known	26	3.5

Abbreviations: TB, tuberculosis; EPTB extra pulmonary tuberculosis; PTB, pulmonary tuberculosis; SS+, sputum smear positive; SS-, sputum smear negative.

Table 3 HIV/ART, substance use, and other related characteristics of patients who were treated for TB from September 2012 to August 2014 in North Shoa Zone, Amhara Regional State, Ethiopia

Variables	Category	Frequency (N)	Percentage
HIV status	Positive	155	21.0
	Negative	584	79.0
ART status	No	584	79.0
	CPT	26	3.5
	ART	99	13.4
	Pre-ART	30	4.1
Subsequent hospitalization	Yes	46	6.2
	No	693	93.8
Availability of supporter	Yes	728	98.5
	No	11	1.5
Cigarette smoking on treatment initiation	Yes	11	1.5
	No	728	98.5
Khat chewing on treatment initiation	Yes	61	8.3
	No	678	91.7
Alcohol use on treatment initiation	Yes	40	5.4
	No	699	94.6

Abbreviations: ART, antiretroviral therapy; TB, tuberculosis; CPT, co-trimoxazole preventive therapy.

(22.9%) were cured and 467 (63.2%) completed. Concerning the history of treatment defaulting, 22 (3%) participants defaulted. Majority of them (19 [2.6%]) interrupted during the intensive phase. In addition, 554 (75%) had a history of

treatment compliance. Ten (1.4%) participants had severe drug side effects during the TB treatment (Table 4).

Factors associated with TB treatment outcome

To note the effect of independent variables on the dependent variable (TB treatment outcomes), the bivariate logistic regression analysis was carried out. The crude analysis included sociodemographic variables, year of TB treatment, TB disease-related variables, HIV and ART status, treatment compliance, defaulting, and other related variables.

On the bivariate analysis, year of treatment, TB contracting history, TB type or disease classification, sputum smear positivity at the second-month follow-up, HIV status, ART status, history of treatment default, and subsequent hospitalization had a significant association with TB treatment outcome. The variables with P -value <0.2 in the bivariate analysis were included in the multivariate logistic regression analysis to control the confounding effect of the different variables on the dependent variables.

The multivariate analysis was employed to assess the net effect of the variables. The results of multiple logistic regression model revealed that the year of treatment, sputum smear

Table 4 TB treatment outcome, defaulting, and drug side effects of patients who were treated from September 2012 to August 2014 in North Shoa Zone, Amhara Regional State, Ethiopia

Variables	Category	Frequency (N)	Percentage
TB treatment outcome	Succeeded	636	86.1
	Failed	103	13.9
TB treatment outcome detail	Cured	169	22.9
	Treatment completed	467	63.2
	Defaulted	22	2.98
	Failed	6	0.8
	Died	28	3.8
	Transferred in	7	0.9
	Transferred out	28	3.8
	Not known	12	1.6
	History of default on treatment	Yes	22
	No	717	97.0
Defaulted in terms of phase	Intensive phase	19	2.6
	Continuation phase	10	1.4
	No interruption	702	95.0
	Not known	8	1.1
Compliance on duration of treatment	Yes	554	75.0
	No	185	25.0
Occurrence of severe drug side effects during TB treatment time	Yes	10	1.4
	No	729	98.6

Abbreviation: TB, tuberculosis.

positivity at the second-month follow-up, history of treatment default, and subsequent hospitalization were significantly associated with the TB treatment outcome (Table 5).

Discussion

This study revealed that TB TSR for the period of September 2012–August 2014 at the public hospitals of North Shoa Administrative Zone, Amhara Regional State, Ethiopia, was 86.1% (169 [22.9%] cured and 467 [63.2%] completed). This finding is not in line with the WHO updated Global Plan to Stop TB (2011–2015).⁴ This study's finding was also lower than the study finding in Enfraz Health Center, Northwest Ethiopia, which was 94.8%.¹⁹ But, TSR of this study was similar to another study finding in Northwest Ethiopia, which was (85.6%),²⁰ and higher than that in Nigeria, which was (76.6%).⁹ This difference could be due to the time gap between the studies that had been conducted and the sociodemographic differences.

With regard to the history of treatment defaulting, 22 (3%) of the study participants defaulted. Majority of them (19 [2.6%]) interrupted during the intensive phase. This study's

finding was higher than the study finding in Northwest Ethiopia at Enfraz Health Center, which was (1.2%),¹⁹ but it was lower than another study finding in Dembia District, Northwest Ethiopia, which was 3.5%.²⁰

In this study, the death rate was 3.5%, which was similar to the study finding in Northwest Ethiopia at Enfraz Health Center and Dembia District, which were 3.4% and 3.3%, respectively.^{19,20} But, this study's finding was higher than the study finding in Ibadan, Nigeria, (1.9%).⁹ The TB treatment failure rate of this study was 0.8%, which was higher than the study finding in Northwest Ethiopia at Enfraz Health Center (0.5%)¹⁹ and was lower than the study finding in Ibadan, Nigeria, (8.1%).⁹ Those differences in TB treatment outcome could be due to different study periods, geographical differences, or sociodemographic and economic conditions. Besides, the effort of the urban and rural health extension workers in the follow-up of these TB patients in their working areas had its own effect on those differences.

In general, the multiple logistic regression model revealed that the year of treatment, sputum smear positivity at the second-month follow-up, history of treatment default, and subsequent hospitalization were significantly associated with the TB treatment outcome.

Those TB patients who were treated from September 2013 to August 2014 were 3.7 times more likely to be successful than those TB patients who were treated from September 2012 to August 2013 (adjusted OR [AOR], 3.723; 95% CI, 2.022–6.857). This might be due to the low default rate and some improvement in the healthcare system and use of technologies like mobile phones for communication.

This study revealed that those TB patients who had no history of treatment default were ~82 times more likely to be successfully treated than those who had a history of anti-TB treatment default (AOR, 81.98; 95% CI, 20.49–327.99). This is in line with the findings of studies in Northeastern Thailand, Brazilian Amazon, and Nairobi, Kenya.^{12,16,18} This high odds ratio with a *P*-value of <0.0001 indicates that there is a strong association between anti-TB treatment default and its outcomes, because defaulting the anti-TB treatment may decrease the effectiveness of drugs and develop the resistance by *M. tuberculosis* in the patients.

The study also revealed that the TB patients who had no history of subsequent hospitalization were 6 times more likely to be successfully treated than those who had a history of subsequent hospitalization (AOR, 6.072; 95% CI, 2.77–13.33). This might be due to the root reasons for the subsequent hospitalization which those patients subsequently hospitalized during the anti-TB treatment. But, they may

Table 5 Factors associated with TB treatment outcome among patients who were treated from September 2012 to August 2014 at public hospitals in North Shoa Zone, Amhara Regional State, Ethiopia

Variables	TB treatment outcome		Crude OR (95% CI)	Adjusted OR (95% CI)
	Success	Failed		
Time of treatment				
September 2012 – August 2013	347	83	1	1
September 2013 – August 2014	289	20	3.456 (2.070–5.771)***	3.723 (2.022–6.857)***
TB type				
EPTB	118	11	1	
PTB	517	81	0.595 (0.31–1.152)	
Not known	1	11	0.008 (0.001–0.072)***	
Sputum smear positivity at the second-month follow-up				
Yes	13	6	1	1
No	613	81	3.493 (1.292–9.444)**	8.812 (2.836–27.379)***
Not known	10	16	0.288 (0.083–1.006)	1.024 (0.222–4.719)
HIV status				
Positive	121	34	1	
Negative	515	69	2.1 (1.33–3.31)**	
ART status				
Not HIV+	516	68	8.67 (4.05–18.55)***	
CPT	20	6	3.81 (1.19–12.16)*	
ART	86	13	7.56 (3.0–19.06)***	
Pre-ART	14	16	1	
History of treatment default				
Yes	3	19	1	1
No	633	84	47.73 (13.83–164.72)***	81.98 (20.49–327.99)***
Subsequent hospitalization				
Yes	30	16	1	1
No	606	87	3.72 (1.95–7.10)***	6.072 (2.77–13.33)***

Notes: Hosmer–Lemeshow test P -value = 0.956. * $P < 0.05$, ** $P < 0.01$, and *** $P < 0.001$.

Abbreviations: ART, antiretroviral therapy; CI, confidence interval; OR, odds ratio; TB, tuberculosis; EPTB extra pulmonary tuberculosis; PTB, pulmonary tuberculosis; CPT, co-trimoxazole preventive therapy.

have other medical problems and their treatment compliance is under question.

This study also identified that those TB patients who had a negative smear at the second-month follow-up were about 9 times more likely to be successfully treated for TB than those who had smear-positive pulmonary TB (AOR, 8.812; 95% CI, 2.836–27.379). This finding is similar to the finding of the study conducted in the southern region of Ethiopia.¹⁴ This indicates that the anti-TB treatment is more effective in treating those patients who had negative smear at the second-month follow-up.

In this study, age of patients, educational status, occupational status, TB type/classification, side effects of drug, TB–HIV coinfection, and ART status were not statistically significantly associated with the anti TB treatment outcomes. Similarly the study conducted in the Tigray Region among pulmonary TB patients showed that the TB treatment outcomes had no statistically significant association with the HIV status among the TB patients. What is more is, it is not statistically significant with the TB treatment success where 88.1% and 78.1% on HIV negative and positive TB patients

respectively. The poor outcome among HIV–TB coinfecting patients could be due to the inadequate immune response to control the infection and delay in diagnosis and getting treatment.^{21,22}

Conclusion

TB TSR in North Shoa Administrative Zone was low. The default rate specifically in the intensive phase of the TB treatment (the first 2 months), on which the DOTS program was implemented, was the main reason for low TB treatment outcomes. The variables such as year of treatment, sputum smear positivity at the second-month follow-up, history of treatment default, and subsequent hospitalization were significantly associated with the TB treatment outcome. To improve TB TSR, it is required to enhance supportive supervision and monitoring mechanisms, counsel during the intensive and continual phases of treatment, strengthen home visits (defaulter tracing), and motivate patients and their supporters through providing health education to reduce treatment interruption. Moreover, further studies, using a prospective study design, focusing on the molecular structure

of TB bacillus, which may be responsible for the TB treatment outcomes, in addition to the sociodemographic, environmental, psychosocial, and physiological variables are warranted.

Limitations

The source of information for this study was secondary data from TB logbook and other routine medical records of the patients. Incomplete data and some missing variables like infected strain or genotypes of TB bacillus, lack of knowledge about treatment, annual income, and distance to travel to get treatment were the limitations during document review.

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Author contributions

All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

References

- Fauci A, Braunwald E, Kasper D, et al. *Harrison's Manual of Medicine*. 17th ed. 2009:538–539. New York: McGraw-Hill Companies, Inc.
- World Health Organization. *Global Tuberculosis Control: WHO Report 2011*. Geneva: World Health Organization; 2011:258.
- Federal Ministry of Health of Ethiopia (FMOH). *Tuberculosis, Leprosy and TB/HIV Prevention and Control Program Manual*. 4th ed. Addis Ababa: FMOH; 2008.
- World Health Organization. *The Global Plan to Stop TB 2011–2015*. Geneva: World Health Organization; 2010. Available from: http://www.stoptb.org/assets/documents/global/plan/TB_GlobalPlanTo-StopTB2011-2015.pdf. Accessed April 10, 2017.
- World Health Organization. *Global Tuberculosis Control: WHO Report 2010*. Geneva: World Health Organization; 2010.
- Lonnroth K, Castro KG, Chakaya JM, et al. Tuberculosis control and elimination 2010–50: cure, care, and social development. *Lancet*. 2010;375(9728):1814–1829.
- Chan-Yeung M, Noertjojo K, Leung CC, Chan SL, Tam CM. Prevalence and predictors of default from tuberculosis treatment in Hong Kong. *Hong Kong Med J*. 2003;9(4):263–268.
- Daniel OJ, Oladapo OT, Ogundahunsi OA, Fagbenro S, Ogun SA, Odusoga OA. Default from anti-retroviral treatment programme in Sagamu, Nigeria. *Afr J Biomed Res*. 2008;11(2):221–224.
- Fatiregun AA, Ojo AS, Bamgboye AE. Treatment outcomes among pulmonary tuberculosis patients at treatment centers in Ibadan, Nigeria. *Ann Afr Med*. 2009;8(2):100–104.
- Tessema B, Muche A, Bekele A, Reissig D, Emmrich F, Sack U. Treatment outcome of tuberculosis patients at Gondar University Teaching Hospital, Northwest Ethiopia. A five-year retrospective study. *BMC Public Health*. 2009;9:371.
- Jha U, Satyanarayana S, Dewan P, et al. Risk factors for treatment default among re-treatment tuberculosis patients in India, 2006. *PLoS One*. 2010;5(1):e8873.
- Mutire BN, Keraka MN, Kimuu PK, Kabiru EW, Ombeka VO, Oguya F. Factors associated with default from treatment among tuberculosis patients in Nairobi province, Kenya: a case control study. *BMC Public Health*. 2011;11(1):696.
- Berhe G, Enquessellie F, Aseffa A. Treatment outcome of smear-positive pulmonary tuberculosis patients in Tigray Region, Northern Ethiopia. *BMC Public Health*. 2012;12:537.
- Munoz-Sellart M, Cuevas LE, 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;14:973–979.
- Farah MG, Tverdal A, Steen TW, Heldal E, Brantsaeter AB, Bjune G. Treatment outcome of new culture positive pulmonary tuberculosis in Norway. *BMC Public Health*. 2005;5:14.
- Anunnatsiri S, Chetchotisakd P, Wanke C. Factors associated with treatment outcomes in pulmonary tuberculosis in northeastern Thailand. *Southeast Asian J Trop Med Public Health*. 2005;36(2):324–330.
- Ai X, Men K, Guo L, et al. Factors associated with low cure rate of tuberculosis in remote poor areas of Shaanxi Province, China: a case control study. *BMC Public Health*. 2010;10(1):112.
- Garrido Mda S, Penna ML, Perez-Porcuna TM, et al. Factors associated with tuberculosis treatment default in an endemic area of the Brazilian Amazon: a case control-study. *PLoS One*. 2012;7(6):e39134.
- Endris M, Moges F, Belyhun Y, Woldehana E, Esmael A, Unakal C. Treatment outcome of tuberculosis patients at Enfraz Health Center, Northwest Ethiopia: a five-year retrospective study. *Tuberc Res Treat*. 2014;2014:726193.
- Beza MG, Wubie MT, Teferi MD, Getahun YS, Bogale SM, Tefera SB. A five years tuberculosis treatment outcome at Kolla Diba Health Center, Dembia District, Northwest Ethiopia: a retrospective cross-sectional analysis. *J Infect Dis Ther*. 2013;1(1):101.
- Lai RPI, Meintjes G, Wilkinson RJ. HIV-1 tuberculosis-associated immune reconstitution inflammatory syndrome. *Semin Immunopathol*. 2016;38(2):185–198.
- Walker NF, Meintjes G, Wilkinson RJ. HIV-1 and the immune response to TB. *Future Virol*. 2013;8(1):57–80.

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